Department of Mechanical Engineering

In the Department of Mechanical Engineering (MechE), we are makers and innovators, embodying the MIT motto *mens et manus* (mind and hand)—as well as "heart"—through uncompromising analysis, hands-on discovery, and an unrelenting passion for what we do.

Innovation and a passion for making are the cornerstones of our department. These qualities allow our faculty and students to transform insights and discoveries into progress that carries the potential to change lives for the better.

Our faculty conduct fundamental research and develop innovative tools to address the grand challenges of today and tomorrow in the areas of health, the environment, innovation, energy, and security.

To meet these challenges, we coordinate research in the department across seven collaborative disciplinary areas: mechanics (modeling, experimentation, and computation); design, manufacturing, and product development; controls, instrumentation, and robotics; energy science and engineering; ocean science and engineering; bioengineering; and micro- and nano-engineering.

Creativity and innovation fuel our research, but they also imbue our classrooms. Our students learn by doing, experiencing a level of understanding that can occur only through creation. They receive not only a rigorous academic education but also first-hand experience and exposure to cutting-edge research.

Led by Professor Sanjay Sarma, dean of digital learning, we are "flipping the classroom" to bring web-based learning technologies to our students and spend classroom time on the type of hands-on education that is so fundamental to the MechE curriculum. We were one of the first departments at MIT to offer our classes as massive open online courses (MOOCs) as part of the online edX platform.

Every year, we attract and enroll top-notch mechanical engineering students. Both our undergraduate and graduate programs continue to thrive, illustrating a sustained and broad interest in mechanical engineering; 586 undergraduate and 552 graduate students were enrolled during AY2015, for a grand total of more than 1,100 students. Our research programs incorporate a growing postdoctoral population of approximately 120 fellows and associates.

In this year's report, we provide snapshots of departmental news and contributions over the past year, including a short synopsis of faculty news (hires, promotions, and deaths); selected research highlights across the department; education highlights, with brief overviews of our undergraduate and graduate programs; and finally awards and recognition.

Faculty

We are very pleased to announce the hiring of Dr. Betar Gallant as an assistant professor as well as the promotions of Rohit Karnik, Kripa Varanasi, and Maria Yang from the rank of associate professor without tenure to associate professor with tenure and the promotion of Xuanhe Zhao from assistant professor to associate professor. Each of them brings unique expertise to the department and the Institute in terms of individual achievements and contributions to research, education, mentorship, and service.

New Faculty

Professor Betar Gallant received her SB, SM, and PhD degrees in 2008, 2010, and 2013, respectively, from the MIT Department of Mechanical Engineering, where she conducted her PhD research in the Electrochemical Energy Lab with Professor Yang Shao-Horn. She worked as a Kavli Nanoscience Institute Postdoctoral Fellow at the California Institute of Technology with Professors Nathan Lewis in the Department of Chemistry and collaboratively with Professor Julia Greer in the Department of Materials Science and Mechanics. Betar has performed research on a range of electrochemical energy technologies and materials, worked at the US Department of Energy on energy program development, and was involved in a number of entrepreneurial energy-related activities while at MIT, including serving as a managing director of the MIT Clean Energy Prize competition. Her research interests include using electrochemistry as a tool to manipulate energy conversion pathways, explore spaces for new materials synthesis, and enable fabrication of efficient and scalable devices. Betar begins as an assistant professor in January 2016.

Faculty Promotions

Professor Rohit Karnik is a leading international researcher in the interdisciplinary field of microfluidics/nanofluidics. His group has made a number of seminal contributions in the fundamental understanding of nanoscale fluid transport. He invented a new vapor-membrane separation concept for desalination and demonstrated the concept experimentally, discovered xylem's potential for water filtration, and established graphene as a serious candidate for gas and ion separation. He explored cell rolling due to weak and transient cell-surface interactions and subsequently developed a cell separation technology, and he demonstrated white blood cell separation from whole blood with minimal sample preparation. Rohit has been recognized with a National Science Foundation (NSF) CAREER award, a Department of Energy Early Career Award, and five best paper awards from different conferences. He has also received the Keenan Award for Innovation in Undergraduate Education and the IIT Bombay Young Alumni Achiever Award. Rohit is an excellent educator and has provided dedicated service to the department.

