

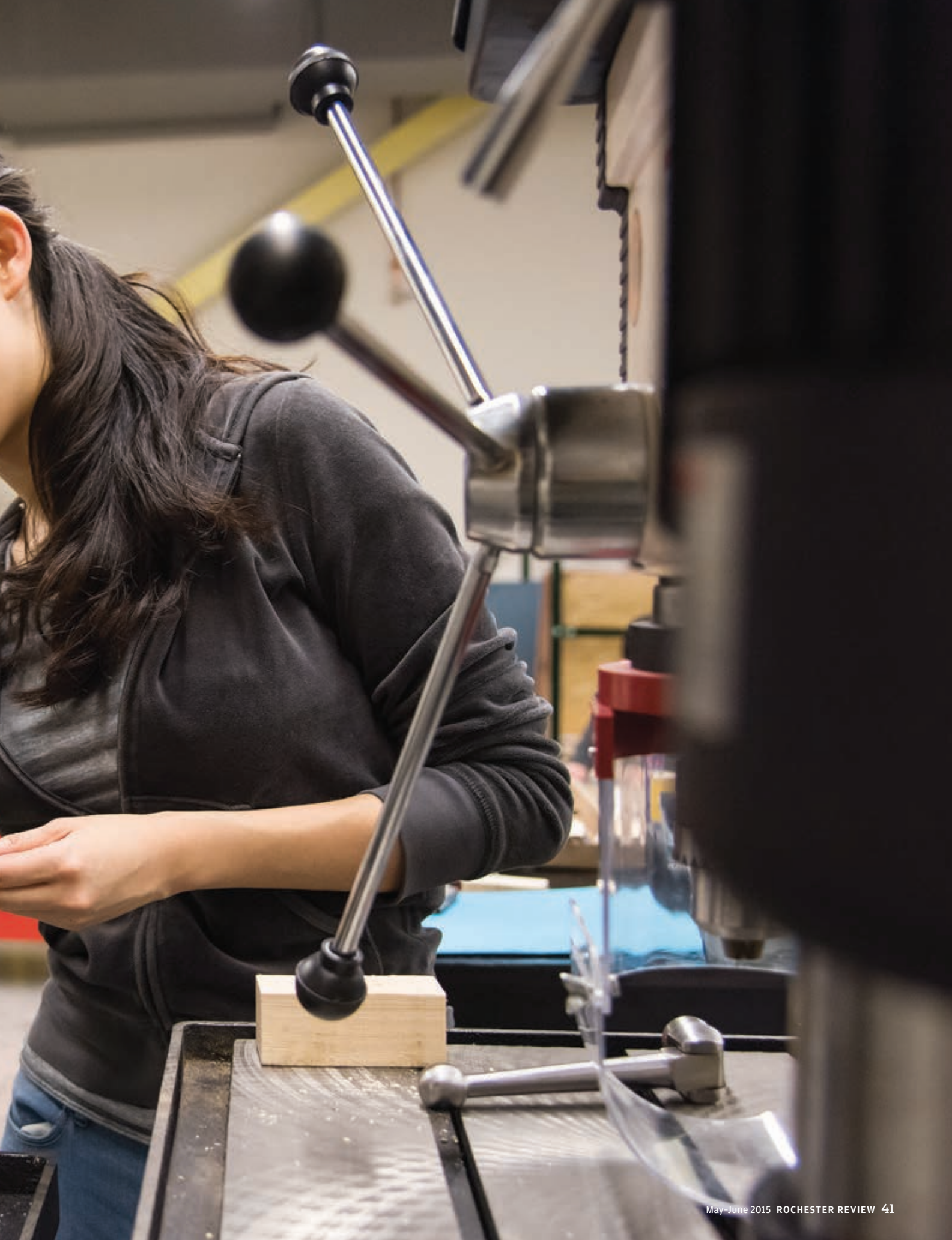
A young woman with dark hair, wearing safety glasses and a dark long-sleeved shirt, is focused on operating a drill press in a workshop. She is holding the handle of the drill bit, which is positioned over a workpiece held in a blue vise. The background shows various workshop equipment, including a yellow forklift and other machinery, slightly out of focus.

