

DARTMOUTH

Engineer

THE MAGAZINE OF THAYER SCHOOL OF ENGINEERING

SUMMER 2011

MAJOR MERGERS

FOR MODIFIED MAJORS,
ENGINEERING IS JUST
THE BEGINNING

► HUMANITARIAN ENGINEERING ► FORMULA HYBRID ► ALUMNI STARTUPS

The Place of Projects

BY DEAN JOSEPH J. HELBLE

PROJECT-BASED LEARNING IS MUCH DISCUSSED AMONG CONTEMPORARY educators. Whether for K-12 or university engineering students, the general view is that the classroom experience can be enhanced by hands-on, open-ended project challenges. Mention “project-based learning” to any Thayer School graduate and you are likely to hear about their ENGS 21 project (“Introduction to Engineering”—a prosaic title that doesn’t come close to doing justice to the experience), or their B.E. capstone design experience. To our alumni, even those who never took a Dartmouth undergraduate course, these courses are known for lessons in creativity, design methodology, problem-solving, innovation, and entrepreneurship—the kind of project-based learning that has taken place at the Thayer School of Engineering since the 1960s.

But what many may not know is that the use of “project-based learning” has grown dramatically across the Thayer curriculum. Solid Mechanics (ENGS 33) has long asked students to build, test, and compress a bridge to the point of failure, a clear assessment of their design and predictive abilities. Digital Electronics (ENGS 31), which requires students to propose, design, build, and demonstrate a working digital system using modern field-programmable gate array technology, has seen the development of games, audio processors, and even simple computers. Thermodynamics (ENGS 25)? Students still build a working Stirling engine, as they have for decades. In Machine Engineering (ENGS 76), students design and team-build robots that pick up and deposit objects such as hockey pucks. This spring students in Structural Analysis (ENGS 71) designed and built a wheelchair-accessible treehouse for the local community, with teams of students developing and integrating the individual components of the project. For three years Computer-Aided Design (ENGS 146) has required students to design a twist car (modified this year to a “wiggle car” with non-circular wheels), requiring innovation that goes beyond the relevant patent literature and participation in a public relay race to demonstrate the quality (and speed) of their designs. Using a 1920s electric car as inspiration one year, Power Electronics and Electromechanical Energy Conversion (ENGS 125) had students add ultracapacitors to an electric-assist bicycle to improve the battery efficiency; another year, students designed and built an “electric bungee.” Through our growing research focus in Engineering in Medicine, our course Intermediate Biomedical Engineering (ENGS 57/169) had students work with Dartmouth-Hitchcock Medical Center surgeons on technologies for operating rooms. Methods in Biotechnology (ENGS 162) challenged students to develop high-throughput screens for a broad range of applications, including purification of human IgG antibodies. And this isn’t close to a comprehensive list.

No wonder our students choose to spend their spare time doing projects: designing, building, and traveling with the Big Green Bus, developing a hybrid formula car for the now-international Formula Hybrid competition they founded, building and deploying a rover for scientific exploration in Arctic regions, designing and installing small-scale hydropower systems in rural Rwanda. There’s no better way to learn.

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Thayer School's fifth annual Formula Hybrid competition drew more teams than ever. Photograph by Kathryn LoConte Lapierre

THE Great Hall

>>NEWS FROM AROUND THAYER SCHOOL



PROTOTYPES

Experiments in Microgravity

FOUR STUDENTS TOOK THE RIDE OF A LIFETIME in June aboard a NASA plane flying parabolic maneuvers over the Gulf of Mexico to achieve 30-second bursts of zero-gravity conditions.

"As the plane rose to the top of the parabola, the cabin went from experiencing 2 Gs of force to zero Gs. All of a sudden I just felt my body floating up in the air," says Broghan Cully '11. "At first it is an uneasy feeling because your brain just has no sense of orientation. However, after the initial shock, it was absolutely incredible to be floating around."

Cully and fellow fliers Sean Currey '11, Max Fagin Th'11, and Michael Kellar Th'11 were participating in NASA's Microgravity University, which offers students the chance to conduct experiments in a space-like environment. The team tried out a project they completed for ENGS 89/90 (previously 190/290),

Thayer's capstone undergraduate design course sequence: a dehumidification system for spacecraft cabins.

"The challenge in spacecraft is that when you exhale, exercise, and perspire you put humidity into the cabin air and there's nowhere for it to go. The only thing you can do is recondense it and recycle it. But condensing water in microgravity is really hard," explains Fagin. "A commercial condensing unit you use in your house cools the airstream and then lets the water rain out into a collection dish. But in space there's no gravity and there's no such thing as rain, so we have to come up with some other way to grab the water and pull it out of the airstream. On the space shuttle and international space station



WEIGHTLESS

Broghan Cully '11, center, and Max Fagin Th'11, left, get the hang of zero gravity aboard a NASA Microgravity University flight.

they have a system for that, but it's heavy and clunky and has a large centrifuge to simulate the effects of gravity. Our project, which was inspired by our sponsor at the Glenn Research Center, does away with all moving components. It uses a block of specially treated porous graphite that works like a sponge, sucking the moisture out of the air without the need for a centrifuge."

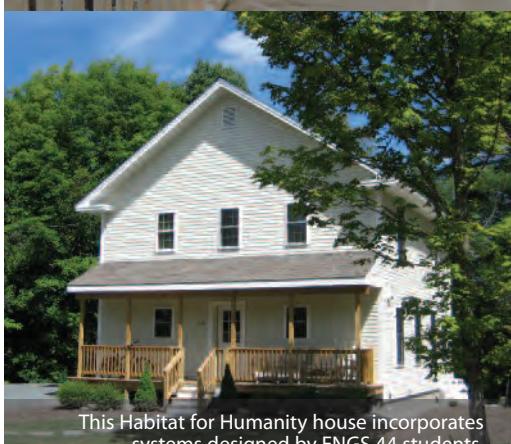
Designed for use in zero gravity, the dehumidification system worked as intended. "We collected great data from our prototype. We were able to show that our porous media condensing heat exchanger functions well under a variety of gravitational environments," says Currey, who interned at NASA's Glenn Research Center in Cleveland in 2010 (see: nasa.gov/connect/chat/currey_ch_at.html).

The team is moving on but hopes that NASA will take over the project. "We are going to pass all of our data from the flight on to Glenn Research Center," says Currey. "There are still a few challenges that need to be overcome. While in Houston, our team had a chance to speak with members of mission control charged with overseeing the current water system and dehumidifier, the Common Cabin Air Assembly, aboard the space station. They were interested in our idea but concerned about how they could keep it clean. This problem had crossed our minds during ENGS 89/90 but was placed on the back burner. Once this issue is resolved, I think the porous media condensing heat exchanger could be put to great use in orbit."

“My first thought upon leaving the aircraft floor was how natural it felt—even after glancing at people floating upside down.” —SEAN CURREY ’11



ENGS 71 class members pose in their treehouse.



This Habitat for Humanity house incorporates systems designed by ENGS 44 students.



Engineering students rebuild Titcomb Cabin.

STUDENT PROJECTS

Cabin Fever

STUDENTS RECENTLY PRODUCED THREE KINDS OF shelters for the Upper Valley.

The first, located in Hanover’s Oak Hill recreation area, is a wheelchair-accessible treehouse that was a project in ENGS 71: “Structural Analysis.” Student teams designed and built one component each—the roof, the walls, the supports—and jointly integrated them into the finished structure. “I always like them to do something real, see it from design on paper all the way through to having it built,” says Professor Vicki May. Students got into the spirit. “We had to determine the site, the layout, the elevation of everything, and from there we just let our minds and creativity go wherever we wanted,” says Christian Ortiz ’11. See the results at youtube.com/thayerschool, search treehouse.

The second shelter is a Habitat for Humanity house built a mile south of Hanover. Students in ENGS 44: “Sustainable Design” developed energy-efficient water, heating, and other systems for the house, which was further developed and erected by Habitat for Humanity members. “It is tremendously more energy efficient than the prior Habitat houses, and it has helped change Upper Valley Habitat’s approach to energy efficiency and building methods,” says studio art Professor Karolina Kawiaka, who taught the project part of the course. “It was great to work on a real project and have such a quick, immediate, local impact,” says Anastasia Miliano ’12, who worked on the house plans and increasing the R-value of the walls.

The third shelter is Titcomb Cabin, located on Gilman Island, a short paddle from campus down the Connecticut River. After the previous cabin burned down in 2009, engineering students stepped in to lead the rebuilding efforts. “We built the cabin in a way that best utilized the logs we had. We had a basic 3D model in SolidWorks at the beginning but tweaked that design heavily as we went along and as we learned more about the process,” says project leader Greg Sokol ’10 Th’11. In May CBS News sent reporter Mo Rocca to Gilman Island for a lesson on how to build a log cabin. See the engineers in action at cbsnews.com/video/watch/?id=7367646n.

kudos

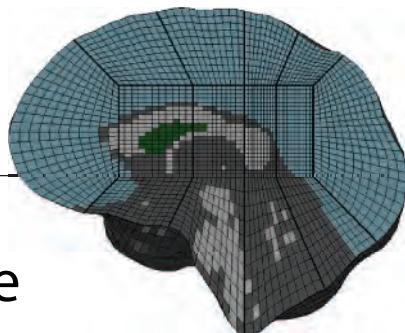
>>Professor Lee Lynd received the 2011 Mines Medal, awarded annually by the South Dakota School of Mines and Technology “to honor engineers, scientists, and researchers who have demonstrated exceptional leadership and innovation.” In June Lynd and Jeremy Woods published an article in the journal *Nature*. “Perspective: A New Hope for Africa” argues that bioenergy could help bring food security to the world’s poorest continent.

