MITMECHE

Fall 2010

Vol. 1, No. 2 Published twice a year

Massachusetts Institute of Technology

MechEConnects

News from the MIT
Department of Mechanical Engineering

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The IDDS effect: Senior Lecturer Amy Smith triggers the next wave of development

When she joined the staff of the Edgerton Center in 2000, Amy Smith began inspiring MIT students to study engineering for developing countries.

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Mens et Manus … bringing MechE solutions to global challenges

Dear Friends,

We were pleased with the enthusiastic response to our first issue of *MechE Connects* last spring. In this issue, I am excited to share with you the wide range of department activities that have occurred in recent months.

Last spring was capped by commencement celebrations in the MechE graduation tent. Our tent has quickly become a tradition, providing a festive gathering place where faculty and students can celebrate. Summer brought the intense focus of faculty, students, and postdocs on research projects. We also had the opportunity to use our laboratories to communicate the excitement of engineering to high school students, through our popular ME Women's Technology Program, and to entering freshman, through our Discover Ocean Engineering, Discover Mechanical Engineering, and Discover Product Development programs.

This fall, we welcomed 162 sophomores into the department, raising our undergraduate enrollment to 500—the largest in recent history. We also welcomed 525 new graduate students. The combination of exceptional students and faculty working on problems with global impact secures our national and international leadership in mechanical engineering, and we are pleased once again to have our undergraduate and graduate programs ranked #1 by *U.S. News & World Report*.

Thanks to generous alumni donations, we are transforming our space in the original 19th-century campus buildings into areas suitable for 21st-century education and research. Several labs have been renovated for research by new faculty members. A major renovation of our historic Heat Transfer Laboratory is complete and is highlighted in this issue. We also have transformed our "Mechanical Engineering Corridor" on the first floor of Building 1 into a formal entrance that includes the Mechanical Engineering Student Commons. This new gateway to the department is a central meeting and workspace for our undergraduate and graduate students.

In this issue of *MechE Connects*, we also celebrate the department's increasing focus on bringing mechanical engineering solutions to challenges with global and humanitarian impact. We begin with Senior Lecturer Amy Smith SB '84, SM '95, named by *Time* magazine as one of the 100 most influential people in the world. Amy's students use technical know-how to solve real problems in developing nations. Her course "Design for Developing Countries," or D-Lab, has pioneered the inclusion of humanitarian design in the curriculums of major institutions.

You will also learn about the impact of MechE research on another global challenge—the production of clean drinking water in both the developing and the developed world, a topic that several MechE faculty members are researching. In this issue, we highlight work in water purification and desalination.

Finally, let me thank all of you for your continued interest in and support of the Mechanical Engineering Department. We invite you to join us on campus for festivities surrounding MIT's sesquicentennial, *MIT150 Inventional Wisdom*. Our open house is on April 30, and you can preview all the Institute's special events and activities at mit150.mit.edu. We look forward to celebrating 150 years of MIT together.

Mary C. Boyce

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

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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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Contact MechE

Department of Mechanical Engineering
Massachusetts Institute of Technology
77 Massachusetts Avenue, Room 3-173
Cambridge, MA 02139

E-mail: mecheconnects@mit.edu

mecheconnects.mit.edu

Newsletter Staff:

Jordan Lewis
Editor/Writer

Sucharita Berger Ghosh
Administrative Officer

B. Harris Crist
Webmaster

Robert & Kathleen Thurston-Lighty
Editorial Contributors

Wing Ngan
Designer

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The IDDS effect: Senior Lecturer Amy Smith triggers the next wave of development

When an inventor flexes her wings in the MIT Department of Mechanical Engineering, a tornado of innovation sweeps across the developing world. This growing phenomenon is the IDDS effect—the International Design Development Summit—and its origins can be traced to MechE Senior Lecturer Amy Smith.

Smith, who was recognized recently by *Time* magazine as one of the world's most influential people, admits she's a bit surprised to find herself at the center of this whirlwind of progress. "I was one of those super-shy, skinny kids in elementary school," says Smith, "but I'll confess that I had a stubborn streak, and I was always determined to try and do the right thing."

A vision in the wilderness

When it comes to mechanical engineering, the right thing in Smith's worldview is to crowd source invention, fabrication, and distribution of technologies that improve the lives of people living in poverty. The resolve to implement this vision came to her in the wilderness—literally.

After receiving her undergraduate degree in mechanical engineering at MIT in 1984, Smith spent four years in Botswana as a Peace Corp volunteer. She was teaching junior high math, science, and English. As much as she loved teaching, Smith missed the creative problem solving of design work. Then one day in the middle of the Kalahari Desert, her life's work came into focus. "I had sort of an epiphany," Smith told the *Boston Business Journal* in 2000. "I was sitting at my desk, looking out over the bush, when I realized I wanted to do engineering for developing countries."

Smith came back to MIT and completed her master's degree in mechanical engineering in 1995. She also started cranking out inventions and winning awards. When she joined the staff of the Edgerton Center in 2000, Smith began looking for ways to inspire MIT students to follow in her footsteps. Over the next three years, she founded or helped found the MIT IDEAS Competition, the Service Learning Initiative at MIT, and D-Lab, a program that teaches students how to develop appropriate technologies and sustainable solutions within the framework of international development.

The birth of IDDS

Smith launched her latest and most revolutionary MIT-sponsored educational innovation—the International Design Development Summit (IDDS)—in 2007. The summit was co-sponsored by Olin College and Cooper Perkins, a technology development company based in Lexington, Massachusetts. "Our goal was simple," she says. "We wanted to develop the creative capacity of communities and individuals in a way that is respectful of the fact that everyone who participates in the process has a real contribution to make."

Smith described the essence of the original vision for IDDS in a funding proposal to the Rockefeller Foundation.

> *Imagine a forum where a doctor from Pakistan is working alongside an agronomist from Haiti and students from Zambia and Brazil to create technologies that will dramatically improve the lives of the world's poorest people. A forum where the director of a small technology center in rural Tanzania learns how to use state-of-the-art rapid prototyping equipment to develop pedal-powered pumps to supply his village with water. A forum where students from MIT, Caltech, and universities around the world come together in the spirit of collaboration, not competition, to use their knowledge and energy to create an impact in the world.*

The first summit convened on the MIT campus in the summer of 2007. Fifty participants from 20 countries spent a month working together on water treatment systems, low-cost lighting technologies, improved cook stoves, and other practical devices targeted at the developing world. It was a life-changing experience for many attendees. "[IDDS] opened my eyes to how technology is a pillar of sustainable development, and that it is the small solutions that make the difference and bring about change," commented one participant. Another said, "IDDS 2007 has left a permanent design scar on my mind. I think design, speak design, and act design."

More than half of the participants were students who were inspired to work side-by-side with field practitioners with little or no formal training. Teams were intentionally diverse in terms of culture, education, and work experience, and each group had a mentor with deep knowledge of the project at hand. "People began to see very early on that inventiveness is not restricted to those who have a formal education," says Smith. "This helped create an atmosphere of excitement, energy, and rapid learning."