Professor Kripa Varanasi is an international leader in the field of surface engineering. His activities are embodied in an interdisciplinary research framework focused on nano-engineered surfaces and interfaces, thermal science, and new materials discovery combined with scalable nanomanufacturing that has impacted multiple industrial segments. Kripa synthesizes ideas from materials chemistry, nanofabrication, hydrodynamics, and tribology to develop unique patterned and textured surfaces that have unprecedented ability to control the wettability and motion of liquids that come in contact with them. He has made major contributions to the understanding of phase change, dynamic wetting, and drop impact phenomena for nanostructured surfaces and to the creation of lubricant-impregnated surfaces and hydrophobic ceramics. Kripa has been honored with numerous awards including an NSF CAREER Award, a Defense Advanced Research Projects Agency Young Faculty Award, the American Society of Mechanical Engineers (ASME) Bergles-Rohsenow Young Investigator Award in Heat Transfer, and the Society of Manufacturing Engineers Outstanding Young Manufacturing Engineer Award. He is also a dedicated educator and mentor who has made strong contributions in teaching core subjects in thermal-fluids engineering in the MechE undergraduate curriculum.

Professor Maria Yang is an established leader in the design theory community through her pioneering and foundational study of early-stage design processes. Early-stage conceptual design plays a dominant role in determining the functional performance as well as manufacturing cost of a final product. Through systematic experiments and analysis, Professor Yang quantifies how informal design representations drive early-stage design processes and outcomes and influence the way a team engages in the process of design. Maria is also an inspirational teacher and a caring mentor and advisor. She has been recognized with numerous awards and honors, including an NSF CAREER Award, the American Society for Engineering Education Merryfield Design Award, the MIT Murman Award for Mentoring, the MIT Ruth and Joel Spira Excellence in Teaching Award, the MIT Capers and Marion McDonald Award for Excellence in Mentoring and Education, and the ASME Design Theory and Methodology Conference Best Paper Award. She was elected as an ASME Fellow in 2013.

Associate Professor Xuanhe Zhao is a leader in the emerging field of soft-matter mechanics, with a focus on understanding and designing soft materials with extraordinary properties and functions such as active polymers that may replace muscles and hydrogels tougher than cartilages. His research has uncovered failure mechanisms for soft dielectrics, revealed a new understanding of various modes of surface instabilities, and established a multiscale, multimechanism design for soft tough materials. He has developed the toughest synthetic hydrogel and the toughest bonding of hydrogel to diverse solid materials, enabling robust hydrogel coatings, adhesives, matrices, and devices. Xuanhe's work has been recognized with several prestigious awards, including an NSF CAREER Award, an Early Career Researcher Award from the AVS Biomaterial Interfaces Division, an Office of Naval Research Young Investigator Award, and a Journal of Applied Mechanics Award from ASME. He is the associate editor-in-chief for *Acta Mechanica Sinica* and serves on the editorial boards of *Nature Scientific Reports* and the *International Journal of Applied Mechanics*. He was a Hunt Faculty Scholar at Duke University and holds the Robert N. Noyce Career Development Professorship.

Faculty Deaths

James A. (Jay) Fay, a professor emeritus in the Department of Mechanical Engineering, passed away June 2, 2015, of complications from lymphoma. He was 91.

Professor Emeritus Fay grew up in Brooklyn, NY, but spent his summers in Southold, close to the waters of the Long Island Sound. This motivated his lifelong interest in sailing and led him to earn a BS at the Webb Institute of Naval Architecture in 1944. Subsequently, he obtained an SM from MIT in marine engineering and a PhD from Cornell University in the unsteady propagation of gaseous detonation waves. After serving on the Cornell faculty from 1951 to 1955, he was recruited to join MIT as an associate professor in MechE, where he remained until transitioning to emeritus professor status in 1989.

Figure 1. James A. (Jay) Fay

The hallmark of Professor Emeritus Fay's success as an innovator and contributor was listening carefully and crystallizing the essence of a discussion. Having reached that point, he was committed to seeing a process through to the appropriate conclusion. His early career work on combustion and detonation, hypersonic heat transfer, magnetohydrodynamics, and plasmadynamics played a key role in his election to the National Academy of Engineering in 1998.