>>Professor Ian Baker has been named a fellow of the Materials Research Society. He was recognized for his scientific leadership in exploring the structure-property relationships of materials.

>>Professor Mary Albert accepted an invitation from the National Academies of Science to serve on its Committee on the Legacies and Lessons of the International Polar Year.

>>Dean Joseph Helble discussed the importance of technological literacy in the 21st century during a TEDx lecture, “The World’s ‘Sputnik Moment?’” (youtube.com/watch?v=HVhJNDlrK-g).

>>Arsanis Inc. of Lebanon, N.H., co-founded by Professor Tillman Gerngross, Errik Anderson ’00 Tu’07, and Eszter Nagy, has raised \$10 million in funding. The start-up is developing fully human monoclonal antibodies to treat a variety of infectious diseases.



Lab Update

MODELING THE IMPACT OF BRAIN DAMAGE

Hundreds of thousands of people experience traumatic brain injuries (TBIs) each year due to sports or recreational activities in the United States alone. Even one blow to the head may cause temporary confusion or extended memory loss and depression.

Thayer assistant professor Songbai Ji is collaborating with Thayer adjunct associate professor Richard Greenwald and Dartmouth Medical School psychiatry professor Thomas McAllister to learn more about such injuries. The researchers equipped college and high school football and hockey players with helmets embedded with sensors—made by Greenwald's company, Simbex—that measure head acceleration. McAllister administered neuropsychiatric tests and brain imaging scans to players before the season, after they experience concussions, and at the end of the season. Ji generated a model linking biomechanical data about head impacts in athletes to assessments of their brain damage.

By estimating tissue strain and stress responses in different brain regions, the model can predict the likelihood and severity of injury following a concussion. Ji's subject-specific model produced more accurate results than a model that simply uses average head dimensions for males. Ultimately, Ji hopes to characterize the patterns of brain damage caused by distinct types of impacts, such as hitting a hard or soft surface. "This information will be useful because it will help us better design helmets and understand under what type of impact conditions there could be a higher risk of head injury in what regions," he says.

—Janelle Weaver '99



STUDENT PROJECTS

I Want One of Those!

▲ Quieter Paper Towel Dispenser

IF THE BUZZ OF ELECTRONIC paper towel dispensers annoys you as much as it irks students in dorms, you'll want this muffling system, which reduces noise from 74.2 to 64.5 decibels. Inventors Phillip Coletti, Zack Cutler, Madeleine Parker, Alison Polton-Simon, and Ian Schneider—all class of 2014—won the Phillip R. Jackson Prize for outstanding performance in ENGS 21: "Introduction to Engineering." Their teaching assistant was Wiley Dunlap-Shohl '12.

SPOT POLL

What's Your Dream Job?

My dream job is to be the lead engineer for a new-build airplane at Boeing. Aviation is one of my passions, and it would truly be a dream to shape the progress of one of the most important industries in the modern world.—**Benjamin Meigs '10 Th'11**

My dream job is to be an entrepreneur. Seeing an idea through from start to company, defining my own ideal job, and responding to disasters are the ultimate engineering challenges.—**Lauren Alpeyrie '10 Th'11**

I want to be the first person on Mars—or at least on the first mission to Mars. I've always wanted a career in space, so I majored in physics and astronomy at Vassar and added engineering through the dual-degree program at Thayer. I think there definitely will be a mission to Mars in my lifetime and I want to be on it.—**Max Fagin Th'11**



Max Fagin Th'11

investiture



THE LARGEST CLASS IN THAYER SCHOOL HISTORY was honored at Investiture, held June 11 at the Hopkins Center. Dean Joseph J. Helble presided over the presentation of hoods, caps, and awards to 169 recipients of Bachelor of Engineering and graduate degrees, including record numbers of Ph.D., M.E.M., and B.E. graduates. (A.B. graduates formed the second-largest undergraduate class at Thayer School.)

The annual Robert Fletcher Award, named for Thayer's first dean and recognizing distinguished achievement and service in the highest tradition of the School, was presented to engineer and educator Dr. Charles Vest, President of the National Academy of Engineering and President Emeritus of the Massachusetts Institute of Technology.

"In this age, it is incumbent on the United States to enhance its capacity for engineering and scientific innovation, and to build the broad technology literacy and skills of its workforce in order to have the possibility to prosper, be healthy and secure, and to contribute to the solution of the great challenges to our planet and its inhabitants," Vest told graduates.

"We need a country with more people dreaming about what's possible, where young people are

inspired to imagine a better world and empowered to make it a reality," he said.

Dean Helble closed the ceremony with a salute to graduates. "We thank you for your creativity, your sense of humor, your countless late nights hard at work, for your view of the world as providing limitless opportunity, for your essential contribution to the extraordinary community that is the Thayer School."

CLASS OF 2011 Engineering Graduates

18	Doctor of Philosophy
12	Master of Science
49	Master of Engineering Management
90	Bachelor of Engineering
85	Bachelor of Arts, Engineering Sciences



PHOTOS, VIDEOS, SPEECHES
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>> Avedro, a startup based on technology developed by **Professor B. Stuart Trembly**, has completed \$25-million series C financing. The Waltham, Mass.-based company offers thermal techniques for reshaping corneas.

>> Engineering majors **Eric Packer '12** and **Stephanie Crocker '12** have been named to the Eastern Intercollegiate Ski Association's All Academic Intercollegiate Ski Team. Packer was also awarded the Francis L. Town Scientific Prize for the class of 2012 for meritorious work in engineering sciences.

>> **Saryah Azmat '11**, an engineering major, was one of five students chosen to represent Dartmouth at a global health case competition at Emory University in March. The team won an honorable mention and \$1,000 for a hypothetical plan to efficiently allocate resources for 800,000 refugees in East Africa.

>> Engineering physics major **Jeremy Brouillet '13** received an honorable mention from the Barry M. Goldwater Scholarship and Excellence in Education Program. Brouillet, who has worked in the laser lab at Thayer, plans to pursue a Ph.D. in materials science.

>> **Lucas Ellis Th'12** attended the annual National Biodiesel Board Conference in February as co-chair of Next Generation Scientists for Biodiesel. An interview with him is at youtube.com/watch?v=aYOWAjp83J8.

>> **Anne Kwei Th'11**, Ilya Bendich DMS'14, and Joe Gigliotti DMS'14 joined together to win the first Dartmouth Medical Technology Business Plan Competition in May. Their plan was for Rytek Medical, a company commercializing a cancer-sensing biopsy needle invented by **Professor Ryan Halter Th'06**. The competition was the brain-child of Jay Miller '82.



ANN BAUM '12

Engineering Modified with Philosophy

Why Engineering: I took a lot of prerequisites for engineering coincidentally. I was interested in physics and wanted to take some math. My roommate, who was an engineering major, asked me why I was taking all the same classes she was. I was also taking philosophy classes and didn't want to give them up. The more I took of both of them, the more they overlapped in interesting ways.

Why Philosophy: I see philosophy as the basis for the sciences. It poses fundamental questions: How do you know what you know? How do you know that any of this is true? Is it because you can see it? Is it because you can feel it?

The Combination: I've joked with friends that I'm taking the most practical major and the least practical major. They're such different types of work. It's really nice to be able to sit down and work through a problem set and just focus on that and then take what almost feels like a break and think about philosophy—do the reading and sit and interpret what I've read. There's a concrete moment when you can say, "Oh wow, I actually did learn something from that reading, because now I'm thinking about this in a whole new way." That's a really nice moment that comes from philosophy.

MAJOR MERGERS

FOR MODIFIED MAJORS, ENGINEERING IS JUST

THE BEGINNING.

Create. Improve. Enhance. That's what engineers do.

And that's what some students do with their studies, combining the engineering sciences major with one of Dartmouth's other liberal arts subjects to form a modified major.

"When I came here I was really excited that you could minor, you could double major, and you could modify major," says Laura Kier '12, an engineering and public policy modified major. "The flexible academic structure was exactly what I was searching for."

On average during the last six years, 33 percent of engineering students have opted to do a modified major. "It's extremely valuable if you're passionate about some specific thing," says Andrew Wong '12, who has modified engineering with environmental sciences.

Students regularly modify engineering with biology, chemistry, computer science, earth sciences, economics, environmental sciences, public policy, and studio art—the most popular. A new neuroscience modified major is pending final Dartmouth approval. Students can also submit their own ideas for modifying engineering with a subject such as philosophy.

"This program is continually evolving and changing," says Thayer School Dean Joseph Helble. "For a student, of course, there are advantages. It's a chance

to combine disparate interests."