When Jodie met Bernard

The story of Jodie Wu BS '09 and Bernard Kiwia is typical of how the IDDS effect is reverberating in the developing world. Kiwia was working as a bicycle mechanic when he made the trip from Tanzania to MIT to participate in the first IDDS in 2007. At the summit, he learned about bicycle-powered agricultural technologies from Carlos Machán, director of the Guatemalan NGO Maya Pedal. That encounter, plus

Amy's enterprises

Here's a sample of what Amy Smith has been up to at MIT:

Inventions

- motorized hammer mill to grind flour (1994/95)
- non-electrical phase-change incubator (1999)
- tool process that converts farm waste into cleaner burning charcoal (2003, in collaboration with Shawn Frayne)

Awards

- B.F. Goodrich Collegiate Inventors Award (1999)
- MIT-Lemelson Student Prize (2000)
- MacArthur Fellowship "genius" grant (2004-2010)
- *Popular Mechanics* Breakthrough Award (2008)
- *Time* Magazine - 2010 "World's Most Influential People"

Key collaborators

MechE students and alumni have been integral to the success of IDDS.

- Nadia Elkordy SB '08
- Amber Houghstow SB '10
- Benjamin Linder SM '93, PhD '99
- Harald Quintus-Bosz SB '90
- Rebecca Smith SB '09
- Lisa Tacoronte SB '10
- Ashley Thomas SB '08
- Jessica Vechakul SB '05, SM '08
- Jodie Wu SB '09
- Aron Zingman SB '07

Read bios of key IDDS collaborators at iddsummit.org/people.

the IDDS design curriculum, jump-started Kiwia's career as an inventor. He returned to Tanzania after the summit and began to produce a variety of bicycle-powered devices to address local needs. "I used to fix bikes," Kiwia says. "Now I make things."

Wu's encounter with the IDDS effect was triggered by her participation in one of Amy Smith's D-Lab classes in the fall of 2007. During the semester, Wu learned about a maize sheller originally developed by Maya Pedal. Energized by Smith's vision of disseminating affordable, appropriate technologies, Wu decided to test the sheller's potential in Tanzanian villages on her D-Lab trip during MIT's Independent Activities Period (IAP) in January 2008.

Although local response to the sheller was encouraging, farmers also pointed out a drawback to the design. To build the Maya Pedal device, a bicycle had to be dismantled for parts—a serious limitation in a region of the world where bicycles are an important means of transportation.

Such feedback from villagers was critical in helping Wu identify potential barriers to widespread adoption of the technology, but it wasn't the only revelation she experienced on the trip. Equally important was a stop at Kiwia's workshop in the city of Arusha. "It was the first place where I had seen local technology created right there in the workshop," Wu told the MIT News Office in 2008.

Wu got her chance to tinker with the maize sheller when she took another D-Lab course in the spring of 2008. For a group project, Wu and her classmates decided to improve the version of the device she had previously taken to Tanzania. The team adapted the sheller so that it could be bolted easily onto an ordinary bicycle frame as needed.

A firm pedal-push forward

Jodie Wu's maize sheller processes grain 30 times faster than the device it replaces. Explore GCS's product line at globalcyclesolutions.com.

IDDS 2010 ventures launch

A major component of the 2010 summit was to develop sustainable enterprise models and plans for production and launch of nine ventures:

AYZH (India)—disseminating appropriate technologies like a home water filtration unit and a birthing kit for midwives.

Fuel from the Fields (Haiti/Rwanda)—creating micro-enterprises that produce clean-burning cooking fuel from agricultural waste materials.

Lo Chlorine (India/East Africa)—producing chlorine and dispensing it accurately to provide safe drinking water.

Solar Innovations Organization (Brazil)—employing solar technology to improve the lives of the urban poor.

Running Water (Kenya)—using sustainable business models to bring clean water solutions to communities in Kenya.

Just Milk (Africa)—reducing the transmission of HIV/AIDS from breastfeeding mothers to their children.

SEED (Bangladesh/India)—providing affordable irrigation products for small plot farmers in Bangladesh and India.

Abari (Nepal)—using a low-cost treatment of bamboo to improve its performance as a construction material.

Sollys Lighting (India/Ghana)—providing low-cost solar lighting to rural communities.

When the operator finished shelling, the equipment could be quickly detached. The bicycle was thus available for riding again and could transport the sheller for use in another location. It could even generate income for the operator.

With support from the Baker Foundation and MIT's Public Service Center, Wu took the improved sheller back on the road in Tanzania that summer. "It was exciting to see my device, which I'd worked on with other students, being used by people who are now making money from it," said Wu.

That return trip was so successful that Wu decided to pursue the enterprise full time. She launched Global Cycle Solutions (GCS) in 2009 after winning the Development Track of the MIT $100K Competition. Kiwia—who has invented a pedal-powered hacksaw, drill press, and cell phone charger—leads the company's R&D efforts and supervises manufacturing. Nine members of GCS's board and management teams have MIT connections, including D-Lab instructor Gwyndaf Jones, mechanical engineering student Caroline Hane-Weijlman '11, and IDDS organizer Daniel Mokrauer-Madden.

A vast wake of entrepreneurship

In the wake of IDDS summer events in 2007, 2008, and 2009, similar partnerships began sprouting up across the developing world. People were linking up as a result of the summits, launching a network of collaborations between engineers, inventors, suppliers, and manufacturers from Zambia and India to Guatemala, Tanzania, and the U.S.

After three successful summits, including the 2009 IDDS hosted by the Kwame Nkrumah University of Science and Technology (KNUST) in Ghana, this summer's 2010 IDDS introduced a major program innovation. The central focus of the event, held at the campus of co-sponsor Colorado State University (CSU), shifted from the creation of technologies to the formation of ventures to disseminate them. Under the guidance of lead faculty Paul Hudnut of CSU, Benjamin Linder SM '93, PhD '99 of Olin College, and Harald Quintus-Bosz SB '90 of the technology development firm Cooper Perkins, participants in the 2010 summit developed sustainable business models and plans for the production and launch of nine existing small-scale enterprises.

IDDS continues to evolve in response to growing demand. "This is the next wave of development, the way I believe development should be done," says Smith. "It's all about capacity building at the local level, creating community-based networks of inventors, manufacturers, and material suppliers as we move on a dual track from prototypes to products and from projects to ventures. A lot of people believe in this model, and I think it can become pervasive."

Given the current trajectory of IDDS, the forecast is favorable. A whirlwind of positive change should continue to spread across the developing world for years to come.

IDDS 2010, participants take a break from designing and go for a day trip to Rocky Mountain National Park.

Find out more ▸ **Learn more about IDDS at iddsummit.org and D-Lab at d-lab.mit.edu.**

Gail Kendall's gift transforms an historic lab

The Rohsenow Kendall Heat Transfer Laboratory completes a total renovation

Left: The Heat Measurements Lab at MIT's former Back Bay campus (1904)

Right: Over 6,000 square feet of newly renovated lab space (2010) Image: Tony Pulsone

In the world of heat transfer and energy, Professor Warren M. Rohsenow and his student, Gail E. Kendall PhD '78, have long been associated with significant contributions to the field. So it is fitting that they should share the spotlight as namesakes of the renovated Rohsenow Kendall Heat Transfer Laboratory in the Department of Mechanical Engineering at MIT.

