

# DARTMOUTH

# Engineer

SPRING 2015

THE THAYER SCHOOL OF ENGINEERING



## OUR PLACE

WHY NEARLY  
HALF OF  
DARTMOUTH  
ENGINEERING  
MAJORS ARE  
WOMEN.

inside

UNDERGRADS IN THE LAB

INVENTOR ERIC FOSSUM

HARDEST CHALLENGES

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# Approaching Gender Parity

JOSEPH J. HELBLE | DEAN

THE THAYER SCHOOL HAS ACHIEVED AN ENVIABLE AND important milestone: we are approaching gender parity in our undergraduate classes. Our senior class is 42 percent women. Our junior class is 48 percent women. As the sophomore class begins to declare majors, early indications suggest it will also be above 40 percent women. Of the more than 300 students admitted to the class of 2019 expressing interest in engineering, more than 40 percent are women. And this year, for the first time, our summer engineering program for high school students will be at gender parity.

Our numbers stand out in a nation in which women have earned more than half of all total bachelor's degrees over the past 20 years, but where the percentage of engineering degrees earned by women has actually declined. According to the American Society for Engineering Education (ASEE), women earned just over 20 percent of engineering bachelor's degrees awarded in 2000, yet just over 19 percent in 2014. This decline is particularly frustrating in light of gains made in medicine and law. In the 1960s, when women earned roughly 35 to 40 percent of all college degrees, the percentages of women earning engineering, medicine, and law degrees were all in single digits. Fifty years later, women earn slightly more than half of all J.D.s, nearly half of all M.D.s., and yet engineering at the bachelor's level has fallen below 20 percent.

Offering advice on "Piercing the 20 Percent Ceiling," ASEE's *Prism* magazine recently observed that programs that succeed in breaking this artificial barrier are likely those that emphasize hands-on experiential learning, create a culture and climate that treats all students the same, and provide opportunities for students to apply what they learn to real-world problems—problems they care about—and opportunities to use their engineering education to make a positive difference.

These are, of course, precisely the qualities that we emphasize and have long implemented at the Thayer School. But we also stress one more critical element: the importance of teaching engineering in combination with the liberal arts.

The intersection of the liberal arts and engineering—what we at Thayer often refer to as "liberal engineering"—is a powerful tool for addressing the real-world problems that all students care about. The liberal arts give students helpful perspectives for understanding the world, providing context for improving life. Engineering gives them the technical knowledge and problem-solving skills to meet human needs and change the world for the better. Neither is as strong without the other.

It's no surprise that so many students interviewed for the article "Our Place" in this issue talk about how much they value studying the liberal arts and engineering, how much they like Thayer's experiential learning and real-world problem-solving, and how comfortable they are in this environment. I'm proud that the Thayer School is setting a national example at a time when the world needs more engineers, especially those trained in liberal engineering, female and male alike.



"One of the main things that drew me to Dartmouth was the fact that I could do research as an undergrad," says Lloyd May '18.  
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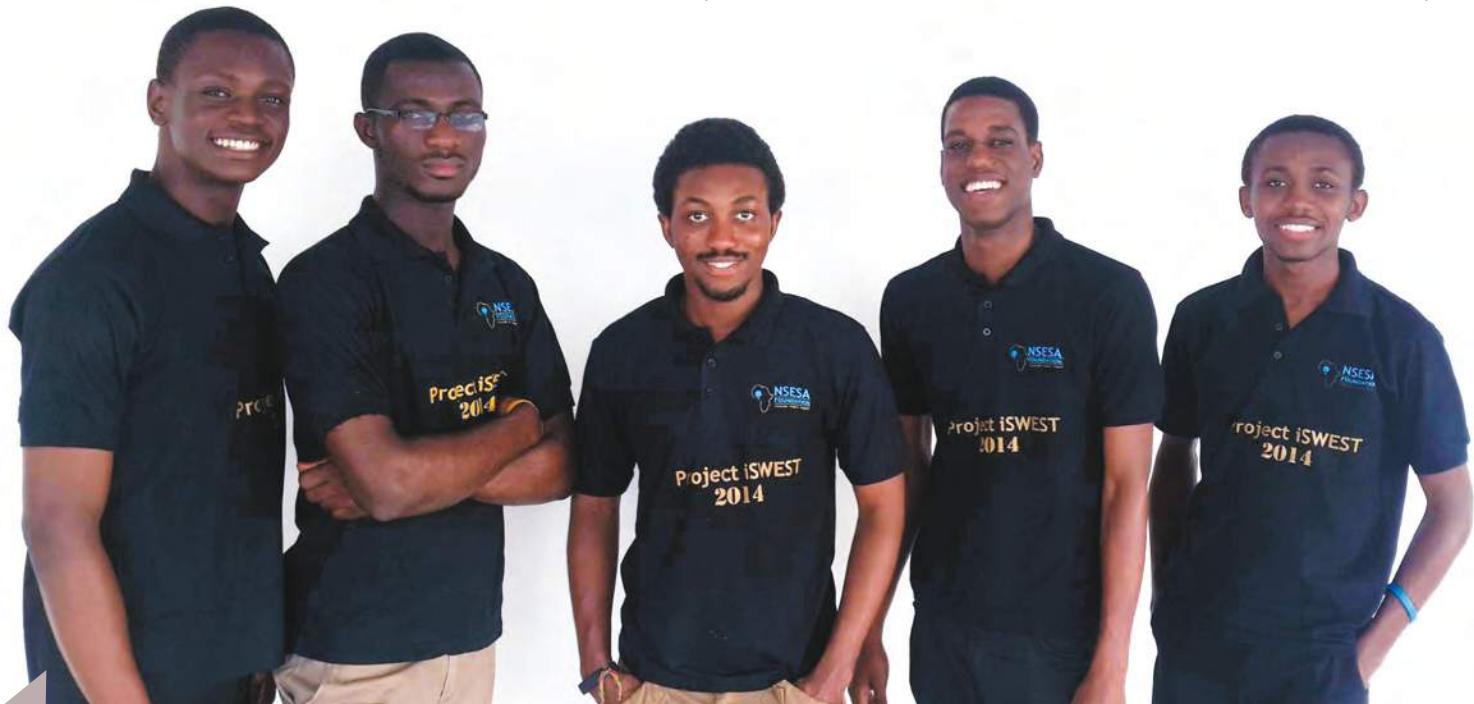
From ice core collection to infectious disease detection, even freshmen work in Thayer research labs.

BY KATHRYN LOCONTE LAPIERRE

# THE Great Hall



NEWS FROM AROUND THAYER SCHOOL



## PROJECT iSWEST

George Boateng '16, center, pictured with iSWEST team members, brought Thayer's signature introductory engineering course to students in Ghana.

### SERVICE TO SOCIETY

## Spreading ENGS 21

ENGINEERING MAJOR GEORGE BOATENG '16 hasn't waited until he graduates to bring innovative ideas to his native Ghana.

Two years ago he created an abbreviated version of ENGS 21 for high school students back home. "Even before I took ENGS 21, the thing that blew my mind about this class was that students without advanced engineering classes could go through a design and innovation process and actually build solutions to real-life problems and start companies out of it," Boateng says.

He started Project iSWEST (Innovating Solutions with Engineering, Science & Technology) and recruited six Ghanaian friends to help him run the program. The team pooled resources to offer a one-week pilot program for students in Ghana's capital, Accra, during the summer of 2013. The pilot was successful enough for Project iSWEST to receive funding from Thayer and from Dartmouth's Institute for Security, Technology and Society (ISTS) and Neukom Institute for a four-week program in Ghana during the summer of 2014. The extended program featured two weeks of workshops in electronics,

robotics, and basic science, two weeks of innovation training, and a pitch day. According to Boateng, three teams of five students each developed simple solutions to local needs, such as a way to make cleaning louvered windows easy and safe. The participants even started a club at school to teach other students what they had learned.

"Our vision is to inspire an innovation revolution for youth across Ghana to create solutions to their communities' problems," says Boateng, an engineering major and computer science minor. "We want this to become part of the culture of Ghana."

Boateng has also developed another project, SpeedAlert!, for Ghana, where traffic accidents are the second leading cause of death. SpeedAlert! lets passengers riding public transport see the vehicle's speed and the

speed limit of the area. Boateng predicts that the device will help Ghanaians put social pressure on drivers to adhere to speed limits. "One thing about Ghanaians, they let you know when you are doing something inappropriate," he says.

SpeedAlert! received funding in November, when it was one of four winners among 21 projects presented at The Pitch, a competition run by Dartmouth's Digital Arts, Leadership, & Innovation (DALI) Lab and the Dartmouth Entrepreneurial Network.

As if that weren't enough, in March Boateng attended the Clinton Global Initiative University's first student Code-a-thon for developing apps to address global health issues. Boateng's team, MediText, won the competition with an app that reminds patients to pick up and take medications.

—Kimberly Slover

## Two New Overseers

**TWO THAYER ALUMNI** were elected to Thayer's Board of Overseers earlier this year:

**DAVID L. SWIFT TH'84** is the executive business partner for Advent International, a global private equity firm. Previously he was president and CEO of Goodman Global Group Inc., president of Whirlpool North America., president of Eastman Kodak's Professional Group, and president of Kodak's Greater Asian Region. He holds a B.A. in math and physics from Amherst College, an M.E. from Thayer, and an M.B.A. from Harvard Business School.



Swift

**SAMANTHA SCOLLARD TRUEX '92 TH'93 TU'95** is chief business officer for Padlock Therapeutics, an early-stage drug discovery company. Her previous experience in commercial-stage biotech included eight years each at Biogen Idec and Genzyme. She holds an A.B. in biology from Dartmouth, a B.E. focused on biomedical engineering from Thayer, and an M.B.A. from the Tuck School of Business.



Truex

OPPOSITE PAGE: COURTESY OF GEORGE BOATENG. THIS PAGE, CLOCKWISE FROM UPPER RIGHT: DAN COYRO, COURTESY OF SAMANTHA SCOLLARD TRUEX, COURTESY OF DAVID L. SWIFT

## Q&A



### Kendall Ronzano '17

>> **KENDALL RONZANO '17** was still in high school in Santa Cruz, Calif., when she put a big effort into building a tiny house. She founded NerdGirlHomes with a clear vision: "building tiny houses for a good cause, because shelter is a birthright, not a privilege." She created the website NerdGirlHomes.wordpress.com, which has gotten more than 96,000 hits. She raised more than \$15,000 for supplies and built Ruby—a 117-square-foot house with living and dining areas, a kitchen, bathroom, and loft bedroom—from the ground up. In February Ronzano, who is now studying engineering at Thayer, sent Ruby off to its new—and previously homeless—occupants in Austin, Tex.

**"Building tiny houses for a good cause, because shelter is a birthright, not a privilege."**

#### Did your tiny house experience give you a leg up in studying engineering?

Absolutely. There's a certain level of confidence that can only be gained through hands-on, real-world experience. The project involved model making, pitching my idea, being rejected by a potential funder, problem-solving the funding issue, building a website, re-pitching my idea, receiving financial support from over 200 donors, becoming proficient with tools, machinery and the construction process, asking lots of questions, making mistakes, learning from those mistakes, presenting my project at TEDx, establishing criteria for choosing the recipient of the house, ensuring Ruby safely arrived in Austin, and wrapping up with a site visit. Ruby may be tiny, but I made sure that function and aesthetic beauty were part of every decision. If I were living in 117 square feet, that's what I'd want.

#### What drew you to Dartmouth for engineering?

Several things: First, the opportunity to get hands-on experience as a freshman. Second, Dartmouth is a liberal arts college. I value my art and Latin studies as much as my STEM classes—it's all connected for me. Third, I found Thayer's facilities inspiring. The blending of old and new architectural features, interesting use of corridors, and vast rooms with natural light appealed to my creative side. And, I fell in love with the vending machine stocked with drill bits, duct tape, and the like. Fourth, Thayer's human-centered design minor.

#### Will you be building more tiny houses?

I hope to, although I don't have anything presently in the works.

## Kudos

### ELECTED

Engineering Professors **Elsa Garmire** and **Alex Scherer** have been elected fellows of the National Academy of Inventors. Garmire was recognized for her work in optics, opto-electronics, and lasers. Scherer, who holds more than 100 U.S. patents, was recognized for his work on the design and microfabrication of a broad range of optical, magnetic, and fluidic devices leading to the establishment of seven companies. They join Professors **Eric Fossum** and **Tillman Gerngross** as fellows of NAI.

### NAMED

Professor **John Zhang**, who joined the Thayer faculty last July after starting his career at UT Austin, has been named a fellow of the American Institute for Medical and Biological Engineering. Zhang's work focuses on developing miniature imaging and biosensing systems to improve health through a broad variety of approaches. He is also co-founder of NanoLite Systems, which focuses on developing products to diagnose cancer through blood screening, tissue imaging, and cell transformations at point of care.

### AWARDED

Professor **Mary Albert Th'84** has been awarded \$17.4 million by the National Science Foundation to oversee the U.S. Ice Drilling Program through 2018. Albert, who has served as executive director of the program since it was established in 2010, leads the ice-drilling research community in mapping out the direction of ice core science and guiding implementation of the resulting plan.

### NAMED

Professor **William Lotko** is one of seven professors selected by President Phil Hanlon '77 to mentor postdoc scholars as part of the new Dartmouth Society of Fellows, an interdisciplinary community to begin this fall that will support the integration of research and teaching excellence.

### EARNED

Ph.D. candidate **Jilai Zhou** has received the Dartmouth Graduate Alumni Research Award. He will use the \$1,000 award to further his thesis research, which is focused on developing new strains of bacteria via metabolic engineering for use in the conversion of cellulose to ethanol.



## STUDENT PROJECT

### CHAINSAW SAFETY BRAKE

If you use a chainsaw, you'll want this ergonomic safety brake that enforces proper cutting form and reduces risk of injury. The brakes are blacked out in the photo below because Cassidy Ladd '16, Daniel Magoon '17, Justin Partyka, dual degree, David Polashenski '17, and Frank Zhang '15 are pursuing patent protection. The group won the Winter Term 2015 Phillip R. Jackson Prize for outstanding performance in ENGS 21: Introduction to Engineering. Their teaching assistant was Lorin Paley '15.

Left to right, David Polashenski '17, Daniel Magoon '17, Justin Partyka, dual degree, Cassidy Ladd '16, and Frank Zhang '15.



## STUDENT PROJECT

### ANKLE BRACE

Athletes will benefit from this comfortable, custom-fitting, semi-rigid ankle brace, which is designed to prevent ankle twisting and other injuries. Having tested the brace on Dartmouth varsity and recreational athletes, Magnus Bigelow '17, Prescott McLaughlin '17, and dual-degree students Graham Scott and Guram Vardiashvili are pursuing patent protection and further development of their "FyreFrame Braces." The group won the Fall Term 2014 Phillip R. Jackson Prize for outstanding performance in ENGS 21: Introduction to Engineering. Their teaching assistant was Kiah Williams '15.



On left, Inuit snow goggles and hide scraper. On right, Thayer's 3-D printouts.

## SOLUTIONS

### From Hands Off to Hands On

WHEN THAYER SCHOOL LECTURER JACK WILSON took students in ENGS 2: Integrated Design: Engineering, Architecture, and Building Technology to Dartmouth's Hood Museum of Art to see a variety of practical tools and artifacts, including snow goggles and hide scrapers made by Inuit peoples of the Arctic, he was both delighted and frustrated.

Delighted because, as he puts it, "Observing and analyzing functional objects made by people from different cultures and time periods helps students to understand the importance of design and collaborative initiative in the progress of culture."

Frustrated because only curators can touch the objects. So Wilson, who co-taught ENGS 2 with Professor Vicki May, replicated the Inuit artifacts with Thayer's 3-D printer. M.S. student and former Thayer design fellow Christian Ortiz '11 Th'11 helped scan the objects and then printed goggles that students could try on and a hide scraper they could handle with impunity.

According to Wilson, the printed versions were a hit with his 50 students—and with him. "There is no greater way to connect with those who have established culture before us," he says, "than to experience their environment, be in the buildings they have built, and touch the objects they have produced."