Whereas the engineering major requires 10 courses, the modified major consists of six engineering courses and four courses in the extra field of study. The modified major builds on the fact that all Dartmouth students—engineering majors included—take a full range of liberal arts courses.

"Our students have more breadth than the typical engineer coming out of other universities," says Helble. The modified major, he says, "puts engineering on an equal footing with the liberal arts."

The modified major also widens the engineering door. "I think it's a way that students who came to Dartmouth not thinking at all about engineering discover engineering," Helble says.

And many of those students stay with engineering. Seventy-five percent of modified majors remain at Thayer to complete the bachelor of engineering degree after earning the bachelor of arts degree. Modified major graduates have gone on to careers in design, architecture, technology startups, and other ventures that depend on multiple talents and skills.

Here, five students tell us about their take on their modified majors.

BY KERRY TROTTER
PHOTOGRAPHS BY JOHN SHERMAN



LAURA KIER '12

Engineering Modified with Public Policy, with an Emphasis on Environmental Policy

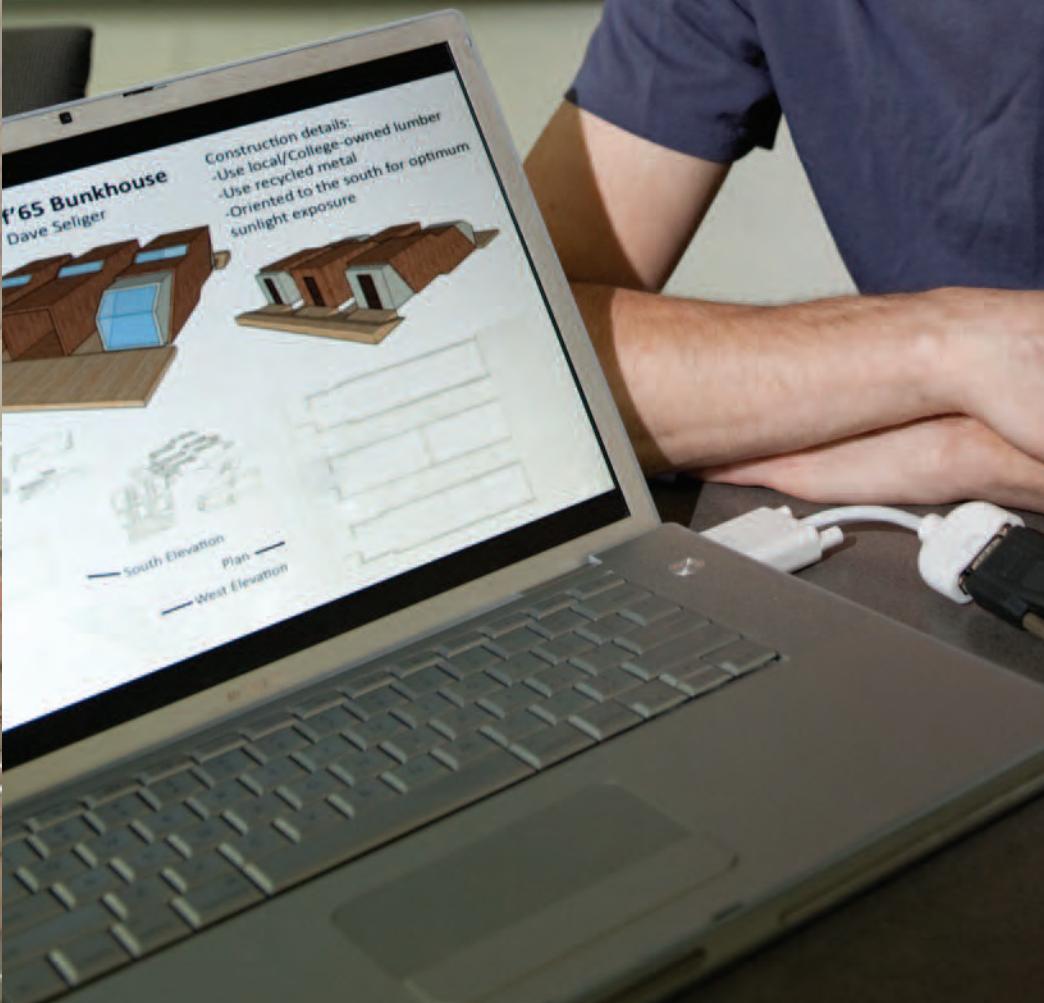
Why Engineering: I'm interested in problem solving. Engineering and public policy are ways in which you can problem-solve, one from a technical perspective and one from a more conceptual perspective.

Why Public Policy: I love current events and everything related to politics, but I realized that wasn't going to be something that fit for me.

The Combination: When you work in the engineering world, you also use the tools you learn in public policy. You're serving a human need, you can relate to people and see how your technologies are serving the lives of others. In terms of the environmental-policy aspect of my studies, I really like the idea of sustainable design. My take on my major is that I will be able to survey human needs, understand environmental policy, and engineer solutions to our increasingly unsustainable world.



DAVID SELIGER '12



Engineering Modified with Studio Art

Why Engineering: I wanted the chance to build something, the chance to make my impact on the world through some kind of creation.

Why Studio Art: My parents are engineers, but my grandfather was a painter. I have art in my blood. Some people are gifted in the technical sense, and some people are gifted in the creative sense. I think I'm somewhere inbetween.

The Combination: The way I want to apply art is through design, which is the intersection of studio art and engineering. It gives me a chance to have an actual impact on the world. You can affect the world through design; for example, buildings shape the way we live, and street signs affect the way we drive on the road. I took both "Product Design" and "Science of Materials" last term and worked harder than I ever worked in my whole life. Product Design is basically four inventions in a three-month span. Inventing something every two weeks while trying to learn about the atomic structure of ceramics and metals kind of makes your head hurt.



ANDREW WONG '12

Engineering Modified with Environmental Sciences

Why Engineering: I really enjoy math and science and found myself gravitating toward engineering. I also really like the practicality of it, the applied-ness of engineering.

Why Environmental Sciences: I grew up in Portland, Ore., where there's an emphasis on being green. I appreciate environmental sciences for the lens through which it allows you to see engineering. You can build stuff, you can create amazing things, but are you doing it in a conscious way? Are you including factors beyond how novel or how cool it is? Are you including factors of environmental sustainability, like what materials you are using or how much energy you're using? I think it really provides a strong framework through which you can approach any kind of engineering.

The Combination: One of the reasons I came to Dartmouth and didn't want to go to a purely technical school was the liberal arts aspect, taking a broader perspective on what goes into engineering. It's really important for me to take the engineering, the practical and the environmental—the moral, you could say—and put those together in a way that creates something novel. It would be cool to do materials engineering, but I would also enjoy working on appropriate technologies in developing countries. Using engineering to help people achieve a better standard of living would be great.





FRANCES WANG '12

Engineering Modified with Environmental Sciences, with a Minor in Biology

Why Engineering: I wanted to build something with my two hands and know that what I'm building or what I'm trying to do is going to solve a problem somewhere.

Why Environmental Sciences: I would like to go into something where I could reconcile developing needs of countries along with environmental needs.

The Combination: I'm still trying to balance the two subjects. I've taken a sustainability class that incorporates both engineering and environmental science. I'm also working with biology professor Celia Chen and engineering professor Mark Borsuk on modeling mercury cycling in a stream environment or estuary environment. We'll run a computer program to see, under certain parameters, how much mercury will leave the sediment and go into the water and how much will get taken up by fish, and how that will impact humans down the line.

Kerry Trotter is a writer based in the Upper Valley.

Formula



Hybrid

THAYER SCHOOL'S INTERNATIONAL COMPETITION RACES TO ITS FIVE-YEAR MILESTONE.

BY GORDON KIRBY



Thayer School's Formula Hybrid International Competition reached its five-year milestone this spring at the New Hampshire Motor Speedway. The competition attracted 34 teams from universities and colleges from around the world, a substantial leap from the five entries in the inaugural 2007 Formula Hybrid competition. Within days of the May 1–4 competition, Formula Hybrid reached another kind of milestone as well: gaining widespread recognition by headlining "Emerging Tech Day" at the Indianapolis Motor Speedway's 100th anniversary celebrations.

This year's Formula Hybrid competition was won convincingly by the team from Texas A&M University. Arriving at the track better prepared than any of their rivals, Texas A&M was the only team able to complete all phases of the competition. Their car, *Medusa*, won the acceleration contest, finished second in the endurance event,

COMPETITIVE SPIRIT

Above: Texas A&M speeds to first place. From left: California Polytechnic Institute takes the tilt test as part of safety inspection. Dartmouth Formula Racing rolls out its car. Fresh from competition, Formula Hybrid teams headline "Emerging Tech Day" at Indie 500's 100th anniversary bash.

"THE MOTIVATION AND THE REASON WE GET INVOLVED IS WE BELIEVE IT IS ONE OF THE FINEST EDUCATIONAL PROGRAMS THERE IS FOR YOUNG ENGINEERS."

