MITMECHE

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Massachusetts Institute of Technology

MechEConnects

News from the MIT
Department of Mechanical Engineering

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Inspiration, perspiration, and a touch of fire: MechE-style product design

Innovative MechE design classes started a worldwide phenomenon, and they continue to showcase students' passion for design today...
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Celebrating 150 Years of Innovation and Wisdom

Atlas Devices demonstrates their APA at the MIT150 Open House in April.

Dear Friends,

We kick off the third edition of *MechE Connects* focused on the sesquicentennial celebration of MIT. MIT's 150th anniversary was a chance to showcase the energy, "out-of-the-box" thinking, and sheer inventiveness of Mechanical Engineering faculty and students.

The MIT Open House on Saturday, April 30, was a grand celebration of this rich history, the result of extraordinary effort by the MechE faculty and student groups who coordinated our many activities. Throughout the day, our department presented lectures on cutting-edge research topics, such as the invisibility cloak, nanostructured surfaces for efficiency in energy and water, and bio-inspired robotics, as well as exciting active demonstrations of biomedical product designs. Right outside Mechanical Engineering headquarters in Killian Court, Atlas Devices demonstrated their Atlas Power Ascender (APA), a powerful device that allows "reverse rappelling" up buildings and other vertical surfaces at unprecedented speeds. Atlas Devices was founded by two recent alums, Nate Ball and Bryan Schmidt, whose invention highlights the entrepreneurial spirit within the Department. Some of our many student team projects, including the Electric Vehicle Team, MITERS, MIT Motorsport, and the Solar Electric Vehicle Team, were showcased in Rockwell Cage. The refurbished Hart Gallery sparkled with new exhibits drawing on the seven areas of MechE, and presented bioinstrumentation research and advances in solar energy conversion. The numerous exhibits and demonstrations of the day truly embodied the MIT motto *mens et manus* – mind and hand.

There was something for all to enjoy, and, as Susan Hockfield mentioned in her thank you note to the community, "'Under the Dome' inspired everyone who joined us, and it was equally magnificent for everyone from MIT who helped put on the show. Like all of this spring's MIT150 celebrations, the Open House raised our sights, refocused us on our mission, refreshed our passion for service – and gave us infinite energy to work together on inventing the future."

The MIT150 also provided a time for us to reflect on the history of our Department. You will find an abbreviated MIT MechE timeline in this issue, and a more comprehensive slideshow can be viewed at http://meche.mit.edu/about/timeline. This timeline serves as a living document of our history, with additional historic elements still to be included, as well as new developments that will occur as we move forward.

I look back with pride at the many amazing accomplishments of the Department of Mechanical Engineering and the people who made it what it is today, and look forward with excitement to the innovation and creativity of our next 150 years.

Sincerely,
Mary C. Boyce,
Gail E. Kendall Professor and Department Head

Massachusetts Institute of Technology

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► mecheconnects.mit.edu

About MechE

Mechanical engineering was one of the original courses of study offered when classes began at the Massachusetts Institute of Technology in 1865. Today, the Department of Mechanical Engineering (MechE) comprises seven principal research areas:

- **Mechanics: modeling, experimentation, and computation**
- **Design, manufacturing, and product development**
- **Controls, instrumentation, and robotics**
- **Energy science and engineering**
- **Ocean science and engineering**
- **Bioengineering**
- **Nano/micro science and technology**

Each of these disciplines encompasses several laboratories and academic programs that foster modeling, analysis, computation, and experimentation. MechE educational programs remain leading-edge by providing in-depth instruction in engineering principles and unparalleled opportunities for students to apply their knowledge.

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Inspiration, Perspiration, and a Touch of Fire: MechE-Style Product Design

Surprisingly dapper in his orange and black leopard-print smock and Fred Flintstone wig, Master of Ceremonies David Wallace (SM '91, PhD '95) presides over a festival to celebrate the creation of fire. Eight tribes of anxious celebrants—members of the red, silver, pink, blue, purple, orange, green, and yellow teams—unleash their human-powered fire-starting machines on Wallace's signal. Within moments, flames sputter to life at strategic points around MIT's Killian Court. The higher purpose of this gathering begins to emerge shortly thereafter as team members huddle around strengthening fires: they are vying to cook the ultimate s'more.

If you happened to stroll along the Charles River at that moment, you would be forgiven for interpreting this scene as a bit of undergraduate mayhem unleashed onto the massive front lawn of MIT. But there is, in fact, quite rigorous method in the apparent madness. The event is a class assignment—the brainchild of MIT Professor of Mechanical Engineering David Wallace and his teaching team for course 2.009—and it's just another day in the life of MIT students who are studying product design. "For me," Wallace says by way of explanation, "teaching design is all about building a passion for the process."

The myth of the "aha" moment

The "aha moment"—that blinding flash of inspiration in which a breakthrough invention spontaneously materializes in the mind of the creator—is a persistent myth in popular culture. More seasoned hands recognize, however, that successful products are almost always born of a bit of sweat, perhaps a few tears, a solid methodology, and a whole lot of passion. It follows therefore that accomplished designers are mostly made rather than born. And that's where MIT's product design courses come into the picture.

Each year, with the help of Director of Undergraduate Teaching Laboratories Richard Fenner, MechE instructors and teaching assistants revisit a fundamental challenge—take some of the world's brightest, most enthusiastic, but relatively inexperienced undergraduates and set them on the path to becoming thoroughbred designers. Three of MechE's most iconic design courses, 2.00b, 2.007, and 2.009, are some of academia's most important models of how such transformations can be accomplished.

Serious play

Affectionately known as the MIT Toy Lab, course 2.00b Toy Product Design was launched in 2004 by Barry Kudrowitz (SM '06, PhD '10), Professor David Wallace, and Bill Fienup (SM '05) with research funding from Hasbro, Inc. Kudrowitz

was doing Nerf-related research for Hasbro at the time, and the company asked him and a colleague to teach a sports product design course. Kudrowitz agreed on condition that the course focus on toy design.

The purpose of the Toy Lab is to get first-year undergraduates excited about product design while they learn to work in small teams of five to six students. "Toy design is accessible to freshmen, in part, because they can relate to the market," says Wallace. "At the same time, the bar for toys is pretty high—they have to be crazy safe, they have to be inexpensive, and they have to be fun. It's a stimulating challenge for a young MIT student."

As the most recent addition to MechE's pantheon of design courses, the Toy Lab has benefited from the iconic status of courses like 2.007 and 2.009. Toy Lab's semester-ending product presentations are eagerly attended by executives from Hasbro and other toymakers, and many students have secured internships on the strength of their projects. Still others have gone on to found their own toy companies.

Battling robots

In contrast to the Toy Lab, Design and Manufacturing I (course 2.007)—arguably the most famous course at MIT—began quite humbly. The course had long required students to design and build a project, but until 1970 the purpose of the device was up to the individual student. The downside of this approach, according to Pappalardo Professor of Mechanical Engineering Emeritus Woodie Flowers (SM '68, ME '71, PhD '73), was that many students spent so much time deciding what to build that they were scrambling to complete their fabrications at the end of the term.

The remedy Flowers prescribed was to provision each student with an identical kit of wood and metal parts from which to build a simple device designed to roll down a ramp at a precisely controlled speed. Because every device was built for the same purpose, Flowers was able to introduce an element of competition. The course that year concluded with an elimination-style event in which the students' devices were tested head-to-head until the most successful device was crowned. The competition, and the course itself, gained wide renown a few years later after airing on the PBS television program, *Discover: The World of Science*.