The lab, which began its life on MIT's Boston campus in 1870, was named for Rohsenow in 1992 to honor his three decades as director. Now the lab has undergone a gut level renovation thanks to a generous gift from Kendall. Only the concrete shell of the existing 6,000-square-foot space in the basement of Building 7 was spared in the demolition. The result is a premier heat and mass transfer research facility that includes state-of-the-art laser test cells, steam experimentation capabilities, fume hoods, enhanced electrical systems, chilled water cooling, and new meeting and office spaces.

Kendall was a doctoral student of Professor Rohsenow's in the 70s and was the second woman to receive a PhD in the MIT Department of Mechanical Engineering. She served as Professor of the Practice of Mechanical Engineering in 2000/2001 and was founding director of the Center for 21st Century Energy at MIT now known as the Center for Energy and Propulsion.

Throughout her career, Kendall has been very active in the energy industry.

As the director of strategic science and technology at the Electric Power Research Institute in the late 1990s, Kendall oversaw a technology innovation portfolio that included energy conversion, delivery, sustainability, and the health and environmental effects of energy use. In her most recent role as an industry executive, Kendall directed Group Environmental Affairs at CLP Holdings (China Light and Power) for eight years until her retirement in 2009. Kendall continues to work as an independent environmental services consultant from her home base in San Francisco.

Find out more ► **Read more about the lab in the research section of the MechE website meche.mit.edu/research/energy.**

The Rainmakers: John Lienhard and his colleagues are rethinking the production of drinking water

"More than one billion people lack access to clean drinking water, and the situation is only expected to get worse."

John Lienhard

Professor John H. Lienhard V
Image: Len Rubenstein

MIT's motto "Mind and Hand" is more than a slogan to mechanical engineers at MIT. It's a credo they live every day. John Lienhard, for example. The MechE professor and his colleagues have spent the last two years working on the critical problem of how to get clean drinking water to people across the world who need it.

"More than one billion people lack access to clean drinking water, and the situation is only expected to get worse," says Lienhard, director of the Center for Clean Water and Clean Energy at MIT and at King Fahd University of Petroleum and Minerals. His solution: desalination—removing salt from seawater to produce potable water. Lienhard and a team of colleagues have immersed themselves in the challenges of desalination, and they're making significant strides.

One of the problems with commercial desalination systems is that they can't meet the needs of enough people, especially those in developing countries. They are also expensive, energy-intensive, rely on fossil fuels, and require a distribution infrastructure. As a result, desalinated water is often not available in poor or rural areas.

Lienhard and his team turned to nature for inspiration: the evaporation of seawater, leaving salts behind, followed by the condensation of that water vapor into fresh water is basically the atmospheric process that results in rain. Known as humidification-dehumidification (HD) desalination, the system assigns these basic natural processes to distinct components, such as a solar collector and a humidifier. Among other advantages, says Lienhard, HD can use an energy source readily available in many third-world countries—the sun.

Attacking the problem with thermodynamics

HD does have a downside, however. It's not energy efficient. Lienhard and his team wondered if the process could be made greener and analyzed the thermodynamics behind different HD systems. "It turns out that no one had done this carefully before," he says. "My background is in thermal science, so my 'bread and butter' is in a discipline that applies very directly to this problem."

Lienhard and his colleagues developed a set of tools that made it possible to assess the thermodynamic efficiencies of these systems, so they were able to systematically compare competing designs. Tools in hand, they investigated whether they could optimize HD—by operating the components under different pressures, for example.

The results are promising.

"We've found very substantial improvements over the efficiency of existing HD systems," Lienhard says, adding that one of the team's proposed systems could outperform a leading commercial technique with respect to the amount of energy needed to produce a liter of drinking water.

But is this a process that works for every population? Lienhard and colleagues are investigating whether HD systems can be produced inexpensively in poor or rural areas by using local materials. One of his students has explored whether the packing material key to one component—the humidifier—could be made of materials like loofah or bamboo that are native to an area. In fact, early research shows that loofah may indeed work in this application. Lienhard's team will continue to explore this and other options.

Providing potable water for everyone on the planet is daunting, but Lienhard is optimistic. "We've found that some desalination problems are very amenable to attack from the classical methods of thermodynamics." He will be addressing the International Desalination Association Energy Conference in November in Huntington Beach, California.

A version of this article, written by Elizabeth Thomson, appeared in the Summer 2010 issue of MIT Spectrum.

Early research shows that using local materials like loofah may help make HD systems more economical for poor or rural areas.

Around campus

MIT turns 150, the Gulf oil spill, and course 2.007 robots

MechE professors tapped for oil spill response

Alex Slocum, the Neil and Jane Pappalardo Professor of Mechanical Engineering and MacVicar Faculty Fellow, was invited by Steven Chu, Secretary of the U.S. Department of Energy, to help resolve the Deepwater Horizon oil spill in the Gulf of Mexico.

At the request of President Obama, Secretary Chu and Secretary of the Interior Ken Salazar assembled the panel of experts in Houston, TX to develop solutions for capping and containing the flow of oil in the Gulf. In describing the effort, Secretary Chu said, “Putting our best scientific minds together with BP’s deep water drilling engineers will enable these dedicated professionals to examine every feasible means and practical solution to this environmental crisis in the Gulf of Mexico.”

In the aftermath of the crisis, the Obama Administration directed the National Academy of Engineering (NAE) and National Research Council (NRC) to form a committee to analyze the causes of the Deepwater Horizon explosion and spill. MIT Sea Grant director, Professor Chrys Chryssostomidis and alum Dr. Roger McCarthy SM ’73, ME ’75, PhD ’77, have been nominated to this 10-member committee. The committee is tasked with identifying measures that will prevent similar accidents in the future.

Course 2.007 highlights

MechE professor Daniel Frey, PhD ’97, hosted the 39th annual 2.007 competition in which students pitted robot against robot for the 2010 course championship. The competition rink was Aztec (or Az-Tech) themed, complete with a temple and a serpent deity.

Design approaches included robotic scissor lifts, autonomous scoring features, gripper ratchets, and multiple bots working on various scoring tasks. “This year was the most exciting finale of a robotics competition I have seen in a long time,” said course instructor Dan Frey.

Course 2.007 is a critical component of the undergraduate curriculum because it requires students to incorporate creativity into their mechanical engineering designs. The course is generously supported by Chevron, Vigor Precision, Ford, General Motors, Solid Works, Exxon Mobil, National Fluid Power Association, and Shell.
See competition videos amps-web.mit.edu/public/courses/2/2.007/.

MIT turns 150

Starting January 7, 2011, MIT will begin celebrating its sesquicentennial anniversary. Special museum exhibitions, an arts festival, and a series of symposia will be presented through May of 2011. The Department of Mechanical Engineering will be participating in the convocation held on April 10th and the open house held on April 30th. Learn about celebration events and offerings specifically for alumni at the MIT150 website mit150.mit.edu.

MechE Student Commons Dedicated 11.10.2010

MechE recently increased the common-room space available to undergraduate and graduate students. Room 1-114 has been transformed into a flexible mixed-use 750-square-foot space perfect for small group projects, reading, problem sets, or just checking email. A dedication ceremony was held on Wednesday, November 10 in 1-114. Generous support for the new MechE Student Commons was provided by Byiung Jun Park ’61 and Chunghi Park.