### Appy Meals

Wouldn't it be great if students could easily meet up with friends at mealtimes? Soon there will be an app for that. For their ENGS 12: Design Thinking class, Katherine Crane '16, Catherine Donahoe '15, and Stephan Johnson '15 proposed a new app, Food@Now, to help improve the student experience at Dartmouth. "Planning meals currently demands time and effort, and there is a fear of appearing desperate for friends when reaching out," the team explained in their class presentation. "On Food@Now, you have a buddy list of acquaintances showing you who is ready to eat when you are. This removes the vulnerability felt when reaching out and takes the hassle out of the process." The team is now working to turn the app from idea to reality.

Great Idea

# lab reports

## Diagnostic Breathprints

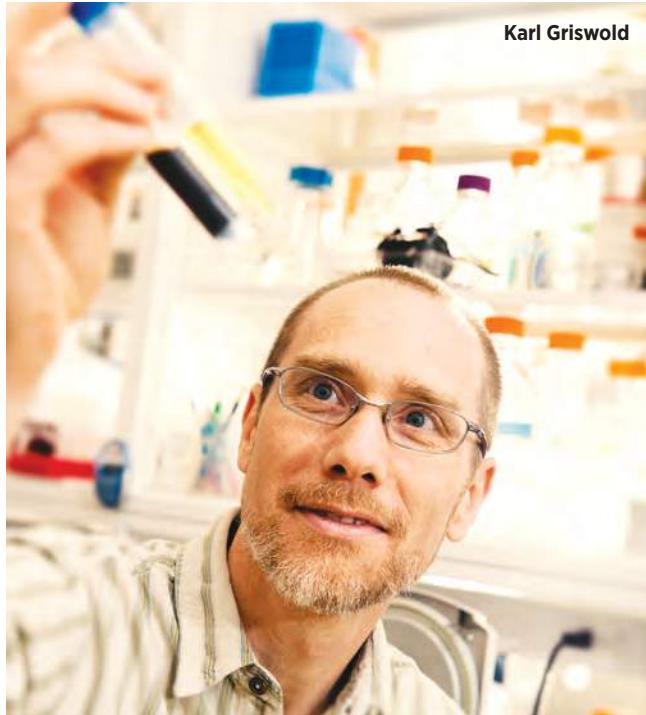
HERE'S A BREATHTAKING advance: Professor Jane Hill is analyzing human breath to quickly and noninvasively identify pathogens that cause flu, pneumonia, and other lung infections. Using secondary electrospray ionization-mass spectrometry (SESI-MS), she has developed ways to take "breathprints" to diagnose lung infections caused by potent bacterial pathogens such as *Staphylococcus*, *Legionella*, *Streptococcus*, and *Mycobacterium tuberculosis*.

According to Hill, the breath-based diagnostics would yield results in less than a minute for use in determining stages of infection. "A truly exciting development is that SESI-MS breathprinting not only detects acute lung disease almost instantaneously, it also allows us to determine the direction of infection so treatment is more effective," she says. "We are identifying a core set of breath markers that can be used to determine if the patient has only been exposed to the infection, currently has the infection, or if the infection has been cleared."

In one study, Hill and her researchers are collecting breath samples from South African patients who have active pulmonary tuberculosis, which kills more than 1.5 million people each year. In another study, Hill and postdoctoral fellow Heather Bean are collecting breath samples from the New Hampshire Cystic Fibrosis Network, which includes Dartmouth-Hitchcock Medical Center, to diagnose *Pseudomonas aeruginosa*, the primary cause of the chronic lung infections and consequent damage responsible for most morbidity and mortality in persons with cystic fibrosis.

"We hope that in the near future, patients will be able to walk into their doctor's office and through a non-invasive breath test instantly determine the cause of illness, resulting in more effective treatment," says Hill.

—Kirsten Mabry



Karl Griswold

## Nanoparticles for Breast and Ovarian Tumors

PROFESSOR KARL GRISWOLD'S RESEARCH TEAM IS making progress in using nanoparticles to selectively target breast and ovarian cancer cells. A recent paper, "Antibody-mediated targeting of iron oxide nanoparticles to the Folate receptor alpha increases tumor cell association in vitro and in vivo," published in the *International Journal of Nanomedicine*, reports the group's findings.

Whereas radiation and traditional drug therapies damage normal as well as malignant cells, nanoparticles have the potential to search out and destroy cancer cells without harming healthy tissue. But getting nanoparticles to target tumors depends on numerous factors, including nanoparticle size and composition, molecular targeting, surface chemistry, route of administration, cancer cell type, and tumor location.

Griswold's group succeeded in getting antibody-targeted iron oxide nanoparticles to accumulate inside breast and ovarian tumor tissues following systemic administration.

"The ultimate utility of anti-cancer nanoparticle technologies will depend in large part on their capacity to selectively home to cancer cells," says Griswold. But, he adds, "achieving optimal targeting of nanoparticles in clinically relevant scenarios remains a key challenge."

According to Griswold, collaboration is essential. "In studying cancer at Dartmouth, we are committed to team science," he says. "Solutions to problems like these require trans-disciplinary collaborations operating at the complex interfaces between molecular biotechnology, nanotechnology, biology, and medicine."

## Kudos

**FEATURED** Professor Vicki May's "The Engineering of Structures Around Us" is one of four massive open online courses (MOOCs) that Dartmouth is offering this year through the digital learning platform edX. The online course is based on ENGS 2: Integrated Design: Engineering, Architecture and Building Technology, which May co-teaches. She says she plans to bring skills gained from this experience into her Thayer classroom. May was recently selected by the New Hampshire College & University Council to represent higher education at this year's New Hampshire Excellence in Education Awards Celebration.

**FEATURED** The Washington Post profiled Professor Vikrant Vaze's studies of the root causes of flight delays, specifically, who's to blame for most of them: airline crew members or passengers. His research—which could help airlines lessen the impact of delays—follows up on recent findings that the average flight delay of 15 minutes translates into an average half-hour hold-up for passengers because of missed connections and cancellations.

**AWARDED** Engineering major Sarah Hammer '15 has been awarded a National Science Foundation Graduate Researcher Fellowship. She will pursue a Ph.D. in chemical and biological engineering at Princeton.

**WON** Two Thayer student projects won funding from The Pitch competition held by Dartmouth's Digital Arts Leadership & Innovation (DALI) Lab and the Dartmouth Entrepreneurial Network. **George Boateng '16** pitched SpeedAlert! for safer driving in Ghana. **SafaPani**, a user-friendly filter for reducing arsenic in drinking water in India, Bangladesh, and Nepal, was pitched by **Meili Eubank '15**, **Aditya Mahara**, **Shannon Carman '17**, **Katie Zhang '16**, **Josh Warzecha '17**, **Eldred Lee '17**, **Thomas Wang '16**, **Emma Ratcliffe '17**, **Kelsey Flower '18**, **Catherine Ledna '15**, **Will Buell '17**, **Michaela LeDoux '17**, and **Aparna Kachalia '10**.



NEARLY HALF  
OF DARTMOUTH  
ENGINEERING  
MAJORS ARE  
WOMEN.  
**HERE'S WHY.**

OUR

FROM LEFT:

Meredith Gurnee '17  
Kelsey Kittelsen '17  
Valerie Zhao '15  
Allison Brouckman '15  
Christine Kanoff '15



BY ANNA FIORENTINO

Kelsey Kittelsen '17 may have been the only girl in her high school class to compete in an egg drop contest, and she's likely to enter an engineering workforce that skews heavily toward men. But as an undergraduate at Dartmouth, she's not facing a boys' club when it comes to engineering.

That's because for the first time in the history of Thayer School, the number of women undergraduate engineering students is nearing parity with men. The junior class, the class of 2016, is 48 percent female, with 58 women and 62 men majoring in engineering. The senior class, the class of 2015, is 43 percent female, with 35 women and 45 men majoring in engineering.

The numbers represent a significant high for Thayer. For the past decade, women have composed an average of 31 percent of engineering majors earning the Bachelor of Arts (A.B.) degree and 27 percent of students continuing on for Thayer's Bachelor of Engineering (B.E.) degree.

The new numbers also represent a national milestone. For the past ten years, just 19 percent of American students graduating with an undergraduate engineering degree have been women.

Clearly, Thayer School is doing something right to attract so many women undergraduates to engineering—and keep them there.

**"I CHOSE THAYER BECAUSE I LOVED THAT I WOULD** be able to have a diverse course of study that includes both engineering and the liberal arts side of the school," says Kittelsen, who is pursuing an engineering major modified with studio art and Thayer's new human-centered design minor. "All of my close girlfriends are in the engineering program."

Meredith Gurnee '17 wanted an array of opportunities. "One of the main reasons I came to Dartmouth was because here I am allowed to play varsity soccer and go abroad. The fact that the engineering program has a foreign study program in Thailand really excited me," she says. "I love how Dartmouth's liberal arts environment allows you to get a degree in engineering, while also developing other areas to become a truly well-rounded student."

She's not alone. "I love that, with the A.B. program and/or fifth-year B.E., you can take plenty of other non-engineering classes that you're interested in taking," says Jessica Link '17. "I plan on taking plenty of humanity courses, and I've already studied a foreign language abroad."

Some Dartmouth women regard engineering as an appealing alternative to other professions. "I thought I would be premed and wanted to be a doctor, but a combination of factors, mostly admitting that I can't stand being in hospitals, made me realize that I'd rather develop health-care-related technology than work as a doctor. That's when I turned to Thayer," says Sophie Sheeline '16, who has served as a teaching assistant (TA) twice for ENGS 12: Design Thinking and once for ENGS 13: Virtual Medicine and Cybercare.

"Touring Thayer, I loved the community feel and hands-on experiences that I saw taking place everywhere. It has not disappointed," says Abigail Reynolds '17.

"The project aspects of Thayer seem to appeal to women," agrees Valerie Zhao '15.

These students are among the many students and members of Thayer's faculty and staff who think that Thayer's hands-on, project-based approach to engineering, interplay with the liberal arts, and curricular flexibility create a particularly welcoming environment for students—including women.

In fact, the community environment appears to be so welcoming that today's students say they don't pay much attention to the number of women and men in their Thayer classrooms and labs—and that

there's little or no difference in the way women are treated.

"I really think the only difference in being a female student at Thayer is that sometimes people assume that I would want to work more on the design and creative portions of a project rather than the mechanical aspects," says Christine Kanoff '15, adding that the assumption isn't accurate.

**HOW DID THAYER ACHIEVE AN UNDERGRADUATE** population that's nearly half women?

"By consciously focusing on the things that are appealing and intriguing to them," says Myron Tribus Professor of Engineering Innovation John Collier '72 Th'74 '75, who reports that he regularly receives emails and phone calls from friends' or alums' high school daughters who are considering engineering. "They're finding us," he says.

"I loved to solve puzzles when I was younger and I still do, and I saw engineering as a way to study puzzles and problem solving," says Rachel Margolese '16. "Learning at Thayer goes beyond the technical aspects of engineering and considers how people relate to engineering problems, which is of particular interest to me."

Still, many women have to overlook old societal views of engineering.

"Tools aren't marketed toward the average woman," says B.E. student Ariana Sopher '14. "Construction toys are becoming more popular among girls, which is really exciting, but I almost never see a female on YouTube teaching me how to fix my bike when I look something like that up."

"People told me when I was in high school that engineering is a male-dominated field, but at Dartmouth I haven't felt out of place at all," says Gurnee. "It is super exciting to see women pursing this path."

Thayer's enrollment trends are a substantial step toward a broader goal in engineering: the day when achieving gender parity is not news but the norm.

"I'm thrilled to be a part of an institution experiencing this kind of paradigm shift in student enrollments," says Associate Professor of Engineering Karl Griswold. "Engineering as a discipline, and in society, has for too long failed to effectively tap into the full potential of women as engineers and scientists."

**FROM THE BEGINNING, THAYER MAKES IT CLEAR** that students don't have to be experienced with tools or building to study engineering.

"We certainly have a goal of making engineering comfortable for anyone, whether or not they are innate tinkerers," says Collier, who has been teaching Thayer's project-based ENGS 21: Introduction to Engineering for decades.

"Historically we found that if we had groups of students and one or two are women, many of them choose to do oral presentations or reports over building," says Collier. "If you've never built things, as many women haven't, it can be intimidating."

This experience led Collier to work with the machine shop and the manager of the instructional labs to develop weekly two-hour skills sessions in which students work one-on-one with the staff to learn how to use computer aided design, fabrication tools, sensors, and actuators. "We've pushed hard to create these modules that are set up to build skills. It's just so happened that the women may have benefitted the most."

Other faculty at Thayer, including Associate Professor Vicki May, make similar observations. "All students are introduced to tools in the machine shop, which I think is empowering for everyone," she says.

Once women start using tools, they realize they can make things just as well as anyone else. "I've only felt discriminated against as a woman when I didn't know how to use power tools, but I quickly learned in

a very open, supportive environment," says Kittelsen. "There's a lot more freedom, and in classes like ENGS 21 you use a lot of different skills to create the project."

Thayer also makes an effort to bring undergraduate women into research labs by participating in Dartmouth's Women in Science Project (WISP). Cofounded in 1990 by former Thayer associate dean Carol Muller '77, WISP works to increase the number of female students pursuing STEM fields by pairing them with an internship in a lab.

"We've brought undergraduate women into our lab through WISP for more than a decade," says Collier. "The WISP students end up recruiting each other. They talk to their roommates and suggest our lab." Collier also notes that over the years he has advised many more female than male graduate students in his biomedical engineering lab.

Another draw for women is the modified major, which allows students to combine engineering with any of the sciences, economics, public policy, or studio art. Kittelsen, who followed in the footsteps of both her cousin Monica Bustamante '08 Th'09 and her grandfather, Thayer Overseer John W. Ballard '55 Th'56 Tu'56, says that a modified major will allow her to pursue a career in either architecture or engineering. "The modified major and minor offered at Thayer demonstrates how much effort Thayer has made to integrate the liberal arts side of Dartmouth into the engineering program," says Kittelsen.

**IF THERE IS ONE THING FEMALE** students at Thayer say they need, it's good role models because society still largely perceives engineering as a man's job. Just look at movies, films and news. "There are female doctors, but rarely engineers," points out Lorin Paley '15. She has seen an engineering generation gap right on campus. "Alumni come visit and are surprised at how 'even girls are studying science these days,'" she says. But, she adds, "The women who made it to the point of being seniors at Thayer didn't think twice about following their passions. That is why we are here still."

Female engineering students at Thayer find support from their professors—male and female—and from each other. In ENGS 21, chances are there's a female TA nearby to help them.

Female ENGS 21 TAs actually outnumber male TAs three to two—during this past winter term, 11 of 15 TAs were women—and that ratio has stuck throughout the past few years. When Collier teaches ENGS 21, his requirements for undergraduate TAs are that they had to have earned an A in ENGS 21 and that they share an enthusiasm for teaching.

"Women teach as TAs just as well as men—maybe better," Collier says. "I have had issues where dynamics between men and women within a group haven't been optimal. Women TAs are particularly good at divining what's going on, meeting with me to discuss strategy, and then going back to put the group on its

**"PEOPLE TOLD ME WHEN I WAS IN HIGH SCHOOL THAT ENGINEERING IS A MALE-DOMINATED FIELD, BUT AT DARTMOUTH I HAVEN'T FELT OUT OF PLACE AT ALL. IT IS SUPER EXCITING TO SEE WOMEN PURSUING THIS PATH."**



—Meredith Gurnee '17

## FEMALE ENGINEERING MAJORS

### DARTMOUTH Class of 2016

48%

### Class of 2015

43%

### National Average

19%

wheels and get it rolling again."

Students at Thayer say they appreciate how Collier and other professors interact with them. They say that faculty are always ready to drop what they're doing to help and don't perceive women differently. "My professors treat me the same way they treat men," says Zhao.

"Success in coursework is not and has never been dependent on gender. Rather, it is a consequence of learning the fundamental concepts and getting comfortable with innovation," says Associate Professor Jane Hill, who joined the Thayer faculty last year. "We have reached a critical mass, and with that status people are more informed about what engineering can be and the cool things that evolve from the experiences at Thayer."

May, who runs summer workshops at Thayer for high school students, passionately advocates for women to pursue engineering. "At Thayer, all students are expected to jump in and work on projects, and that helps encourage them," she says. "It's important to show the young female students that it is possible to make it in the world of engineering."