# FULL SPECTRUM *and* FULL THROTTLE

Enrollment is soaring at the Hajim School, as undergraduates embrace the chance to become multidimensional, “full spectrum” engineers.

*By Karen McCally '02 (PhD)*

**TOOLS TO BUILD ON:** Wen Zhou '18, an optics major from Beijing, China, operates a drill press in Basic Mechanical Fabrication, a course held in the Ronald Rettner Hall for Media Arts and Innovation, which opened in fall 2013.



**T**wo years ago, when the Hajim School of Engineering & Applied Sciences introduced a new major in audio and music engineering, Mark Bocko, chair of the department of electrical and computer engineering, thought the department would probably have to accommodate about 16 students at a time in its sound design lab.

It turned out that he was well off the mark.

Twenty-five students declared the new major in its first year. “Just that number of students was more than we were anticipating,” Bocko says. “And we have more people from outside the major taking these courses than we have majors.”

He went from offering one section to offering four. And, he adds, “we still have a waiting list.”

Bocko’s experience is echoed across the Hajim School’s six departments. Faculty and staff have all been taking on an expanded work load. But as Bocko, Distinguished Professor in Electrical and Computer Engineering, says, when students are clamoring for what you’re offering, “it’s a good problem to have.”

The number of college students studying engineering has risen markedly across the country. According to data collected by the American Society for Engineering Education, American colleges and universities graduated 74,170 students at the bachelor’s level

2008 probably played a significant role in generating student interest. “Since the crash of 2008, and the realization that college is really expensive, they’re looking much more for a return on their investment,” says Richard Waugh, the chair of the biomedical engineering department, of students and parents. “Engineering is sort of the poster child for that.”

Matthew Yates, chair of the chemical engineering department, notes that interest in his field has tended to ebb and flow with the state of the oil and gas industries. But “a bad economy and job market,” he thinks, is “part of the reason” interest in engineering, including chemical engineering, has risen precipitously.

Nationally, it’s likely that more than one factor has contributed to growing interest in engineering. At the Hajim School, that’s almost certainly the case. The same month that Lehman Brothers collapsed—the event often cited, rightly or wrongly, as the beginning of the Great Recession—Dean Robert Clark arrived in Rochester armed with a plan to enhance the engineering school’s visibility and enrollment. Clark was fresh from Duke’s Pratt School of Engineering. When he took stock of Rochester, he saw strength among faculty and in research facilities, but too few undergraduates. At the time, there were just over 700 undergraduates who had either officially declared engineering majors or declared the intention to do so.

“For us to be at around 700 undergraduates for the kind of reputation Rochester enjoyed—that was just too small,” Clark says. There were drawbacks to the small size. For example, national recruiters make visits to schools based not only on the quality of graduates, but also on how many of them they are. “We didn’t have quite enough critical mass” to draw as many recruiters as the school should, Clark believed, based on its quality.

In addition, engineering schools are expensive to run, and Rochester’s was experiencing an unsustainable drain on its endowment. More students would mean more tuition revenue. As it turned out, the school received a tremendous boost in October 2008, when Edmund Hajim ’58, the chair of Rochester’s Board of Trustees and a graduate in chemical engineering, announced a landmark commitment of \$30 million dollars to the school for scholarships and endowment support.

“You cannot overemphasize the importance of Ed’s gift,” Clark says. In addition to providing much-needed financial support, “it conveyed to the students that they were part of something special. And we’ve just kept emphasizing that.”

**I**t’s one thing to set a goal. Executing the goal has required the efforts of everyone from deans to the undergraduate coordinators, lab assistants, graduate teaching assistants and undergraduate mentors, and workshop leaders who make it possible for the growing school to maintain an approach to education that is team oriented and hands on. “Our students, faculty, and staff welcomed prospective students, made time to meet with parents, adapted programs, and took on massively increased advising roles,” Clark says. They even lent a hand to freshmen and their parents on a sweltering move-in day—and gave out ice cream.

It’s all part of what Waugh calls an “esprit de corps” that has developed at the school. The school lays out a long and durable welcoming mat, starting at the application process, where messaging has been chiefly in the hands of Assistant Dean Lisa Norwood ’86, ’95W (MS).