Although the parts and tools have evolved to include industry-standard computer-aided design, microcontrollers, and servomotors and the competitive tasks have grown more complex, the essential spirit of 2.007 has remained constant. "No one owns 2.007, 2.007 owns you," says Alexander Slocum (BS '82, SM '83, PhD '86), the Neil and Jane Pappalardo Professor of Mechanical Engineering. When teaching this course, he adds, "you are just the current caretaker."

The ethic of continuous improvement has always driven the evolution of course 2.007. Following on the heels of former Professor Harry West (PhD '86), now CEO at Design Continuum, Inc., Slocum introduced several key innovations. The project scheduling and decision documentation requirements he inserted in the mid-90s reflect actual industrial engineering design practices. Slocum also added teaching assistants to help manage the increasing complexity of the course.

Daniel Frey (PhD '97), Associate Professor of Mechanical Engineering, took charge of 2.007 in 2009 and is the course's current instructor. The latest 2.007 innovation is a 40-minute video created by Professor David Gossard (PhD '75) that illustrates the agonizing twists and turns of the design process—brainstorming ideas, narrowing the options, prototyping and fabrication, and conceiving fixes for broken parts and flawed designs. "We showed it the second day of class this year, and it was a huge hit," says Frey. "It laid bare the raw nature of the process. It definitely lowered students' anxiety and made them more willing to experiment and risk failure early in the process."

Frey continues to up the ante on the course-concluding competition event. It has to be challenging, of course, but not impossible. It should be entertaining for spectators. And it must be doable by multiple strategies using only the equipment supplied in the kit. Frey and his team spent in excess of 1,000 hours devising and building this year's competition table. The theme was MIT's hacking tradition. To win, the competitors' robots must score points by performing tasks inspired by four of the most memorable pranks in Institute history—the midfield weather balloon at the Harvard-Yale football game, the Class of 1994 Super Ball drop, the MIT Campus Police cruiser on the Great Dome, and the "theft" of Caltech's Fleming Cannon.

For all its bells and whistles, 2.007's core challenge remains the same. "It's about one person, one machine," Frey says. "This is probably the first and very likely the last opportunity most of our students will have to conceive, design, and build a functional product from scratch as an individual. They will spend their entire careers working in teams, and I think there is great benefit to doing it all yourself at least once."

Immersed in the story

A crucial next step in the training of a MechE designer is provided by Wallace's Product Engineering Processes (course 2.009). The course description begins with a premise, "You are part of a successful product development firm that prides itself on being on the cutting edge of technology.... Each year your company challenges a select group of teams to propose and develop innovative products in a new strategic direction." And so begins the latest installment of the 2.009 story.

"We work in big teams of 15 to 19 students because that's the real world of product development," says Wallace. "By immersing them in a story, we are giving them a full industrial experience in a supportive context that allows them to try, fail, and keep on trying until they get their designs to work."

Like 2.00b and 2.007, course 2.009 places heavy emphasis on highly structured, active learning experiences. Every class is a combination of lecture and activity/challenge that engages students with the day's content. Techniques like prototyping and teardowns, scheduling and project management are reinforced with exercises like creating a fire-starting device in an hour or predicting and then documenting the time it takes to build a simple origami ball. "These little challenges become the building blocks for the second half of the course," says Wallace. "That's when they have to figure out which of their hundreds of ideas is the most promising."

Once their ideas are set, the teams spend the remainder of the semester in development and production mode. The role of the teaching staff shifts at this point. Critiques become an essential part of the learning process, and group design reviews are conducted every two to three weeks for the remainder of the course. Instructors and industry professionals post their comments online so that all the teams can see and learn from each other's critiques.

The goal, as Wallace sees it, is to create an environment where students feel comfortable floating any idea or even saying they don't know or don't understand something. "Ideally, 2.009 sets up MechE design students for whatever they want to do with the rest of their lives," says Wallace. "It shows them how they can use their passion for engineering to make a valuable contribution to the world."

New Hart Gallery Celebrates Nautical History and Research Frontiers in MechE

A new MechE exhibit was recently installed in the Hart Nautical Gallery of Building 5 as part of the Department's MIT150 activities. The exhibit, a collaboration between the MIT Museum and the Department of Mechanical Engineering, was the result of a complete overhaul of the space.

Collections Curator Kurt Hasselbalch, along with Department Head Mary Boyce and Professor John Leonard, worked closely with a wide range of faculty and students to create an ongoing and evolving showcase of the tremendous range of ground-breaking research being conducted in MechE. "MechE now has a unique high-profile public showcase, and the Hart Gallery looks more elegant and inviting than ever before," says Hasselbalch about the new space.

The evolution of ship design is a main focus of the new Gallery. Forty of the Museum's finest full-hull ship models depict 1,000 years of ship building, ranging from a 15th-century iron-clad warship to the swiftest clipper ships. Also featured is an extraordinary model of N.G. Herreshoff's "Reliance," winner of the 1903 America's Cup.

The Gallery also features two rotating showcases of Mechanical Engineering research and projects. The current exhibit presents recent prototypes in bioinstrumentation created by students and post-docs in the Bioinstrumentation Lab and a presentation of photovoltaic design for increasing the conversion efficiency of solar energy.

MIT Museum's Hart Nautical Collections were originally formed in 1924 under MIT's Department of Naval Architecture and Marine Engineering, which was later renamed the Department of Ocean Engineering in the 1970s. In 2005, Ocean Engineering merged with the Department of Mechanical Engineering to become one of seven major research focus areas for the department:

- Mechanics: Modeling, Experimentation, and Computation (MMEC)
- Design Manufacturing and Product Design
- Energy Science and Engineering
- Control, Instrumentation and Robotics
- Ocean Science and Engineering
- Bioengineering
- Micro and Nano Engineering

The Hart Gallery is free and open to the general public from 9am to 5:30pm seven days a week.

Mens et Manus: A History of Mechanical Engineering at MIT

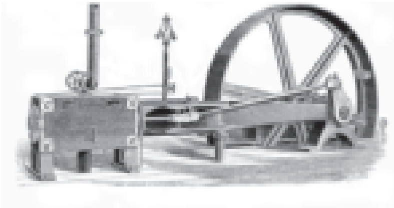
We have embarked on assembling a timeline of historic events within the Department. A sampling appears here. For a more complete timeline, go to http://meche.mit.edu/about/timeline. We welcome additional items to capture the complete rich history of Mechanical Engineering at MIT.

1865

Six courses of study are offered to the first class of MIT students. Mechanical Engineering is designated Course I, then later renamed Course II in 1873.

1874

The department's first lab is established with the donation of a steam engine, inaugurating a focus on energy and power systems that remains at the core of MechE research today.



1893

MechE curricular options serve as the basis for Course XIII, Naval Architecture, which later becomes Ocean Engineering in 1970, then rejoins MechE in 2005.

1901

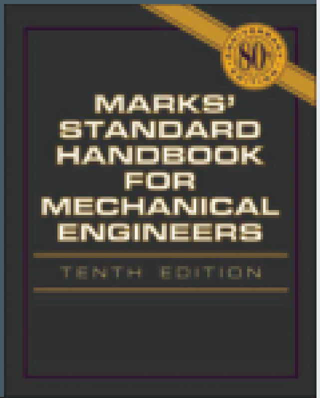
A program in Naval Construction is established as a collaboration between MIT and the US Navy; its graduates include many of the Navy's fleet admirals.

1908

The first graduate program in MechE includes coursework in advanced steam and gas engineering, directed readings, and independent research.

1916

Lionel S. Marks publishes *Standard Handbook for Mechanical Engineers,* a codification of engineering knowledge that is still widely used.



1929

The Sloan Automotive Lab is established.