—MICHAEL ROYCE, CHIEF MECHANICAL TECHNICAL INSPECTOR

and achieved the top overall score of 871.2 points. Second place was taken by Brigham Young University's *Blue Fury*. The team won the presentation and endurance segments and totaled 712 points. Third overall with 691.6 points and winner of the design segment of the contest was Sweden's Lund University.

Dartmouth finished fifth overall but placed second in the design contest—and won Chrysler's Best Hybrid System Engineering Award for developing an accumulator consisting strictly of ultracapacitors.

"We put a lot of effort into the design," says Frank Fortin-Houle '10 Th'11, Dartmouth Formula Racing co-captain and primary driver. "We did some out-of-the-ordinary things with final belt drive, a fuel injected engine, and the whole electric side with only capacitors. A lot of the things added to the complexity of the car. But we're engineers and we tried to push for as much as we could."

The Formula Hybrid competition is organized by Douglas Fraser, a research engineer who has taught in Thayer instructional labs for 30 years and used to advise the Dartmouth Formula Racing team. Fraser's key colleague in bringing Formula Hybrid to life is Wynne Washburn. Fraser oversees the technical aspects of the competition, while Washburn handles administration, funding, promotion, and marketing.

According to Washburn, Formula Hybrid is increasingly gaining attention from the automotive industry. "We're starting to see more and more companies and corporations coming to us who are curious about what the competition is all about and how they can get involved," she says. This year Formula Hybrid attracted 33 sponsors—including Chrysler, Ford, General Motors, and Toyota—more than double the competition's original 14 backers.

Formula Hybrid was conceived back in 2004 when the Dartmouth Formula Racing team built a hybrid racecar and tried to enter it in a Formula SAE competition. The Society of Automotive Engineers banned the car because it didn't conform to competition rules. Fraser convinced Thayer School to start a separate Formula Hybrid competition.

SAE quickly endorsed the idea. "The SAE

has been very supportive right from the beginning," says Fraser. "They sent us the source for the Formula SAE rules, which we went through and modified heavily."

Fraser convened an organizing conference at Thayer in 2006 to hammer out the parameters of the competition with members of Formula SAE and representatives from the electrical engineering world, most notably the Institute of Electrical and Electronics Engineers (IEEE).

"There are many different hybrid configurations," Fraser notes. "The Formula Hybrid rules require that the vehicle has an internal combustion engine and an electric motor system as opposed to hydraulic accumulators, flywheels, and fuel cells. The only devices that are approved for electric accumulators are batteries or capacitors and they have very different characteristics that can be used to advantage in different ways."

A significant change from the SAE rules was reducing Formula Hybrid's maximum engine size from the SAE's 600 cc to 250 cc. There's no minimum or maximum weight for Formula Hybrid. The cars must have four wheels and a minimum wheelbase of 60 inches. "We have deliberately set up a minimum of rules because we want the students to be as creative as they can be," Fraser says.

The four-part competition at the New Hampshire Motor Speedway in Loudon, N.H., takes place over four days—up from the original three because of the increased number of competitors. The competition opens with the teams making formal presentations and sales pitches to a panel of judges who act as if they were venture capitalists. This initial presentation is worth 100 points in the competition's potential total of 1,000 points and is followed by an engineering and design analysis valued at 200 points. On-track competition consists of a pair of acceleration runs over 75 meters, an autocross on a twisting, challenging course, and a concluding 22-kilometer endurance test. The two acceleration runs carry 75 points apiece. The autocross is worth 150 points and the endurance event carries 400 points.

The acceleration runs must be completed in no more than 10 seconds, and one of the two acceleration runs has to be completed with electric-only power. If the car can't

make it, the team doesn't qualify for the rest of the competition. The concluding endurance event must be completed as quickly as possible without using more than 20 megajoules of energy, the equivalent of 2.3 liters of gasoline (taking into consideration internal combustion engine efficiency).

All the teams start the event with the same amount of energy on board. Their accumulator systems are filled to capacity. They are then given just enough liquid fuel to round out the 20-megajoule limit.

Formula Hybrid has established itself as an ideal recruiting ground for the auto industry to find skilled and motivated young electrical and hybrid engineers, according to Michael Royce, a veteran Chrysler engineer and Formula Hybrid's chief mechanical tech inspector. Royce, who chaired the Formula SAE rules committee for nine years, and his wife, Suzanne, chief tech inspector at the United States Grand Prix Formula One races and Indy's motorcycle Moto GP, are among the judges who hold Formula Hybrid students to high standards.

"The motivation and the reason we get involved is we believe it is one of the finest educational programs there is for young engineers," Royce says. "What these young men and women are really learning is not so much hybrid systems or how suspensions work or that sort of thing. What the industry is really interested in are the softer skills that they cannot teach in the classroom—team building, team organization, project management, planning, and budgeting."

Royce adds that the skill of learning to work together with people who have different ideas or opinions is a key element in Formula Hybrid. "Conflict resolution is one of the important lessons," he observes. "Anybody involved in motor sports has an ego and when you get two people who've got different ideas on the design direction or have a packaging conflict, somebody has to have a way of resolving that. To compete effectively the teams need to have worked out those processes. From equipment manufacturers and tier-one suppliers on down within the auto industry, those things and people are what the industry wants to employ."

"You had GM, Ford and Chrysler here

Track Record

Creating a hybrid racecar is harder than it looks

wanting to sign people up," adds Royce. "The word is getting around that the people from Formula SAE and Formula Hybrid are the people they want to hire. Working on these projects gives the students about a two-to-three-year flying start, and it's stuff that the companies don't have to pay for."

Texas A&M advisor Make McDermott is an equally big supporter of Formula Hybrid. "It's a great technical exercise and also a great project management study," he says. "The students have got to deal with all the dollars and schedules and people issues that they will face in their professional careers. Mastering those things will pretty much determine their success in their professional lives."

The pressure to get the car prepared is just like any other motor racing competition. "I tell the students that the schedule is not going to slip. When the race starts, they're going to wave the green flag whether our team is there or not," says McDermott. "Engineers in particular want to keep trying new things, but at some point you've just got to quit that game and say, this is good enough. This works, and we've got to go out there and compete."

In this race, winning isn't everything.

"We were a bit frustrated about the outcome because we worked so hard on it through a whole year," says Dartmouth's Fortin-Houle. "But when you step back and think about what the purpose of this is, we learned a lot. Winning would have been nice, but I think learning to manage the process that we went through—the resources, the money, the people, the time, and making sure the components are designed and made—all that was really important."

Formula Hybrid is a great motivator for many engineering students across the United States and around the world. The competition helps supply the automobile industry with fast-thinking, hands-on young engineers dedicated to improving the efficiency and performance in the automobile. In today's world, that's an admirable goal.

Gordon Kirby is the United States editor of *Motor Sport* magazine and author of many auto racing books, including *A Driving Passion*, the award-winning biography of Mario Andretti.



2007

Car: Tina

Highlight: Won first place for design

Heartbreak: Unable to complete endurance run because of electrical problems



2008

Car: Molly

Highlight: Set course records for electric-only and unlimited acceleration runs

Heartbreak: Unable to complete endurance run because of electrical problems and oil leak



2009

Car: Georgia

Highlights: Hybrid drivetrain debuted independent rear-wheel drive and an electronic differential; won IEEE Future of Engineering Award for technical sophistication

Heartbreak: Unable to finish autocross and endurance



2010

Car: Penny

Highlights: Parallel drivetrain; carbon-fiber steering wheel with driver display and paddles to control regeneration and boost