In 2008, Norwood, a Hajim School alumna with a degree in geomechanics, began working with the Office of Admissions and Financial



in 22 distinct categories of engineering in 2008. Five years later, in 2013, that number rose to 93,360, an increase of just over 25 percent.

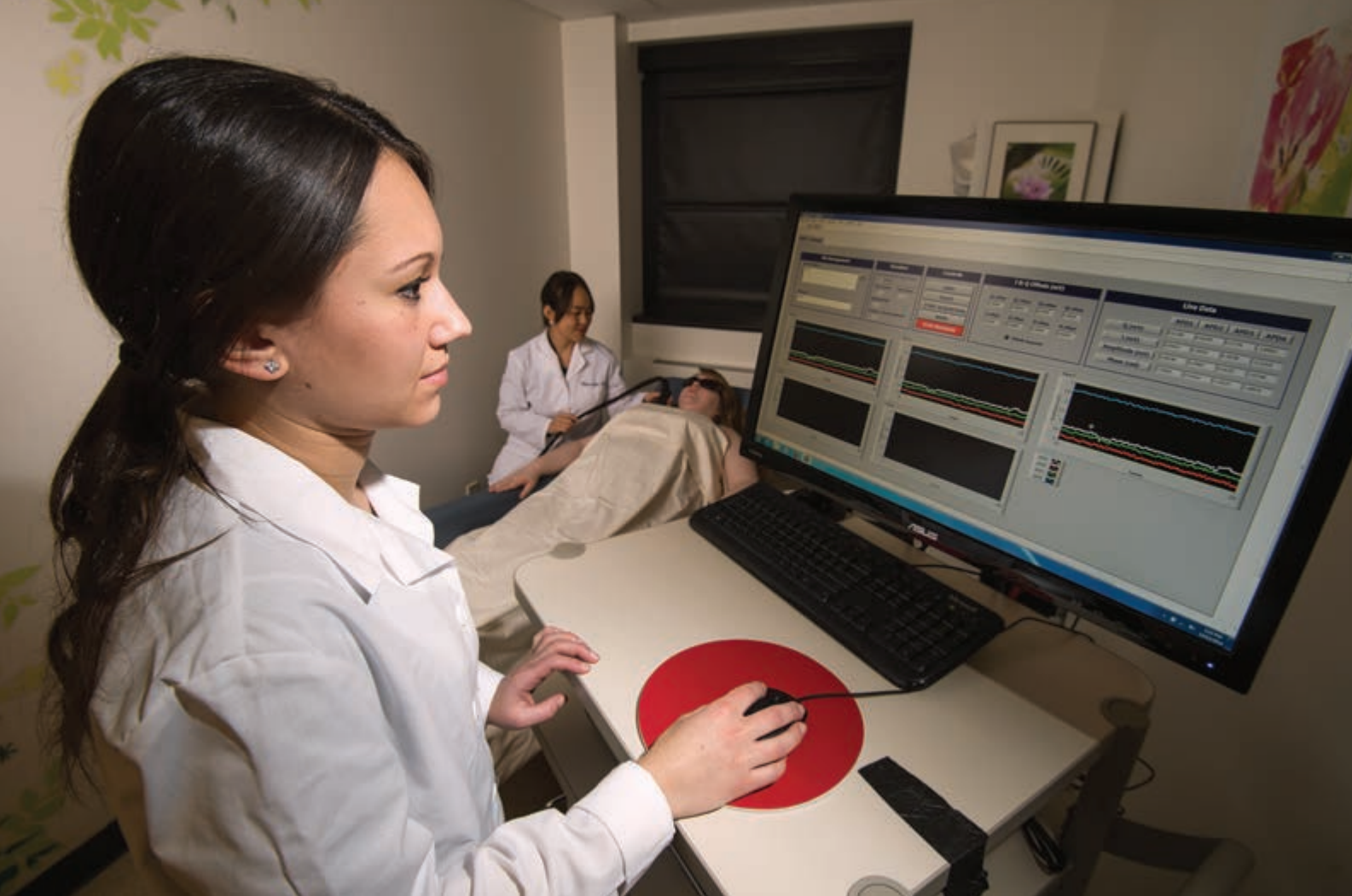
Conventional wisdom is that the financial crisis of 2008 marked a turning point in higher education. Economic uncertainty led to diminished interest in the humanities, for example, and rising interest in STEM—science, technology, engineering, and math—disciplines.