Alumni take the lead in making change

MechE alumni are leaders in their industries and their communities

Megan Smith '86, SM '88

Megan Smith has spent her life driving change—social and mechanical. As a MechE student, she built a solar car and drove it across the Australian outback in the first Cross-Continental Solar Car race. As director of new business development at Google, she's managed strategic acquisitions that resulted in the creation of two of the company's premier tools, Google Earth and Google Maps. Smith arrived at Google from PlanetOut, an interactive media company serving the gay and lesbian community where she was CEO. "It was rewarding," she says, "to build a successful for-profit company with millions of members who come from every country in the world." PlanetOut was named a 2001 Technology Pioneer by the World Economic Forum (WEF). Smith is currently serving a five-year term as a member of the MIT Corporation. Read an in-depth profile of Megan Smith in MIT's online magazine *Infinite Connection* alum.mit.edu/.

Douglas Bailey '72, SM '74, ME '75

Doug Bailey is a role model in many realms. Scholar—he received four degrees in six years: BS, MS, and ME degrees in mechanical engineering at MIT and an MBA from Harvard. Financial leader—he is president and CEO of American Bailey Corporation, a private-equity firm in Stamford, CT that he cofounded with his father in 1984. Energy executive—he is chairman, president, and CEO of Fuel Tech, Inc., a public company that focuses on cost-effective and environmentally sustainable energy technologies. Foxtrotter—Bailey and his wife Sara are accomplished ballroom dancers, and he competes in events around the country. Philanthropist—the couple's generous gift in 2007 supports graduate fellowships in mechanical engineering. "There are many deserving places one can support, but you have to follow your heart," he says. "I chose MIT because of what it did for me and what I believe it can do for others." Spoken like a true role model.

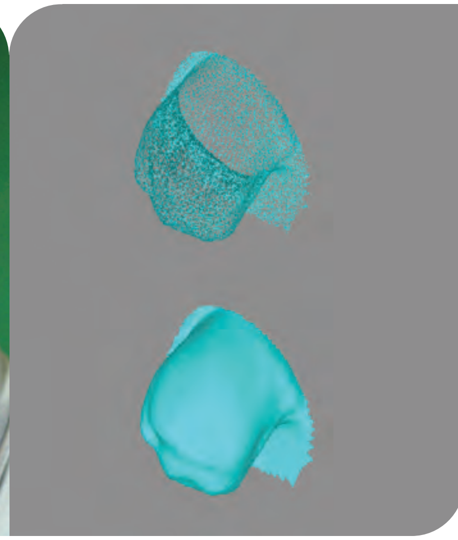
Diane Greene, SM '78

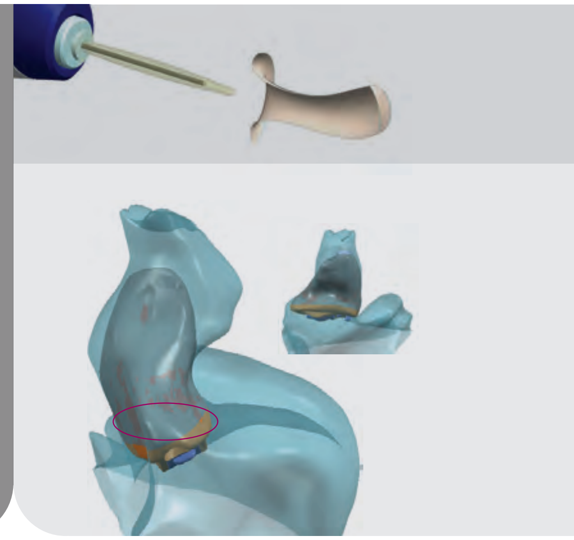
Co-founder and CEO of VMware, one of the hottest IPOs of the last five years, Diane Greene was described in *Fortune* magazine as "a techie-windsurfer-sailor" and "the toast of Silicon Valley." More to the point, she was honored by the magazine as one of the "50 Most Powerful Women in Business." She also made *The Wall Street Journal*'s venerable "50 Women to Watch" list. With degrees in mechanical engineering, naval architecture, and computer science, Greene has held technical leadership positions at Silicon Graphics, Sybase, and Tandem and was CEO of VXtreme. Under her leadership, VMware created the market for mainstream virtualization and the resulting virtualization software industry. With VMware now in her rearview mirror, Greene is making a direct impact as a member of the MIT Corporation, the board of Intuit and the Chair of the MechE visiting committee.

Hear—and now

Building a better hearing aid with 3-D imaging

Professor Douglas P. Hart





3-D images of an ear canal are used to design personalized hearing aids.

Just 20% of those who could benefit from wearing a hearing aid actually do, according to the National Institute on Deafness and other Communication Disorders. MechE Professor Douglas Hart wants to better that number.

The problem, Hart says, is fit. Getting useful sound amplification depends on a tight fit between hearing aid and ear canal. Unfortunately, the current method of modeling patients' ears is messy and not always accurate, leading to a device that often fits and functions poorly.

With 36 million Americans suffering from hearing loss, addressing the issue of fit has become an imperative. "A lot of people are likely walking around with hearing aids that don't fit," Hart says, "because they don't know what they're supposed to feel like." His solution: a new way of scanning the ear canal with 3-D imaging technology—a process that is faster, easier, and more accurate than the plaster-mold technique now in use.

Patients who require a hearing aid usually have to spend an hour with an audiologist, who fills the patient's ear canal with a gooey silicone substance. After about 15 minutes, the gel hardens into a mold that is removed from the ear and shipped to a hearing-aid manufacturer, who scans the mold and builds a custom-fit hearing aid using a 3-D printer.

The problem is that it can be difficult to achieve a tight seal between the hearing aid and the patient's ear canal with this method. But a tight seal is necessary to prevent feedback between the microphone and receiver, which can produce squealing sounds annoying to the wearer and anyone nearby.

The "Holy Grail" of hearing aid technology

Getting a precise 3-D scan of the ear canal is the "Holy Grail of the hearing-aid industry," says Scott Witt, head of research and development for hearing-aid manufacturer Phonak.

"Taking these impressions is still the messiest, least exact part of the process."

With Hart's innovation, a stretchy, balloon-like membrane is inserted into the ear canal and inflated to take the shape of the canal. The membrane is filled with a fluorescent dye that can be imaged with a tiny fiber-optic camera inside the balloon. Scanning the canal takes only a few seconds. In fact, the entire fitting process takes only a minute or two.

Because the camera captures 3-D images so quickly, it can measure how much the surface of the ear canal deforms when the pressure changes, or how the canal shape changes when the wearer chews or talks.

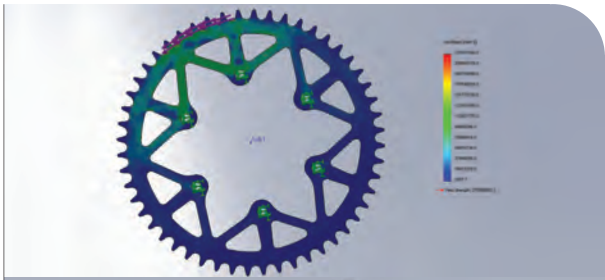
The new technology is similar to a recently commercialized 3-D scanning system that Hart developed for dentistry, designed to replace the silicone molds traditionally used to make impressions for dental crowns and bridges. Impressed by his work in this area, hearing-aid manufacturers approached him to see what he could do to improve their fitting process.