1934

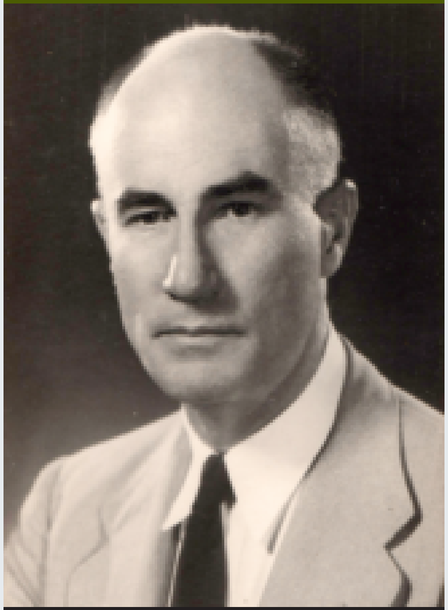
The Heat Measurements Laboratory, later renamed the Heat Transfer Laboratory, joins MechE.

1936

Joseph Keenan and Frederick Keyes publish *Steam Tables: Thermodynamic Properties of Water,* which remains a standard reference in the analysis and design of power systems.

1943

International expert on vibrations Jacob P. Den Hartog is recruited to MIT, bringing Westinghouse design school methods to MechE's teaching of dynamics.



1946

Samuel C. Collins and colleagues perfect a helium liquefier that provides a reliable and affordable supply of liquid helium for research in superconductivity and semiconductors.

1957

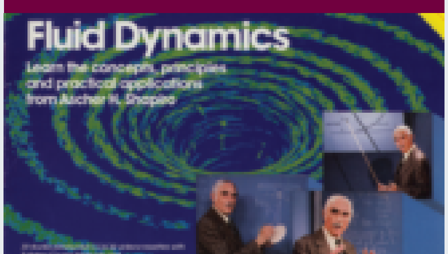
H. Guyford Stever chairs the NACA Special Committee on Space Technology that develops the plan for the National Civil Space Program.

1957

An Introduction to the Mechanics of Solids, by Stephen Crandall, Norman Dahl, and Thomas Lardner, provides the framework of equilibrium, kinematics, and constitutive response for the teaching of mechanics.

1961

Ascher Shapiro begins producing a series of films that will introduce generations of students and practicing engineers to the complexities of fluid flow.



1971

"Introduction to Design" holds a design contest that becomes an annual robot-building competition. Course 2.70's (later 2.007) experiential, hands-on apprenticeship becomes the department's flagship sophomore subject.

1975

Ocean Engineering faculty members launch a program on Arctic acoustics leading to such fundamental discoveries as the first proof of Artic Ocean warming.

1977

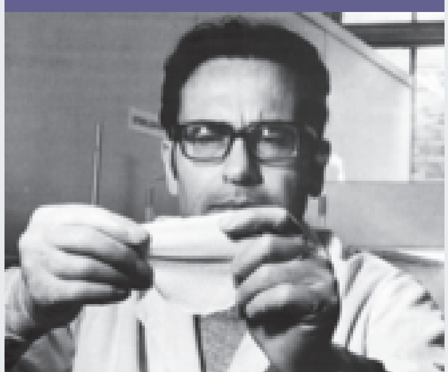
The Laboratory for Manufacturing and Productivity (LMP) is established. LMP research has created advances such as microcellular foams, 3D printing, photovoltaic ribbon technology, and RFID technology.

1978

Thomas Sheridan and William Verplank establish a ten-level taxonomy of human/machine interactions, which becomes the basis for understanding how people interact with products and complex systems.

1981

Ioannis Yannas completes synthesis of the first "artificial skin," which emulates the regenerative properties of living skin.



1988

The MIT Sea Grant Autonomous Underwater Vehicle (AUV) Laboratory is established.

2002

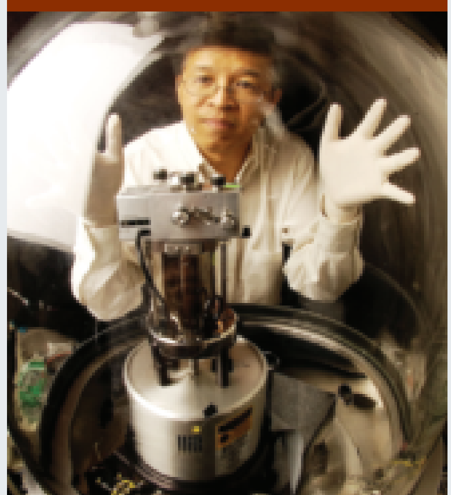
MechE's pioneering flexible engineering degree, Course 2-A, receives accreditation. 2-A students customize their own course of study.

2002

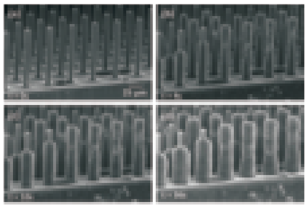
Amy Smith creates D-Lab and challenges students to design simple, affordable devices to address problems in the developing world.

2009

A team led by Professor Gang Chen determines that heat transfer can be 1,000 times greater than Planck's Law predicts.



Frost-Free Planes: A MechE Team Refines a Flawed Solution to a Dangerous Problem



Snapshot images of frost formation on textured hydrophobic surfaces imaged for the first time in a scanning electron microscope.

MIT Assistant Professor Kripa Varanasi (left) and graduate student J. David Smith work with a cold stage, a system for cooling materials in a precisely controlled way, to study frost formation.

Ice is one of the most treacherous substances on earth. It can seize up the engine of an aircraft, snap high voltage power lines, and jettison workers off an oilrig into a frigid ocean. But solutions to icy build-up can be as problematic as the hazard itself: Many de-icing chemicals are toxic and require continual reapplication, and heating coils embedded in surfaces can prove logistically challenging and use an inordinate amount of energy.

Kripa Varanasi, the d'Arbeloff Assistant Professor of Mechanical Engineering, and his student J. David Smith, along with Tao Deng and colleagues at General Electric, recently discovered a critical flaw in what many considered the best solution on the horizon. Until now, researchers have assumed that if a surface repelled water, it repelled ice. Varanasi and his colleagues, however, discovered that a surface must also repel frost.

Their research, published recently in *Applied Physics Letters*, indicates that most super-hydrophobic coatings don't work consistently because of frost. Technically speaking, frost is ice that forms on a surface directly from a vapor state or by the freezing of condensed droplets. The formation of frost can completely defeat the water-repelling properties of a surface designed to inhibit ice buildup — and, in fact, could actually promote ice formation.

But the team's findings weren't all bad news. Their research also suggests that a more complicated, patterned surface might work.

Water-repellant is not necessarily frost-repellant

The idea behind super-hydrophobic coatings is that they cause water to bead up into droplets instead of spreading out across a surface. Researchers have assumed that such coatings would also prevent ice from forming or sticking to the surface. But using an environmental scanning electron microscope to study the process, Varanasi and his team found there's a limit to the extent these coatings can prevent ice from adhering to a smooth surface.

"If frost forms, it actually aggravates the problem," Varanasi says, because it provides a kind of foundation on which ice quickly can build up to form a thick layer. "We need to be able to control this first phase when ice nucleation occurs," he says.

Find out more ►

Read the full MIT News article:
http://web.mit.edu/newsoffice/2010/frost-formation-1222.html

But in understanding the limitations of this solution, Varanasi and his team discovered a few promising answers. The key was looking at what happens when water droplets are in rapid motion before striking a surface. It turns out that certain kinds of complex nanoscale texturing of the surface can drastically improve the hydrophobic qualities, even on a moving surface, by preventing the forming droplets from finding a suitable flat surface to stick to. "We have to go another way; we have to do textures," Varanasi says, adding that getting the size and configuration of these textures exactly right will be the subject of future research.