National figures certainly suggest a correlation. A highly publicized study by researchers at the University of California at Los Angeles and the University of Pennsylvania analyzed data on the intended majors of incoming freshmen at four-year institutions around the country. The most dramatic rise was in the number of freshmen studying an engineering discipline. That figure grew by 57 percent nationally from 2007 to 2011.

At the Hajim School, growth has been especially pronounced. During that same period, the number of freshmen rose by 42 percent, a remarkable rise to take place within any *single* institution. As of fall 2014, total undergraduate enrollment was double what it was in 2008.

That growth was spread across departments. Enrollment in all six departments grew substantially, and most departments saw their number of majors double from 2008 to 2014.

Hajim School leaders generally agree that the Great Recession of



**LEADING EDGE:** Clark (opposite page, left) and Norwood led a planned expansion of the Hajim School, starting in 2008; Stacie Zwolski '15 (above, foreground), a biomedical engineering major from Boston, works on a medical imaging project with Regine Choe (center), assistant professor, and technician Ashley Proctor, posing as a patient.

Aid to highlight engineering in ways the University hadn't before. For example, admissions began offering prospective students who indicated an interest in engineering a tour of the Hajim School facilities, in addition to the standard River Campus tour.

The school also produced a brochure titled "Take on the World: Be an Engineer." It showcased students taking part in a wide range of extracurricular activities, participating in study abroad, and pursuing multidisciplinary majors, such as archaeology, technology, and historical structures, that combine engineering and other fields.

Norwood believes the initiatives were major factors in attracting more students. "We thought our ideal freshman class size would be about 350 students. And the very first year, we got 350 freshmen," she says. "We unleashed the tide, and now that the word is out, it seems like there's no stemming it."

Given the expense of college and the uncertainty of the job market, it's not surprising that more students would look at engineering. But some Hajim School students question how much impact the financial crisis has actually had. They grew up with a knack for math and science, an urge to tinker and to build, and strong encouragement in a society that's embarked on both informal and formal campaigns to push STEM education.

They've also responded to the call for what Clark calls "full spectrum engineers"—engineers with multiple interests who pursue those interests with the same zeal they bring to their major.

Bill Green '16, a mechanical engineering major from Long Island, says financial security had little to do with his decision to pursue engineering, or the decisions of many of his friends.

"It comes up as something that I don't think I'll need to worry much about," Green says about job and financial security. "But I don't think that financial security is an end goal for many of the students here. In talking to friends, they don't have their minds on the end goal being the job; more on what their education allows them to do in a more general sense."

Green says his interest in engineering was a natural outgrowth of the hobby of building computers that he pursued in high school. When he visited campus, he was captivated by a serendipitous encounter with students on the Baja team. Each year, the team designs and builds an off-road vehicle. Then, the team takes their vehicle and races it in an intercollegiate competition. Green was taken past the Baja shop as part of his tour of the engineering facilities.

"There were students in there at four o'clock on a Saturday afternoon welding, putting parts together, and still willing to take time out to explain what they were doing," recalls Green, who went on to participate in Baja his first two years at Rochester.

Nancy Vargas '17, a first-generation college student from San Antonio, also says that the financial crisis played little role in her decision to study engineering.

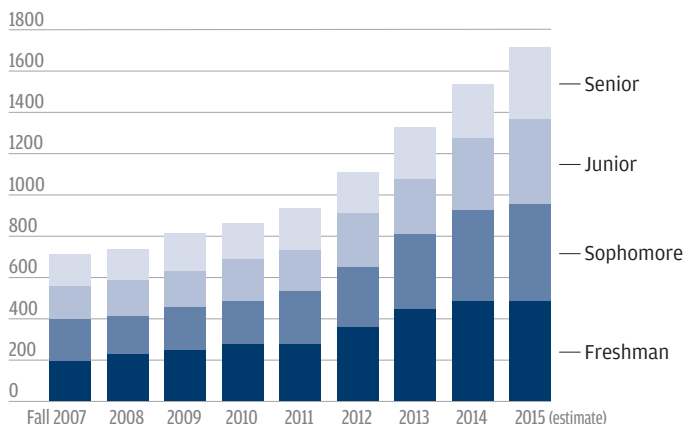
"I started taking classes at a college when I was 13," she says. Gifted in math and science, Vargas relished her advanced classes in math, science, and programming. But the electrical and computer engineering major also says she was exposed to many opportunities to pursue her talents. "There's more of a focus on math and science now," she says, recalling her secondary schooling. "And there are so many opportunities for female Hispanic engineers."