Heartbreak: Sixth-place finish overall



2011

Car: No. 6

Highlight: Won Chrysler's Best Hybrid System Engineering Award

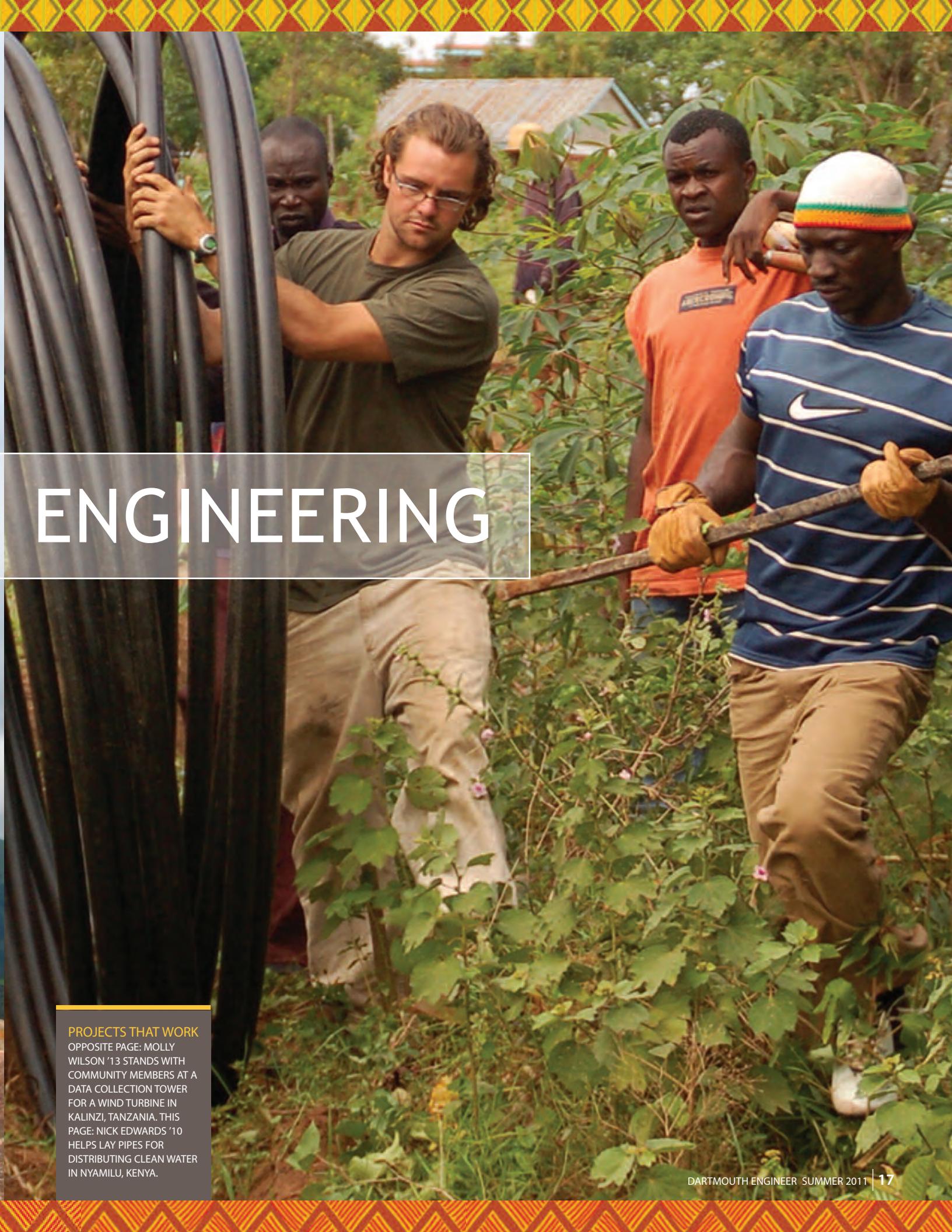
Heartbreak: Completed only 21 of 40 laps in endurance run before track closed



WORKING OVERSEAS, STUDENTS ENCOUNTER
THE TECHNOLOGICAL AND HUMAN SIDES
OF MEETING PEOPLE'S NEEDS.

BY KATHRYN LOCONTE LAPIERRE

HUMANITARIAN



ENGINEERING

PROJECTS THAT WORK
OPPOSITE PAGE: MOLLY WILSON '13 STANDS WITH COMMUNITY MEMBERS AT A DATA COLLECTION TOWER FOR A WIND TURBINE IN KALINZI, TANZANIA. THIS PAGE: NICK EDWARDS '10 HELPS LAY PIPES FOR DISTRIBUTING CLEAN WATER IN NYAMILU, KENYA.

For more than a decade, Thayer students have pursued a wide range of humanitarian engineering projects overseas. In 2003, students established a Dartmouth chapter of Engineers Without Borders. Two years later, they founded their own organization, Humanitarian Engineering Leadership Projects, which morphed into Dartmouth Humanitarian Engineering in 2010. Despite the evolving nomenclature, the students' goal remains the same: engineering a better life for those in need.

While some projects were done in the Dominican Republic, Nicaragua, and Nepal, most of the students' humanitarian efforts have centered on rural areas of Africa. Here's a look at the scope and progress of those projects.



KENYA



CLEAN WATER

The Nyamilu Community Water Project began in 2005 as a joint Engineers Without Borders (EWB) project between Dartmouth and Louisiana State University (LSU). Dartmouth agreed to construct a well and install a solar-powered pump; LSU would handle the water distribution system.

The Dartmouth engineers arrived in the village of Nyamilu eager to select a well location, secure drilling permits, and get to work. Reality took a slower pace. "Information was inaccurate and it was difficult to depend on people," says Michael Bolger Th'05 '07. "We were unable to procure a drilling permit from the Kenyan government until the majority of our project team had left the country." Bolger, who stayed on, helped bring the Dartmouth portion of the project to a successful conclusion: implementing a 98-meter borehole and installing a photovoltaic-powered water pump.

The LSU team started to add a gravity-fed water distribution system the next summer; six Dartmouth students returned to finish the job in 2007.

"We ended up having to do a lot of work," says Bradley Fierstein '06 Th'08. "The pump had been undersized and there was a lot of damage. There was a lot of catching up to be done, and we started from scratch."

But they had lots of help from village residents. "With a community workforce, we finalized distribution points and then set about getting the trench excavation done for the pipelines. We had 40 people working together. We really started cruising after that," says Fierstein.

After three days of digging trenches, the team

turned to building masonry tap stands, fitting the plumbing, and testing for leaks. "That's when we ran into one of our bigger problems," says Fierstein. "The storage tank that had been constructed by the LSU group had developed a crack and started leaking." The Dartmouth group had to gut the walls and effectively rebuild and fortify the storage tank.

The finished project incorporated a 30,000-liter tank and 6,000 meters of pipe that ran a radius of two kilometers around the well. The distribution system ultimately brought water to 12 different tap stands placed in a communal location. As projected, the solar-powered pump met the drinking-water demands of 2,000 people.

The success was short-lived, however. "Unstable political conditions in Kenya have led to desperate times and the theft of the solar panels," Bolger reports.

The project remains instructive, says current Dartmouth Humanitarian Engineering (DHE) president Annie Saunders '12. "It did really help us understand the different challenges of working internationally and trying to collaborate on an engineering project."



RWANDA



SANITATION, BIOGAS FUEL

Benjamin Koons '08, J.J. Johnson '06 Th'07, and Andrew Johnston '06 Th'08 worked at a health clinic in the remote village of Bisate. Partnering with Wyman Worldwide Health Partners, a small, Hanover-based healthcare NGO, the team helped build sanitary latrines to serve the village's 20,000 residents.

The next step would be really ingenious: install a biogas digester system to convert the human waste into fertilizer for crops and methane



COMMUNITY BONDS

CLOCKWISE FROM ABOVE: BENJAMIN MEIGS '10 TH'11 IN TANZANIA; NATHANIEL BRAKELEY '12, THIRD FROM RIGHT, WITH USERS OF NEW ROCKET STOVES IN MWAMONGO, TANZANIA; MANAURE FRANCISQUEZ RODRIGUEZ '11, LEFT, DISCUSSES WORK ON A PICO-HYDROPOWER SYSTEM IN BANDA, RWANDA; BENJAMIN KOONS '08, SECOND FROM LEFT, DIGS TRENCHES FOR THE PICO-HYDROPOWER SYSTEM IN BANDA; KATHLEEN MEYER '12, LEFT, AND BRYNNE WEEKS '12, IN BLUE SKIRT, MEET WITH RESIDENTS OF KALINZI, TANZANIA.





ONE OF DARTMOUTH HUMANITARIAN ENGINEERING'S BIG TENETS IS THAT WE'RE WORKING WITH PEOPLE RATHER THAN FOR THEM, THAT WE AREN'T REALLY HELPING THEM SO MUCH AS WORKING WITH THEM. WHEN YOU'RE THINKING THAT WAY, IT MAKES ALL THE WORK EASIER BECAUSE YOU'RE BUILDING TOWARD A COMMON GOAL."

—NATHANIEL BRAKELEY '12



for fuel. The students thought the methane would be a welcome alternative to the charcoal residents made from wood—especially given that the Rwandan government had prohibited people from cutting down trees.

Progress was slow. “We had planned for this,” says Koons, “but not well enough.” By the time the biogas digester was actually producing methane, the Dartmouth students were already back in Hanover. They hoped their partner would continue the work, but for various reasons the NGO moved on to another clinic. “This was frustrating and out of our control, but also an important lesson in who we choose as in-country partners,” says Koons.

PICO HYDROPOWER

Members of Humanitarian Engineering Leadership Projects (HELP) began to work on an inexpensive small-scale hydropower system in the village of Banda in 2008. HELP partnered with the Wildlife Conservation Society and gained sponsorship from the United Nations Development Programme.

HELP’s plan was to design a prototype at Thayer School and then travel to Rwanda to install at least one locally fabricated turbine based on that prototype. The system would generate enough electricity to power a battery-charging station for the village.

“There were batteries in the community, but people would have to walk 44 kilometers each way to the nearest village with gridded electricity. That would take two days,” says project member Koons. “That’s two days that they don’t have lights.”

Based on lessons learned from past projects, the HELP group stipulated that the project would use local materials, engage local labor, and teach community members how to recreate the technology in other villages once the Dartmouth students had returned home.

It was a formula for success. “When we left Banda we had two hydro turbines producing electricity,” says Koons. When Derek Brand ’09 Th’10 visited Banda that fall to develop the business model, trouble-shoot any issues, and expand the electricity distribution, the project was going strong.

It still is, reports DHE president Saunders. “Recently there’s been a big effort to get more students involved,” she says. “Since that project was installed we’ve had two ENGS 89/90 teams working on the project, revamping the casing, adding an emergency shut-off-valve, and increasing efficiency.”