Female students say they would like to have more female professors at Thayer. Currently, out of 53 core faculty members, 10 are women.

"I think it has been really important to have role models, but the fact is, I've only had three female professors out of all of the classes I've taken at Thayer. I would really like to see that number increase," says Sopher.

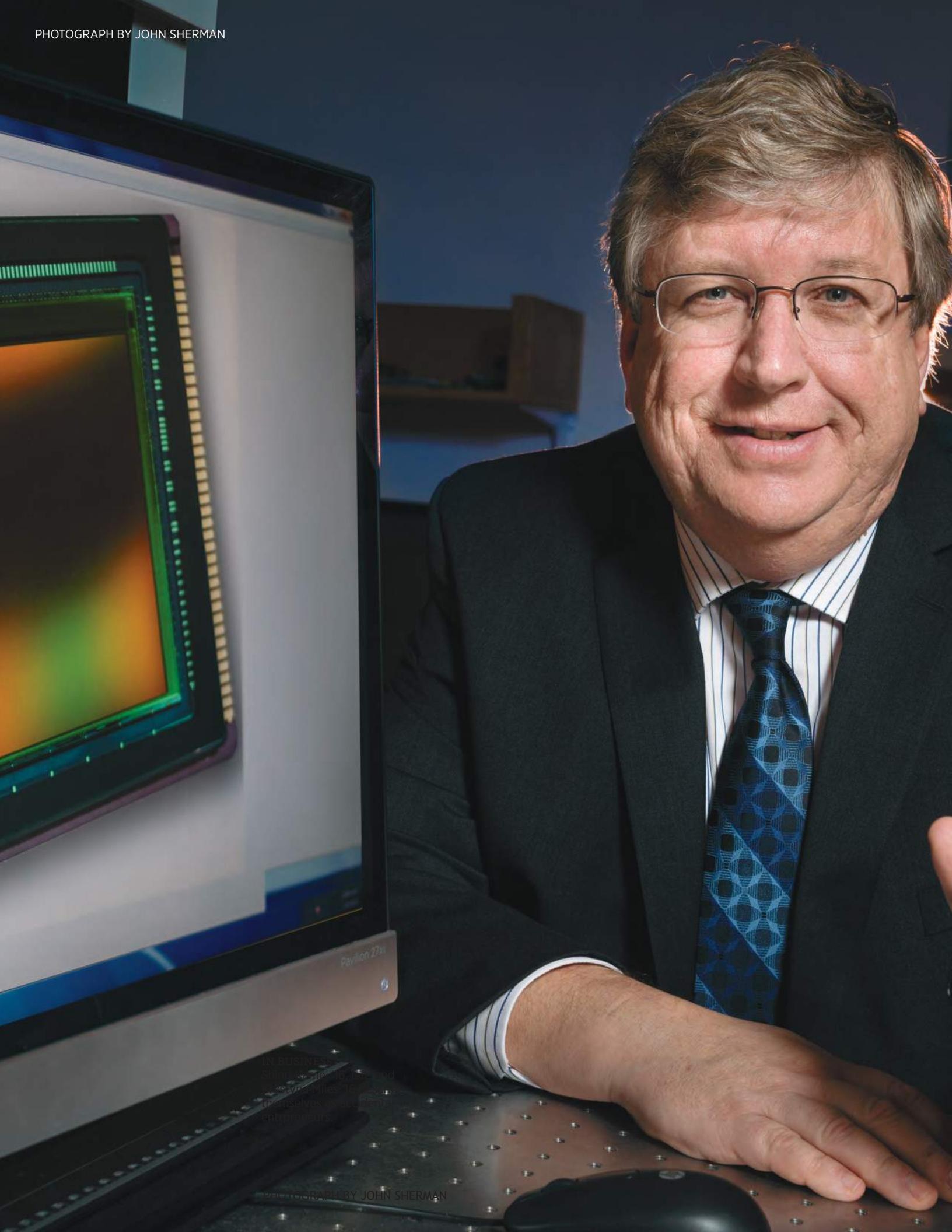
"With the expansion of Thayer, I would love to see more female and other minority group professors join the ranks of the impressive engineering faculty," agrees Allison Brouckman '15, who, like many Thayer B.E. women, is studying biomedical engineering.

Meanwhile, Thayer professors—male and female—encourage prospective female students to explore engineering at informational sessions and open houses. Thayer also cohosts a recruitment event through the Dartmouth Bound STEM Exploration Program, which targets women and other underrepresented minorities. And, says Holly Wilkinson, Thayer's assistant dean of academic and student affairs, "Once students are at Dartmouth, we look for ways to engage them in the Thayer community."

But the strongest ambassadors for female students are the students themselves. Many women say they heard about the hands-on learning environment directly from the source: the "girls' club" that has formed around current and former female engineering undergraduates.

"I have encouraged freshmen and sophomores to think about engineering as an option for a major, and I tell them I definitely never feel discriminated against based on my gender," says Sopher. "I've always felt that my work is evaluated as an engineering student, never having anything to do with the fact that I am a female."

ANNA FIORENTINO is senior writer at *Dartmouth Engineer*.



IN BUSINESS  
Shing Leung '16, '17, and  
Corynne Miles '16 describe  
themselves as accidental  
entrepreneurs

HOW PROFESSOR ERIC FOSSUM INVENTED THE DIGITAL CAMERA—AND IS HELPING TODAY'S STUDENTS CREATE THEIR OWN TECHNOLOGICAL INNOVATIONS.

# THE INVENTOR'S EYE

BY MICHAEL BLANDING



**A MERE DECADE AGO, CAMERAS WERE** special-occasion objects. We brought them to birthday parties and beach vacations, capturing only the biggest moments of our lives and downloading them for safe-keeping. A decade before that, digital cameras were virtually unknown; taking a picture meant loading film into a camera, determining whether a shot was worth using up a precious 24th of a roll, and hoping the image lived up to our memory when we sent it out for developing.

Now with smartphones, we carry cameras in our pockets virtually all the time—spontaneously catching photos of family gatherings, nights out with friends, or just pretty scenes in the park, and emailing or uploading them to Facebook instantaneously. We use these smartphone cameras to video-call friends halfway across the world, record our children's school concerts, and apply makeup without a mirror. So much have these cameras become a part of our lives that we barely think about how much they have deepened our ability to capture and share the precious moments of our days.

The origins of the cell phone camera, however, come from as far away from our everyday experience as it's possible to get—outer space. Solid-state device engineer Eric Fossum was working at NASA's Jet Propulsion Laboratory (JPL) trying to make space camera technology lighter and smaller when he came up with a camera-on-a-chip breakthrough that made modern-day digital cameras possible. "I was born in October 1957, which was the same year Sputnik was launched," says Fossum. "The space program was part of my life growing up, and so when the opportunity came to work for the space program it was irresistible."

After that camera breakthrough, however, Fossum had to fight to get anyone to take it seriously. Finally, he struck out on his own as an entrepreneur to produce the first digital camera sensors, which took years to finally



FROM THE GERM OF  
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BETTER CAMERA FOR  
SPACESHIPS,  
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WORLDWIDE.

catch on. Now Fossum makes the most of his experience: As a professor at Thayer School, he not only teaches classes on engineering, but also runs the Ph.D. Innovation Program to encourage the next generation of entrepreneurs to learn how to commercialize new technologies.

“There’s a real need for engineers to understand the basics of business and realize it’s not rocket science,” he says, pun intended. And along the way, Fossum and his students are currently working on the next generation of digital camera technology, which could be as revolutionary today as his initial breakthrough was 25 years ago.

Growing up in Connecticut, Fossum thought that starting his own business was the last thing he’d ever do. He watched his father, a mechanical engineer, struggle with his company, which made electromagnetic clutches and brakes. “I’d spend Saturday in his facility installing light fixtures or cleaning toilets or something,” remembers Fossum. “He was always under a lot of stress. It was always financially difficult.”

Fossum himself swore he’d never run his own business. But he was interested in computers and studied computer engineering and physics at Trinity College and Yale, where he earned his doctorate in electrical engineering. Through a doctoral fellowship, he spent summers at Hughes Aircraft Co. in Canoga Park, Calif., working on visual devices to help guide missiles. “The whole process of making these things at the semiconductor level was exciting,” he says. “I realized that was where I wanted to be.” After graduating in 1984, he became an engineering professor at Columbia, where he researched state-of-the-art image sensing technology based on the “charge-coupled device” or CCD. But by 1990 he had gotten the call to work at NASA’s JPL at CalTech and jumped at the chance. “I’m a country person at heart, and didn’t really enjoy living in New York City,” he says. “But the space program was the real lure for moving out west.”

Now instead of missiles, he was making image-sensing technology for spacecraft journeying far into the solar system. Originating from Japan, the current consumer CCD cameras then in use provided good image quality, but they were also power hungry, requiring large batteries to operate. In addition, scientific CCDs were very susceptible to damage caused by radiation. That meant that spacecraft would need to carry large solar panels, as well as metal radiation shields, all of which added excessive weight to precious payloads.

Fossum’s job was to try and shrink the cameras down in size and reduce the overall weight of the spacecraft. To do that, he came up with a new idea. Instead of using CCD technology, he proposed using complementary metal-oxide-semiconductor (CMOS) technology, the standard for constructing integrated circuits on computer chips. Using that technology, combined with a new technique called “active pixel sensing,” Fossum hypothesized that he could dramatically shrink the size of the camera and the power it consumed and make it less susceptible to radiation damage.

He describes the difference this way: Imagine a football field full of people whose job it is to measure rainfall, using buckets that completely cover the surface area. Once people’s buckets get filled with water, they carefully pour them into the buckets of the people next to them, and so on until the water gets to the sideline, where it is measured to get the total amount.

That’s what CCD technology is like. Individual pixels sense the amount and color of light that hits them, and then circuits transfer the information across the chip to where it is recorded. That’s why they required so much energy to operate. “If you imagine that football field and people pouring buckets in a bucket brigade, you can imagine you’d have to pour pretty carefully to get anywhere near what you started with,” says Fossum. “With the CCD technology, you have to transfer the charge packet that represents the accumulated photoelectrons step by step across the chip without losing many electrons or else the image-quality deteriorates rapidly.” The

greater the number of pixels, the faster that charge has to travel and the more power that is required to transfer it.

With active pixel technology, however, each pixel could individually sense and record the photons that hit it. It’s as if, says Fossum, all of the people on the football field had their own individual measuring sticks and cell phones and could call in their measurements without having to do the bucket brigade.

Engineers had dismissed CMOS technology, however, because it produced too much noise that drove down image quality compared to the CCD cameras. Fossum and his team at JPL figured out a way to reduce the noise through a process called intrapixel charge transfer, which measured the charge before and after the pixel was hit by photoelectrons. Fossum compares the process to the way that cold cuts are weighed at the deli, first by weighing the wrapping and then weighing the wrapping with the lunchmeat to figure out the total weight of your purchase.

“I spent a lot of time figuring out why nobody had ever thought of this before,” says Fossum, surprised at how easy the ultimate solution proved to be. “I thought there must be something wrong—what am I missing?” Once he had proven to himself that this technique could work, however, he gained confidence in the new technology and began proselytizing to others in the field. At the time, NASA was encouraging engineers to partner with American businesses to commercialize new technology, and Fossum hit the road pitching it to Bell Labs, Kodak, National Semiconductor and other companies, trying to sell them on the idea of “portable videophones” that consumers might carry with them to take pictures and videos.

He got a few takers, but businesses were skeptical of the new technology, which seemed too different from what they were used to. “It seemed there was this window of opportunity to introduce this new technology, and I felt like people were going to miss the boat,” says Fossum. At the same time, he started receiving some custom requests from customers looking for his revolutionary camera-on-a-chip, such as an Israeli medical company that wanted to create a pill camera that could be swallowed by patients.

In 1995, with his then-wife, Sabrina Kemeny, he took it upon himself to found Photobit Corp., continuing his day job at JPL while Kemeny stayed at home and ran the company with a small team of engineers. In short time, it became clear that the company had grown too large for Fossum to work on it only part-time, and he made the decision to leave JPL to commit to it. “There were two paths—one was working as a salary man for someone else, the other was to grow this company,” he says. “I felt the CMOS image sensor was my baby, and I wanted to give it every opportunity to succeed.”

Fossum headed up the engineering side of the company, while Kemeny ran the business side. They planned strategy over the kitchen table. “My kids were always complaining at dinner—would you stop talking about this?” Fossum laughs. Despite his vow as a child never to follow in

his father's footsteps as an entrepreneur, Fossum found himself running a small business after all. Unlike his father, however, Fossum began seeing faster success in his industry. Little by little, Photobit began establishing the technology as a way to create digital cameras that took up a fraction of the space of those then being used.

Although Fossum took out patents on his ideas—eventually he would hold more than 150—other companies began adopting CMOS technology and competing against his upstart firm to produce digital cameras and web cameras for laptops. “The real swing happened when Toshiba started to produce sensors based on our technology,” says Fossum. “That was scary to us, but it gave us instant credibility, so everyone started paying attention and getting interested.”

Photobit eventually grew to a corporation with more than 125 employees and \$20 million in annual revenues. With such success, it attracted the attention of other firms, and in 2001 the board decided to sell to semiconductor company Micron Technology. With the advent of cell-phone cameras a few years later, the technology took off. Fossum stayed on as an individual contributor for a year, but the thrill had gone. “Going from being the big cheese to working for somebody else who doesn’t understand the business as well as you do and then feels like they have to establish themselves as the boss is just a rotten situation, and I was glad to exit finally,” says Fossum.

Retired for a few years, he was asked to lead another startup company, called Siimpel, which used microelectromechanical systems (MEMS) technology to produce smaller auto-focus systems for cell-phone cameras. “I got the chance to try out all of the things I’d learned about business,” says Fossum. “It was so much easier the second time around.” Apropos of the new business venture, he says the number one thing he learned is the importance of focus. “It’s important to start with a few strong customers and make a particular product for a particular application rather than trying to make something for everybody,” he says. “They call it the bowling pin strategy. You take out the center pin first, and then it knocks down all of the others.”

Another lesson was driven home to him, appropriately, at an actual bowling alley. “They always tell entrepreneurs how important it is to make your investors and customers happy, but it’s also important to treat your employees well, because they are really the key to your success,” says Fossum. “I remember at Siimpel we held an event for employees and their families at a bowling alley with pizza and everything and my wife, Susan, turned around and whispered in my ear, ‘You better not screw this up.’ And I did my best not to.”

After several years of growing the firm as CEO, Fossum this time left the company before it was sold and became a consultant for Samsung and other companies. By 2010 he was restless again. “I felt I wasn’t done intellectually yet, and maybe I had something more to contribute,” he says. Living in New Hampshire, he contacted Dartmouth, asking if he might teach a course at Thayer. Dean Joseph Helble not only offered him a full slate of classes, but also asked if he would be interested in directing a new innovation program to teach entrepreneurial skills to Ph.D. students.

Fossum says he couldn’t imagine a better match for his skills. “I was thinking of my academic credentials, and I found my entrepreneurial credentials were also appreciated. It was an opportunity to use the entirety of my life experience.” In addition to counseling Ph.D. Innovation Program students on how to turn their engineering ideas into potential businesses, Fossum is pursuing a next-generation image sensor that is as much a step ahead of the CMOS sensor as that one was ahead of the CCD sensor.

“With the CMOS sensor, if you recall, we were last out on the football field with a bucket, but that meant having to measure each bucket accurately,” says Fossum. “But what if we counted every raindrop that

came in.” That is the principle behind the so-called quanta image sensor, which would use pixels on the order of 500 nanometers, so small that they could detect individual photons of light. “It would be like using a thimble instead of a bucket,” says Fossum. Each time a photon hits, theoretically, it would knock loose an individual electron that could be counted with high sensitivity. “It is harder to achieve, but it would also be faster because we are just detecting a 1 or 0 for the presence or absence of light. It becomes a binary decision.”

Fossum has set up a lab at Dartmouth to research and design the technology, organizing a half-dozen graduate students into a team resembling a working research group at a company. Assistant Professor of Engineering Kofi Odame is impressed with the focus Fossum’s lab shows. “Academic labs are typically run in order to extend the body of knowledge, and the structure and discipline you’d find in industry is not there,” says Odame, who is collaborating with Fossum to design the integrated circuits that would translate Fossum’s analog signals into digital readouts. “The way he goes about things, he clearly defines who is the client, what are their goals, what are the deliverables, so there is a lot less fuzziness.”