## A Data Snapshot

The number of college students studying engineering has risen across the country in recent years. Nationally, the number of freshmen planning to study an engineering discipline has risen more than 50 percent since 2007. The Hajim School absorbed a 42 percent increase during the same period, a remarkable expansion for a single institution. Growing student interest, and markedly better retention, combined to double undergraduate enrollment at the Hajim School from 2008 to 2014.

### ENROLLMENT

The number of incoming freshmen in the Hajim School has climbed steadily. The school surpassed its goal of 1,200 students in 2013. This fall, the number of incoming freshmen enrolling at the school is projected to remain the same as last year.

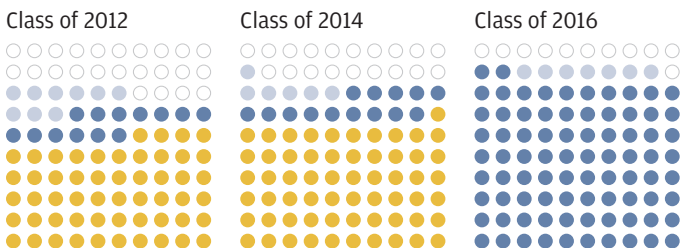


### UNDERGRADUATE RETENTION

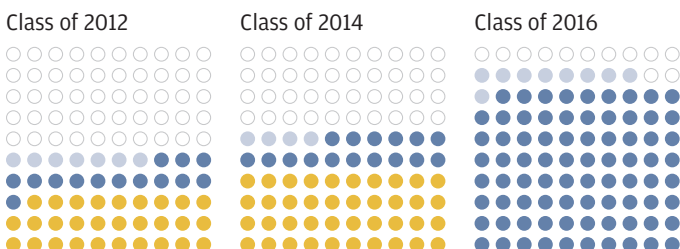
In the late 1990s, fewer than half the students who started out in an engineering discipline stuck with their programs and earned a bachelor's degree within four years. For underrepresented minorities, that figure was less than 10 percent. These figures began to rise dramatically in 2008. For the Class of 2010, the figures were roughly 60 percent and 40 percent respectively.

- For every 100 students enrolled, this number ...
- Remained at the end of the first year
- Remained at the end of the second year
- Graduated after four years

#### All Students



#### Underrepresented Minorities\*



\* Black, Hispanic, American Indian, Alaska Native, Native Hawaiian, or multi-race combination that includes at least one of these categories.

SOURCE: ARTS, SCIENCES & ENGINEERING

Green and Vargas have both taken advantage of another opportunity Rochester affords its engineers: the chance to explore other areas of interest to a greater degree than at many other institutions. The requirements to earn a bachelor of science degree in any engineering field are hefty, leaving engineering students less room to explore other fields than many of their counterparts in the School of Arts & Sciences. At Rochester, engineering students take clusters of courses in either the humanities or the social sciences. The cluster system gives students wide latitude. Green is pursuing a cluster in Roman history, and doing so through Rochester's study abroad program in Arezzo, Italy. Vargas was drawn to anthropology, and has developed a substantial interest in Latin American immigration to the United States. "I'm probably going to do a minor in anthropology," she says, reflecting the desire of many Hajim School students to go beyond the cluster requirement.

The Hajim School's full spectrum engineers are also sticking with their rigorous programs in larger numbers than in the past.

"We have a lot more students who can do engineering than we did 20 years ago," says Waugh, pointing to increasing strength of the overall undergraduate population at Rochester.

But there's also a cultural shift at play.

A generation or two ago, it was customary for engineering professors to put the fear of God in their incoming students. "Look to your left, look to your right," they would say—or so the story goes. "At least one of the people sitting next to you won't be here come graduation." Or come next year. Or by the end of the semester.

"There was a point in history where engineering schools took pride in flunking out half to two-thirds of their class," says Waugh. "I think that era has gone by the board."