He also notes that in order to be a practical solution for the many applications where ice buildup is a problem, it must be possible to manufacture the patterning on large surfaces at reasonable cost. The true breakthrough, Varanasi says, will take place when someone finds a way to produce "scalable manufacturing techniques with material that can survive in these kinds of applications."

The first step toward a new set of challenges—and discoveries

Neelesh Patankar, Associate Professor of Mechanical Engineering at Northwestern University, believes Varanasi's work is significant, because "it shows clearly that frost formation imposes severe constraints on the development of textured icephobic surfaces. This was not previously known." Patankar notes that the fact that Varanasi and his team showed that textures of a certain scale (micron-sized patterns) are not viable is an important result in the field "since it possibly tells us where not to look."

The next challenge on the de-icing frontier as Patankar defines it: "What are the right parameters, specifically, the roughness scale, that could lead to icephobic surfaces even in the presence of frost formation?" Varanasi and other researchers have a head start toward getting the answers to those essential questions.

Excerpted from an MIT News *article by David Chandler.*

"If frost forms, it actually aggravates the problem."

Professor Kripa Varanasi

Student Snapshots

Around Campus

Toy Lab, MIT150, and commencement

2011 Commencement

The Department of Mechanical Engineering hosted a reception immediately following commencement on Friday, June 3, 2011. The day was filled with pride and joy as we celebrated our graduates, reconnected with friends, and showcased our latest research. Congratulations to all our graduates!

MechE Innovations on Display at MIT150 Open House

On Saturday, April 30, 2011, the Department of Mechanical Engineering, in conjunction with MIT, invited the public to take a look inside the Institute's world-renowned innovational culture at its Open House event. In celebration of MIT's 150th anniversary, MechE students presented working prototypes ranging from the Braille Maker and solar electric vehicle to biomedical products for home sleep monitoring and minimally invasive surgery. Two of the founding members of Atlas Devices demonstrated their Atlas Powered Ascender, a reverse-rappelling device they developed as students in the department. Young visitors to the event enjoyed hands-on projects building rubber band cars, catapults, and edible structures using marshmallows and dry pasta. The day's lectures held audiences spellbound with robotic advances in areas like physical rehabilitation and nuclear reactor inspection and nanoengineered surfaces for energy efficiency and invisibility. *See a full list of MechE-related Open House events at http://meche.mit.edu/life/mit150/.*

Designers at Play

Serious fun is the assignment in Course 2.00b, also known as the Toy Lab. Named one of "30 Awesome College Labs" by *Popular Science* magazine, the purpose of the Toy Lab is to get first-year undergraduates excited about toy product design while they learn to collaborate in small teams to design for play and entertainment. The teams work closely with a local sponsor, elementary schools, upper classmen, and experienced mentors on a themed toy design project. *See recent inventions from the MIT Toy Lab at web.mit.edu/2.00b.*

Four Faculty Win Prestigious Keenan Award for Innovation

Rohit Karnik, d'Arbeloff Professor of Mechanical Engineering; Sang-Gook Kim, Professor; Carol Livermore, Associate Professor; and Todd Thorsen, Research Staff at Lincoln Labs were recognized with the Joseph Henry Keenan Innovation in Undergraduate Education Award for their development of the popular Micro/Nano Laboratory taken by more than 50 undergraduates last year.

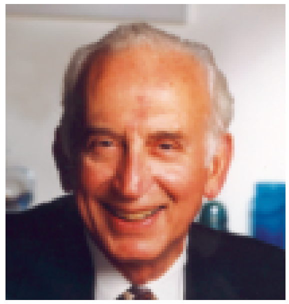
MechE Student Space Gets A Facelift

This past fall, the MechE Student Commons was upgraded as part of a larger effort to beautify the Mechanical Engineering entrance and hallway, and provide much-needed mixed-use space for the more than 1,000 undergraduate and graduate students in MechE. The expansion created individual and team work spaces as well as social and study areas for between classes or on weekends. The new, improved Commons was funded through a generous donation by MechE alum BJ Park and his wife Chunghi Park.

Alumni Profiles

BJ Park and George Hatsopoulos

BJ Park



George Hatsopoulos

BJ Park

BJ Park (SM '61, ME '63) is a man who holds education in the highest regard. "Education and passion together create the foundation of success in any field," he says. Interested in textiles and the mechanical properties of fabric, BJ left his home in Korea in 1958 to attend the Rhode Island School of Design for textile engineering, then MIT for his SM and ME in Mechanical Engineering, and finally Leeds University for a PhD in textile engineering. Park was first introduced to the idea of consumer product testing as a student in MechE. That small seed of an idea later became a highly successful company called Merchandise Testing Laboratories (MTL). Under Park's leadership, MTL was a global leader in consumer product testing, inspection, and social accountability for products shipped to the US from overseas. Bureau Veritas Group purchased MTL in 2001, and he has served as a special advisor to the company since then.

Park has remained a loyal supporter of MechE in the years since he graduated. In 2001, he and his wife Chunghi Park made their first of many generous donations to MechE for the renovation of classrooms 3-270 and 3-370, now known as the Park Lecture Halls. More recently, they funded a major renovation of the MechE Student Commons, creating much-needed mixed-use space for MechE students.

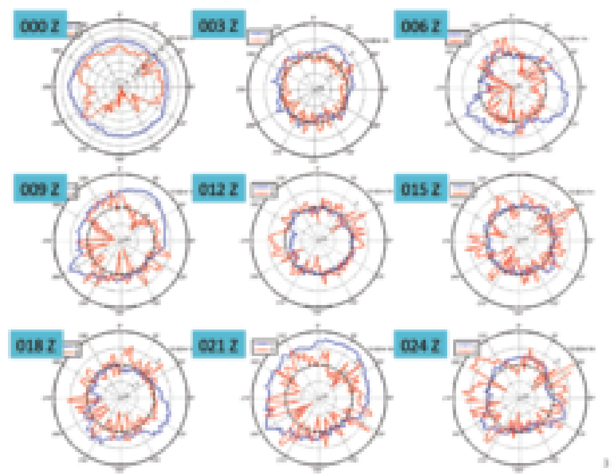
Park is a member of the American Society for Testing and Materials (ASTM), as well as several other textile organizations. He is also a recipient of the Bronze Medal from the Northern Textile Association and the Harold DeWitt Smith Award from ASTM.

George Hatsopoulos

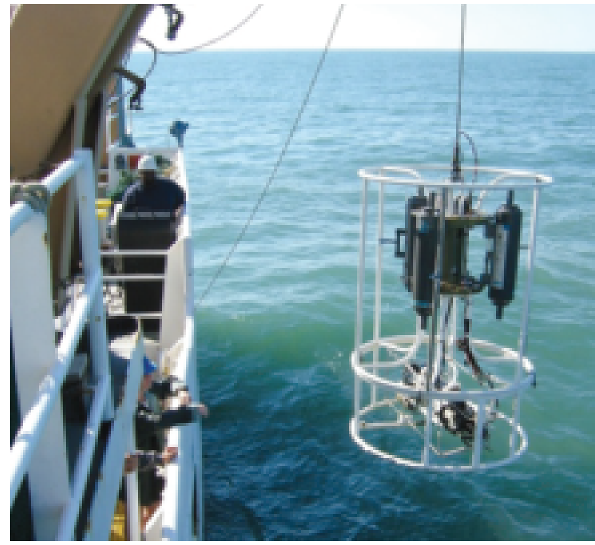
George Hatsopoulos (BS '49, SM '50, ME '54, ScD '56) is a MechE alum and former faculty member. A man with unusual vision, Hatsopoulos exhibited a rare ability to apply fundamental concepts of thermodynamics in significant real-world applications. Early on in his academic career, he worked on engineering physics and thermodynamics, in the process realizing he could use electron energy as generators, with applications to spacecraft design. Hatsopoulos left his post at MIT to start ThermoElectron Corporation in 1956, now Thermo Fisher Scientific, a high-technology company that currently employs 30,000 people. As chairman and CEO from its founding until his retirement in 1999, Hatsopoulos has grown the company around many novel thermodynamic applications using new and unique business models. He is currently the director of Tecogen, an energy efficiency company, and its different affiliates.