Rather than having students meet individually to discuss progress, Fossum has them come together in weekly meetings in which each student discusses his or her part of the project with the others. That not only keeps everyone apprised of the project as a whole, says doctoral student J.J. Ma, but also holds everyone accountable. “All of the students are working very hard, in part because of our own personalities, but also because of the way Eric manages the team,” says Ma. “It’s a very competitive environment—everyone wants to show they are making progress.”

Along the way, students are getting practical experience in the hard work of turning theory into practice. Last summer, Ma interned at Rambus, a design and development company that is partially funding Fossum’s research and working to commercialize his quanta imaging technology. So far, Rambus imaging division head Michael Ching says that the company has been able to produce a binary pixel architecture on several test chips. “It’s achieved many of the benefits that Eric hypothesized,” he says. “It’s an exciting first step.”

Fossum’s experience running his own companies has made him uniquely qualified to collaborate with business in helping to make his latest ideas a success. “It’s very refreshing,” says Ching. “Oftentimes when you work with people in academia, concepts sounds good but only a small number of them are actually practical even in a 10-year timeframe,” he says. “Eric thinks about these advanced concepts but also understands the practical aspects of these technologies. His approach spans the entire range.”

If that approach is successful, Fossum may within the next decade have another accolade to add to an already spectacular career of innovation—which includes membership in the National Academy of Engineers and a place in the National Inventors Hall of Fame. Whatever happens with his latest research designing the next generation of imaging sensors for consumer devices, however, he still treats his contribution to the current state of the art in imaging sensors with an air of disbelief.

“It’s pretty overwhelming to think about,” he says. Even after all these years, he is amazed at how his idea has taken on a life of its own. “There is a sense of surprise about that—it really works, it does what I thought it was going to do.” From the germ of an idea to make a better camera for spaceships, his technology is now carried around in the pockets of millions of people worldwide. “As an engineer,” he says, “you never know where your inventions are going to end up.”

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**MICHAEL BLANDING** is an award-winning investigative journalist. His most recent book is *The Map Thief*.

# UNDERGRADS IN THE

FROM ICE CORE  
COLLECTION  
TO INFECTIOUS DISEASE  
DETECTION, EVEN  
FRESHMEN WORK IN  
THAYER RESEARCH LABS.

BEICHEN DAI '16

**LAB:** Bioimpedance  
**P.I.:** Professor Ryan Halter

**RESEARCH:** We are developing a kind of thermal imaging for patients with prostate cancer. After a surgeon has removed the prostate, we heat up the surrounding tissue. Based on the cooling properties of the tissue, this new kind of imaging will be able to differentiate between the tissue around the prostate and the prostate itself so that surgeons can immediately tell whether they've missed a spot, helping them cut better margins.

**MY ROLE:** I started out by making a circuit, taking a piece of steak, and connecting some infrared LEDs to it. I used a temperature sensor to watch the meat heat up—to show that with the LEDs I could actually get the meat to heat up. I plotted everything, and then we moved on to trying to make the temperature increase more significant. I used SolidWorks to design a ring that could hold 16 infrared LEDs. I printed it out on Thayer's 3-D printer and then heated up the meat again and again. Now I use a heat gun to heat up the meat, and then I take a video with a thermal camera.

## THEY DON'T DO COFFEE RUNS OR MAKE COPIES.

When undergraduates work in faculty research labs at Thayer School, they devise and conduct experiments, operate high-tech equipment, and gain real-world investigative experience and skills. "You are part of the whole

I run code that I've written and construct the images.

**WHY THIS LAB:** Professor Halter's website listed robotic surgery as one of his specialties, and I thought it sounded really cool. I emailed him and we met a week later. It's awesome to be able to just email a professor and hop on a project right away.

**THE EXPERIENCE:** It's been really helpful to be surrounded by grad students who are much more experienced than I am. There's always someone working next to me, and I can ask them questions: "I'm trying to write this code and this is what I want to do. Do you have any ideas on how I can move forward?" I've learned to think of different ways to accomplish one thing and to not be discouraged when one thing doesn't work. If something doesn't work, scrap it and try something else. That's okay. That's research.

**WHAT'S NEXT:** I want to make an impact in the medical engineering field, whether on the physician side or in the medical engineering industry side. I haven't decided yet.

# LAB

BY KATHRYN LOCONTE LAPIERRE



process. The undergrads are not relegated to doing busy work that isn't important or isn't relevant. Most undergrads are working on projects that are a huge part of the lab," says engineering major Bridget Shaia '15, who has been working in the Dartmouth Biomedical Engineering Center with Professor Douglas Van Citters '99 Th'03 '06 ever since she took ENGS 21: Introduction to Engineering. "At Thayer it's really easy for an undergrad to get involved," Shaia says.

First-year students can find research internships either through Dartmouth's Women in Science Project (WISP), a program co-founded in 1990 by former Thayer associate dean Carol Muller '77, or through Thayer's recently launched First-Year Research in Engineering program. At any time, an eager email or a knock on a professor's door can also lead to lab work that can last until graduation—or even beyond.

In the following, nine Dartmouth undergraduates tell us what they've learned about research—and themselves—in their time in Thayer labs.

## KAREN JACQUES '17

**LAB:** Ice Research  
**P.I.:** Professor Ian Baker

**RESEARCH:** We are studying soluble impurities in polycrystalline ice. There are impurities in ice, such as glaciers, just about everywhere, and we are working to see how the different impurities affect the rate at which ice grains grow, to see whether there's a significant difference between the impurities and pure ice. We're starting at very small scale, but seeing how different impurities affect the world at a larger scale will translate to something such as the impact on the ice caps. Global warming and what is happening to the ice caps affects water levels, which in turn affect the world around us every day.

**MY ROLE:** I run the trials and collect all the data. I cool a glass plate in a dry ice and methanol bath and drop a single water droplet onto the plate. When the droplet freezes, I shave it down and set it up under a micro-

scope that's equipped with a time-lapse camera that takes pictures of the ice grains as they shift into place. I use MATLAB to analyze the time-lapse images. We then create graphs of the growth rates of each trial.

**WHY THIS LAB:** I applied through the Women in Science Project my first year. They have a giant list of programs that match mentors and mentees. I didn't know exactly what I wanted to do, but working in an ice lab sounded interesting. I really like the program, and I applied to stick with Sophomore Scholars through this year.

**THE EXPERIENCE:** Coming in my freshman year, I didn't really know what research entailed. But being able to be with it from the start, I've gotten to see how research actually develops. Just because something goes wrong doesn't mean it's a failure. Even though a trial may not run perfectly doesn't mean that you throw that data away. For instance, we weren't getting the growth rates we expected and that led us to look into whether or not temperature has a bigger role in the grain growth than we thought it would. That led us to tweak our procedure. Being able to work hand-in-hand with the Ph.D. student and Professor Baker and to see how research progresses has helped me so much. Doing research as an undergrad is one of the best things Dartmouth has going for it.

**WHAT'S NEXT:** I am pre-health right now. When I graduate, I will have already had a head start on people who may never have done research before. Even though I'm not an engineering major, I still get to see how you would take ideas that you're learning in a classroom and apply them to research. It's a way to see how studies interact with the real world.



### SARAH HAMMER '15

**LAB:** Energy Biotechnology

**P.I.:** Professor Lee Lynd Th'84

**RESEARCH:** My research focuses on using microbes to break down and convert cellulosic biomass, such as switchgrass, to ethanol, which can be used as an alternative fuel.

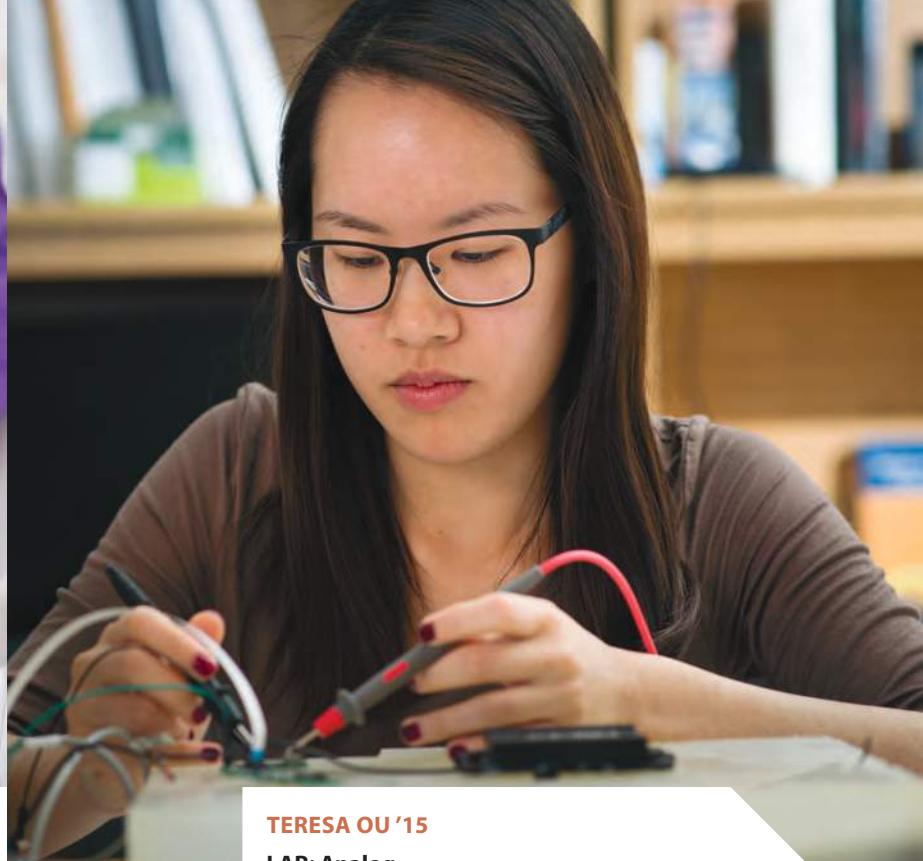
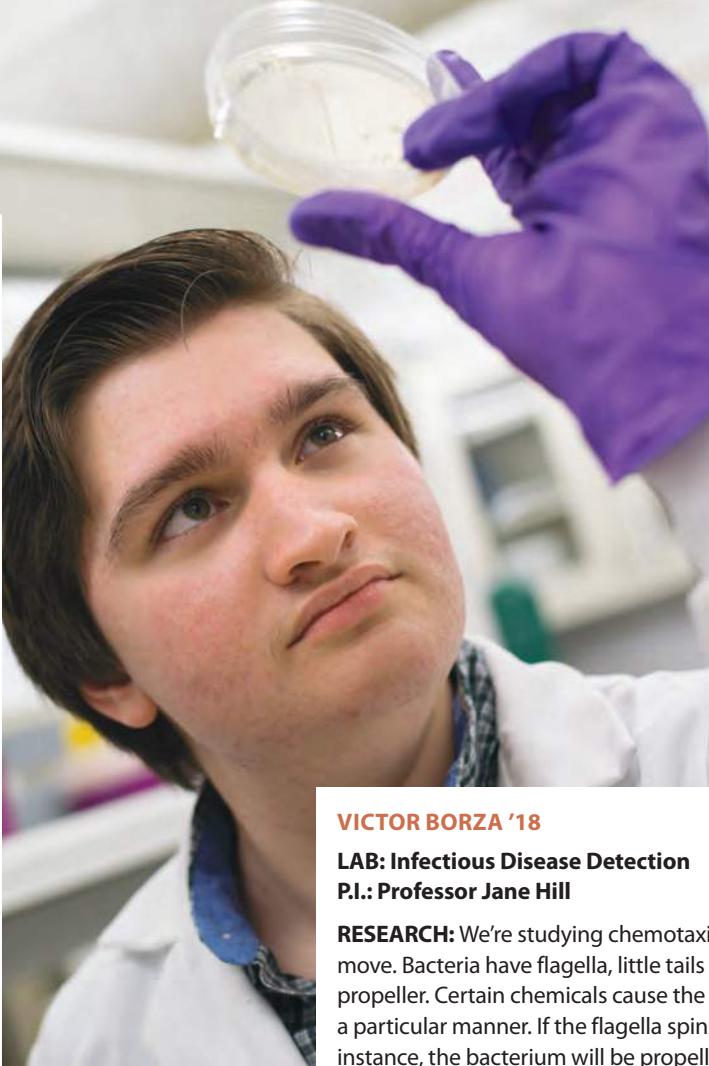
**MY ROLE:** I focus on the phenomenon by which microbes utilize switchgrass as a substrate for ethanol production. The microbes under investigation are unique in their ability to break down the complex carbohydrates in the switchgrass into soluble carbohydrates such as glucose and xylose. My first project in the lab aimed to compare different bacteria based on this desired capability. If you take samples of switchgrass, put each in a separate bottle with a different strain of bacteria, and ferment them under identical conditions, which bacteria does the best job at breaking the switchgrass down into simple sugars? Once I confirmed that *Clostridium thermocellum* was the best among the candidates tested, I've focused on trying to improve the yield of simple sugars from switchgrass in the presence of *C. thermocellum*. Subsequent work found that ball milling, the mechanical rubbing of the grass particles, in-between stages of fermentation with *C. thermocellum* significantly increases the amount of carbohydrate that's able to be solubilized. I'm learning that without added chemicals or large costs, you can use a simple mechanical mechanism to greatly increase yields.

**WHY THIS LAB:** When I came to Dartmouth, I was interested in chemical engineering, biology, and sustainability. I was inspired by the work done in Professor Lynd's lab, which integrated all of these interests. Since working in his lab, I've grown a passion for alternative fuels.

**THE EXPERIENCE:** I am very grateful to have had the opportunity to work in research laboratories as an undergraduate. Many of my friends at other universities have not been able to work in any labs, or not until their senior year. Dartmouth enabled me to participate in laboratory research since my freshman year. It has really enriched my experience as an undergraduate, allowing me to apply concepts that I've learned in my coursework directly to real-world problems, and to feel that I'm contributing in some way—albeit small—to the scientific community.

Something special about the Lynd lab is its sense of community. It has provided me with a group of people of all ages who I feel like I can connect with and talk with about science. Our conversations have been inspirational and have helped me decide to pursue a Ph.D.

**WHAT'S NEXT:** My experience in the Lynd lab has helped prepare me for graduate school, and participating in full-time research as an undergraduate certainly played an important role in my acceptance to graduate programs. It has also confirmed my passion for laboratory research, specifically in the field of bioenergy.



### VICTOR BORZA '18

**LAB:** Infectious Disease Detection  
**P.I.:** Professor Jane Hill

**RESEARCH:** We're studying chemotaxis—how bacteria move. Bacteria have flagella, little tails that act like a propeller. Certain chemicals cause the flagella to spin in a particular manner. If the flagella spins clockwise, for instance, the bacterium will be propelled forward. If it spins counterclockwise, the bacterium will turn around. We're looking at how different chemicals trigger different responses and how they get the bacteria to move. Understanding the movements can be useful in designing therapeutics. Once we understand what bacteria are attracted to and why they're attracted, we can go about understanding the causes of infection much better.

**MY ROLE:** We make capillary tubes and load them with a certain attractant or repellent. We insert the capillary tubes into small bacteria cultures and see if they move into the tube. If they move into the tube, then we know they're attracted to that substance. We can then quantify the attraction by growing the bacteria from the tubes on plates and seeing how many grow.

**WHY THIS LAB:** I've found infectious diseases very interesting—being able to see what attracts bacteria to an infection site, and then questioning whether we can invent therapies. I like research because I like to solve problems, to build things, to create solutions, and I love analyzing how things work. This seemed like a perfect fit.

**THE EXPERIENCE:** The First-Year Research in Engineering program was really interesting because usually undergraduates don't have that many opportunities to work in labs, especially in their first year.

**WHAT'S NEXT:** I'm interested in doing an M.D./Ph.D. program when I graduate. Starting research early is a great way to build connections with the professor and then become more involved in interesting projects.