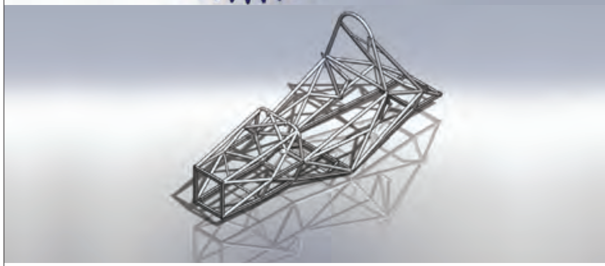
Hart's researchers have built a prototype scanner to demonstrate the proof of concept, and are now working on a handheld version of the device. Once it's ready, they plan to do a study comparing the fit of hearing aids built with the new scanner to that of traditional hearing aids.

Witt believes the MIT scanner has more potential than any other proposed imaging system he has seen in the past several years. The new technology could be seamlessly integrated into existing manufacturing practices, he says. "We could do it right now. The rest of our manufacturing process is set up to receive digital scans," he says.

The Deshpande Center for Technological Innovation funded the development of the new technology, which Hart described in a 2004 article in the journal *Applied Optics*. He patented the system in January. While his priority has been to bring the technology to hearing-aid manufacturers, he believes the innovation will also be useful in building fitted earphones for MP3 players or custom-fit earplugs for military personnel and those who work in noisy environments.

A version of this article, written by Anne Trafton, originally appeared in the online journal MIT News.





"Last summer, each member created a design for the wheel hubs. Then we ran simulations to find out which design would perform the best before we selected the winner."

MIT Motorsports team feeds the need for speed

MechE students pursue fuel economy and racing glory

MechE undergrads who enjoy fabrication in 2.007 get the chance to enhance their skills by designing precision parts for the MIT Motorsports racecar.

Accelerating from zero to 60 mph in a head-turning 3.4 seconds, MIT Motorsports' latest racecar generates 1.5 horizontal g-force as it exits the starting gate. The team behind this feat of engineering is a group of MechE students dedicated to design, fabrication, and—most definitely—speed. Team members are recruited from core MechE courses like 2.670 and 2.007.

The Motorsports team, under the leadership of Professor Dan Frey, has just begun construction on the 8th generation MIT racecar for completion in summer 2011, when the students will compete against 80 colleges in a three-day event hosted by SAE International (formerly the Society of Automotive Engineers). Teams are evaluated in multiple categories, including design, cost, fuel economy, reliability, and racing. At the 2010 finals in Fontana, CA, the highly competitive MIT team placed 8th overall.

Competition rules don't allow for a team's vehicle to be recycled from year to year, so the vehicle's core component, the frame, must be built from scratch for every competition. In fact, during the 18-month build process, the Motorsports team constructs every aspect of the vehicle except the engine itself. Specialists focus on subsystems including dynamics, fluids, thermodynamics, microelectronics, power electronics, ergonomics, and controls.

Two older Motorsports vehicles, vestiges from past competitions, are parked in the lab as reminders of how far the shop's research has evolved. "We are continually refining the parts of the vehicle to reduce mass and increase efficiency," says MechE student Erich Brandeau. "Last summer, each member created a design for the wheel hubs. Then we ran simulations to find out which design would perform the best before we selected the winner."

Adhering to the design constraints is a perpetual challenge and interpretation of the rules a constant topic of discussion. Students conduct a rigorous inspection to ensure safety and to confirm that each parameter and guideline has been incorporated. They work with software tools like Solid Works to conduct simulations before the first weld is ever tacked.

Find out more ▸ **Watch video of actual test runs at web.mit.edu/fsae/gallery/index.html.**

MIT Motorsports' corporate sponsors include Ford Motor Company, General Motors, and Schlumberger.

Student awards

SNAME Graduate Paper Prize

Four MechE graduate students, Roberto Urrutia Valenzuela, Philippe Menard, Emmanouil Sarris, and Iason Dimou, were awarded the Graduate Paper Prize by The Society of Naval Architects & Marine Engineers (SNAME). The students presented the winning paper, "DDG-51 Flight IIA Modified Repeat Project: Area Air Defense Destroyer," at the SNAME Student Paper Night hosted by MIT.

NEMB 2010 Student Poster Award

MechE graduate student Gunjan Agarwal won second place in the Best Student Poster competition at ASME's First Global Congress on Nanoengineering for Medicine and Biology (NEMB). Agarwal's project concerned the sorting of biological cells by size using self-assembly techniques. This technology has potential applications in medical research and diagnostics and tissue engineering. Agarwal conducted her research with Associate Professor Carol Livermore.

Marshall Scholar

Tanya Goldhaber, a mechanical engineering major with minors in music and brain and cognitive sciences, will pursue a doctorate degree in inclusive design at the Engineering Design Centre at the University of Cambridge with the help of a Marshall Scholarship. Goldhaber is a founding member of the Gordon Engineering Leadership Program at MIT as well as an accomplished violinist and four-time winner of an Emerson Scholarship for private study.

Goldwater Scholar

Omar Abudayyeh, a junior in mechanical engineering, was one of four MIT undergraduates among the 278 students recently named Barry M. Goldwater Scholars—an honor given to mathematics, science, and engineering students based on academic merit. Goldwater Scholars receive up to $7,500 per year for each of their remaining academic years. The awards are given to sophomores and juniors planning careers in science and engineering.

Phi Beta Kappa

Six mechanical engineering students were inducted recently into the Phi Beta Kappa Society: Emily Houston, Leo Luo, Jenna McKown, Samuel Weiss, James White, and Kent Willis.

Fulbright Scholarship

Amos Winter SM '05, PhD '10, was awarded a Fulbright Scholarship and will travel to India to continue work on the "Leveraged Freedom Chair," a wheelchair he developed specifically for use in the developing world.

The "Leveraged Freedom Chair" was also named a 2010 recipient of the R&D 100 Award by R&D Magazine.

Pi Tau Sigma

In spring 2010, fourteen students were inducted into the mechanical engineering honor society Pi Tau Sigma: Omar Abudayyeh, Stephanie Brown, John Boghossian, Mindy Eng, Evan Lampe, Tanya Goldhaber, Lauren Hernley, Vu Hong, Zachary Rose, Ian Rust, Amrita Saigal, Katrina Schoen, Will Vega-Brown, and Kent Willis

Tau Beta Pi

Five students were initiated into Tau Beta PI this past Spring: Omar Abudayyeh, Trevor James Shannon, Katrina Michelle Ellison, Vu Anh Hong, and Eric Robert Reuland.

For a complete listing of MechE student awards, please visit mecheconnects.mit.edu.