A group of students planned to return to Rwanda this summer to follow up in Banda and

assess a new site outside of Kigali. The eight Dartmouth students planned to optimize and expand a network of small-scale hydropower systems, funded in part by the National Collegiate Inventors and Innovators Alliance. “We start projects with the intent of making them sustainable in the long run,” says Saunders.

TANZANIA

In the spring of 2008, Dartmouth engineers began a major undertaking in Tanzania to address health and energy needs. Students conducted assessment trips in the Kigoma region and developed collaborative relationships with the Jane Goodall Institute and the University of Dar es Salaam College of Engineering and Technology. In the summer of 2009, students were ready to introduce two new cooking stoves. Why cooking stoves? Because traditional wood stoves are inefficient and smoky, leading to high rates of deforestation and acute respiratory infections.

WOOD-BURNING ROCKET STOVES

The students introduced rocket stoves in Mwamgongo. “The rocket stove consists of six clay bricks surrounded by a mud brick housing structure,” says Saunders. “The cooking is done on top of a short insulated ‘rocket’ chimney. It burns wood more efficiently, requiring less fuel and reducing smoke.”

With community members’ help, the group built approximately 20 stoves in local homes. “The stove was widely adopted in Mwamgongo,” says Zachary Losordo ’10 Th’11. Government restrictions on the amount of wood each family can gather have increased demand for the stove. “As a result,” says Losordo, “the government has been extraordinarily supportive of our project, collaborating with us to market and distribute the stove to the community.”

“The rocket stove is a very cheap means of cooking,” says Nathaniel Brakeley ’12. “It uses about 50 percent less fuel and burns a lot cleaner, so it helps with both health issues and energy problems.”

Students returned to assess how the stoves were faring one year later. Taking notes from villagers on possible enhancements, they improved the size, aesthetics, and stability of the stoves. Then the team focused on a large-scale distribution initiative. “The idea was to have local technical experts, who can build the stove and know the benefits of it,” says current project leader Stephanie Crocker ’12.

“In order to disseminate the technology, we hosted a seminar where we taught a group of 11 community members how to assemble the stoves from scratch,” says Losordo. “The participants put the entire stove together in under two hours.”

The aim was to have the community drive the distribution system. “We want people to teach their neighbors and their friends to build the stove,” says Crocker.

Another group of students monitored progress again during winter 2010. “Some sub-villages were more successful than others,” says Crocker. “Our current estimate is that 50 to 55 stoves are in use right now. There are about 500 households, so it’s reaching about 10 percent of the population.”

Continuity is crucial, according to Saunders. “The longer we’ve been there, we’ve developed closer relationships,” she says. “Those close relationships lead to better trust, and that’s a really crucial part of the success in any project.”

COFFEE-HUSK-BURNING STOVE

For the village of Kalinzi, located in Tanzania’s northern coffee region, Dartmouth students designed a stove that burns plentiful coffee husks instead of scarce wood. “We thought it would be great if we could take a waste product and use that as fuel,” says Kathleen Meyer ’12.

After an initial assessment trip in 2008, students designed the stove as their ENGS 190/290 (now called ENGS 89/90) project, using Hawaiian coffee husks as fuel. When they tried out the stove in Kalinzi in 2010, they found it didn’t work as well in Tanzania because of differences in the size and density of local coffee husks. Kevin McGregor ’11 and Ryan Birjoo ’11 redesigned the stove for Tanzanian conditions. Another group of students planned to test the reconfigured stove in Tanzania this summer. “The goal is to solidify the technology in the first month and spend the next month implementing and marketing it,” says Meyer.

“We’re hoping to identify entrepreneurs who would like to start selling the stove and help them start their business,” says Crocker.

“Overall, it has been a really successful technology for developing countries,” says Meyer. “It’s something that could be implemented in other places, which we’re really excited about.”

COMPOSTING LATRINE

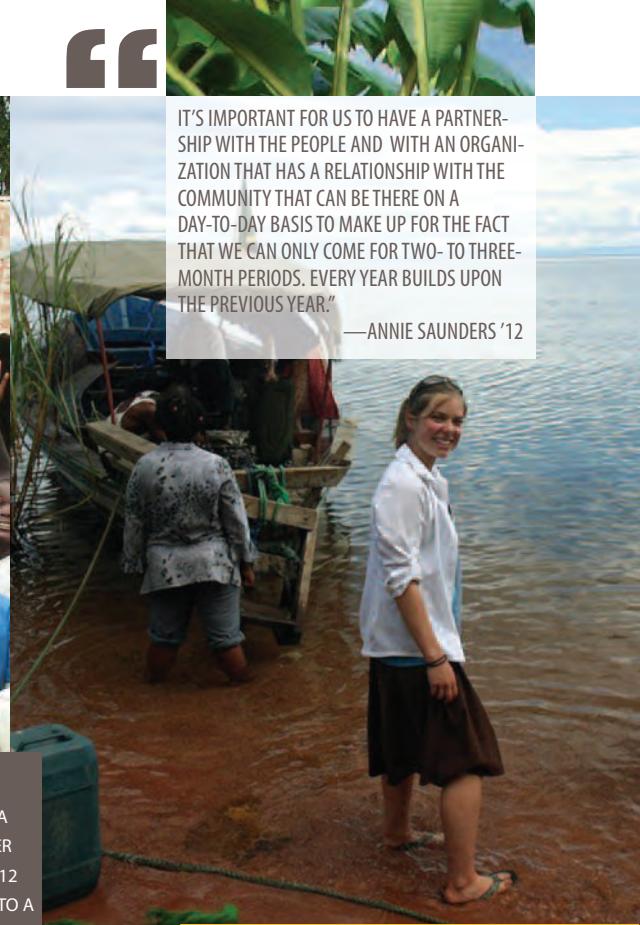
As students traveled around Tanzania, other challenges and problems came to light. “We keep our eyes open while we’re working,” says Saunders. “We make the most of our time and resources and focus on multiple issues.”

One problem: a high rate of water contamina-



TIME WELL SPENT

ABOVE: MICHAEL BOLGER TH'05 '07, ON LEFT, TAKES A BREAK FROM WORKING ON A SOLAR-POWERED WATER PUMP IN NYAMILU, KENYA. RIGHT: ANNIE SAUNDERS '12 AND COLLEAGUES LOAD ROCKET STOVE SUPPLIES INTO A BOAT BOUND FOR MWAMGONGO, TANZANIA.



IT'S IMPORTANT FOR US TO HAVE A PARTNERSHIP WITH THE PEOPLE AND WITH AN ORGANIZATION THAT HAS A RELATIONSHIP WITH THE COMMUNITY THAT CAN BE THERE ON A DAY-TO-DAY BASIS TO MAKE UP FOR THE FACT THAT WE CAN ONLY COME FOR TWO-TO THREE-MONTH PERIODS. EVERY YEAR BUILDS UPON THE PREVIOUS YEAR."

—ANNIE SAUNDERS '12

tion. The students' solution: a composting latrine.

The composting latrine consists of two pits. When the first is full, the contents are left to turn into compost, which can be used as fertilizer. People use the other pit, and then the system alternates.

"The object was to teach locals how to build and maintain the latrine to prevent flooding or collapsing," says Andrew Wong '12.

The idea didn't take. "Unfortunately, we found that the concept of using human waste as fertilizer was kind of taboo," says Saunders.

"Our lack of experience led to our downfall," says Losordo. "We didn't understand the challenges associated with working in an entirely different cultural context. This failure gave us a much better sense of our scope as an organization."

SOLAR WATER DISINFECTION

As another solution to sanitation needs, DHE has begun research in solar water disinfection, which uses only sunlight and PET bottles to disinfect water. "It's a really simple technology," says Crocker. "We will be doing some testing this summer."

SANITATION CHECKLIST

Students have instituted a sanitation checklist to help villagers document problems and keep up

on the general maintenance of latrines and other systems. After following up with the community, the students found the simple checklist to be successful. "It's not changing the water systems dramatically," says Crocker, "but it has raised awareness for the communities."

WIND POWER

The last current project that students are working on in Tanzania is a wind turbine to bring much-needed electricity to one of Kalinzi's 10 sub-villages. The turbine would be an alternative to the three diesel generators in the center of town.

"The wind turbine would be really small-scale electricity, but right now the people in this sub-village have a 45-minute walk to charge small electronics," says Meyer.

Kalinzi residents and students collaborated to construct a data collection tower with two anemometers for measuring wind speed and frequency, which will collect data for one full year. "We're all pretty excited about this project," says Crocker. "We're starting to figure out a design, and we're going to try and build a local site this summer."

Kathryn LoConte Lapierre is the assistant editor of *Dartmouth Engineer*.

PERSONAL IMPACT

CHANGING LIVES, INCLUDING THEIR OWN

THE CHALLENGES THAT AROSE ATTEMPTING TO COMPLETE EVEN A BASIC ENGINEERING PROJECT IN THE DEVELOPING WORLD GREATLY OUTWEIGH ANYTHING THAT I HAVE FACED IN MY PROFESSIONAL LIFE. YOU LEARN A LOT WHEN YOU MUST UNDERSTAND CULTURAL ETIQUETTE, MOTIVATE PEOPLE TO COMPLETE WORK WITHOUT PAY, AND ULTIMATELY IMPLEMENT A FUNCTIONAL SOLUTION.