Professor Emeritus Fay served the Commonwealth of Massachusetts from 1972 to 1977 as chairman of the Massachusetts Port Authority (Massport). Under his leadership, Massport transitioned into a sleeker, more environmentally aware public-serving entity. He played key roles in no fewer than 20 environmental organizations and panels that sought to develop public policy in a new world threatened with pollution and environmental hazards. This included 46 years of service as a director of the Union of Concerned Scientists seeking to ameliorate the threat of nuclear catastrophe. His reasoned and thoughtful scientific approach to these problems was critically important in building credibility for public examination of our approach to environmental threats.

Research Highlights

Our faculty are innovators and problem solvers, always with an eye toward developing technologies that will make the world a better place. As noted above, they are focused on five major global challenges: health, the environment, innovation, energy, and security. Here we provide a snapshot of the varied and diverse research conducted in the department.

Anette (Peko) Hosoi

Squishy robots for health and safety. In the movie *Terminator 2*, the shape-shifting T-1000 robot morphs into a liquid state to squeeze through tight spaces or to repair itself when harmed. Now a phase-changing material built from wax and foam that is capable of switching between hard and soft states could allow even low-cost robots to perform the same feat. The material—developed by Anette Hosoi, a professor of mechanical engineering and applied mathematics at MIT, and her former graduate student Nadia

Cheng—could be used to build deformable surgical robots. The robots could move through the body to reach a particular point without damaging any of the organs or vessels along the way. Robots built from the material, which is described in an article published in the journal *Macromolecular Materials and Engineering,* could also be used in search-and-rescue operations to squeeze through rubble looking for survivors, Hosoi says.

Gang Chen

"Phonon tunneling" explains heat flow across nanometer-wide gaps. Conduction and thermal radiation are two ways in which heat is transferred from one object to another: conduction is the process by which heat flows between objects in physical contact, such as a pot of tea on a hot stove, while thermal radiation describes heat flow across large distances, such as heat emitted by the sun. These two fundamental heat-transfer processes explain how energy moves across microscopic and macroscopic distances. But it has been difficult for researchers to ascertain how heat flows across intermediate gaps. Now Professor Gang Chen has developed a model that explains how heat flows between objects separated by gaps of less than a nanometer. Chen and his team have created a unified framework that calculates heat transport at finite gaps and have shown that heat flow at sub-nanometer distances occurs not via radiation or conduction but through "phonon tunneling."

John Lienhard

Getting the salt out. The boom in oil and gas produced through hydraulic fracturing, or fracking, is seen as a boon for meeting US energy needs. But one byproduct of the process is millions of gallons of water that is much saltier than seawater after leaching salts from rocks deep below the surface. Now, researchers at MIT and in Saudi Arabia say they have found an economical solution for removing the salt from this water. The new analysis appears in the journal *Applied Energy*, in an article co-authored by MIT professor John Lienhard and colleagues. The method they propose for treating the "produced water" that flows from oil and gas wells throughout their operation is one that has been known for decades but had not been considered a viable candidate for extremely high-salinity water: electrodialysis.

Harry Asada

Underwater robot for port security. MIT researchers have unveiled an oval-shaped submersible robot, a little smaller than a football, with a flattened panel on one side so that it can slide along an underwater surface to perform ultrasound scans. Originally designed to look for cracks in nuclear reactors' water tanks, the robot can also inspect ships for the false hulls and propeller shafts that smugglers frequently use to hide contraband. Because of its small size and unique propulsion mechanism—which leaves no visible wake—the robot could, in theory, be concealed in clumps of algae or other camouflage. Fleets of them could swarm over ships at port without alerting smugglers and giving them the chance to jettison their cargo. The half of the robot with the flattened panel is waterproof and houses the electronics. The other half is permeable and houses the propulsion system, which consists of six pumps that expel water through rubber tubes.

Ken Kamrin

Motion-induced quicksand. Ken Kamrin, an assistant professor of mechanical engineering at MIT, studies granular materials, using mathematical models to explain their often-peculiar behavior. Now Kamrin has applied a recent granular model, developed by his group, and shown that it predicts a bizarre phenomenon called "motion-induced quicksand"—a scenario in which the movement of sand in one location changes the character of sand at a distance. Researchers have observed this effect in a number of configurations in the lab, including in what is called an "annular Couette cell," a geometry resembling the bowl of a food processor with a rotating ring in its base. In experiments, researchers have filled a Couette cell with sand and attempted to push a rod horizontally through the sand. In a stationary Couette cell, the rod will not budge without a significant application of force. If, however, the cell's inner ring is rotating, the rod will move through the sand with even the slightest push, even where the sand does not appear to be moving. While others have observed this effect in experiments, there has not previously been a model to predict such behavior.