### TERESA OU '15

**LAB:** Analog  
**P.I.:** Professor Kofi Odame

**RESEARCH:** We are developing a small, unobtrusive, wearable cough monitor that attaches to your chest, detects whether you are coughing, wheezing, or having some other types of symptoms, and sends the data to a smartphone. For people who have asthma, chronic obstructive pulmonary disease, or other respiratory conditions, being able to track their symptoms can help them avoid hospitalization. The device would also help parents monitor the health of children with respiratory problems.

**MY ROLE:** The cough monitor picks up some noise from chest movements, and I've been developing algorithms to clean up that noise. I've been working on MATLAB code and working with data to see how well it can be cleaned up.

**THE EXPERIENCE:** Even as a freshman I was able to get involved with research at Thayer. I have the chance to try to learn new things on my own and apply them. A lot of the work that I've been doing for research doesn't draw that heavily from what I've learned in my classes. I've had to learn through reading research articles, talking to Professor Odame, or asking him for resources I should look at. The skills that I'm learning are applicable to real life. Last summer I did an internship at a communications company, and I didn't really know anything about communications or satellites. But the skills that I learned from my research helped me have confidence that I would be able to learn things on my own for that job.

**WHAT'S NEXT:** I will be pursuing a master's in electrical engineering at UC Berkeley.



### LLOYD MAY '18

**LAB:** Infectious Disease Detection  
**P.I.:** Professor Jane Hill

**RESEARCH:** We're studying chemotaxis, how bacteria move and what attracts them and what repels them. The lab is doing work with infectious diseases, mainly focusing on early detection of tuberculosis.

**MY ROLE:** We're still in the training phase, learning how to treat bacteria. We're using MATLAB programs and learning how to count colonies. We're using spectral analysis and working with *E. coli* K12 before moving on to *Pseudomonas*, which can be dangerous if you don't work with it in the right way.

**WHY THIS LAB:** I am a part of the First-Year Research in Engineering program. One of the main things that drew me to Dartmouth was the fact that I could do research as an undergrad. It's cool to learn about the math and sciences in class, but applying it in real life and actually doing research really appealed to me. Professor Hill's work with infectious diseases drew me because if patients are HIV positive, normal TB testing can sometimes produce a false positive or a false negative. Growing up in South Africa, I had a lot of friends who were negatively affected by TB in their families. I know what TB can do. Also, I've always been interested in molecular and cell biology, and this is right up my avenue.

**THE EXPERIENCE:** In Professor Hill's lab we have Women in Science Project students and First-Year Research in Engineering students, and it's cool how those two programs complement each other. In our lab, we have people who have similar academic interests but come from such diverse backgrounds. We have varsity athletes, we have people who are pre-med, we have people who are interested in economics, and everyone works toward the same goal. I think one of the best ways to work is through experiential learning. Research gives you a love for the lab. The hands-on learning perspective and seeing theory used in real life is a big takeaway.

**WHAT'S NEXT:** I'm interested in biomedical and chemical engineering. I'll probably do a master's degree. Then I'd like to go back to South Africa and work at an engineering firm there. But you never really know what the future holds. I might fall in love with something really obscure during my master's. Whatever I do, I'll be far more prepared because I've worked in an actual research lab.



### BRIDGET SHAIA '15

**LAB:** Dartmouth Biomedical Engineering Center  
**P.I.:** Professor Douglas Van Citters '99 Th'03 '06

**RESEARCH:** The lab centers around orthopedic implants. When surgeons remove a failed implant, they send it here. We work with companies that design the implants to figure out why they're failing and how the designs can be improved.

**MY ROLE:** When someone gets a knee replaced, the lower part of the implant, the tibial tray, is attached to the top of the tibia with an acrylic-based bone cement. For my thesis, I'm working on improving the strength of that interface between the bone and the cement. I do a lot of mixing cement, putting it on different test samples, and then breaking it apart. It's active work and it's always changing a little bit, which I really enjoy.

Many surgeons currently drill holes in the top of the tibia before they put the cement on in order to help the cement interdigitate better with the bone, but this practice isn't regulated and there isn't any data on the optimal way to do it. I'm part of an engineering and surgical team that is identifying the reason that these holes improve the interface strength. This knowledge will help surgeons improve patient care through optimization of the hole sizes and density.

**WHY THIS LAB:** When I took ENGS 21: Introduction

to Engineering, I built a biomedical surgical device for orthopedists. I wanted to learn more. I had heard about the lab from some older students, so that drew me in.

**THE EXPERIENCE:** Biomedical engineering is broad, and the lab has enabled me to see a very focused part of what it looks like in practice. I've developed skills in how to approach and tackle a complicated research problem: I've learned how to break it down, look at one thing at a time, and design an experiment. Also, it's been a really cool experience seeing how a research lab interacts with companies that come to Dartmouth for testing or help in designing something new.

At Thayer it's really easy for an undergrad to get involved. You are part of the whole process. The undergrads are not relegated to doing busy work that isn't important or isn't relevant. Most undergrads are working on projects that are a huge part of the lab. It gives you a lot of perspective as to what you might want to be doing in the future.

**WHAT'S NEXT:** I'm coming back next year to finish the B.E., and because of the exposure I've had here at Thayer in the lab, I'm really interested in designing medical devices.



### BRENDAN NAGLE '14, B.E. CANDIDATE

**LAB:** Nanophotonic Materials

**P.I.:** Professor Jifeng Liu

**RESEARCH:** We are using a new method to fabricate Germanium nanowires. This oxide-assisted growth method creates higher purity nanowires for making optical devices on chips.

**MY ROLE:** I've been doing the nanowire fabrication. We put down Germanium oxide on silicon and etch a trench. When you heat the Germanium oxide, the particles grow from one small site on the silicon into a wire structure about 10 to 20 nanometers thick and a couple micrometers long.

**WHY THIS LAB:** I did a course in my study abroad in optical electronic devices where we started learning about lasers and LEDs, and I fell in love with it. At the time I wanted to be a physics major. Then I took Professor Liu's ENGS 24: Science of Materials class. It was a great application of quantum mechanics—all the things I loved in physics, but it was also very applicable to real life. Professor Liu is very open, very friendly, very giving, very good at explaining things. Whenever I go into his office he always has time. It seemed to be a good fit.

**THE EXPERIENCE:** My research has shown me that I am independent and motivated. I've learned to use the cleanroom and learned a lot about microscopy. I was able to use the scanning electron microscope and the transmission electron microscope. With that machine you can see planes of atoms.

I've learned a lot about fabrication processes. We used a lot of photolithography—which is using light to make nanoscale patterns on a wafer or in a material—to get our wires to grow in different ways. That was a very useful skill to pick up. With that I could go into chip design as an engineer at a company. Now I know a little bit about how those processes work, and therefore I'll be better at designing things. The experience has been very helpful looking at graduate schools, and at most job interviews I've been on, they're like, "You've done research, that's fantastic!"

**WHAT'S NEXT:** I signed an offer at Oracle. I'll be writing code that defines how a microprocessor operates.



## ELLYN GOLDEN '17

**LAB:** Ice Research

**P.I.:** Professor Rachel Obbard

**RESEARCH:** We look at the microstructure of sea ice, which is a layer between the ocean and the atmosphere. It's a conduit between those two mediums for materials such as brine or bromide to move through. We're looking at how bromide moving through the ice depletes tropospheric ozone, and what this can tell us about global climate change.

We're looking at multi-year ice versus first-year sea ice. First-year sea ice has just formed that winter. Multi-year sea ice froze long ago, melted on top, and refroze and melted each winter and summer since then. First-year sea ice is overtaking multi-year sea ice because every summer all the ice is melting. We're looking at whether that's going to change how materials move from the ocean into the atmosphere. I'm demonstrating the processes behind that.

**MY ROLE:** I get one quarter of an ice core from Antarctica. Being careful to know which end is the top, I measure the ice core into 10-centimeter increments and cut it into 2-centimeter-by-2-centimeter cubes. I get the cubes onto a tiny copper stage that screws into the micro CT scanner. The scanner takes two-dimensional pictures, and I reconstruct the images into a 2-D model. It comes up as a smattering of black and white. The white is brine channels, the black is air pockets, and the grey in between is the ice. I do some mathematical analysis about how connected all the channels are to each other to see how easy it is for materials to move through the ice.

**WHY THIS LAB:** I got into this as a Women in Science Project student my first year. I interviewed with people on the earth science side of things because I knew I wanted to be either an earth scientist or a biologist. I like earth processes and rivers, ice, and glaciers.

**THE EXPERIENCE:** I've struck gold on this project in being able to work with Professor Obbard and Ph.D. candidate Ross Lieb-Lappen. Some of the things I understand, but a lot of it is also right over my head. It's definitely been a very difficult learning curve. The micro CT scanner gives you 20 different mathematical



analyses, and you have to be able to search for the one that might tell you anything. But it's been the best science experience that I've ever had.

I know much more about sea ice than I thought that I would when I started out. I know how to use a micro CT scanner and an electron backscatter diffraction machine. I've been to Argonne National Lab to use their advanced beamline photon source. I've also traveled to Alaska for six weeks to collect sea ice cores. Field research is the greatest thing that you could possibly get under your belt as an earth scientist.

I'm learning what it is to be and collaborate as a research scientist. That's not something that you get in the classroom.

**WHAT'S NEXT:** I will graduate with a degree in environmental earth sciences, which is earth sciences supplemented with sustainable design courses in engineering. I would like to remain in the earth sciences or the sustainability field. I could see myself keeping with my interest in ice for a long time, especially sea ice because it is so beautiful and complex.

KATHRYN LOCONTE LAPIERRE is senior editor of *Dartmouth Engineer*.

# Alumni News

FROM AROUND THE WORLD

## spotlights

Andrea Marron Th'12



After working for fashion brand Nicole Miller (and CEO Bud Konheim '57) for almost three years, **Andrea Marron Th'12** has launched data software startup Ragtrades Inc. "Our mission is to help fashion brands and retailers increase profitability through data-driven decision-making on how to buy, price, and digitally promote products," says Marron, who was the vice president of digital, managing the e-commerce business and digital marketing when she left Nicole Miller. "In an aggressive markdown environment and an industry where timing is critical because products are

perishable, we help our customers take advantage of data to make informed decisions," she says. The most successful product so far, Ragtrades, has been a price-tracking program for retailers and brands. Marron is now experimenting with using the price-tracking data to offer individual consumers a way to compare prices, like a Kayak.com for leather bags and sweaters, and is hoping to launch that engine this summer. She credits her Thayer background, especially as the inaugural Conrades Fellow, with her success: "Through that fellowship, Thayer, and Tuck's entrepreneurial initiatives, I was

able to get hands-on learning experiences in business and tech entrepreneurship that I draw on every day."

Despite being in investment for almost 40 years, **Geof Greenleaf '66** never ran a mutual fund—until last year. At 70 he launched the Greenleaf Income Growth Fund ([greenleafincomegrowthfund.com](http://greenleafincomegrowthfund.com)) to serve people who are at or near retirement or who receive Social Security and Medicare benefits but don't want to stop working. "The idea came about when I touted the benefits of inflation indexing with Social Security to a client," he says. "He was not impressed and said, 'Yes, but it doesn't even pay my bar bill.'" Greenleaf aims to boost cash flow to keep up with inflation. "Looking at my own case, I want to maintain my current standard of living" he says. "I want to steer as clear as I can from draining principal, and I want to leave behind as much as possible for my children and grandchildren." Greenleaf is also the CEO and cofounder of investment management firm Private Harbour, based near Cleveland, Ohio.

Water conservation and efficiency expert **Amy Vickers Th'86** has earned the 2014 Water Star Award from the Alliance for Water Efficiency. She was honored for more than 25 years of achievements in the water efficiency field, particularly her role in writing the national water efficiency standards for plumbing fixtures adopted under the U.S. Energy Policy Act of 1992, which has saved the nation trillions of gallons of water during the past two decades. "Amy has been an unfailing champion for water conservation, wise and efficient water use," says Alliance for Water Efficiency president Mary Ann Dickinson. A prolific author, Vickers has written more than 75 professional papers, articles and op-eds as well as the *Handbook of Water Use and Conservation: Homes, Landscapes, Businesses, Industries, Farms*—"one of the best sources on water topics," according to

*National Geographic*. She's working now on her second book.

California Gov. Jerry Brown has appointed **Andrew McAllister '87** to the Sacramento-based California Energy Commission (CEC), the state's primary policy and planning agency. "We're working hard to decarbonize California's energy systems by scaling up deployment of energy efficiency and a wide variety of renewable energy technologies, as well as investing in infrastructure needed to electrify the transportation sector," he says. McAllister has built a career in the field of clean energy, providing energy services to communities in remote areas of Latin America, Africa, and Southeast Asia before directing the clean-energy non-profit California Center for Sustainable Energy in San Diego. With a Ph.D. in energy and resources from UC Berkeley, he fills the "economist member" slot on the five-member CEC. "California is in a great place to provide leadership in expanding clean energy and confronting climate change," says McAllister, "so it's a very exciting moment to be shaping those efforts."

"I always felt my education gave me a leg up, and places like Dartmouth and MIT gave me scholarships and enabled me to get a good education," says **Michel Zaleski '68 Th'69**. "I felt I should give back." After earning his degrees at Dartmouth and an M.S. from MIT, Zaleski went on to a successful career in investment and real estate, serving on the Council on Foreign Relations, the board of the Soros Economic Development Fund and Thayer's Board of Overseers. His interest in philanthropy and education prompted him in 1995 to start a program through Dartmouth's Tucker Foundation to bring students to Cabarete, Dominican Republic, to teach in public schools. That effort grew into the Dream Project ([dominicandream.org](http://dominicandream.org)), an educational organization that builds and runs schools in the Dominican Republic.

# On the Job

CALVIN KRISHEN TH'07 | WAVE TEST DIRECTOR

Calvin Krishen Th'07 is test director at the Naval Surface Warfare Center's 12-million-gallon pool, the most sophisticated scientific wave-testing basin in the world. With the 21-million 216 state-of-the-art wave boards, each with its own motor synced up to software, he can precisely recreate eight ocean conditions—from flat calm to typhoon-like—across all seven seas. Here he explains how the new technology works.

## How do you configure the water test to ensure similitude between the scale models and the full-size vessels?

For seakeeping tests, studying how vessels perform in waves, the most apparent parameter is carefully sizing simulated waves to a geometrically scaled-down model. Since waves are characterized by their height and period, the rates at which motions occur happen faster when scaled down. A model that is bobbing around rapidly could be representing the slow undulation of a vessel at full scale. Another important parameter is the energy content, or spectra, of the waves. Waves are made up of smaller ripples layered on top of larger rolling waves. Sometimes these ripples and rollers come from varying directions. The spectra of a wave characterize the occurrence of those smaller ripples and larger rollers as well as the direction they come from. When performing a model test, it is important to reproduce waves that have characteristics close to what you would find in nature.

## Are there any types of designs that are particularly hard to test?

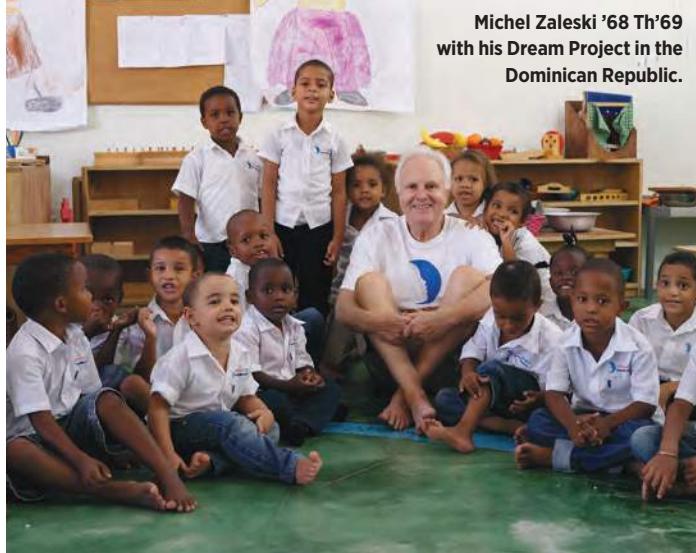
A single model isn't always suited for simultaneously testing multiple aspects of a ship's design. For example, a model built for seakeeping may be too small to measure structural loads. On the environment side, wind and currents cannot be reproduced in our indoor facility at present. Wind affects the energy content of ocean waves and imposes a force on a vessel. Yet even if every variable can't be simulated, a well-designed test will still advance your knowledge.