—MICHAEL BOLGER TH'05 '07

THE HELP PROJECT CHANGED MY LIFE PERMANENTLY. NOT ONLY DID IT GIVE ME THE BEST TANGIBLE HUMAN CONNECTION TO AN ENGINEERING PROJECT I COULD ASK FOR, BUT IT GAVE A CONTEXT TO THE TREMENDOUS IMPACT ENERGY HAS ON DAILY LIFE. SINCE THE PROJECT, I HAVE COMMITTED MYSELF TO TRYING TO BETTER UNDERSTAND THE INCREDIBLE COMPLEXITIES SURROUNDING ENERGY AND ITS RELATIONSHIP WITH BOTH THE DEVELOPED AND DEVELOPING WORLDS.

—BRADLEY FIERSTEIN '06 TH'08

THERE IS HUGE POTENTIAL FOR CREATIVE ENGINEERING SOLUTIONS TO MAKE A SERIOUS IMPACT. THE TIME I SPENT WITH DARTMOUTH HUMANITARIAN ENGINEERING WILL CONTINUE TO HAVE A PROFOUND IMPACT ON HOW I VIEW THE WORLD AND MY PLACE IN IT AS AN ENGINEER.

—BENJAMIN KOONS '08

Alumni News

► spotlights



DESIGNING WOMAN
Elizabeth Gerber '98
founded Design for America.

Elizabeth Gerber '98 knows a good design isn't just about technical function—it's about developing a product that is both usable and desired. Trained as a product designer and behavioral researcher, the Northwestern assistant professor of mechanical engineering uses behavioral science to understand and inform the design of products and services.

Gerber's "aha" moment came while working on an aircraft fuel gauge while at B.F. Goodrich Aerospace Engineering. "At the very end

of a long discussion on functionality, very casually someone introduced the fact that a mechanic refueling the plane is going to need to *read* the gauge—while standing on a ladder leaning against the side of the plane," she says. "One of my favorite parts is talking to people about how they actually experience a product—understanding the technical, behavioral, and emotional needs." She is exploring that interface as the principal investigator for the Creative Action Lab at Northwestern's Segal Design Institute,

which investigates the role of technology in supporting individual and group creativity. There she applies behavioral sciences to the design of tools and practices to improve creative performance.

Gerber is also the founder of Design for America (DFA), an extracurricular, design-based learning initiative building creative confidence in students through design for local and social impact.

"DFA is a 'product,' a pipeline for future innovators," says Gerber. "My dream is that all DFA students firmly believe that they have the ability to innovate solutions to challenging societal problems and believe that their ideas are valued."

Her efforts came full circle this spring, when DFA staff led an innovation workshop at Dartmouth. More than 70 participants from various academic departments—anthropology, geography, English, and engineering—gathered to tackle a single design problem: helping out elderly people living in rural New Hampshire and Vermont.

Gerber says she first found inspiration for unconventional design education when leading Dartmouth's first-year outdoors orientation. "I realized the potential of peer-to-peer learning and the transformational power of physical and mental immersion experiences in transforming our identity and confidence," she told **Dave Seliger '12** for his first post in *Core77*, the leading industrial design blog. "I danced the 'Salty Dog Rag' with the first years...then sent them off on their trips with a sense of excitement of what they would learn from each [other] and about themselves." To read the whole post at core77.com, search: Seliger Spotlight Design for America.

A new Dartmouth chapter of DFA, led by **Alison Polton-Simon '14**, **Sean Hammett '14** and **Lucas Yamamura '14**, begins this fall. See designforamerica.com/Dartmouth.

M.E.M. grad **Gabe Farkas Th'02** is putting his second graduate degree,



in statistics, to work in the San Antonio Spurs' front office as coordinator of basketball analytics. Farkas, a former contributor to Mike Kurylo's *CourtsideTimes.Net*, says his research is used primarily as part of game strategy and to build the roster. The amount of data being collected—publicly and privately—is growing exponentially, he says, and the next big thing in sports analytics will be the development of systems that integrate all the disparate data sources. A basketball fan since he was a kid, Farkas brings a passion for and understanding of the sport to his review of the numbers. "The NBA is definitely the sport I've followed the closest," he says. "To work in professional sports, you need to be really dedicated, since the hours sometimes can be long and the workload demanding. Also, you need to have a solid, non-numerical understanding of the game to be able to gauge if your results pass 'the laugh test.'"

Dave Lindberg '09 Th'10 is bringing his experience working on Thayer School's Formula Hybrid racecar to Mombasa, Kenya. As the lead engineer of Mobius Motors (mobiusmotors.com), Lindberg is hoping to



CAR GUY
David Lindberg '09 Th'10
engineers affordable cars
for African conditions.

create the next generation of reliable and affordable transportation across Africa. The challenge is to create a vehicle capable of handling the continent's unpaved and poorly maintained terrain while keeping it inexpensive. "My company plans to incorporate low-cost components available from small-production cars into a welded tubular steel chassis, sparing the amenities and using only the most essential systems," says Lindberg. "We hope the end result gives lower-income people access to mobility and also serves as a platform for transportation entrepreneurs, giving even the most impoverished access to employment." He's working on developing two prototypes (Mobius Two and Mobius Three), lowering costs, and organizing production. A majority of the parts are off-the-shelf Toyota components, he says, but the steel chassis and all custom parts were modeled in SolidWorks for fabrication by local workers in Kenya. After spending the last two months in the shop, Lindberg has almost finished his first prototype. Then it's on to the development of Mobius Three before he returns to the States this winter.

ASK THE EXPERT

The Expert: Philip Coyle '56 Th'57

Associate Director for National Security and International Affairs,
White House Office of Scientific and Technology Policy



When it comes to national security, there's not much Philip Coyle hasn't handled in his 40-year career. He spent 33 years developing and testing nuclear weapons, lasers, and other high-tech systems at the Lawrence Livermore National Laboratory—and worked for several Democratic and Republican administrations.

During the Carter administration, he oversaw the Department of Energy's nuclear weapons programs, nuclear safeguards and security, arms control, and non-proliferation. During the Clinton administration, he served as assistant secretary of defense. President George W. Bush appointed him to the Defense Base Realignment and Closure Commission. President Obama appointed Coyle to his current position in 2010.

The going hasn't always been easy. Coyle attracted both praise and criticism following his 2009 assessment before the House Armed Services Strategic Forces subcommittee that America's missile defense program suffers from technological and testing shortcomings and questionable strategic value.

In the following, Coyle discusses his career in national security.

What lessons from your years developing and testing weapons did you bring to your current position?

This answer isn't original, but it's true: I learned that the devil is in the details. Success can hinge on persistent attention to engineering details. In products for everyday life as well as for our soldiers in battle, those details also involve the expected operational environment and the expectations of the end user in practice.

You've worked for Democratic and Republican administrations. What challenges come with that territory?

All administrations feel vulnerable to accusations that they aren't doing enough to solve this or that particular problem, even as they are doing everything that they can, and doing it as well as anyone could. Why haven't we solved cancer or world hunger or world peace? It's certainly not for lack of trying, but rather because the problems themselves are so difficult.

What is it like working at the Office of Scientific and Technology Policy?

From one day to the next we may not know what issue we are going to have to grapple with. It may be the outbreak of a new disease strain, something new happening in the Middle East, or something to do with cybersecurity. We worked hard to help the Japanese with the aftermaths of the earthquake and tsunami and the subsequent nuclear reactor accidents near Fukushima. We need to be able to adapt quickly, and we do.

We also work on America's energy security. For example, the Navy and Air Force are experimenting with biofuels made from algae in fighter jet aircraft. The Department of Defense (DOD) can help America develop a clean-energy economy by being an early buyer of effective clean-energy technologies, much as DOD investments in semiconductors spurred commercial industries in computers and cell phones.

What has been the most rewarding aspect of your career?

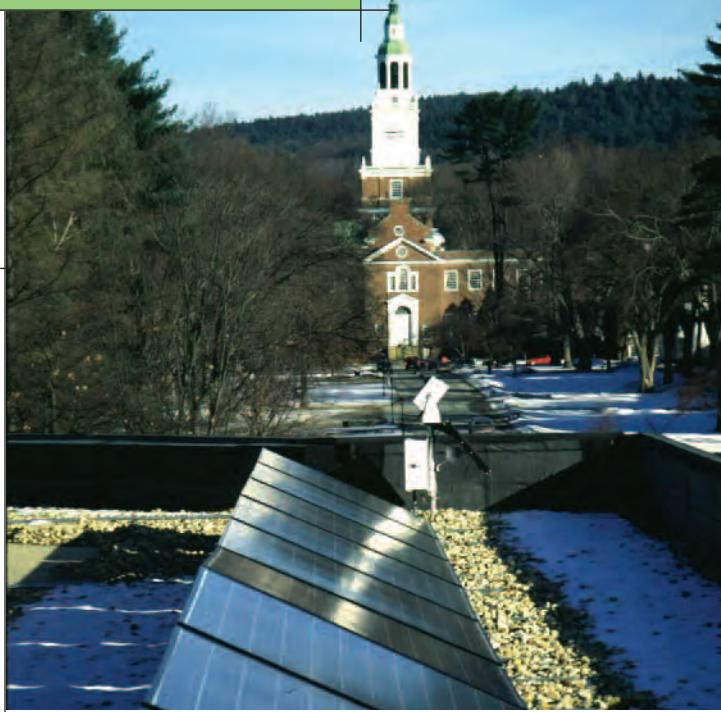
My entire career has been devoted to American national security. I've worked on developing and testing some of America's nuclear weapons. I've worked on experimental new sources of energy. In the DOD my job was to make sure that the systems we provide our troops would be effective in battle. It has been rewarding to see the things I have worked on come to fruition and contribute to a strong national defense.