Domitilla Del Vecchio

New device could make large biological circuits practical. Researchers have made great progress in recent years in the design and creation of biological circuits—systems that, like electronic circuits, can take a number of different inputs and deliver a particular kind of output. But while individual components of such biological circuits can have precise and predictable responses, those outcomes become less predictable as more such elements are combined. Professors Domitilla Del Vecchio and Ron Weiss have now come up with a way of greatly reducing that unpredictability, introducing a device that could ultimately allow such circuits to behave nearly as predictably as their electronic counterparts. According to Del Vecchio and Weiss, there are many potential uses for such synthetic biological circuits, including biosensing (e.g., cells that could detect markers indicating the presence of cancer cells and then trigger the release of molecules targeted to kill those cells).

Sangbae Kim

MIT cheetah robot lands the untethered running jump. In a leap for robot development, the MIT researchers who built a robotic cheetah have now trained it to see and jump over hurdles as it runs, making this the first four-legged robot to run and jump over obstacles autonomously. To get a running jump, the robot plans out its path, much like a human runner. As it detects an approaching obstacle, it estimates that object's height and distance. The robot gauges the best position from which to jump and adjusts its stride to land just short of the obstacle before exerting enough force to push up and over. Based on the obstacle's height, the robot then applies a certain amount of force to land safely before resuming its initial pace. In experiments on a treadmill and an indoor track, the cheetah robot successfully cleared obstacles up to 18 inches tall—more than half of the robot's own height—while maintaining an average running speed of 5 miles per hour.

Thomas Peacock

Researchers unveil secrets of hidden waves. Detailed new field studies, laboratory experiments, and simulations of the largest known "internal waves" in the Earth's oceans provide a comprehensive new view of how these colossal, invisible waves are born, spread, and die off. According to Professor Thomas Peacock, one of the studies' lead researchers, the new observations resolve a long-standing technical question about how internal waves propagate: whether the towering waves start out full strength at their point of origin or whether they continue to build as they spread from that site. Because of their size and behavior, the rise and spread of these waves are important for marine processes, including the supply of nutrients for marine organisms, the distribution of sediments and pollutants, and the propagation of sound waves. They are also a significant factor in the mixing of ocean waters, combining warmer surface waters with cold, deep waters—a process that is essential to understanding the dynamics of global climate change.

Amos Winter

Sun-powered desalination for villages in India. Around the world, there is more salty groundwater than fresh, drinkable groundwater. For example, 60% of India is underlain by salty water, and much of that area is not served by an electric grid that could run conventional reverse-osmosis desalination plants. Now, an analysis by MIT graduate student Natasha Wright and Assistant Professor Amos Winter shows that a different desalination technology called electrodialysis, powered by solar panels, could provide enough clean, palatable drinking water to supply the needs of a typical village. Winter explains that an understanding of the full set of constraints imposed by the market is needed to find optimal solutions to problems such as saline groundwater. The factors that point to the choice of electrodialysis in India include relatively low levels of salinity—ranging from 500 to 3,000 milligrams per liter, as compared with approximately 35,000 milligrams per liter for seawater—as well as the region's lack of electrical power. Such moderately salty water is not directly toxic, but it can have long-term effects on health, and its unpleasant taste can cause people to turn to other, dirtier water sources.

Xuanhe Zhao

New research provides a general formula for understanding how layered materials form different surface patterns. The process of wrinkle formation is familiar to anyone who has ever sat in a bathtub a little too long. But exactly why layered materials sometimes form one kind of wrinkly pattern or another—or even other variations, such as creases, folds, or delaminated buckles—has now been explained at a fundamental level by Associate Professor Xuanhe Zhao. The underlying process is the same in all of these cases: layers of material with slightly different properties tend to form patterned surfaces when they shrink or stretch in ways that produce different effects. But the new analysis, for the first time, creates a unified model that shows exactly how the properties of the individual layers, and how they are bonded to each other, determine the exact form of the resulting texture. By understanding the factors that produce these patterns, the researchers say, it should become easier to design synthetic materials with exactly the kinds of surfaces needed for specific applications, such as better traction or water-shedding properties. The work could also lead to a better understanding of many biological processes, Zhao says, including the growth of plants, animals, microbial colonies, and organs in the body.

