

Department snapshot: Mechanical Engineering

Massachusetts Institute of Technology

Photos: M. Scott Brauer and Jin Suntivich (images 1-3)

This is part of an [occasional series of features](#) [1] profiling academic departments at MIT.

What does ketchup have to do with mechanical engineering?

Well, it turns out that if you want the condiment to garnish your burger in a timely fashion, principles of mechanical engineering can [speed an otherwise stubborn, slow-moving pour](#) [2]. The key, as MIT mechanical engineers have found, is at the interface.

Faculty and students in MIT's [Department of Mechanical Engineering](#) [3] (MechE) are examining these boundaries, manufacturing new textured coatings that, at the nanoscale, interact with liquids in surprising and often innovative ways. This relatively new field, called interfacial engineering, combines the study of mechanical forces, physical texture and materials chemistry to generate novel solutions to a host of problems: clearing pipelines, cooling electronics, optimizing battery efficiency, sorting cell samples, defogging windshields and, yes, unclogging ketchup bottles.

Indeed, in a broader sense, engineering at interfaces has become one emerging theme of both research and education in MechE.

Traditionally, mechanical engineers worked within one of the discipline's core areas, such as mechanics, controls, manufacturing or thermodynamics. But today, researchers are also reaching beyond MechE's traditional boundaries. While some are enlisting ideas from materials science and chemistry to manufacture a variety of surfaces, others are building autonomous robots, exploring molecular biology for next-generation biomedical devices, or manipulating materials and optics to design solar panels and invisibility cloaks.

To be a mechanical engineer today is to work at the boundaries of many different domains, says Mary Boyce, head of MIT's Department of Mechanical Engineering.

"We're really working and educating at the interface of many disciplines," says Boyce, who is the Ford Professor of Engineering. "Engineers today can study mechanical engineering and enter fields as diverse as clean energy and water; information technology; aerospace and automotive; shipping; oil and gas; security; biomedical devices — you name it. The opportunities for impact are simply incredible."

A customized curriculum

It's this diversity of options that has attracted students in recent years to pursue mechanical engineering degrees, known at MIT as [Course 2](#) [4]. In fact, in the last decade, undergraduate enrollment has doubled, with 11 percent of MIT students now majoring in mechanical engineering. As the number of incoming MechE students has steadily increased, many are choosing to pursue what's dubbed [Course 2-A](#) [5] — a flexible engineering program that allows a student to design his or her own curriculum, crafted around a set of core MechE courses.

In addition to studying the fundamentals of mechanical engineering, students may cast a wide net around campus for classes that augment their chosen area of study. For example, a student interested in robotics may sign up for electrical engineering courses, while a student who wants to work in energy may add chemistry and materials science, as well as an energy policy class.

MechE's students are coming in more focused on "what's the challenge they want to solve, and not so much what's the discipline they can learn," Boyce says. "Instead of coming in and saying, 'I want to be the world's expert on thermodynamics,' students are coming in saying, 'What's the next revolution in energy that I can be part of, and that I can be instrumental in inventing and engineering solutions for?'"

This year, for the first time ever, MechE's customized Course 2-A program enrolled more students than the department's traditional, core-focused Course 2 degree program. Both programs have been around for quite some time: Course 2, then named Course 1, was one of six curricula offered to the first MIT class in 1865, while Course 2-A was established in 1934.

Why have students recently gravitated to Course 2-A? The answer, Boyce says, has to do with academic credibility. While Course 2-A has been an option for decades, it wasn't until 2002 that the department sought to accredit the program — a certification that Course 2 had received years ago.

"MIT students want to know that their customized engineering curriculum meets every standard and challenge, and is as rigorous as any engineering degree at MIT," Boyce says. "I think once it was really established that this is 'MIT-hard,' the students said, 'I'm going to go for it.'"

Fun with fundamentals

Indeed, as any MechE student can attest, pursuing a mechanical engineering degree at MIT, whether Course 2, Course 2-A, or [Course 2-OE](#) [6] (the undergraduate program in mechanical and ocean engineering), is a challenging endeavor. But the department also prides itself on observing what Boyce calls the "celebratory nature" of mechanical engineering. In other words, there's a little fun to be had in studying the fundamentals.

A prime example, Boyce says, is a course called 2.671 (Measurement and

Instrumentation). Students in this class learn the history of standards and units, as well as the underlying physics and design of instrumentation needed to measure and analyze various phenomena. As part of the course, students are given a final assignment, dubbed “Go Forth and Measure,” where they choose their own subject and method of measurement. Presentations have included measurements of everything from the rotation of a Frisbee to the force output involved in arm wrestling.

This celebratory nature also takes other forms within the department. For example, each year, 2.007 (Design and Manufacturing I) hosts a legendary [end-of-semester robot competition](#) [7], challenging students to conceive, design and build a robot to complete an obstacle course; on competition day, the atmosphere often rivals that of any college athletic event. The same can be said for 2.009 (The Product Engineering Process), in which students learn to design, construct and market [high-quality prototypes](#) [8]. The course culminates in an engineering presentation and business pitch in which students present their prototypes to an often-packed auditorium.

The know-how students gain from such experiences — how to take a design from concept to prototype, and how to articulate the need for such a prototype to potential investors — represent real-world skills that Boyce hopes will stick with students long after they leave MIT.

“We attract students who want to make a difference, who realize they will need to go deep in knowledge and engineering principles and then bring these fundamentals to physical design and production,” Boyce says. “We’re looking to educate that more holistic engineer.”

A transformation in the works

A walk through MechE’s halls illustrates just how interdisciplinary the department has become. In the last few years, MechE has undergone a physical transformation, renovating its research and teaching labs to adapt to the discipline’s expanding nature.

Research spaces still house the traditional workhorses, such as machine tools, drill presses and lathes — but together with rapid prototyping capabilities, including 3-D printers, water-jet machines and laser cutters. But Boyce notes that more MechE labs have been outfitted with chemical and biological ventilation hoods — necessary for the department’s growing research in microfluidics, battery and photovoltaic technologies, surface engineering and bio-inspired robotics.

“Ten years from now, the molecular level of engineering will just be inherently part of mechanical engineering [and] part of what it means to be a mechanical engineer,” Boyce predicts.

The transformation within MechE, both physical and philosophical, has attracted a record number of graduate students, postdocs and faculty members in recent years. In the last five years, the department has hired 13 new faculty members, and

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has seen its research funding increase by 50 percent. Last year, MechE received 30 percent more applications from prospective graduate students than the previous year — an increase that reflects students' growing desire to bridge disciplines, Boyce says.

“You’re starting to see a transformation throughout MechE,” Boyce says. “If you walk through the halls, you’ll see a professor who’s designing a cheetah robot next to a professor who’s engineering with bacteria. That mixture of talents and interests is going to end up leading to newer ways of doing everything.”

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http://www.ecnmag.com/news/2012/10/department-snapshot-mechanical-engineering?qt-video_of_the_day=0

Links:

- [1] <http://web.mit.edu/newsoffice/topic/department-snapshot.html>
- [2] <http://video.mit.edu/watch/liquiglide-11535/>
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