## Has your Dartmouth Formula Racing experience helped in your work?

One of the most valuable skills I learned from Formula Racing is the ability to lead a large team through a long, complex, and stressful project. The product cycle of a Formula car is about nine months and is executed with a team of 10 or more. Keeping a team on track requires careful planning, persistent multitasking, and finessed collaboration skills. Going through this cycle several times taught me that one of the keys to leading projects is understanding the interfaces, both technical and personal. Being the lead on a project means setting an example. It's amazing how contagious attitudes and discipline can be in a team setting.

**"When performing a model test, it is important to reproduce waves that have characteristics close to what you would find in nature."**

—CALVIN KRISHEN TH'07



**Michel Zaleski '68 Th'69**  
with his Dream Project in the  
Dominican Republic.

Now more than 5,000 students receive an education through 14 programs in 15 communities—in preschools, after-school remedial classes, at-risk youth programs, summer schools and camps, libraries, computer labs, music programs, and vocational programs. The project is run by a paid local staff of more than 50 Dominicans (many as certified teachers) and more than 200 volunteers. Zaleski continues to guide the project as president and chairman, and the Zaleski Family Foundation continues to be one of the largest donors to the nonprofit.

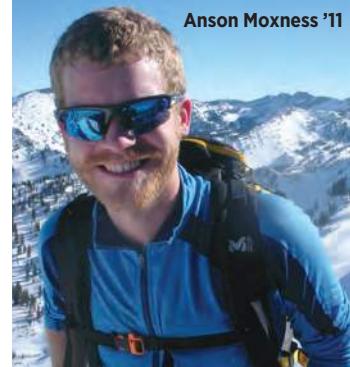
**Anson Moxness '11** has a new role as Nordic coach at Alaska Pacific University (APU). Last winter he headed APU's development program for middle-schoolers, coached the girls' team at his alma mater, West Anchorage High School, to top honors in the state championship—and worked as a civil engineer at Spurkland Engineering in Anchorage. With that firm closing, he has more time to focus on coaching. "Nordic skiing is a lifetime sport," says Moxness, who competed in high school and for two years at Dartmouth. "Part of my job as a coach is to help athletes excel, but part of my job is also to introduce new skiers to the sport and help foster a desire to be active and outside." He says Thayer reinforced his belief that hard work is rewarded. "Whether you are training or

racing hard in bad conditions or getting stuck on a problem or need another hand for an engineering project," he says, "having a supportive community of friends working with and around you can make all the difference."

LuminAID cofounders **Anna Stork Th'08** and **Andrea Sreshta** received a \$20,000 investment when they successfully pitched their emergency lights to a panel of investors on ABC's *Shark Tank* in February. The pair, who met as students at Columbia University's Graduate School of Architecture, developed the world's first inflatable solar lights in response to the 2010 earthquake in Haiti. "At the time there was a lot of clean water, shelter, and food being shipped to Haiti, but most people in informal settlements were without a light source," says Stork. "We saw a need for a portable light source to improve safety of people living in tents." The simple solar technology has since been included in charitable projects in more than 50 countries. "Each time we hear a new story about where our product has made a difference, we are reminded of how grateful we are to have the opportunity to share our product with the world," says Stork. A milestone for the company came in 2013, when they worked with ShelterBox to distribute more than 20,000 lights to victims of Typhoon Haiyan in the Philippines. Today, their solar-powered lights are in

the L.L.Bean catalog, on shelves of Bass Pro Shops, and online at [luminAID.com](http://luminAID.com). A winner at last year's Chicago Innovation Awards and the Toyota Mothers of Invention competition, LuminAID is rolling out a new series of lights for emergency kits and camping.

Degenkolb Engineers design engineer **Laura Weyl Th'08** is tackling both the design and construction aspects of a seismic upgrade for a hard-drive manufacturing facility in the San Francisco Bay Area. "I'm on site a lot and doing more of the coordination and scheduling than is typical of the structural engineer," she says. "It's a chance to see how the contractors work and really understand the construction side of the project rather than just the design." The seismic upgrade will allow the building to support heavier weights and reduce the facility's downtime after an earthquake. "Even buildings that are considered structurally safe in an earthquake can experience significant non-structural damage, sometimes so bad that a building will need to be rebuilt anyway," says Weyl. "These clients lose a lot of money every time the facility is shut down, so they want to minimize this time after an earthquake." Working on the non-structural phase now, Weyl says the greatest challenge is that nothing can move. "Everything has to be braced, strengthened, or anchored around what's existing, so nothing is typical," she says. "Each of the 4,600-plus pieces of equipment has a specific anchorage detail and the



hundreds of pipes, ducts, and conduit that run throughout the facility need to be braced along their entire length. It keeps me sharp!"

Sproxil founder and CEO **Ashifi Gogo Th'09** discussed "Should Business Lead the Social Agenda?" at the World Economic Forum annual meeting in Switzerland in January. Focusing on whether businesses can and should help find solutions to global challenges, Gogo said that corporations have a supporting role to play: "Even though businesses should not lead the agenda, because businesses specialize in creating value for their shareholders and society," he said, "they should be very strong collaborators with the specialists like governments in civil society, who do look at social issues more on a long-term basis." Gogo founded Sproxil in 2009 to enable consumers in Kenya, Ghana, Nigeria, India, and Pakistan to use cell phones to identify counterfeit products.



**Anna Stork Th'08, right, and colleague**  
**Andrea Sreshta** on ABC's *Shark Tank*.

# just one question

Q.

## What's the hardest engineering challenge you've ever faced?

My hardest engineering challenge was to come up with a jet engine pressure-ratio transducer. They were all analog electro-mechanical devices in those days, and a bright young engineer had a fancy geometric way of doing it with fine wires that didn't work out. The transducer division took my invention of a pure-crystalline silicon hollow evacuated cylinder with a very thin closure at one end that served as a diaphragm with thin n-p-n channels configured as a strain-gauge bridge. A young engineer that I had spirited from my former job developed the analog electronic circuits to provide an output linear vs. absolute pressure. That had its own significant error, multiplied by the error of analog computing the ratio of outputs of two instruments. Not good enough. An excellent company bought the patent and made a lot of money by developing producible transducers and digitizing the outputs for accurate division.

—Tom Harriman '42 Th'43

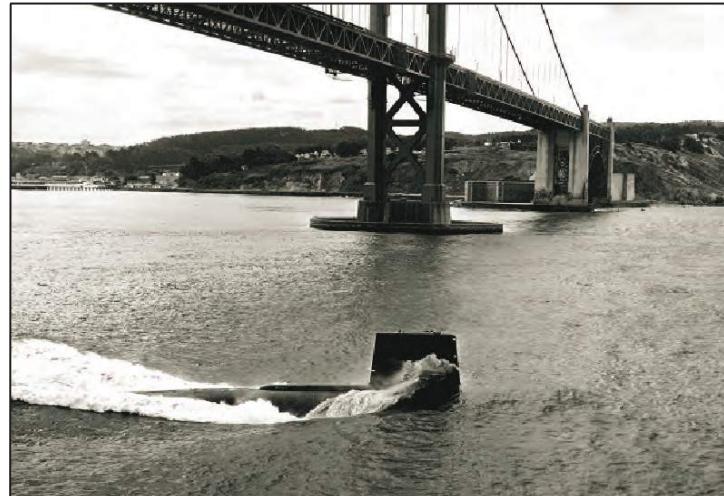
In the early 1980s Baxter & Woodman, a consulting engineering firm of which I was then president, was retained by the Village of Deerfield, Ill. We were asked to conduct an in-depth investigation of its sanitary sewer system, which for decades had been subject to extensive flooding, resulting in frequent and massive backups into basements. The study was to be an "infiltration-inflow" evaluation to identify and quantify the sources of groundwater and storm water. At that time information on the causes and sources of infiltration and inflow was limited and a subject of discussion and supposition, so we were entering into somewhat unexplored territory and had to develop equipment and procedures. One of the infiltration sources was sump pumps, which discharge into the house sani-

tary sewer connection. They were not believed to be pumping storm water, because the common belief was that surface water would take considerable time to percolate into the ground and reach the footing drains the sump pumps were serving. We installed some devices that we had fabricated to produce a time record of sump-pump operation, and found that most of the sump pumps in the study would be running full-bore for several hours, starting less than 15 minutes after the start of a significant rain event. We also blocked off sections of the storm sewers, which we then filled from a fire hydrant, and observed the increase in flow in the nearby sanitary sewer, measuring it from the velocity read with miniature flow meters and locating the leaks with submersible television cameras. We identified thousands of sources of infiltration and inflow totaling more than 70 million gallons per day leaking into the sanitary sewer system, which was designed for a sewage flow of 2-5 million gallons per day. (I presented a paper on our procedures and results to a standing-room-only audience at a national conference of the Water Pollution Control Federation.)

We estimated the cost of correcting each of these sources of infiltration and inflow and arrayed them in order of cost effectiveness vs. augmenting the capacity of the sanitary sewer system, on which a highly effective \$10 million remedial construction project was based, virtually eliminating the sewer backups that had plagued Deerfield for so long.

—Hjalmar Sundin '47 Th'47

During a five-year period from late 1987 through early 1992, the firm I was then leading was threatened by bankruptcy. Modjeski and Masters was found liable by an Orleans Parish jury verdict of \$9 million in a



**"My greatest challenge was qualifying as a chief engineer for a naval nuclear power plant on my first tour of duty on the USS Scamp."**

—Clinton Harris '69 Th'70

1987 lawsuit following a head-on crash on the Greater New Orleans Bridge, which we had designed. Our insurance coverage was denied, and the liability, which greatly exceeded the firm's net worth, extended to the partners' personal assets. Our impecuniosity prevented us from filing a suspensive appeal (Louisiana requires a 150-percent full-value bond) and the plaintiff was beginning, in 1990, to file documents to seize the firm's assets. However, the U.S. Supreme Court in late 1990 granted us an emergency stay of execution, and we were then able to file our appeal. The court of appeals in 1991 vacated the jury verdict and by early 1992 we had recovered most of our \$1.1 million in legal costs from our former insurance company. This ended an unforgettable episode for my partners, my family, and me in my professional engineering career.

—William Conway '52 Th'54

I was in charge of restoring a 50,000-square-foot clubhouse at Harbour Ridge Yacht and Country Club in Palm City, Fla., where we live. It was totally destroyed and rendered useless by two hurricanes in 2004. The club-

house was redesigned to better suit the needs of both members and staff and reopened in 2006 to critical acclaim. It functions beautifully to this day and should do so for many years to come.

—Bob Simpson '53 Tu'54 Th'54

Mining coal with water was the technical challenge of a lifetime. During the mid 1970s I was working at the Bendix corporate research labs in Southfield, Mich., as a senior project engineer. We had developed some proprietary capabilities for producing high-pressure (30,000-plus psi) water jet nozzles and intensifiers capable of cutting through almost any material. The U.S. Bureau of Mines was interested in the possibility of using water jets to mine underground coal. The objective was to reduce the hazard of mine fires and miner black lung caused by combustible coal dust generated by traditional mechanical drilling and continuous mining techniques. Bendix, teamed with the Consolidation Coal Co., was awarded an R&D project to begin developing a coal mine water jet/slurry transport system. There were two major technical challenges. One was to meet a production rate of 10

## just one question



**No one on our engineering team had ever worked in a mine environment or even been in a mine, except for me.**

—Ron Read '57 Th'58  
Designed a coal-water slurry transport system

tons of coal extracted per minute. The other resulted from using high-pressure water jets to cut the coal at the working face. This would result in vast amounts of coal-water slurry to be transported out of the mine. The transport system had to have a low profile because of the low seam height typical of coal mines.

The Bendix task was to first develop a slurry transport system. When we put the engineering team together we discovered no one had ever worked in a mine environment or even been in a mine, except for me. My dad had been general manager for the International Salt Co. mine under the city of Detroit. During my summer breaks from Dartmouth my summer job was "back to the salt mines." Based on these rather questionable qualifications, I was assigned as the project lead engineer. Our team found it was infeasible to haul the coal-water slurry using bulk transport because of the low haul way roof conditions. We decided on a hose transport system consisting of two 1-foot-diameter flexible hoses, one for water feed to the jet cutters and one for the slurry return. The hoses were positioned one on top of the other. The hose assemblies were clamped to each other and mounted to a steel I-beam linkage system with pin joints. The linkage and hose assembly was propelled by hydrostatically powered two-wheel carts at-

tached to the linkage assembly every 25 feet. Our prototype hose hauler hardware was designed and built in a shortened 150-foot-length version, as the production design called for a 1,000-foot length.

The prototype system was delivered for testing to the Consolidation Coal Robinson Run Mine in West Virginia. This prototype tested perfectly, snaking through the narrow mine haul ways. Unfortunately, the second technical challenge of producing 10 tons per minute using the limited and inefficient energy conversion of water jet energy to coal face extraction rate proved impossible. The Bureau of Mines decided not to pursue further development. So today the 150-foot hose hauler sits underground gathering coal dust, waiting for a higher-powered, more-efficient water jet cutting system.

—Ron Read '57 Th'58

My first civilian job after Vietnam service was at Dorr-Oliver as a program manager and lead sanitary engineer for a membrane bioreactor (MBR) project for advance wastewater treatment for the U.S. Navy. What was hard about this work was also its greatest joy: When you venture into truly new territory, there are no rules. The MBR process was patented by Dorr-Oliver in the late 1960s, and combined the use of an activated sludge bioreactor with a cross-flow membrane filtration loop. The objective was to efficiently treat wastewater to high purity in systems with a small footprint, low-energy consumption, and high biological stability. A cross-functional team of membrane scientists, mechanical, fluids, and sanitary (biological) engineers was assembled to develop and deliver a shipboard wastewater treatment system for a 200-man crew component. It was to be contained within a space envelope of 8-by-8-by-6-feet, allowing all service functions to be performed within an aisle adjacent to that space. Added challenges included fast startup, stability at sea, and operation in fresh- and salt-water environments.

Simulation of performance under changing salinity conditions was a crucial part of the contract. Our studies demonstrated unambiguously that the reactor was "upset" by osmotic forces rupturing microbial

cells. However, the combination of positive mass retention by the membranes and operation at high biomass concentrations maintained effluent quality through the upset period. The benefit of mass retention by the membranes also served to promote fast reactor startup after periods of non-use on the high seas.

There was significant concern over accumulation of suspended solids, because ultrafiltration membranes retained everything in the reactor. Long-term pilot studies with "real" waste provided a surprising and beneficial finding: Solid matter, particularly paper fiber, which traditionally is reduced under anaerobic conditions, was broken down in the aerobic-activated sludge reactor. Because the reactor biomass was notably higher than in conventional reactors, it was postulated that high biomass required additional nutrients, which triggered aerobic pathways for cellulose lysis.

An interesting side note of the Dorr-Oliver MBR activity was the installation of a wastewater treatment plant at the visitor center on top of Pike's Peak (elevation 14,114 feet) to treat wastewater for reuse. This plant operated for more than 20 years. Similarly, Sanki Ltd., a Japanese engineering partner, used this technology for wastewater recycling at Tokyo Central Station and many commercial buildings. When build-



**What was hard about this work was also its greatest joy: When you venture into truly new territory, there are no rules.**

—Ivars Bemberis '64 Th'65  
Developed a shipboard wastewater unit

ings incorporated wastewater reuse practices, occupancy limits could be increased, allowing construction of higher structures.

—Ivars Bemberis '64 Th'65

Of my 50 years in technology, I think my hardest challenge was in ES 21 Introduction to Engineering my freshman year at Dartmouth. Our class was the first ES 21 class, so no one really knew how it would work. Our problem was to build an energy-conserving bicycle. That is, you ride downhill, the bike stores energy and carries you back uphill. There were four teams. My team had English majors, art majors, etc. Everyone in the class intellectually proved that it would not work. Our team decided to try it out, so we built a bike with a generator motor. We tried it on Tuck Hill. And it did not work, for the most part. So for our presentation we rode the bike into the classroom and then showed why it was not feasible. We won the competition. No one else had actually built a working model. And we learned a lifetime of things.