Mathias Kolle

Optical features embedded in marine shells may help develop responsive, transparent displays. Assistant Professor Mathias Kolle, along with scientists from Harvard University, has identified two optical structures within the blue-rayed limpet's shell that give it its blue-striped appearance. The structures are configured to reflect blue light while absorbing all other wavelengths of incoming light. The researchers speculate that such patterning may have evolved to protect the limpet, as the blue lines resemble the color displays on the shells of more poisonous soft-bodied snails. The findings represent the first evidence of an organism using mineralized structural components to produce optical displays. While birds, butterflies, and beetles can display brilliant blues, among other colors, they do so with organic structures, such as feathers, scales, and plates. The limpet, by contrast, produces its blue stripes through an interplay of inorganic, mineral structures arranged in such a way as to reflect only blue light. The researchers say that such natural optical structures may serve as a design guide for engineering color-selective, controllable, transparent displays that require no internal light source and could be incorporated into windows and glasses.

Event Highlights

MIT Mini Maker Faire

Figure 2. The first-ever MIT Mini Maker Faire in October.

In October 2014, nearly 3,000 attendees ascended upon the North Court of the MIT campus for the first-ever MIT Mini Maker Faire. A celebration of STEAM (science, technology, engineering, arts, and math) and the fun of making, the faire—part of the Maker Faire series started by the editors of *Make* magazine—featured 110 exhibitors. More than half were MIT affiliates, while the rest were local makers. Adults and children, beginners and hobbyists, advocates and experts all made their way through booth after booth of creators, technologists, scientists, engineers, and artists before moving on to the go-kart race course and, finally, the panel discussions taking place inside the Ray and Maria Stata Center. Additional highlights included the all-day robot tournament, featuring robots built by MIT and local makers, and the MIT Hobby Shop exhibit, which displayed exquisite craftworks by Hobby Shop members. The event was organized almost exclusively by MechE students and staff and sponsored in large part by the Department of Mechanical Engineering.

Inaugural MechE Research Exhibition

This past October, the Graduate Association of Mechanical Engineers (GAME) hosted the inaugural MechE graduate research exhibition, sponsored by the Department of Mechanical Engineering, to encourage community, collaboration, and communication skills among MechE students, faculty, and staff. The event, which was organized by GAME President Lee Weinstein, GAME Vice President Natasha Wright, and MechE Day Chair Ranjeetha Bharath, along with Professors Nick Fang and Franz Hover, ran from 10 am to 5 pm on a Saturday afternoon at the Ray and Maria Stata Center. It featured research presentations—in the form of videos, demos, and posters—from approximately 70 graduate students, who were judged by a medley of MechE students, staff, and alumni. Altogether, there were close to 300 attendees throughout the day, including several MechE faculty and alumni as well as MechE alum and keynote speaker Mick Mountz, CEO and founder of Kiva Systems. GAME awarded several prizes to the students who scored highest for their presentations. The top prizes went to Meng Yee Chuah, Daniel Dorsch, and Michael Buchman.

Figure 3. Attendees at the inaugural MechE graduate research exhibition.

Education Highlights

Undergraduate Enrollment, AY2011–AY2015

	AY2011	AY2012	AY2013	AY2014	AY2015
Sophomores					
2	94	78	84	87	85
2-A	64	62	98	86	85
2-OE	4	5	3	4	7
13	0	0	0	0	0
Subtotal	**162**	**145**	**185**	**177**	**177**
Juniors					
2	88	90	80	94	89
2-A	**58**	67	61	102	102
2-OE	5	3	6	4	3
13	0	0	0	0	0
Subtotal	**151**	**160**	**147**	**200**	**194**
Seniors					
2	104	79	87	73	92
2-A	57	64	68	66	104
2-OE	7	3	4	8	5
13	0	0	0	0	0
Subtotal	**168**	**146**	**159**	**147**	**201**
5th-year students					
2	5	5	8	11	4
2-A	4	10	7	12	7
2-OE	1	0	0	1	3
13	0	0	0	0	0
Subtotal	**10**	**15**	**15**	**24**	**14**
Total	**491**	**466**	**506**	**548**	**586**

Graduate Enrollment, AY2011–AY2015

Degree program	AY2011	AY2012	AY2013	AY2014	AY2015
Master's	212	240	232	230	193
Doctoral	268	255	299	310	312
MEng	13	17	15	18	12
MechE	2	0	0	0	0
Eng (naval)	30	30	33	33	34
Total	**525**	**542**	**579**	**591**	**551**

2.12 Introduction to Robotics

It's an introduction to robotics—for some students, that's all they need to know to get excited about this popular class. For a mechanical engineering student, it's a fun, hands-on convergence of design, manufacturing, kinematics, controls, mathematics, mechatronics, problem solving, and computer science.