Hatsopoulos served on the board and chaired the Federal Reserve Bank of Boston, is a fellow of the American Academy of Arts and Sciences, and is an honorary member of the American Society of Mechanical Engineers (ASME) and the National Academy of Engineering. He won the John Fritz Medal in 1996 and the Heinz Award in Technology, the Economy, and Employment in 1997. He is a lifetime member of the MIT Corporation. Hatsopoulos is the principal author of a classic textbook on general thermodynamics and many articles, including some in thermo-economics. He has been a generous donor to his alma mater, endowing the Hatsopoulous Chair and enabling the renovations of the prolific George and Daphne Hatsopoulous Microfluids Lab.

Understanding the Sound and Motion of the Ocean



Coupled ocean-acoustic predictions of transmission loss for different bearing angles, over 24 hours (3 hours interval)



Conductivity, Temperature, and Depth (CTD)

Seventy-one percent of the Earth's surface is covered by ocean, and 80% of all life on the planet resides there. It's no surprise, then, that the deep blue sea also presents some of civilization's great scientific and engineering challenges. Achieving a better understanding of some of those challenges and finding solutions to them can have a significant impact on the future of life on Earth.

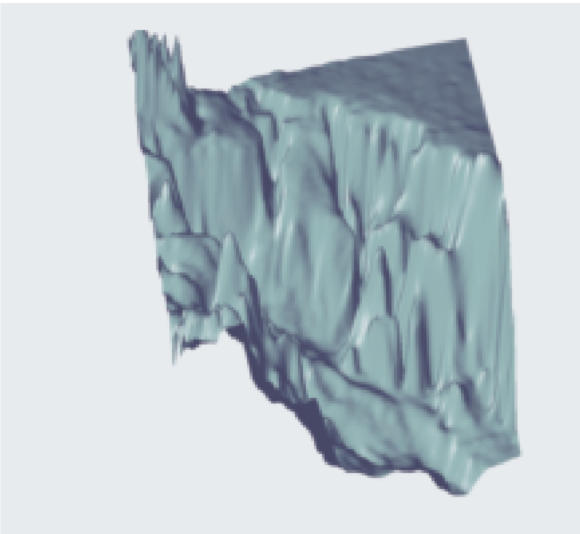
Case in point: Research conducted by Mechanical Engineering Professor Pierre Lermusiaux, the Doherty Associate Professor in Ocean Utilization, could aid in basic interdisciplinary ocean science, naval operations, and the control and location of underwater vehicles. Lermusiaux and a research team of students and group members, in collaboration with Taiwanese and Woods Hole Oceanographic Institution scientists, have been studying and predicting the way ocean variability—the perpetual changing of currents, temperatures, salinity, and the contours of the seafloor—alters the way sound travels through the water.

The results of this research could make it easier for Navy submarines to evade detection or for remotely operated underwater vehicles, like those used to combat the recent oil spill in the Gulf of Mexico, to maneuver more accurately. It could also aid in basic oceanographic and climate research by helping to calibrate systems for using sound waves to measure ocean properties, such as temperature and seafloor topography.

Using both theoretical computer models and on-site experiments close to the islands of Taiwan and Kauai, the team found unexpected changes in the way ocean and sound waves interact when they are emitted near the edge of a continental shelf, where the average slope of the seafloor changes abruptly. For the first time, they were able to make integrated four-dimensional ocean and acoustical predictions of how sound waves would propagate at a given time and location, evaluate the degree of uncertainty in those predictions, then verify them with acoustic measurements.

Find out more ►

Read the full article in *IEEE Xplore*:
http://ieeexplore.ieee.org/search/freesrchabstract.jsp?tp=&arnumber=5638588



Bathymetry of the region

Paving the Way for New Acoustic Applications in Underwater Operations and Communications

The continental shelf area is important because such regions are increasingly being exploited for oil and gas drilling, and are key to the undersea naval operations of many nations. These regions are also significant in assessing the health of the oceans and climate dynamics. "A lot of research interests," he says, "are now focusing on the complex shallower seas and their interactions with the deep ocean."

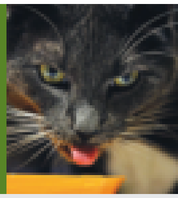
Lermusiaux's research, which was funded by the Office of Naval Research and published in the *IEEE Journal of Oceanic Engineering*, predicted and explained how sound waves used for sonar imaging and underwater communications can be affected by the interplay of large-scale currents, eddies, internal tides, and the irregular topography of the seafloor. It also demonstrated where and when each could be a key factor in predicting how sound waves will travel. Some scientists, including researchers at MIT, have suggested that measuring the propagation of sound waves over long distances in the ocean could make it possible to monitor the effects of climate change by allowing them to determine ocean temperatures and circulations over large regions.

Nadia Pinardi, Professor of Oceanography at the University of Bologna, believes that the research "confirms unequivocally that ocean acoustic uncertainties are connected to a detailed knowledge" of features and processes of the ocean at a specific location and time. She adds that these results could pave the way for new acoustic applications in underwater imaging and communications.

Arthur Miller, a research oceanographer and senior lecturer in climate sciences at the Scripps Institute of Oceanography in San Diego, observes that techniques pioneered by Lermusiaux now make it possible to determine which factors are most important, and thus improve the accuracy of predictions used for carrying out underwater measurements—results, he adds, that are critical to practical applications in sonar operations.

Excerpted from an MIT News *article by David Chandler.*

The Physics of a Drinking Cat



During demonstrations for the MIT150 Institute-wide "Open House" on April 30, MIT faculty shared their story of a cat named Cutta Cutta, who inspired them to study the physics of how cats lap.

Pedro Reis, of Mechanical Engineering and Civil and Environmental Engineering (CEE), and Roman Stocker, of CEE, represented MIT on the interdisciplinary team, which included researchers from Princeton and Virginia Tech. They analyzed high-speed video of domestic cats, including Stocker's family cat, as well as a range of larger felines, such as ocelots and tigers. In what could be a first for a paper published in *Science*, they gathered additional data by analyzing YouTube videos of big cats lapping.

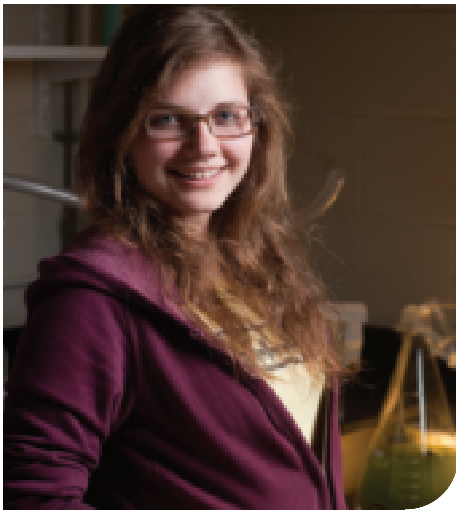
Earlier insights into the way cats lap were revealed in a 1940 film made by Harold "Doc" Edgerton, the MIT electrical engineering professor who first used strobe lights in photography to stop action. Video from this new study makes clear that the top of the cat's tongue is the only surface to touch the liquid—and that it barely touches the surface before the cat draws its tongue back up. The team's findings: Cats expertly balance the physical ingredients of gravity and inertia while drinking milk at four laps per second.