Faculty awards

IEEE-ASME Itherm Best Paper Awards

The 2010 IEEE-ASME ITherm Conference (Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems) was a success for MechE faculty members and researchers. A team that included professors Evelyn Wang, John Brisson, and Jeff Lang (electrical engineering), and their DARPA research team—Dr. Matthew McCarthy, Dr. Teresa Peters, Jon Allison, Alonso Espinosa, David Jenicek, Arthur Kariya, and Catherine Koveal—received a Best Paper Award for “Design and Analysis of High-Performance Air-Cooled Heat Exchanger with an Integrated Capillary-Pumped Loop Heat Pipe.”

At that same conference, Kripa Varanasi, d’Arbeloff Assistant Professor of Mechanical Engineering, received a Best Paper Award for “Controlling the Nucleation and Growth of Water Using Hybrid Hydrophobic-Hydrophilic Surfaces.”

Rohan Abeyaratne to receive 2010 Drucker Medal

Rohan Abeyaratne, SMART Director and the Quentin Berg Professor of Mechanics, will receive the 2010 ASME Applied Mechanics Division Drucker Medal. The Daniel C. Drucker medal was established in 1997 to recognize distinguished contributions to the field of applied mechanics and mechanical engineering through research, teaching, and service to the community over an extended period of time.

Kripa Varanasi receives DARPA Young Faculty Award

Kripa Varanasi, the d’Arbeloff Assistant Professor of Mechanical Engineering and leader of the Lab for Surface Science & Engineering in the Department of Mechanical Engineering at MIT, has received a 2010 Young Faculty Award from the Defense Advanced Research Projects Agency (DARPA).

Varanasi will use his award to focus on developing novel nanoengineered surface technology-enabled thermal-fluid systems for ultra-high-heat flux thermal management. This work could impact multiple industries spanning electronics, photonics, energy, water, agriculture and transportation. Crucial challenges in thermal management include removing heat from electronic and photonic devices while maintaining acceptable component operating temperatures.

Peko Hosoi named 2010 MacVicar Faculty Fellow

Associate Professor Peko Hosoi was recently named a 2010 MacVicar Faculty Fellow. She was specifically lauded for her outstanding undergraduate teaching, mentoring, and educational innovation.

The MacVicar Faculty Fellows Program was established in 1992 to honor the life and devotion to teaching excellence of Margaret MacVicar ’64, ScD ’67. MacVicar was MIT’s first dean for undergraduate education and founder of UROP (the Undergraduate Research Opportunities Program). The 10-year fellowship provides an annual scholar’s allowance to support faculty efforts to enrich undergraduate learning experiences.

Alexander Mitsos receives Best Practice Award for Research & Discovery in Life Sciences

Assistant Professor Alexander Mitsos received a Best Practice Award from Bio-IT World for his work in systems biology with Leo Alexopoulos at NTU Athens. Mitsos’ background in mixed-integer optimization enables Alexopoulos to reconstruct signaling networks in normal and cancerous cells. By comparing these networks with and without the effect of drugs, the two researchers are able to identify which parts of the pathway a drug is acting on.

Steven Dubowsky and Francesco Mazzini win Best Paper Award from ASME

Graduate student Francesco Mazzini and Professor Steven Dubowsky won the Best Paper Award from ASME’s Mechanisms and Robotics Committee. Their paper, “The Tactile Exploration of a Harsh Environment by a Manipulator with

Faculty awards

Joint Backlash," was presented at the 34th Mechanisms and Robotics Conference in Montreal, Canada.

Roger Kamm elected to the Institute of Medicine

Roger D. Kamm SM '73, PhD '77, the Singapore Research Professor of Biological and Mechanical Engineering at MIT, is one of 65 new members nationwide elected to the Institute of Medicine. One of four national academies in the U.S, the Institute of Medicine serves as a national resource for independent, scientifically informed analysis and recommendations on human health issues.

Kamm's research seeks to understand the fundamental nature of how cells sense and respond to mechanical stimuli. Kamm hopes to employ the principles revealed by these studies to find new treatments for vascular disease and develop tissue constructs for drug and toxicity screening. Current research activities in Kamm's laboratory fall into three broad categories: tissue engineering and microfluidics, cellular rheology, and molecular mechanics. Kamm also received the ASME H.R. Lissner Medal in the summer of 2010.

European Materials Research Society Best Poster Award

Professor Tonio Buonassisi, graduate student Sergio Castellanos, and UROP student Vidya Ganapati won Best Poster at the European Materials Research Society Meeting in Strasbourg, France for their poster "Infrared birefringence imaging of residual stress and bulk defects in multicrystalline silicon." Visiting students Stephan Schoenfelder and Sebastian Oener also participated in the project.

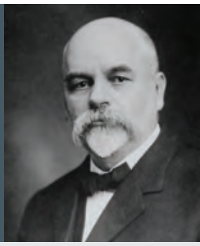
Evelyn Wang receives 2010 Air Force Young Investigator Award

Evelyn Wang, Assistant Professor of Mechancial Engineering, has received a 2010 Air Force Young Investigator Award. Wang's work aims to investigate advanced nanostructures to manipulate coupled fluidic and heat-transport processes for high-flux, two-phase microfluidic thermal-management systems. Specifically, her work will utilize nanostructure design to enhance heat transfer of both evaporator and condenser designs.

Domitilla Del Vecchio receives Eckman Award

Domitilla Del Vecchio received the 2010 Donald P. Eckman Award from the American Automatic Control Council, "For contributions to the theory and practice of hybrid dynamical systems and systems biology." Her research interests are in the control of hybrid dynamical systems with imperfect information and in the analysis and design of bio-molecular feedback systems.

Peabody Visiting Professorships in Mechanical Engineering



MechE inaugurated the distinguished Senior Visiting Professorships this spring with the visit of Professor T. Pedley FRS, the G.I. Taylor Professor of Fluid Mechanics (Emeritus) from DAMTP, University of Cambridge. Professor Pedley joined MechE on February 1, 2010 and taught a special topic class on Fluid Dynamics of Swimming (2.998). Under this program, MechE students, postdocs, and faculty will engage with highly distinguished visiting professors and promote collegiality and new collaborations between institutions.

These professorships are named in honor of Cecil Hobart Peabody (1855 – 1934). Peabody was a professor of steam engineering at MIT who helped establish the Department of Naval Architecture and Marine Engineering in 1893. After serving as the first chair of the program, Peabody continued to teach thermodynamics and steam engineering until his retirement in 1920. His contributions to the field include nine books on a wide spectrum of engineering topics.

Learn more about Cecil Hobart Peabody: web.mit.edu/hmtl/www/peabody.html

Faculty promotions

George Barbastathis
Professor

Sanjay Sarma
Professor

Thomas Peacock
Associate Professor

Alexandra Techet
Associate Professor

Kimberly Hamad-Schifferli
Associate Professor

George Barbastathis
Professor

Professor George Barbastathis has established an internationally-recognized research program in three-dimensional (3D) optical engineering. His research activities are centered on information optics—the processing and analysis of information by systems composed of optical, mechanical, and computational elements.

Professor Barbastathis' work is focused on fundamental research and application development within two principal areas. The first is digital holography and volume holography for imaging of complex biological and fluidic systems. The second is subwavelength optical engineering using novel 3D assembly methods, such as nanostructured origami. Nanostructured origami leverages precision patterning by two-dimensional lithography with folding to achieve 3D structures primarily for optics, but also for sensing and energy storage.