An elective subject for upperclassmen taught by Professor Harry Asada, 2.12 goes beyond abstracts, providing students with a way to visualize complex mathematical concepts and a chance to build on their foundation in mechanical engineering basics. Students spend the first five weeks learning about controls, programming, and relevant mathematics, and during the final seven weeks they split into teams and focus on building a robot that will compete in the subject's final challenge. All of the team members focus on a different element of their robot: controls, manufacturing, or computer vision.

The theme for the final challenge, chosen by Professor Asada and Professor Kamal Youcef-Toumi, a co-instructor of the class, is based on a recent world event that will be relevant for students, such as the Fukushima nuclear disaster or the Summer Olympics. Last year's soccer World Cup was the inspiration for this year's 2.12 final project. The students had to design, build, and test two complex, automated soccer robots, one that played the position of striker and one that played goalie. The robots had to be able to receive or kick a ball and withstand the related impact forces.

The students also used cameras that enabled their robot to intercept the ball and then save or strike it. The robots had to conduct real-time processing of the images and then predict the trajectory of the ball while simultaneously generating their own motion plan to meet and intercept it, regardless of whether the ball was rolling or bouncing.

Mens et Manus Around the World

Travel to China, Russia, the United Arab Emirates, or Saudi Arabia, and it shouldn't take too long to feel like you're right back at MIT. That's because each of these nations houses at least one—in some cases, more than one—MIT-based education or research institution. Some of these partnerships go back a long way, while others have been freshly formed, but they all have roots in the MIT spirit of global cooperation, creation, and innovation.

The MIT-Singapore University of Technology and Design (MIT-SUTD) Collaboration is a recent education-focused partnership directed by MechE Professor John Brisson, while the Singapore-MIT Alliance for Research and Technology (SMART) stems from an old friendship with Singapore that originally began with a distance learning setup at MIT for students in Singapore. SMART is now focused entirely on research, entrepreneurship, and postdoctorate education. From 2008 to 2012, MechE Department Head Emeritus Rohan Abeyaratne directed the program, which includes five tracks: infectious disease, environmental sensing and monitoring, biosystems and micro-mechanics, transportation, and low-energy electronics.

Among the roughly 60 MIT faculty members involved in SMART are several MechE faculty, including Professors Nicholas Patrikalakis, Michael Triantyfallou, George Barbasthatis, Roger Kamm, Harry Asada, Peter So, Yang Shao-Horn, Evelyn Wang, and Tonio Buonassisi. The SMART campus provides many unique research opportunities for faculty that do not exist in the United States, including access to clinical data on malaria as well as new custom-built labs with state-of-the-art facilities.

Even before SMART, MechE was sharing its well-oiled pedagogical processes and research projects with the King Fahd University of Petroleum and Minerals (KFUPM) through a partnership led by Professor John Lienhard, director of the Center for Clean Water and Energy at MIT and KFUPM.

With the help of Professors Warren Seering, Kamal Youcef-Toumi, and Maria Yang, Professor David Wallace, a highly regarded ambassador for active learning in engineering education, spearheaded an educational transfer to KFUPM, helping to develop a curriculum there that focuses on making and doing, hosting faculty workshops that teach its faculty how to motivate students, designing individual hands-on engineering classes similar to MechE's 2.007 Design and Manufacturing I and 2.009 The Product Engineering Process, and setting up physical labs.

Figure 4. Professor Wallace (front, in white) stands with faculty from KFUPM.

Honors and Recognition

Faculty

Professor John Brisson received the MIT Earll M. Murman Award for Excellence in Undergraduate Advising.

Associate Professor Tonio Buonassisi won the MIT Everett Moore Baker Award for Excellence in Undergraduate Teaching.