Find out more

► **Read the full MIT News article.** **http://web.mit.edu/newsoffice/2010/cat-lapping-1112.html**

Turning Garbage into Treasure

MIT Students Develop New Use for Waste Vegetable Oil in Brazil



Angela Hojnacki

You're a wastepicker in Brazil, and the government just passed new regulations for disposing of vegetable oil, one of the items you regularly pick up on your fuel-guzzling trips around São Paulo. What should you do?

That was the question posed to MIT student group Biodiesel@MIT, whose goal is to increase awareness of waste-to-energy possibilities using waste vegetable oil (WVO). Out of the wastepickers' problem arose a new group dedicated to finding the answer: Green Grease Project (GGP).

"The obvious solution was to use it as fuel," says MechE undergrad Angela Hojnacki, president of Biodiesel@MIT and project coordinator of Green Grease Project. "But there are two different ways you can use WVO in a diesel engine. We chose to convert the engine using recycled materials to make it less expensive and more applicable to the wastepicker community in São Paulo."

GGP was able to bring down the conversion cost a whopping $700, from $1,200 to $500. According to Hojnacki, by converting the engines and running on their own WVO, wastepickers, who earn their income by picking up recyclables from around the city and selling them to recycling companies, can decrease their operational costs by 20%.

Once the engine is converted to run on waste vegetable oil, the next step is to filter the oil. The wastepickers put the oil out in the sun to heat it up, isolating the highest-quality oil on top by allowing all the particulates to drop to the bottom. This process is repeated several times, and must be put on hold every time the sun goes down.

Once again, Green Grease Project is on the case, led by Hojnacki. The team is currently working on creating one large container with exchangeable filters and solar collectors to heat the oil up more quickly. This new process would speed things up to about one day, a vast improvement from the approximate two weeks it currently takes.

Student Awards

Graduate Student Awards

American Bureau of Shipping Scholarship for Demonstrated Excellence in an Incoming Graduate Student in Ocean Engineering

Josh Leighton and Daniel Hanks (2010)

Matthew L. Gildner and Leah R. Mendelson (2011)

Carl G. Sontheimer Prize for Creativity and Innovation in Design

Jesse Austin-Breneman, Barry Kudrowitz, and Geoff Tsai (2010)

Daniel S. Codd, Heidi Q. Chen, Lisa A. Schlecht, and Caroline M. Hane-Weijman (2011)

Clement F. Burnap Award for Outstanding Masters of Science in the Marine Field

Emmanouil Sarris and Gregory E. Fennell (2011)

John C. and Elizabeth J. Chato Award for Excellence in Bioengineering

Michaelle Mayalu (2010)

Sean M. Cockey, Bonnie L. Blackburn, and Jillian M. Oliveira (2011)

Luis de Florez Award for Graduate Design

Conor Walsh (2010)

Jacob E. McKenzie (2011)

Luis de Florez Award for Graduate Science

Jonathan Hopkins and Robert Panas (2010)

Daniel J. Payen (2011)

Meredith Kamm Memorial Award for Excellence in a Female Graduate Student

Lisa Burton (2010)

Yi "Ellen" Chen and Maria J. Telleria (2011)

Rabinowicz Tribology Award for Outstanding Graduate Research in Tribology

Michael P. Roberts and Sanha Kim (2011)

School of Engineering Graduate Student Extraordinary Teaching and Mentoring Award

Amos Winter (2010)

Wunsch Foundation Silent Hoist and Crane Award for Outstanding TA in Course 2.674

Marco Cartas (2010)

Wunsch Foundation Silent Hoist and Crane Award for Outstanding Performance in Course 2N

Jon Gibbs, Roberto Urrutia, and Phil Menard (2010)

Wunsch Foundation Silent Hoist and Crane Award for Outstanding Graduate Research

Sheng Shen and Reza Sharifi Sedeh (2010)

Hyukmin Kwon and David Smith (2010)

Wunsch Foundation Silent Hoist and Crane Award for Outstanding Thesis

John A. Williams (2010)

Wunsch Foundation Silent Hoist and Crane Award for Outstanding TA in Course 2.002

Ashley Browning and Benjamin Druecke (2010)

Claudio V. DiLeo and Kaspar A. Loeffel (2011)

Wunsch Foundation Silent Hoist and Crane Award for Outstanding TA in Course 2.003

Audren D.P. Cloitre and Jason S. Ku (2011)

Wunsch Foundation Silent Hoist and Crane Award for Outstanding TA in Course 2.007

Shane Colton and Mohammad Imani-Nejad (2010)

Wunsch Foundation Silent Hoist and Crane Award for Outstanding TA in Course 2.086

James D. Penn and Masayuki Yano (2011)

Undergraduate Student Awards

Alfred A.H. Keil Ocean Engineering Development Fund Award for Excellence in Broad-Based Research in Ocean Engineering

Roberto Melendez (2010)

Javier E. Ramos (2011)

AMP Inc. Award for Outstanding Performance in Course 2.002

Vibin A. Kundukulam, Emily Shao, and Richard Larson (2010)

Nigel C. Kojimoto and Marcel A. Thomas (2011)

Department Service Award for Outstanding Service to the M.E. Department

Erika Bildsten, John Boghossian, Toomas Sepp, Katrina Schoen, Tish Scolnik, and William Vega-Brown (2010)

Heather E. McDonald and Linda Liu (2011)

Ernest Cravalho Award for Outstanding Performance in Thermal Fluids Engineering

Vibin A. Kundukulam (2011)

International Competition Winners for 2.007

Randall Briggs, Dan Fourie, Joseph Conte, and John Romanishin (2010)

Wyatt Ubellacker, Cecilia Cantu, Jackson Crane, and Bee Vang (2011)

Lauren Tsai Memorial Award for Academic Excellence by a Graduating Senior

Emily Houston (2010)

Lauren R. Hernley (2011)

Link Foundation Fellowship for Creativity and Innovation in Design

Jordan Stanway (2010)

Lockheed Martin Prize for Outstanding Sophomore in Mechanical & Systems Engineering

Ari. S. Umans (2011)

Louis N. Tuomala Award for Outstanding Performance in Thermal Fluids Engineering

Reuben M. Aronson (2011)

Luis de Florez Award for Undergraduate Design

Andrew Marecki (2010)

Ian McKay (2011)

Luis de Florez Award for Audience E-mail Competition

Samuel Weiss (2010)

Park Award for Outstanding Performance in Manufacturing

Kevin Rustagi and Evan Schneider (2010)

Luke M. Mooney and Emily W. Tow (2011)

Peter Griffith Prize for Outstanding Experimental Project

Katherine M. Smyth (2010)

Yoshio S. Perez (2011)

Rabinowicz Tribology Award for Outstanding Undergraduate Research in Tribology

Michael P. Roberts (2011)

Robert Bruce Wallace Academic Prize for Academic Excellence in Ocean Engineering

Roberto J. Melendez (2011)

Society of Naval Architecture and Marine Engineering Award for Outstanding Student in the Marine Field

Matt Gildner and Leah Hokanson (2010)

Marie McGraw, Milo Feinberg, and Christian Welch (2011)

Thomas Sheridan Prize for Academic Excellence by a Graduating Senior

Gregory Tao (2010)

Brendan J. Englot (2011)