Professor Barbastathis developed and popularized an optics curriculum within the Department of Mechanical Engineering. His joint undergraduate/graduate course 2.71/2.710 has been offered continuously for a decade now, attracting students from across the School of Engineering and other schools at MIT.

Sanjay Sarma
Professor

Professor Sanjay Sarma's research contributions have spanned several areas: manufacturing, radio frequency Identification (RFID), and distributed and mobile sensors.

Sarma's research in manufacturing automation resulted in major innovations in work-holding, 5-axis machine tools, and 5-axis CAM systems. His research in RFID lead to the EPC suite of UHF RFID standards, which is used by more than 1,000 companies in over 30 countries. Sarma lead a team that transformed RFID tags into the new bar code, literally from concept to large-scale industrial implementation. His work, which was a game-changer in supply chain management, is now influencing new areas such as healthcare. The area has grown into a fertile field of scholarly research.

Sarma is also recognized as an exceptional educator, teaching an unusual range of core undergraduate courses ranging from disciplinary mechanics courses to the hands-on design and manufacturing courses. He has been recognized with several awards including the Institute-wide MacVicar Fellowship.

Thomas Peacock
Associate Professor
Promoted with tenure

Professor Thomas Peacock is a rising international leader in the fields of stratified flows and nonlinear dynamics. Stratified flows occur in many physical systems through spatial variations in temperature and/or composition (e.g. salinity in the ocean), leading to buoyancy-driven convection and internal waves. These internal waves are prevalent throughout the ocean and atmosphere and impact large-scale environmental phenomena, such as oceanographic mixing, as well as engineering technologies, such as submarines and pipeline operations. Many of the predicted theoretical phenomena have been quantified for the first time in Peacock's experimental laboratory.

Research in Peacock's laboratory has also revealed a novel form of self-propulsion associated with the diffusive flux of stratified fluids near solid boundaries. Most recently, Peacock has been utilizing modern ideas about Lagrangian Coherent Structures to improve decision-making strategies for ocean-based events like oil spills and air-sea rescues. A unique and distinguishing feature of Peacock's research is a careful and thorough combination of laboratory experimentation accompanied by theoretical analysis, which is reinforced by participation in large-scale field experiments.

Peacock has invigorated the department's curriculum in linear and nonlinear dynamics. He is an excellent lecturer and popular mentor as well as a skilled communicator of scientific ideas. Through his NSF CAREER award, he is helping convey the importance of the dynamics of stratified fluid flows to a broad public audience.

Alexandra Techet
Associate Professor
Promoted with tenure

Professor Alex Techet is a rising international leader in the field of experimental hydrodynamics. Her research addresses challenging problems of critical practical importance and scholarly significance, including free surface water entry of projectiles, maneuvering and propulsion of aquatic creatures, and sensing of the water/air interface of breaking waves using innovative spatial and temporal flow imaging techniques. Techet's work on the water entry of ballistic projectiles has unraveled the role of spin in cavity evolution and projectile trajectory. Her imaging of live fish maneuvering, using a novel near-infrared particle imaging velocimetry technique, has helped uncover the role of vortex rings that enable fast starts and rapid turns at low energy cost. These physics guide the design of biologically-inspired propulsion systems. Techet's group developed an innovative 3D synthetic aperture particle image velocimetry system capable of non-intrusive, non-holographic measurements of complex flow fields. Techet's research has been recognized with numerous awards, including winning images in the Gallery of Fluid Motion and an ONR Young Investigator Award.

Techet is also a talented and dedicated educator and mentor. She is committed to the vitality and vibrancy of ocean engineering education and research, including a leadership role in the MIT/WHOI joint program and as MIT PI of the Naval Engineering Education Consortium, a major new education and research initiative that will educate the next generation of civilian engineering leaders for the U.S. Navy.

Kimberly Hamad-Schifferli
Associate Professor

Professor Kimberly Hamad-Schifferli has focused her research program on the interface between nanotechnology and biology, engineering the design of nanoparticles for biomedical applications. The use of nanoparticles to control biologically relevant processes is a rapidly expanding research area due to its potential in disease detection and treatment. Hamad-Schifferli's research focuses on designing the geometry and surface chemistry of nanoparticles for controlled biomolecular release. She is the first to propose and demonstrate the use of gold nanorod size and geometry to selectively release different biomolecules, capitalizing on the size-dependent resonant absorption wavelength of the nanorods to activate release. Her group further tailors the surface chemistry of nanoparticles to control protein conformation (and function), providing design rules for protein-nanoparticle linking.
Hamad-Schifferli has introduced, in collaboration with Professor Linda Griffith, a new undergraduate course Statistical Thermodynamics of Biomolecular Systems that is now a required course in Biological Engineering.

Talking shop

Professor Evelyn Wang

Jordan Lewis asks MechE Professor Evelyn Wang about the Device Research Laboratory and the thrills and challenges of research at the nanoscale.

Your research includes solar energy, desalination, and thermal management. Is there a common thread?

Yes, they involve heat and mass transport at the micro and nanoscales. In the Device Research Laboratory, we're trying to control these processes for a wide range of mechanical engineering applications. The nanoengineered surfaces and devices we are developing can improve membranes for desalination in one project and control the cooling of solar cell arrays in another.

Cooling a solar cell array must present very different challenges from, say, cooling an automobile?

Managing the heat generated in an automobile engine versus a nuclear reactor is far different because of the scale. We have learned that to develop compact, high performance cooling devices, the dominating physics—the physics that drive the flow of fluids during phase change, for example—are not as easily defined or predictable when you work at the nanoscale.

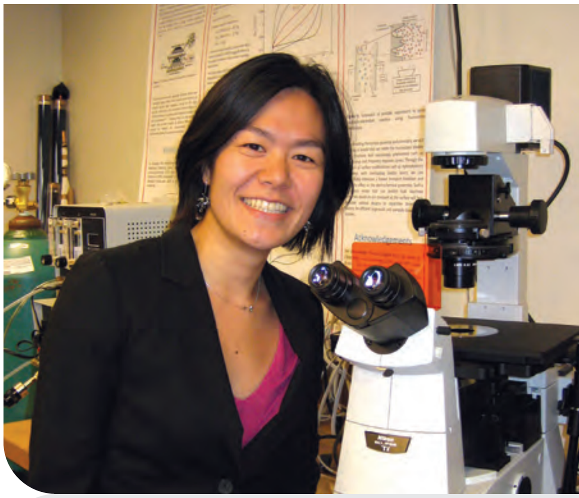
In the lab, when we use water as a cooling medium, we find that the surface tension of water plays a much bigger role in the flow than what you would find in a larger scale system. We are only starting to understand how our designs will perform at the nanoscale, and that's what makes for exciting research.

How are you applying your research to the desalination process?

We are studying zeolite crystals to see if they can be incorporated into water filtration membranes. Zeolites, which have pores that are smaller than a billionth of a meter, could offer the ideal geometry and material properties for separating salt from water, while reducing the energy required for the process. Learning exactly how this separation process occurs is the first step—but utilizing zeolites in a large-scale desalination process is our ultimate goal.

What role does your nanoscale research have in your teaching?