Gang Chen, department head and Carl Richard Soderberg Professor of Power Engineering and Mechanical Engineering, received the 2014 Nukiyama Memorial Award from the Heat Transfer Society of Japan and the 2014 Outstanding Alumni Award from the Huazhong University of Science and Technology. He was elected as an Academia Sinica academician in 2014. In addition, Professor Chen's work on batteries that can capture low-grade waste heat and convert it to electricity was named one of Scientific American's 2014 World-Changing Ideas.

Professor Nick Fang was named in the 2015 *MIT Technology Review* list of 10 breakthrough technologies for his work on nano-architecture.

Professor Ahmed Ghoniem received the 2015 ASME James Harry Potter Gold Medal, which recognizes eminent achievement or distinguished service in the science of thermodynamics and its application in mechanical engineering.

Professor Roger Kamm received the Huiskes Medal for Biomechanics from the European Society of Biomechanics for his significant contributions to biomechanics throughout his career.

Assistant Professor Ken Kamrin won the ASME Eshelby Mechanics Award, which recognizes rapidly emerging junior faculty who exemplify the creative use and development of mechanics.

Associate Professor Sangbae Kim was presented with the Ruth and Joel Spira Award for Excellence in Teaching by the School of Engineering.

Professor John Leonard was appointed to the Samuel C. Collins Chair Professorship.

Professor John Lienhard was named the Abdul Latif Jameel Professor of Water and Food. Also, he received the 2015 Heat Transfer Memorial Award for outstanding contributions to the field of heat transfer.

Professor Seth Lloyd received the MIT Alan J. Lazarus Excellence in Advising Award.

Professor David Parks was named an ASME Fellow.

Assistant Professor Themis Sapsis received the 2015 Young Investigator Award from the Office of Naval Research and was named a 2015 Alfred P. Sloan Research Fellow in Ocean Sciences.

Professor Yang Shao-Horn was elected as a fellow of the American Association for the Advancement of Science.

Professor Alex Slocum received the 2014 Association of Manufacturing Technology Charlie Carter Advanced Manufacturing Award and the 2014 ASME Thar Energy Award. He also received a Nuclear Energy University Program award to develop a seawater uranium extraction system that will work symbiotically with an offshore windmill.

Professor Michael Triantyfallou was named an American Physical Society Fellow.

Assistant Professor Amos Winter and PhD student Natasha Wright won the Desal Prize from the US Agency for International Development for their photovoltaic-powered electrodialysis reversal system for off-grid regions. Professor Winter also received the Freudenstein/General Motors Young Investigator Award at the 2014 ASME International Design & Engineering Technical Conferences.

Professor Ioannis Yannas was recently inducted into the National Inventors Hall of Fame for his invention of "artificial skin."

Associate Professor Xuanhe Zhao received the 2015 Journal of Applied Mechanics Award for his paper "Phase Diagrams of Instabilities in Compressed Film-Substrate Systems."

Undergraduate Students

Alfred A.H. Keil Ocean Engineering Development Award (Excellence in Broad-Based Research in Ocean Engineering): Brian K. Gilligan and Beckett C. Colson

AMP Inc. Award (Outstanding Performance in Course 2.002): Patricia A. Das and Xiaoyue Xie

Cambridge "Firsts" (Outstanding Academic Performance at Cambridge University): Teresa Y. Lin and Kirsten B. Lim

Carl G. Sontheimer Prize (Creativity and Innovation in Design): Nikhil Padhye, Sarah N. Brennan, David D'Achiardi, and Iman S. Bozchalooi

Department Service Award (Outstanding Service to the Department of Mechanical Engineering): Joanna K. So, Tobi G. Rudoltz, Fernando L. Nunez, and Tachmajal M. Corrales Sanchez

Ernest Cravalho Award (Outstanding Performance in Thermal Fluids Engineering): Clare M. Zhang

International Design Competition (Outstanding Performance in Course 2.007): Allison Edwards

Lauren Tsai Memorial Award (Academic Excellence by a Graduating Senior): Dacie J. Mainion

Link Foundation Fellowship (Excellence in Study of Ocean Engineering Instrumentation): Gabriel D. Bousquet

Louis N. Tuomala Award (Outstanding Performance in Thermal Fluids Engineering): David F. Larson

Luis de Florez Award (Outstanding Ingenuity and Creativity): Jaguar P. Kristeller and David O. Afolabi

MIT Lincoln Laboratory Beaver Works Barbara P. James Memorial Award (Excellence in Project-Based Engineering): Otto J. Briner, Peter T. Godart, and Jaya Narain