Whitelaw Prize for Originality in 2.007 Design and Contest

Laura Ware and Brett van Zuiden (2010)

Phitchaya “Mangpo” Phothilimthana (2011)

Faculty Awards

2011 Phi Beta Kappa Inductees

- John Boghossian
- Carmen Graves
- Caroline Hane-Weijman
- Vibin A. Kunukulam
- Linda Liu
- Michael Roberts
- Katrina Schoen
- William Vega-Brown
- Teerawut Wannaphahoon

Wunsch Foundation Silent Hoist and Crane Award for Outstanding Undergraduate Student

Trevor Shannon (2010)

Wunsch Foundation Silent Hoist and Crane Award for Academic Excellence

Nadia Tepper, Jenna McKown, and Samuel Weiss (2010)

Omar O. Abudayyeh, John G. Boghossian, Riley E. Brandt, Carmen M. Graves, Daniel M. Kubaczyk, Vibin A. Kundukulam, Peter Lu, Amy Qian, Michael P. Roberts, Emily C. Shao, and Kathryn Olesnavage (2011)

Triantaphyllos Akylas

Triantaphyllos Akylas was recently elected a fellow of the American Physical Society. The society recognized him for his “elegant and insightful theoretical investigations of nonlinear surface and internal gravity wave phenomena.”

Harry Asada

Harry Asada, Ford Professor of Engineering and Director of the d’Arbeloff Laboratory for Information Systems and Technology, was recently recognized with the 2011 Ruth & Joel Spira Award for Distinguished Teaching. Harry was also recognized with the prestigious 2011 ASME Rufus Oldenburger Medal for lifetime achievement in automatic control.

George Barbastathis

George Barbastathis, SMART Research Professor of Optics and Professor of Mechanical Engineering, was recently named a fellow of the Optical Society of America. In addition, the result of recent research, his amazing Invisibility Cloak, was recently named No. 4 on *Physics World’s* list of top 10 breakthroughs in 2010.

Gang Chen

In recognition of his outstanding mentoring contributions as a professor in MIT’s School of Engineering, Gang Chen has been selected as a recipient of the 2011 Capers and Marion McDonald Mentor Award.

Douglas P. Hart

Lantos Technologies, an MIT spinoff cofounded by Mechanical Engineering Professor Douglas P. Hart and Sloan School of Management graduate Shahid Azim, recently won the 2011 North American Enabling Technologies Award for an invention that dramatically increases the functionality of hearing aids.

Anette (Peko) Hosoi

Peko Hosoi, Associate Professor of Mechanical Engineering, was recently selected for the 2011 Bose Award for Excellence in Teaching.

Franz Hover

Professor Franz Hover was recently named the Finmeccanica Career Development Chair of Engineering.

MechE Department News

Peter So

Professor Peter So was recently named the SMART Research Professor of Bioinstrumentation and Bio-imaging.

Kripa Varanasi

Kripa Varanasi, the d'Arbeloff Assistant Professor and leader of the Lab for Surface Science & Engineering, has won the Best Practice Award for research and discovery in life sciences. Effective on July 1, 2011, Kripa will become the Doherty Career Development Chair in Ocean Utilization.

Evelyn Wang

Evelyn Wang, Esther and Harold E. Edgerton Assistant Professor, recently won the Air Force Office of Scientific Research Young Investigator Award.

Staff Awards

This past February, Instructor **Barbara Hughey** was honored at the MIT Excellence Awards for her exceptional teaching in the core undergraduate 2.671 instrumentation laboratory.

Ed Jacobson, Administrative Assistant II, was the 2011 recipient of the Joseph (Tiny) Caloggero Service Award for his outstanding contribution to the Department of Mechanical Engineering.

Angela Mickunas, Asst. Director for Administration and Research, KFUPM, won this year's Infinite Mile Award for her willingness to go above and beyond in her service to the Center for Clean Water and Clean Energy.

Invisibility Cloak Unveiled

In conjunction with his team at the Singapore MIT Alliance of Research and Technology (SMART), George Barbastathis, Singapore Research Professor of Optics and Professor of Mechanical Engineering at MIT, was recently acknowledged for his work on an invisibility cloak, which was named No. 4 of the top 10 breakthroughs in 2010 by *Physics World*.

The cloak works by placing a wedge of calcite crystal—a crystalline form of calcium carbonate, the main ingredient in seashells and stalactites/stalagmites in caves—over an object. When the object is then illuminated by visible light and viewed from the direction perpendicular to the wedge, it "disappears" from sight, because the observer perceives the wedge as flat, and thus nonexistent.

For now, the system is essentially two-dimensional, limiting the cloaking effect to a narrow range of angles, but Barbastathis, in conjunction with co-researchers SMART postdoctoral fellow Baile Zhang, MIT postdoctoral fellow Yuan Luo, and SMART researcher Xiaogang Liu, says they have some ideas about how to make it three-dimensional.

Aside from its obvious potential applications in defense or law enforcement, the ability to render something invisible could have uses in research, Barbastathis suggests, such as providing a way to monitor animal behavior without any visible distraction.

Two MechE Teams Win Prestigious Three-in-Five Competition for Innovative Product Design

During the recent annual Design of Medical Devices Conference, teams from MechE Course 2.75 Design of Medical Devices won two out of three prizes in the prestigious Three-in-Five Competition. The competition handpicks eight teams with rapid translational potential to pitch their product by presenting three slides in five minutes.

One of the winning MIT teams, comprised of presenter Thomas Cervantes, Edward Summers, Rachel Batzer, Julia Stark, Raymond Lewis, Christie Simpson, and Dr. Nadeem Dhanani, pitched a renal cooling device for use in minimally invasive surgery. The other winning MIT team, comprised of presenter Thomas Lipoma, Pablo Bello, Carson Darling, and Dr. Matthew Bianchi, presented a shirt fitted with sensors to monitor sleep at home.

Each winning team received a $500 prize and an invitation to publish in the *ASME Journal of Medical Devices*.

Robot-Assisted Therapy Named a Top Advance in Stroke Research

The American Heart Association and the American Stroke Association selected the work of Dr. Igo Hermano Krebs, Principal Research Scientist and Lecturer in the Department of Mechanical Engineering, as one of the top 10 advances in stroke research in 2010.

With strokes affecting more than 6 million Americans and becoming a leading cause of long-term disability, usually in an upper limb, Krebs and his colleagues were interested in finding a way to increase arm mobility six months post-stroke, a time period for which nothing has been shown to definitively improve functionality. The team published results of their research in the *New England Journal of Medicine* that show that robot-assisted therapy increases improvement significantly after 36 weeks compared with usual care.

MechE in memoriam

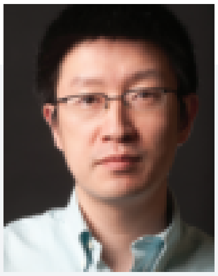
Frank A. McClintock

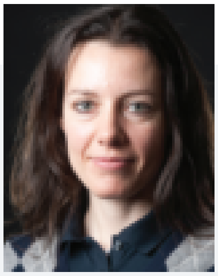
Frank Ambrose McClintock (SB ’43, SM ’43), Professor Emeritus in the Department of Mechanical Engineering, died on February 20, 2011, in Needham, Mass., at age 90.

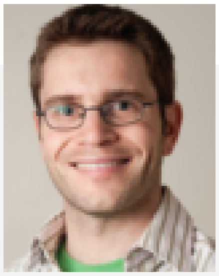
McClintock was born in 1921 in St. Paul, Minn., and earned his SB and SM degrees from MIT in 1943, and his PhD from the California Institute of Technology in 1950. He was named Assistant Professor of Mechanical Engineering at MIT in 1949; by 1959, he had risen to the level of Full Professor. He retired from the Institute in 1990. McClintock was a pioneer in the melding of applied mechanics and materials science. In 1966, he co-authored a book on the subject with Ali Argon titled *Mechanical Behavior of Materials* that remains in print to this day.