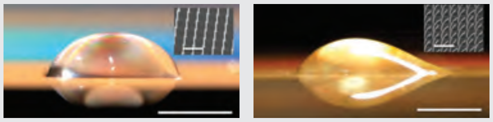
In the undergraduate thermal fluids engineering courses (2.005 and 2.006), we are often working with problems that focus on learning the fundamentals of heat transfer, fluid flow, and thermodynamics. Yet in my research, we find that scaling a process down to the nanoscale tends to introduce multiple layers of questions that complicate the answers. This semester, I'm offering an advanced undergraduate course in heat transfer (2.51) in which students can start to tackle some of the nanoscale problems that we face in the lab. And we can still apply some of the lessons learned from 2.005 and 2.006. It will be fun.



Professor Evelyn Wang, the Esther and Harold E. Edgerton Career Development Assistant Professor in Mechanical Engineering, joined the MechE faculty in 2007. She was honored with the DARPA Young Faculty Award in 2008. She earned her BS from MIT in 2000 and an MS and PhD from Stanford University in 2001 and 2006. Her recent collaboration with Professor John Brisson and their DARPA project team earned a Best Paper Award at the IEEE-ASME ITherm Conference.

Learn more: drl.mit.edu/

MechE Connects editor Jordan Lewis is a communications specialist in the Department of Mechanical Engineering.



ASYMMETRIC WETTING

Nanostructured surfaces for controlled wetting and transport from the research of Professor Evelyn Wang and her group.

MechE research news

MechE partners for naval engineering education

Under the leadership of MechE professor Alexandra Techet, MIT and eleven partner universities have formed the Naval Engineering Education Consortium (NEEC). The goal of the consortium is to train the next generation of naval civilian engineers and to promote innovation and research in naval systems engineering. The program will focus on areas of high priority to the Navy in education and research.

NEEC will train civilian engineers at both the graduate and undergraduate levels at a time when design and construction is beginning on the next generation of vessels. To encourage the best domestic science and engineering students to consider careers in Navy organizations, NEEC will engage them in Navy-related science and engineering projects that are both challenging and relevant for current and future objectives. NEEC was recently awarded $50 million in funding from the Naval Sea Systems Command (NAVSEA) over the next five and a half years, approximately $6.1 million of which was awarded to MIT. Professor Michael Triantafyllou, director of the MIT Center for Ocean Engineering, is co-principle investigator on the project.

Universities partner for bio-inspired robotics

Supported by a $1.5 million grant from the Department of Defense Office of Naval Research, researchers from four universities will join forces to study rat brains to help military robots navigate and map their surroundings. MechE professor John Leonard is one of eight researchers involved in the multidisciplinary university research initiative (MURI).

The research will focus on the ability of a robot to perform navigation toward selected goals in the environment. It will also explore the capacity for a human operator to communicate with a robot about locations and goals. The work will require robots to learn a representation of the environment during exploration while accurately recognizing location, a process called simultaneous localization and mapping (SLAM) that was developed in part by Leonard.

The researchers on this MURI grant include team leader Michael Hasselmo, Chantal Stern, and Howard Eichenbaum of Boston University, Nicholas Roy, John Leonard, and Matthew Wilson of MIT, Ila Fiete of the University of Texas at Austin, and Neil Burgess of University College, London.

University research collaboration in Singapore

The Department of Mechanical Engineer is pleased to announce the establishment of the MIT-Singapore University of Technology and Design (SUTD), a research collaboration between MIT and Singapore's Ministry of Education. MechE professor and new SUTD director Sanjay Sarma will succeed Professor Tony Patera, who led the negotiations between MIT and Singaporean officials.

SUTD will become Singapore's newest research university and will admit its first students in 2012. MIT's role will include developing curricula and advising SUTD on faculty recruitment, including a "teach the teachers" component. In addition, MIT will help develop an International Design Center (IDC) with facilities both in Singapore and at MIT. Mechanical Engineering Professor Dan Frey is co-principal investigator on the IDC project. The collaboration will bring significant financial support to MIT for curriculum development, graduate students, and faculty research.

2.674: Hands-on micro and nanoengineering

Undergraduate students can now explore micro/nanotechnology as part of their course 2 curriculum. A group of mechanical engineering faculty has developed course 2.674 to challenge students to think creatively and solve multi-scale and multi-disciplinary problems at the micro and nanoscale. Students in course 2.674 must understand basic physics, chemistry, and the behavior of materials at nano and micro length scales in order to design, engineer, and fabricate their projects. Through alternating lecture and laboratory segments, students continuously take concepts introduced in lectures to the laboratory bench top.

Students at work in the lab for course 2.674

Pappalardo II lab renovations

Thanks to generous support from Neil and Jane Pappalardo, fourteen individual MechE laboratories have recently completed renovations. The labs, which are all part of MechE's main group, provide research facilities for 12 faculty and more than 30 graduate and undergraduate students. The area, affectionately referred to as Pappalardo II, is now home to research in nanoengineering, experimental hydrodynamics, and bio-inspired robotics. Pappalardo II also houses two undergraduate teaching laboratories, the robotics and ocean engineering teaching lab, and the nanoengineering teaching lab.

The renovations have dramatically improved Buildings 3 and 5, which now offer a bright and bustling throughway, glass doors, large windows, and wide-open research labs. Combined, the labs, offices, and meeting space total nearly 10,000 sq. ft. The decision to renovate these spaces followed a successful 2006 overhaul of the department's undergraduate teaching laboratory, Pappalardo I, which provides shop space and machines for courses 2.005, 2.007, 2.674, and others.

MechE in memoriam

The Department of Mechanical Engineering lost three valued colleagues last summer with the passing of professors James C. Keck, Ain A. Sonin, and H. Guyford Stever.

Keck, the Ford Professor of Engineering, developed teaching and research programs in thermodynamics, kinetics, and mechanics. He was a member of the National Academy of Engineering, the American Academy of Arts and Sciences, and the American Physical Society

Sonin, an expert in advanced fluid mechanics, was the department's graduate officer for 25 years and earned several teaching awards. He was a member of the American Society of Mechanical Engineers, American Physical Society, American Nuclear Society, and the American Association for the Advancement of Science.

Stever was head of the Department of Mechanical Engineering at MIT from 1961 to 1965, and went on to be chief science advisor to Presidents Richard M. Nixon and Gerald R. Ford, Chief Scientist of the U.S. Air Force, President of Carnegie Mellon University, and Director of the National Science Foundation. He was a member of the National Academy of Sciences, the National Academy of Engineering and the Carnegie Commission on Science, Technology and Government.

MITMECHE

Massachusetts Institute of Technology
Department of Mechanical Engineering
77 Massachusetts Avenue, Room 3-173
Cambridge, MA 02139

Coming in the next issue:

► Join us as we celebrate 150 years of MIT

► MIT's Toy Lab is one of *Popular Science* magazine's "30 Awesome College Labs."

TEST DAY (circa 1917): Working on the Cambridge side of the river, Mechanical Engineering students in the Steam Laboratory collaborate to complete a test laid out on the chalkboard. Calculations in the Steam Lab included pounds of steam per horsepower, per hour, and thermal efficiency.

See for yourself how our laboratories have changed at the MechE open house on April 30—part of the MIT 150 celebrations (page 11).

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