—Ed Keible '65 Th'66

My hardest engineering challenge, other than actually graduating from Thayer, was qualifying as a chief engineer for a naval nuclear power plant on my first tour of duty on the *USS Scamp*. Four of my five years at Dartmouth were paid for through a NROTC scholarship, and in return I committed five years to the Navy, including going through nuclear power training and serving on two nuclear submarines, mostly at sea and mostly underwater at a time when the Cold War was about as hot as it got.

Once on board your first submarine, you went through a 12- to 18-month process of learning the engineering and how to operate every piece of equipment on the "boat" to earn your gold dolphins (like getting your wings as a pilot). The second stage, which very few officers were offered, was to complete your qualifications as a chief engineer. This included more schoolwork, more operations experience and going back to Washington, D.C., for a three-day exam ending with a second interview with Admiral Hyman Rickover, which I am proud to say I completed successfully in 1973.

My Thayer School training was a wonderful foundation for what I was able to achieve in the Navy. Thayer's multidiscipline approach to engineering made it possible for me to quickly learn the full range of technologies on a modern nuclear submarine, from mechanical systems and thermodynamics all the way through to nuclear physics. Thayer's approach to teaching teamwork and project design was incredibly well suited to learning how to work with your shipmates in an environment where real-time, practical engineering was critical. The first rule of submarine is "to make your total number of times you surface at least equal to the total number of times you dive."

—Clinton Harris '69 Th'70

The California high-speed rail (HSR) project! For six years I have worked on the initial stages of North America's first HSR system. I have been Aecom Technology Corp.'s regional consultant project manager on the first segment of the project, which will link San Francisco and Los Angeles. As the first of seven segments, the 65-mile Merced-to-Fresno segment required our team to work closely with numerous federal, state, and local agencies, communities, and stakeholders in creating the processes to develop alternative alignments for consideration, completing the federal and state environmental analyses, preparing the engineering design on the preferred route, creating environmental mitigation plans, obtaining all environmental permits, and assisting in property acquisitions.

Our efforts were rewarded with the start of construction in late 2014 on our \$1 billion segment. We employed more than 400 individuals during the life of the project. We had many engineers designing over, under, through, and around communities and super-rich farmlands and orchards, while many biologists and other environmental engineers concerned themselves with impacts to people, landscape, endangered species, and the precious commodity of water. The total cost of the 450-mile system is projected at \$68 billion, a very hefty price tag until compared to the more-than-double cost of

new interstate highways and airport runways that will be needed to carry the same capacity to meet the 20 million-person immigration projections expected in California during the next 20 years.

Extensive outreach presentations of our work were required from the public community centers all the way up to the state and federal governmental agencies and legislatures. The HSR project is extremely emotionally charged—you either love it or hate it.

This project was an all-out sprint for six years, easily the longest, largest, toughest, most environmentally important and controversial transportation project I could ever have imagined I'd be participating in. Yet it was easy to sustain the required effort knowing how important the project is as the prototype for our country's initial steps into this type of transportation. It was very hard and very satisfying. It was also fun to realize that a very high percentage of my studies at Thayer was called into play during this six-year roller coaster ride.

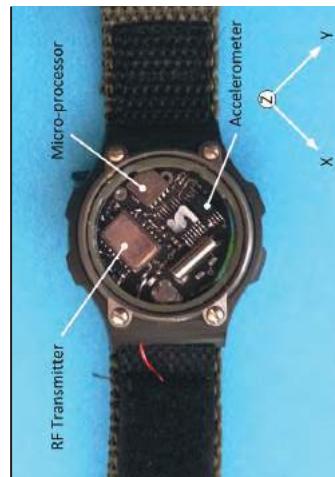
—Dick Wenzel '71 Th'72

My hardest engineering challenge was convincing the Thayer School to allow me to complete my B.E. after my Dartmouth A.B. I failed.

—Robin Felix '75

One of my most challenging and rewarding projects involved developing an instrument to identify and quantify the duration of stereotypical movements in kids with autism. "Stereotypy" refers to movement behavior that is repetitive, rhythmical, and non-goal directed. Stereotypy can be problematic in intensity and frequency, and can interfere with the ability of an affected individual to participate fully in educational or rehabilitative activities. Thus, for some individuals, stereotypy may be a target for intervention or a measure of the effectiveness of treatment.

While working at Creare Inc., a Hanover-based engineering R&D firm, I was the principal investigator on a National Institutes of Health-funded project to address this problem, which came to our attention during a perfect storm of technology development. Very small, low-power microprocessors and radio frequency transponders were just emerging,



**"My challenge was developing a wireless, wearable body acceleration monitor for children with autism."**

—Hal Greeley Th'77

as were user-friendly artificial intelligence development platforms. One of the challenges presented by this project was to understand and leverage these relatively new technologies. That's what engineers do all the time, but we had the added challenges of learning autism-related movement patterns, how the autistic children would handle the introduction of the monitors, and how to interact with these children as we validated our system's accuracy.

Working with the Dartmouth-Hitchcock Medical Center child psychologist who had introduced us to the need for this technology and provided access to volunteer test subjects and with Creare firmware engineers who developed a superb wearable movement monitor, I developed artificial neural network (ANN) software that recognized stereotypical movements hidden within normal movement activities. After testing with autistic kids, ANN processing of the device's acceleration signals clearly demonstrated its potential utility for certain forms of stereotypy—particularly movements involving large muscle groups and whole body or bilateral movements.

—Hal Greeley Th'77

In my field of energy development,

the hardest challenges involve a blend of technical, economic, environmental, community, and political issues. Often the technical challenge is the easiest part. The toughest project I've worked on would have to be the Point Arguello project and the design, permitting approval, construction, and startup of the Gaviota oil and gas plant. Located along the south-central California coast, in Santa Barbara County, the development had to account for stringent environmental standards and sensitive habitats, and faced vigorous political opposition from some segments of the community. We devised design features and construction techniques that limited emissions and minimized impacts to environmentally sensitive areas while dealing with the hydrogen sulfide content of the produced oil and gas (which posed safety and corrosion challenges). The project received development approval, with stringent permit and monitoring conditions, after extended delay, and then we had to complete a supplemental environmental impact assessment, with more conditions, before we could proceed. We overcame the technical challenges and built a high-quality facility, which performed as designed, after we dealt with the usual startup problems. While the project was a model for development in an environmentally sensitive area, the opposition continued to be contentious. It was a lesson in attempting to apply technical solutions to what are basically political issues and the difficulty in managing projects with regional or national benefits while posing local impacts.

Speaking more generally, there's an extremely hard challenge that remains open: how to produce transportation fuels from cellulosic biomass in a system that is affordable, sustainable, and scalable.

—Will Fraizer '78

The hardest engineering challenge I've ever faced is the project currently on my desk: the design of a new kind of ultra-high resolution medical imaging equipment with an analog front end that has to be very quiet. Those circuits have to coexist peacefully with a staggering amount of digital signal processing circuitry.

## just one question



**"I was leading the video compression work in our team, and it was the hardest engineering challenge I've ever faced."** —Jian Lu '93

*Lu, right, with Apple CEO Steve Jobs in 1999. Lu was a member of the engineering team that developed QuickTime streaming.*

Where about a dozen multi-channel 80-megahertz analog-to-digital converters bridge the analog and digital domains, things get particularly interesting. The printed circuit board on which it all sits is physically large enough that every piece of data moving on it has to be treated as an exercise in impedance and time-of-flight control. And when the signals all get where they're going, they have to be treated as having come from completely different time domains, even if the clock that generated them all was the same to start out. At two gigahertz and about a few nanoseconds per foot for signal propagation in copper, physics will do that to you. It will allow surgeons and diagnostic-imaging radiologists to collaborate in real time while a surgery is being performed and see higher resolution images than the best equipment out there today. The result will be less-invasive surgery and more thorough resection of tumors. (Having had a very rare form of usually fatal cancer myself 12 years ago, part of the reason I took on this very difficult job was that I hold a grudge against cancer, and this is one of my personal ways of getting even.)

But the technical details really aren't the point of my answer. What I'd prefer to say is that if every three years I'm not taking on a job that's the hardest I've ever done, I need to find another line of work. Part of the reason I founded Focus Embedded (fo-

cuseembedded.com) was to regularly do projects that have an extremely uncomfortable birthing process.

—Eric Overton '87 Th'89

Today, we take it for granted to watch video streamed from the Internet on our PCs or smartphones. Back some 18 years ago, when most homes were connected to the Internet via a 56k modem, streaming video through that narrow pipe was unthinkable. Yet my team in QuickTime engineering at Apple was assigned the task to develop a new streaming video system that could deliver video using a 56k modem. The engineering requirements were strict: Video had to be compressed down to 28 kilobits per second (kbps) and audio to 16 kbps. I was leading the video compression work in our team, and it was the hardest engineering challenge I've ever faced. To picture it, at the required data rate, three minutes of video (including audio) had to be squeezed to less than 1 megabyte in file size, which is smaller than a single still picture that most smartphones generate today.

But we made it. In summer 1999 Apple released QuickTime streaming and QuickTime TV. Meeting that challenge was a major milestone and foundation for Apple in delivering Internet video. Today, billions of video streams are delivered to users on their PCs and mobile devices on a daily basis. In 2013 Apple received

an Emmy Award in Technology and Engineering for its "eco-system for real time presentation of TV content to mobile devices without the use of specialized TV hardware." Now I am chief technology officer of 360 video at Qihoo 360 Technology, based in Beijing, China.

—Jian Lu '93

The hardest challenge I've ever faced was designing, building, and launching a complete mobile video messaging service for iOS and Android 100 percent by myself in 12 months. The individual problems were not complex when broken down, but the sheer magnitude of the task took quite a bit of intestinal fortitude, considering I had not really written any code myself in almost 20 years. That said, it was an experience that I wouldn't trade for anything.

The second most challenging was figuring out how to reinvent the TV remote control and integrate it into the HTC One smartphone. There were several complex challenges, including building in an infrared emitter that worked in any hand position while hiding it beneath the power button so that we didn't have to cut another hole in the aluminum unibody. We had to figure out how to make the setup of a TV and set-top box dead simple, how to get infrared codes for 100,000-plus TVs, set-top boxes, and audiovisual systems and TV show lineups for every cable and satellite provider in 25 launch countries. We did it in less than nine months. It was a true team effort that I merely had the privilege to lead, and it was a lot of fun.

—Bjorn Kilburn '95

The hardest engineering challenge I ever faced was as an eighth-grade math teacher in Harlem, N.Y. I was struggling to make math feel relevant and important to my students in a way that engineering makes math feel relevant and important implicitly. My students were ages 13 to 15 and on average at a fifth- and sixth-grade level of math, just starting to get over the hump of some of the most challenging mathematical concepts we face growing up: negative numbers and fractions. It was a tough year, with my co-teacher changing mid-year (twice), a curriculum that

felt hodge-podge at best, and low class morale. I wanted to come up with a way to show my students the significance that math had to me, in an engineering type of way. (Even as a student at Thayer, I ultimately identified far more with the problem-solving, idea-generating aspect of engineering than the numbers-crunching, formulaic foundations of engineering.) Time and again, I failed to show the truly inspirational part of math. No matter the presentation or the "real world" application, for the most part my classroom was a mess and the content wasn't hitting home.

At the end of the year, I decided to get more personal with my students. I showed them my senior-year honors thesis, in which I designed an instrumented orthodontic retainer for biomedical purposes under the guidance of Assistant Professor Ryan Halter. Suddenly, my typically noisy room turned silent and 15 hands shot up with questions and comments. Some were obnoxious, eighth-grader comments, but others were about the specific process of my project, what inspired it, what problem I was trying to solve. It was my aha! moment of the year: My show-and-tell item that was meant as a personal aside ended up guiding my approach to my classroom for the remainder of the year. I had always wanted to bring engineering to my classroom, but I had tried to throw in engineering concepts and real-world applications of algebraic concepts and formulas *after* we learned the "boring stuff." Now my kids were engaged because the problem felt real and engaging in its own right, independent of the numbers or formulas. It was still algebra—it was still about logic and problem solving—but it didn't sound like that awful word al-ge-bra that my students hated.

So, after the state test, I had a math-free unit that had zero numbers. It was like a miniature ENGS 21, in which students got into groups for problem brainstorming, then solution brainstorming, then solution research, then solution selection, then solution mock-ups in big posters. It was a hit. I renamed my classroom "Logic and Problem Solving" on the spot. Algebra included, engineering inspired.

—Sam Worth '13

# thayer notes

## 1960s

**Tom Brady '66 Th'68:** I have several restored cars, and estimate I have at least 10,000 hours of my time in this hobby, which I began 15 years ago when my last child graduated from college. I have stepped back some from running the Plastic Technologies Inc. (PTI) companies, so I do have a bit more time than I did 15 years ago, when I began to seriously restore cars in my garage. When we built our home 15 years ago, I treated myself to a shop and garage that I could only dream about while we were raising three kids and I was starting four companies! However, today I can park seven cars in my garage (using two parking lifts) and drive from my garage directly into my woodworking and auto mechanics shop, where I have a working lift, complete hardware store, separate heating and ventilation system, and a view of the lake in back of our house.

Although I remain chairman of the PTI companies, I am actually working only about half time. My focus has shifted from plastics packaging to education. I spent two years at the University of Toledo (UT) as the interim dean of education, beginning in 2009, which put me in a perfect position to spend my extra time these days helping to change the educational paradigm from pre-kindergarten through college. I am on the governance board for the Toledo School for the Arts, a charter school, and I chair the governance board for Toledo Early College, a magnet school. I sit on the Toledo public school superintendent's business advisory board, focusing on expanding career tech education and instituting universal pre-kindergarten opportunities for all urban families. I am also involved in Students First Ohio and serve on the board for Lourdes University, the advisory board of the UT College of Engineering, and the board of UT's Rocket Innovations, a nonprofit that focuses on startup companies requiring university support. Whenever I speak publicly I tell the story of how I got my first taste of entrepreneurship in my ES 21: Introduction to Engi-

neering class back in 1963, and how I have helped to replicate that model here at the UT's College of Engineering, where my wife, Betsy, and I have endowed the Freshman Entrepreneurship Program and have funded the Engineering Innovation Center.

## 1970s

**Steve Askey '76 Th'77:** I am still an independent contractor with BHP Billiton in Houston, Texas (have been since July 2010), as a quality assurance engineer handling intelligent down-hole tools and measuring devices, directional drilling, logging, and other duties as required. It is currently a global role, although the recent oil price decline has shifted some of my duties from our shale plays back to deepwater. I am attempting to fully retire, but all I've managed is a two-week on, two-off rotation from our place in Florida. My wife and I bought an old house in Ormond Beach last year. Still playing guitar. I managed to hook up with some guys and form a band in Ormond. Our first gig, in January, went well, so there is a plan for life after full retirement.

**Hal Greeley Th'77:** After graduation I worked as director of a neurophysiology research lab at the Dartmouth Medical School and then as a biophysicist at the Veterans Administration Hospital in White River Junction, Vt. Through the years I have been working at Upper Valley companies involved in engineering research and development, chiefly in the bioengineering realm. This culminated in 2005, when I started a one-man shop (Response Applications) to recruit collaborators on a case-by-case basis as the need for specific outside expertise arises. This eliminates labor overhead and has allowed me to work with great folks at places such as Dartmouth-Hitchcock Medical Center, the University of New Hampshire, and the University of Massachusetts. Currently, I'm excited to be working with the Center for the Translation of Rehabilitation Engineering Advances and Technology (TREAT), which has strong

Thayer School connections.

These experiences foster my belief in the power of crosstalk between people with different areas of expertise. However, as project director in many cases, it's been my responsibility for eventual success or failure. I strongly believe that my Thayer experience had given me the self-confidence that this requires. I think about advice from my graduate advisor, John Strohbehn, when I would tell him that I had hit a dead end and was hoping that he would guide me along to the right solution. He usually just said, "Well it sounds like you're going to have to think of something clever." I think that he was telling me that there are fewer dead ends if you just have confidence in your abilities.

## 1980s

**Ralph "Buz" Wright Th'84:** I went to medical school after Dartmouth and went into radiation oncology. I work in Denver for Rocky Mountain Cancer Centers at St. Anthony Hospital.