His professional contributions revolutionized the understanding of the fracture processes in engineering practice by introducing a physical and mechanistic perspective emphasizing the plasticity aspects of ductile fracture and fatigue crack propagation.

New MechE Faculty


Nicholas X. Fang
Associate Professor


Domitilla Del Vecchio
Assistant Professor


Ken Kamrin
Assistant Professor


Pedro Miguel Reis
Assistant Professor


Kostya Turitsyn
Assistant Professor

Nicholas X. Fang
Associate Professor

Nicholas X. Fang received his BS and MS in physics from Nanjing University, and his PhD in mechanical engineering from University of California Los Angeles. He arrived at MIT earlier this year as an associate professor in MechE. Prior to MIT, he worked as an assistant professor at the University of Illinois Urbana-Champaign. Professor Fang's areas of research are in nanophotonics and 3D nanomanufacturing. He was an invited participant of the Frontiers of Engineering Conference by National Academies in 2010; he won the NSF CAREER Award in 2009, the Society of Manufacturing Engineering Outstanding Young Investigator Award in 2009, the MIT *Technology Review Magazine's* 35 Young Innovators Award in 2008, and the ASME Pi Tau Sigma Gold Medal Award in 2006.

Domitilla Del Vecchio
W. M. Keck Career Development Assistant Professor

Domitilla Del Vecchio received a PhD in control and dynamical systems from the California Institute of Technology, and the Laurea degree in electrical engineering from the University of Rome at Tor Vergata. She was an assistant professor in the Department of Electrical Engineering and Computer Science at the University of Michigan for four years before joining MIT. Professor Del Vecchio is a recipient of the Donald P. Eckman Award from the American Automatic Control Council (2010); the NSF Career Award (2007); the Crosby Award, University of Michigan (2007); the American Control Conference Best Student Paper Award (2004); and the Bank of Italy Fellowship (2000). Her research interests include analysis and control of nonlinear and hybrid dynamical systems, and the analysis and design of bio-molecular networks.

Ken Kamrin
Assistant Professor

Ken Kamrin earned his PhD in applied mathematics at MIT in 2008 under the supervision of Professor M.Z. Bazant. His research area is in the mechanics of deformable materials, with a focus on complex constitutive models, primarily for granular materials, as well as numerical simulation methods. He was awarded the Metropolis Award in 2010 for the best dissertation in computational physics by the American Physical Society.

Pedro Miguel Reis
Esther and Harold E. Edgerton Assistant Professor

Pedro Miguel Reis came to MIT with a joint appointment in the Mechanical Engineering and Civil and Environmental Engineering Departments. His research focuses on the mechanics of thin elastic objects under large deformations, which may couple with other phenomena such as adhesion, fracture, and flow. Professor Reis received a BSc in physics from the University of Manchester, a certificate of Advanced Mathematics from St. John's College and Department of Applied Mathematics and Theoretical Physics at the University of Cambridge, and a PhD in physics from the University of Manchester.

Kostya Turitsyn
Assistant Professor

Konstantin (Kostya) Turitsyn earned his PhD at the Landau Institute in Moscow, with a focus on nonlinear dynamics and statistical mechanics. His PhD thesis, completed in 2007, focused on the dynamics of polymers in random flows. Later, as a Rice-Kadanoff post-doctoral fellow at the University of Chicago, he worked on a wide variety of problems, including the nonlinear dynamics of vesicles in external flows, the dynamic collapse of gas cavities, the dynamics of plugs in microfluidic channels, and nonlinear waves in optical fibers. Before joining MIT, he was an Oppenheimer fellow at Los Alamos National Laboratory.

Talking Shop

Assistant Professor Sangbae Kim

How does biology inform your research?

Our core motivation is to discover the design principles of biological systems to implement in robotic design. Simply mimicking their mechanical features may not be an effective method, because, unlike in nature where every feature needs to function alongside other physiological requirements, such as growth, reproduction, and digestion, engineers don't need to consider these things. After learning more about biology through literature and discussions with biologists, I realized it takes much deeper reasoning to extract principles from such complex systems with intermingled design requirements.

Our research is centered around the idea of testing our hypotheses about biological design to ultimately solve our engineering problems. Because there are so many constraints and variables in nature, we decided to try testing in an engineering domain. Interestingly, sometimes the principles inspired from biological study is verified in robotics systems but not applicable to biological systems, due to that complexity.

How do you apply this information to your work in robotics?

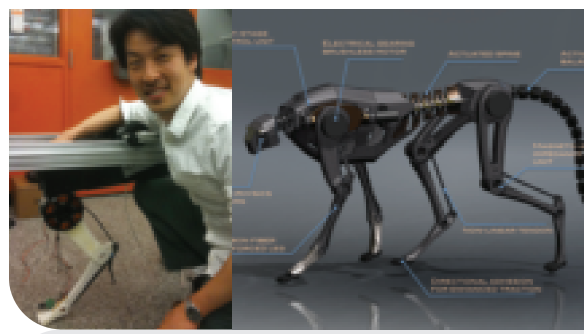
We are trying to develop design and control principles to enhance the mobility of robots through these interdisciplinary research activities. There have been tremendous advances in robotic intelligence systems, but the mobility of robots is still very limited. For them to be useful in hazardous environments, or even in our living spaces, mobility is a critical factor. That, combined with the interest in how animals work, was the impetus for the hyperdynamic robotics we're working on now.

Explain your current project, a robotic cheetah.

The fastest land animals, reaching speeds of about 70mph, cheetahs are fascinating. We are trying to extract design principles from these extraordinary creatures to develop dynamic mobile robots.

We have very little data for cheetahs, but there are two behaviors we found fascinating. One is that we noticed that cheetahs use their backs so much more than other animals, for example, greyhounds. We hypothesize that it helps them run faster. Their tail movements are very interesting too. When cheetahs change direction while they're running, their tails are whipped in the opposite direction. These are both very interesting phenomena but extremely difficult to analyze. We are excited to implement our hypothesized design principles in our robotic systems and evaluate them.

There are many unexplored principles in biological design. It's thrilling to discover them since they advance our engineering system building blocks. But an even more vital benefit of bio-inspiration is its ability to introduce a new perspective. We created airplanes by implementing the principles from birds, but we may never have even thought about flying if there were not flying animals.



Sangbae Kim joined the MIT Department of Mechanical Engineering in May 2009. He received a PhD from Stanford University, followed by a post-doctoral appointment at Harvard University's Micro Robotics Lab. His research focuses on bio-inspired robotics and adhesion, and his work has been featured in several media outlets, including The Discovery Channel, *Forbes Magazine*, and *National Geographic*. In 2006, his Stickybot creation was selected as one of *Time* magazine's best inventions of the year.

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Coming in the next issue:

- MechE Research in Clean Energy
- The M.Eng in Manufacturing: Innovation and Leadership in Manufacturing Education

This past March, the Naval Sea Systems Command, sponsor of the Department of Mechanical Engineering's Course 2N (Naval Construction and Engineering), invited MIT faculty to tour the Navy's newest nuclear-powered aircraft carrier. Department Head Mary Boyce, Associate Department Head Gareth McKinley, Professor Franz Hover, and Associate Professor of the Practice and Naval Officer Pete Small observe flight operations from the flight deck of the USS George H. W. Bush (CVN-77).

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