Clark has turned the story on its head. "I've said that we need to say, 'Look to your left, look to your right. If you see someone struggling, let's see if we can help them out. Let's work as a team to get through this together.'"

Clark has a personal stake in that approach. He grew up in rural Virginia, in a tiny town outside Roanoke. He was the first person in his family to go to college. During his first semester at Virginia Tech, he was behind. "There were kids who already knew what was going on in the introductory engineering courses," he recalls. "I had no idea. I was playing catch up."

Clark knows that although he ended up thriving, he might have benefitted from the inclusive, team-oriented approach the Hajim School is fostering now. He also notes that it's a different scenario—and a harder one—for students who are not only first-generation college students, but also from underrepresented minority groups. While engineering is challenging for everyone, these students are especially vulnerable to feelings of self-doubt.

Norwood, who came to the Hajim School in the 1980s as an underrepresented minority herself, and who has been advising students in the school for more than 20 years, knows how pervasive these feelings can be.

"You can feel that sentiment just walking into a room. And if you feel it enough, you start second-guessing yourself. If you're not from this environment, this is a very hard place to navigate."

The Hajim School has boosted the retention of minority and low-income students through the STEM Gems program—a system of peer mentoring in which new students from underrepresented groups are guided, each step of the way, by a group peer who understands the unique challenges these students face and is an example of the success that perseverance can bring.

STEM Gems is part of a broader effort at the Hajim School to distinguish itself as a welcoming place for a diverse student body. The school has made two goals explicit: to increase the percentage of underrepresented minorities from 13 percent in 2014 to 20 percent by



**TUBULAR!** Senior chemical engineering majors (left to right) Stephan Tewksbury of Wyalusing, Pennsylvania; Garrett Meier of Caledonia, New York; Erik Laurin of Castleton, New York; and Sidney Royal of Dallas, work on their senior design project, a tubular reactor.

2018; and to become one of the first engineering schools in the nation to reach gender parity. The school's undergraduate student body is already nearly one-third female, well ahead of the national average of 18 percent as of 2014. And in many cases, diversity begets diversity. Vargas, for example, was accepted to multiple schools. But when she narrowed her decision, one factor stood out. At another school she visited, "the ratio of female to male was really off," she says. "I liked the diversity here."

**B**ut at liberal arts universities with growing engineering programs, the question is almost universally raised: what impact does their growth have on other disciplines? Both nationally and at Rochester, the percentage of students declaring majors in the humanities has declined markedly in recent years. And given the substantial requirements of engineering degrees—which leave students less room in their schedules for exploring various disciplines—how can colleges ensure robust programs across fields?

It's an especially important question at Rochester, given that the Hajim School attracts students on the promise that they'll be able to pursue multiple interests. And it's a question that weighs on Clark. "If we grew significantly more than we currently are, it would change the campus culture as a whole," he says. Having strong programs in the humanities and social sciences, he adds, is "an atmosphere that

enhances the education of the engineering student. We don't want to be a technical university."

Undergraduate enrollment in engineering is estimated to exceed 1,700 in fall 2015—well over the goal of 1,200 that Clark set in September 2008. Nonetheless, Richard Feldman, professor of philosophy and dean of the College, says the College is far from becoming a technical school. "The issue is not so much what percentage is here and what percentage is there, but do we have strong programs in each of the different areas," he says.

Enrollment in the College has been growing in general. Although the share of students majoring in the humanities has declined, in terms of pure numbers, students pursuing the humanities are well within the range of what they have long been. Just over 500 students were majoring in humanities disciplines in 2013–14, virtually smack in the middle of the high point (618 in 2008–09) and low point (353 in 1997–98) from 1996 onwards. Citing new faculty appointments in the humanities, Feldman adds that "the goal is to keep those programs strong."

Norwood emphasizes the Hajim School's integration into the College, offering students latitude to move easily in and out of engineering majors. To be sure, she and other Hajim School leaders want to retain students, and even welcome nonmajors to explore courses in engineering. But, she says, "Our philosophy in the College is for students to follow their passions and their interests.

"We don't want to lock students into a major. If they come in and say they want to study engineering, great. If they come in and think they'd like to study something else, or if they come in planning to study something else and want to move into engineering, we want them to have that flexibility." 