Park Award (Outstanding Performance in Manufacturing): Julia C. Canning and Nicholas W. Fine

Peter Griffith Prize (Outstanding Experimental Project): Ann M. Huston

Robert Bruce Wallace Academic Prize: Justin W. Carrus

Thomas Sheridan Prize (Creativity in Man-Machine Integration): Murthy Arelekatti and Margaret M. Coad

Whitelaw Prize (Originality in Course 2.007): Amado Antonini, Kodiak D. Brush, Jason Z. Fischman, and Diego A. Huyke

Wunsch Foundation Silent Hoist and Crane Awards: David F. Larson, Jimmy A. Rojas, Jonathan T. Slocum, and Deborah Ajilo

Graduate Students

Carl G. Sontheimer Prize (Creativity and Innovation in Design): Michael Stern

Luis de Florez Award (Outstanding Ingenuity and Creativity): Michael Stern, John W. Romanishin, Jeremy Cho, and Gerald J. Wang

Martin A. Abkowitz Travel Award: Jacob S. Izraelevitz, Chengxi Li, and Mustafa A. Mohamad

Meredith Kamm Memorial Award (Excellence in a Woman Graduate Student): Shreya H. Dave and Jocelyn M. Kluger

Wunsch Foundation Silent Hoist and Crane Awards: Michael S. Boutilier, Khalid Jawed, Hussain Karimi, Anshuman Kumar, Brian R. Solomon, Anna Tarakanova, and Natasha C. Wright

2015 Tau Beta Pi Inductees: Joshua Born, Laura Jarin-Lipschitz, Nicholas Kwok, Felipe Lozano-Landinez, Jared McKeon, Morgan Moroi, Joseph Campion, Margaret Coad, Kirsten Lim, Teresa Lin, Dacie Manion, Jaya Narain, Ernesto Ramirez, and Kelsey Seto

2015 Phi Beta Kappa Inductees: Sarah Fay, Kirsten Lim, Naina Mehta, Emma Nelson, Nathan Spielberg, Spencer Wilson, and Kathy Yang

Space Renovations

In continued support of the department's dedication to hands-on education and the community's passion for making, this year we were very pleased to open a brand new, state-of-the-art maker facility called Maker Works.

The new space, located in Building 35, provides MechE students, staff, and faculty with convenient after-hours access to technology, equipment, and mentorship for academic and hobby projects. It includes multiple 3D printers and laser cutters, a water-jet cutter, a mill, a shop-bot, a lathe, electronics fabrication, hand tools, and several other maker tools.

Maker Works is based on the pedagogical belief that the ability to build outside of the classroom is essential to mechanical engineering education, not only for the purpose of applying classroom concepts but also to provide students with the opportunity to learn through experimentation that yields practicable results. The facility will be managed by MechE students, who will also act as mentors for the MechE community and enable the space to function outside of the normal 8 am to 4 pm shop workday to better match student schedules.

The Maker Works staff aims to help nurture the MIT maker community by bringing students together around their passion for making, to strengthen hands-on learning within the MIT community, and to act as a spearhead for similar efforts around the MIT campus by making tools, knowledge, and motivation available to students on their schedules.

The Department of Mechanical Engineering opened Maker Works in partnership with a complementary space, Proto Works, in the Martin Trust Center for MIT Entrepreneurship. This partnership creates a synergy among the two spaces, enabling valuable integration of engineering and entrepreneurship for students in both groups. We are grateful for the support we received in opening Maker Works from the Richard A. Lufkin Memorial Fund, the Martin Trust Center, and the MIT School of Engineering.

Conclusion

The Department of Mechanical Engineering continues to represent *mind*, *hand*, and, as MechE alumna Megan Smith insightfully noted in her 2015 commencement speech, *heart* in everything it does, upholding all of the principles that make it one of the strongest such departments in the world: an unyielding dedication to research and educational excellence, a passion for hands-on learning, a flair for innovation, and a real desire to do good in the world—all supported by a strong network of ecosystems. We look forward to seeing what our faculty and students will discover, solve, and make next year.

Gang Chen
Department Head
Carl Richard Soderberg Professor of Power Engineering

John Leonard
Associate Department Head, Research
Professor of Mechanical and Ocean Engineering

Anette "Peko" Hosoi
Associate Department Head, Education, and Undergraduate Officer
Professor of Mechanical Engineering