## 1990s

**Andrea Korber '98:** I was an undergraduate engineering major modified with studio art, and went on to the Harvard Graduate School of Design, earning a master of architecture in 2002. While I was at Dartmouth I was on the alpine women's ski team. That passion for skiing carried me to Aspen, Colo., and I became a partner with Land+Shelter Architects ([landandshelter.com](http://landandshelter.com)) in 2014. Our team of nine architects enjoys design brainstorming together and building a firm with passion for design. I'm currently working on a portfolio of sustainable projects, including a state-of-the-art equestrian center in Snowmass, Colo. I enjoy keeping in touch with my Dartmouth friends and would love to go for a run (skiing or sneakers, really) with anyone who's visiting Aspen. Give me a shout at [andi@landandshelter.com](mailto:andi@landandshelter.com).

## 2000s

**David Black-Schaffer '00:** During the past five years I have been work-

ing my way through to a tenured associate professor position in computer science at Uppsala University, Sweden. Currently, I split my time between leading a growing research group and developing innovative tools and pedagogy to support active learning. My research group consists of five Ph.D. students and a few postdocs working on energy-efficient computer architecture and programming systems. We collaborate with industrial and academic partners in Sweden and across Europe and are in active discussions with several U.S.-based companies about licensing our research designs. We are constantly looking for exceptional Ph.D. and postdoc candidates ([www.it.uu.se/katalog/davbl791](http://www.it.uu.se/katalog/davbl791)).

I also have been leading a team to develop next-generation active learning tools to support flipped classroom teaching. Our goal is to help teachers replace passive lecturing with interactive online preparation and active in-class learning. We have developed a tool that provides interactive online material to help prepare students for class, and learning analytics to help teachers understand where their students need more help and how to bring that knowledge into the classroom. Our tools are used by thousands of students across Northern Europe and around the world. We are currently working with a range of teachers across the sciences, engineering, humanities, and high school level to learn how we can best support active learning across different disciplines. Our next big push is to better assist teachers to collaborate on course development. We are always looking for energetic teachers who want to improve their students' learning through flipped/active/just-in-time teaching.

**Dominic Germana '01 Th'02:** My wife (a Dartmouth '99) and our twin 4-year-old boys are enjoying life in the Triangle region of North Carolina. In February we took the boys to Hanover for Winter Carnival to give them a taste of real winter.

Nearly two years ago I took the plunge and started a product devel-

## thayer notes

opment consulting firm called Impact Embedded, LLC. We specialize in hardware and firmware development for custom embedded systems and provide full-spectrum electrical, software, and mechanical integrated development as well. I'm so happy that I decided to go into business for myself. It has been truly fulfilling to help a variety of organizations both local and remote to develop new prototypes and products.

**Afua Amoah Djimi Th'06:** After Dartmouth I never worked as an engineer, but my engineering degree has allowed me to move seamlessly throughout my professional career, and I very happy to have done what I did. I am a senior associate at Black Rhino, based in Johannesburg, South Africa, involved in reviewing and evaluating appropriate projects as they relate to the company's proposed and existing projects. I am also responsible for working with third-party public and private funding sources to create financing solutions for development projects. I earned my M.B.A. from Duke's Fuqua School of Business, and before joining Black Rhino I worked with Barclays Africa in the project finance group. Prior to that, I worked as an investment banker at Deutsche Bank AG in London and New York.

**Brooks Smith '08 Th'09:** On September 23, after six months and two days of backpacking, I summited Mount Katahdin and completed my thru-hike of the Appalachian Trail. It was interesting going through Hanover as a thru-hiker; despite my many years there I had never noticed all those white blazes going down Main Street!

Right now, I'm writing this email while en route with a one-way ticket to Australia! They have a shortage of engineers Down Under, and make it very easy for engineering graduates to get an 18-month work visa without having a sponsor. Whether I stay there or not, I don't know—but it'll be a great adventure no matter what!

**Kristen Barnico Th'09:** In August I married **Bob D'Angelo '08 Th'09** '10 in Hanover. It was so special to celebrate where we met in 2009 at the Thayer School. The ceremony was at Aquinas House and the reception at Occom Pond. We both worked as engineers, but I'm finishing my M.B.A.

at Yale and Bob is in medical school at the University of Connecticut.

**Kyle Sherry '09 Th'10:** I recently moved to Rochester, N.Y., to take a position as a process engineer at Novomer after three years working in biofuels in Boston. We're developing a novel process that's cheaper and greener than the existing routes to manufacture acrylic acid, a commodity chemical used in a variety of applications. It's an exciting change!

**Phil Wagner '09:** I am head coach of a robotics team for middle schoolers in Longmont, Colo., and the team just wrapped up an excellent season. They competed in the F.I.R.S.T. LEGO League, a nationwide competition that has students build autonomous LEGO robots and develop a research project. Our team, the Pink Pony Pirates, is based in Casa de la Esperanza, a learning center for immigrant families in Longmont. This year they set a new record for the Casa program by taking second place overall at the regional tournament out of a field of 26 teams! They went on to the state championship, competing against the best 70 teams in the state. They put in a ton of great work and their robot finished 30th overall.

In my engineering life, I am working as a process development engineer for OPXbio, a biotech company in Boulder.

### 2010s

**Lauren Alpeyrie '10:** In April 2014 I left L.E.K. Consulting and moved to San Francisco to work for Google's people operations as an analyst in a team nicknamed "Quantified HR." I serve as an internal consultant and perform large-scale data analysis to keep Google's growing hiring operations flowing smoothly. Last August I was sent by Google as a first-time attendee of the Grace Hopper Conference, which is the biggest women in computing conference in the world. I highly recommend the experience to any students and alums!

**Caitlin Johnson '10:** I am student teaching—physics and engineering!—at Boston Green Academy in Brighton, Mass. I love it!

**Jeff Forsyth Th'11:** I recently transitioned to a position at Globus Medical in Andover, Mass., working as senior software engineer on our robotics system. This product has the

potential to improve patient care by allowing surgeons to place spinal implants (screws) with greater accuracy and precision than is possible today. I am excited to hear that Dartmouth recently launched its Center for Surgical Innovation under Dr. **Keith Paulsen Th'84**—this program will be great for the students at Thayer.

**Tim Harsch '11:** I cofounded Owler with Jim Fowler and Rajan Madhavan. (I interned at their previous company, Jigsaw, which is now data.com under Salesforce.) Owler is a competitive intelligence tracking company. We track more than 4 million companies around the world to allow people to stay up-to-date on their competitors, clients, partners, and sales prospects and always know when there is a big news event, acquisition, leadership team change, or round of funding at any company they follow. We also show members how they compare against their closest competition. I lead the product team. It's been an incredible learning experience seeing the company grow from just us to more than 100 employees! Since our development team is in India, I've traveled to Coimbatore numerous times.

Thayer has been instrumental in my approach to problem solving and being able to analyze situations across disciplines (ranging from finance to user retention analysis). The technical background and ability to code has also made it easy to integrate with a top-notch engineering team and be able to dive into the details of exactly how we are going to solve big engineering problems. None of this would have happened without the incredible alumni network and my introduction to Jigsaw by **Jeff Crowe '78** many years ago. With that on my mind, we've had a number of '13, '14, and now '15 interns, with one now a full-time employee! Looking forward to making it to Hanover soon!

**Derrick Kuan Th'11:** After graduating with an M.E.M. in 2011, I am now working as a product manager at Activision Blizzard, a video game company, specifically, for the Skylanders brand, which combines video gaming with physical toys. My engineering degrees have proved useful in this role, as physical toys require an understanding of design and high-volume tooling. Part of my team's role

is to ensure that the amazing innovations our studios come up with are cost-effective and executable. I work closely with our toy designers and have even had the chance to design a few special, limited-edition toys myself. Taking some of my learnings from Thayer, I have also created optimization models, learned in Dr. Ian Baker's course, to determine which toys we release in each "wave" in order to maximize variety while satisfying production constraints. I am also dating **Alexandra Blackstone Th'10**, and we are both living in Santa Monica, Calif., with our bearded dragon Orlando and new puppy Penny!

**Sharang Biswas '12 Th'13:** I'm graduating in May from the interdisciplinary telecom master's program (ITP) at Tisch School of the Arts at NYU. My program combines art, technology and design to foster innovation. I'm interested in how technology can enhance theatrical or performative storytelling. Last summer I created a multimedia, interactive theatrical experience (featuring elements of improvisation and role-play) called *Treason* that was exhibited at the Brick Theatre in Brooklyn. Following that I was part of a project to create a technology-driven immersive haunted house experience at NYU, where participants were taken on a journey through the land of the dead. Now I'm working with technologists, dancers, and scenic designers on a show that explores the inevitability of the future and our efforts to come to terms with it. I'm trying to embrace the liberal arts spirit of Dartmouth, combining things I learned at Thayer and the rest of the College with what I'm learning at Tisch and trying to figure out what to do after graduation. I also just became a board member for the Dartmouth Gay, Lesbian, Bisexual and Transgender Alumni Association as a way of keeping in touch with the College and with queer issues.

**Amir Golnabi Th'12:** In August I completed my postdoctoral training at Mass General Hospital and Harvard Medical School and joined the department of mathematical sciences at Montclair State University as a tenure-track assistant professor. At Thayer I shared in earning the 2014 Sylvia Sorkin Greenfield Award for the Best Paper Published in Medical

Physics. My research interests include mathematical modeling, numerical methods, inverse problems, medical image processing, and image reconstruction algorithms.

**William Derdeyn '13:** I work for Abengoa Bioenergy at one of the first commercial cellulosic ethanol plants, in Hugoton, Kan. We produced cellulosic sugars as of the end of 2014 and will soon start production of ethanol. My job is shift supervisor, so I oversee all operations activities during a 12-hour shift.

**Annabel Frank '13:** I am a first-year student at Perelman School of Medicine at the University of Pennsylvania. My education at Thayer was invaluable to my development as a self-directed learner and continues to be a real asset. Having a solid foundation in the mathematics underlying statistics and systems science is excellent preparation for medicine, with direct application to courses such as biochemistry, pharmacology, epidemiology, and more. I have Thayer to thank for my comfort level with research design and biomedical technology. The opportunity to take medical imaging with Dr. Brian Pogue as a capstone course my senior year was a real privilege. Regardless of whether I am using technology in the operating room, developing improved drugs, or interpreting clinical data, I will always have an engineering perspective with me.

**Scott Lacy '13 Th'13:** I work in Jackson, Wyo., for Square One Systems Design as a mechanical design contract engineer on precision positioning systems and robotic automation. I am designing a cryogenic, ultra-high vacuum-compatible, multi-axis positioning system under a U.S. Department of Defense Small Business Innovation Research contract. The current task is sourcing and testing various linear actuators for cryo-vac compatibility as well as designing and simulating full systems in cryo temps (less than 70° K), using finite element analysis. From writing proposals and research to building relationships with vendors and outside experts, to design and analysis, to manufacture, to prototype iteration, to final products—I get to see the project from all sides and from start to finish, something Thayer prepared me for.

**Alfredo Velasco '13:** I'm in a Ph.D. program in computer engineering at Duke University. I'm collaborating with information theorists to encode information in new ways to address the physical limitations of new memory technologies, such as phase-change memory (PCM). PCM is a new type of resistive memory where each memory cell is no longer a floating gate transistor or a capacitor but a small amount of material that can be in a highly resistive state (amorphous) or in a lower resistive/conducting state (crystalline). The phase of the material is programmed by heating the material with varying amplitude and duration bursts of current. In PCM we use the resistance in each cell to save bits as opposed to charge in dynamic random-access or flash memory. As PCM is scaled and the cells are placed closer together, the programming of a cell may partially change the state of a neighboring cell, resulting in a programming error or an unintended bit flip. We are working on encoding the bits to be written in a way that will prevent patterns that are susceptible to these bit flips. I'm also keeping up with my guitar playing and want to set up a workshop and start making guitars and furniture again, like I used to do at Dartmouth.

**Natalie Afonina Th'14:** I'm at Thayer pursuing a master's in materials science. Recently the ENGS 21 project I worked on two years ago—Ice Core Extraction while Maintaining In-Situ Temperature Transitions (ICE-MITT)—was deployed to Barrow, Alaska, by Professor **Rachel Obbard Th'06** and her research team. They collected 20 meters of ice cores from 10 sites, stored them in ICE-MITTs, and then drove back through Canada and the northern states doing outreach at several schools about the project. I joined Professor Obbard's group in Alaska for a week of fieldwork. The ICE-MITTs did their job, keeping the ice cores at their temperature gradient.

## obituaries |

Obituaries for the following alumni are online at [dartmouththeguide.com](http://dartmouththeguide.com):

**Michael Roger Pender '47**  
**Peter R. Brown '49 Th'49**  
**Pieter von Herrmann '50 Adv'53**  
**Kevin J. Travers '51 Tu'52 Th'52**



### on the job

**1. Amir Golnabi Th'12** has joined the department of mathematical sciences at Montclair State University as a tenure-track assistant professor.

**2. Natalie Afonina Th'14** (left) and Ph.D. candidate **Ross Lieb-Lappen** collected ice cores in Barrow, Alaska, in March.

**3. Tim Harsch '11** (middle row, third from left) has cofounded Owler, a competitive intelligence tracking company based in Silicon Valley, with a development team in Coimbatore, India.

**4. Afua Amoah Djimi Th'06** is a senior associate at Black Rhino, an infrastructure development company based in Johannesburg, South Africa.

# Inventions

DARTMOUTH COLLEGE LIBRARY. INSET: THAYER SCHOOL OF ENGINEERING



## THE GREATEST TRACK

### >> INVENTOR:

**PROFESSOR HAROLD LOCKWOOD**



With CAD and computer modeling ubiquitous in the 21st century, it seems improbable that the combination of ignorance and error could result in a successful invention.

But it can happen. Consider Dartmouth's thirties-era indoor track. It was there on March 3, 1938 that legendary miler Glenn Cunningham set a world record.

Cunningham came to Hanover because Dartmouth track coach Howard Hillman believed that Dartmouth's new indoor track was the fastest in the nation. It was the only thing that could explain why his team typically ran faster on campus than when they competed off-campus. To prove his hypothesis, Hillman wrangled Cunningham into coming to Hanover for an exhibition race. At the time, Cunningham was a sports celebrity. His visit to Hanover attracted the same kind of attention one might expect today if LeBron James scrimmaged in Leede Arena with the basketball team.

The unique attributes of the track, which was engineered by Thayer Professor Harold Lockwood, stemmed from the fact that Lockwood, who taught electrical engineering, knew nothing about track design. He didn't realize that tracks of the era were built of hardwood planks laid atop cement. Lockwood's design placed 1.5-inch spruce planking over cinders. His plan also called for two-foot banked curves. The College's carpenters screwed up and built three-foot banked curves. The steeper banks and the springier surface helped propel Cunningham to a record-breaking 4:04.4 mile.

"It's the greatest track I've ever run on," Cunningham told *The Dartmouth*, "and sometime I'd like to try it again." Cunningham never returned but representatives of the famed Millrose Games, held in Madison Square Garden, came to Hanover to study the track.

—Lee Michaelides



## Random Walk

For 24 hours on an April weekend, Thayer turned into the site of Dartmouth's first hackathon. "A hackathon is where you get a bunch of nerds, geeks, and kids who are interested in technology together, give them all the swag, food, and caffeine they need, and see what kind of software and hardware projects they can make," says HackDartmouth co-organizer Colby Ye '16, who is pursuing an economics major modified with engineering. The hackathon, attended by some 200 students from Dartmouth and several other schools, had lofty goals, according to Ye: "first, to give students a chance to apply what they're learning in the classroom to real-world projects, Second, to expose them more to careers in technology entrepreneurship, and third and perhaps most importantly, to foster a sense of creative, collaborative problem-solving here at Dartmouth." A three-member Dartmouth coding team won the "Best Dartmouth Hack" competition category—one of several prize divisions—with a Swipr app for the Pebble smart watch to let students easily track their meal plan accounts. "Our idea was basically to have a meal plan watch app so you can see how many swipes you have right on your wrist," says Henry Wilson '18, who built the app with Kooshul Jhaveri '18 and Robert Sayegh '18. "There's a whole slew of schools that use the same exact program, so this app would work for them as well," says Wilson. App-happy coders will convene again in October at HackDartmouth II.

PHOTOGRAPH BY ALEX ARNONE

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