Let's spool backwards. What did you study at Thayer?

My degree was in mechanical engineering, but at Thayer I studied fluid mechanics, heat transfer, optics, electronics, economics, and many other fields. That turned out to be important because my career was never limited to mechanical engineering. My education at Thayer gave me the confidence that I could solve just about any technical problem that came my way.

Did any professors particularly influence you?

Professor J.J. Ermenc was an important influence for me. He was studying renewable energy decades before it was "cool." All the professors at Thayer engaged students in a way I'd never experienced. They discussed each topic with us, taking our feedback and questions until they were sure we understood. They didn't just lecture at us; they worked with us. It was a wonderful experience, and it changed my life.



BRIGHT SPOT

Irradiance, the company founded by Edward Kern Jr. '67 Th'68, designed the solar panel system on the roof of Dartmouth's Murdough Center.

project and oversee the hotel part of it. My firm never had more than three employees. I loved that flexibility. Science courses and case studies in business school were important aids in my work. During my two-year stint in the Army, I studied interrogation techniques at intelligence school. That helps in negotiations, which you do every day. Most importantly, if you treat people nicely and do good work, more work comes in the door.

—Jack Hodgson '60

After six to seven years with a very large firm, CRSS, my partner and I bought the Chicago office of CRSS Civil Engineers, of which I was president, in 1993. We formed Meridian Engineers & Planners Inc., saying, "Now if we're doing anything stupid, it has to be our fault!" We functioned with a staff of 25 to 30 until 1996, when we concluded that we didn't function well selling from a "small wagon." We merged Meridian into Edwards & Kelcey in a great cultural and services fit that saw me to retirement in 2006. We more than doubled the size of the office to 70 and ultimately realized an excellent return on our original investment.

—Tom Jester '63 Th'64

In 1994, after 20 years as a manager in a Silicon Valley electronics company, I left and co-founded an RF semi-conductor company called Endwave. I had been introduced by a venture capital firm to an enthusiastic group of engineers who had a new idea for building cost-effective broadband, radio-frequency semiconductors. We built a business plan and raised our first round of financing. Six years later, after more venture capital funding, we did an initial public offering and raised funds to advance the business. Last year we sold the majority of the company to a larger semiconductor company, and I retired as CEO.

I would advise a few things for budding entrepreneurs:

- Hire the best people that you can find, then empower them to do their job. Only intervene if it would be a major problem, otherwise let them learn from their own mistakes, not yours.
- When raising money from institutions, back your truck up and load in all you can get, as you will probably need it.
- Whatever your initial business plan is, it is wrong and will need to be modified. Be open to changing it as the environment dictates.

► just one question

Q. Have you founded a company?

In 1971 I was in the investment business. I had a friend who wanted to diversify his business and we set out to acquire the company for him. I became chairman, he became treasurer. The company engineered coal preparation facilities and was a small factor in a fairly large industry. It did turnkey construction based on its engineering designs, but had no construction facility. During the next three years the coal industry had a strike, the price of coal went sky high, and the company, which was capable of building two plants at a time, was building seven. We paid off all the debt and had cash left over. It was decided that we would begin a holding company and acquire other companies. We have made various investments, including two construction companies designed to assist the coal processing engineering company. I do not consider that we have been particularly successful. We should have been investing in tomorrow's business instead of yesterday's. We set out to develop a fast-growing company; we ended up with cyclical, smokestack companies. The most significant lesson we have learned is that it is critical to set goals, develop a plan to achieve them, and constantly review the plan and the results—and that you will make some mistakes.

—Nate Parker '52 Tu'53 Th'53

In 1987-88 I founded a company that we

named IMCOR (the interim management recruiting company). The company grew rapidly, and in 1997 I sold it for \$10 million to a large temporary-help firm. We drew on the large pool of downsized executive talent that then (as now) existed in the United States. We challenged a large number of executive recruiting tenets as a part of our strategy and used networking concepts and laptop computers to locate and source specific skill sets and provide rapid service. We had a small but significant retainer and provided nearly perfect executive candidates in less than two weeks. All of our placements were interim assignments of six months. Our pricing and conversion fees were engineered to be both profitable (to us and to the executive) as well as considerably less expensive than the executive recruiting business model. And then we found that 80 percent of our placements were offered a permanent position after completing the interim assignment. Models of recruiting behaviors, economic tradeoffs, and negotiating tactics were used continuously in our training and mentoring. And all of this was before monster.com.

—Bruce Clark '60 Th'61 Tu'61

In 1972 I left as the development officer of what is now Westin Hotels and started my own firm, Jack N. Hodgson Co., specializing in hotel development. I'd attach myself to a developer doing a major

• Be careful of being too far ahead of society. Many great ideas have failed not because they were wrong, but because they were too early and ran out of funds. My company spent millions on wireless broadband in the 1990s, 10 years before anyone really cared—a real waste.

• Traits essential for success include honesty, judgment, and perseverance.

• The most important skill set in a company is sales and marketing experience in the target market. Without customers, there is no reason for the business.

• If you have a great idea for a business but no management experience, you might do best by hiring a professional manager for CEO and become the chief technology officer. A popular venture capital comment to technologists in Silicon Valley is: "With that great idea, you can either get rich or be CEO, not both."

—Ed Keible '65 Th'66

I was a VP and director of technology for Owens-Illinois (O-I) Inc. when I founded Plastic Technologies Inc. (PTI) in 1985. The premise for creating PTI was that Coca-Cola bottlers wanted to develop new and innovative PET plastic soft drink packaging products, including a plastic can. Four Coca-Cola self-manufacturing cooperatives agreed to jointly sponsor and fund several major product development and engineering projects. I proposed establishing a separate independent company to manage these projects—and PTI was created. The contracts assured PTI of initial funding and required PTI to manage the plastic can development project and carry out other engineering and development projects for the combined Coca-Cola cooperatives. PTI developed client relationships with other high-profile self-manufacturing concerns, resin suppliers, machinery builders, brand owners, and converters. We learned how to work with competitive customers and are recognized for protecting customer intellectual property and confidentiality. PTI customers are involved in every step of the PET value chain, from raw material supply through end-of-life recyclability process studies. PTI is recognized today as the premier PET technical development and support resource in that industry, with nearly 120 employees worldwide, and offices and labs in Ohio and Geneva. Recent technological developments include biopolymers, nanotechnology for material additives, flexible packaging and pouches, sustainable pack-



WORK HARD, PLAY HARD

Eric Overton '87 Th'89, founder of Focus Embedded, uses his down time to reproduces a Nieuport 12 biplane.

aging initiatives, and instrument development with new sensors.

—Tom Brady '66 Th'68

In 1983 I co-founded and was president of Aqua Design, a desalination company based in California that established seawater desalination operations on 14 islands. We sold the company in 1996 to Ionics, and it is now part of General Electric. The company was an extension of a 1963 Thayer ES 21 project with Professor Paul Shannon and a reverse osmosis graduate research project that Dean Spatz '66 Th'67 and I conducted under the guidance of Dean Myron Tribus.

Aqua Design engineered, manufactured, constructed, owned, and operated seawater reverse osmosis desalination plants supplying water to governments and resorts mainly in the Caribbean. Essentially we were selling water by the cubic meter. Since we owned the plants, we were able to test new ideas and developments on a commercial scale under real-world conditions. By 1987 we had the reduced energy consumption for the main desalination process to less than 9 kilowatt-hours per thousand gallons by reusing the hydraulic energy in the waste brine by means of our dynamic pressure exchange systems.

—Chris Miller '66 Th'67

I played a significant role in the rebirth of the family-owned business, Schweizer Aircraft Corp. During its first 44 years the company developed and produced a line of sailplanes and manufactured airplanes, as well as airplane parts and assemblies for major aerospace companies and the U.S. government. A second generation of Schweizers (all engineers) joined the company in the 1970s, including my brother Paul '68 Th'69, after eight years in engineering at Boeing, and me, after picking up a master's in aeronautical engineering from Princeton and three years at Boeing. In 1983 we acquired the company, which was in bad shape in terms of its technology, product base, and finances. Our first major move was to acquire an existing light helicopter line, which included the Army's primary flight trainer, from Hughes Helicopter Inc. During the next 21 years the company developed two new light helicopter models and an unmanned helicopter for the U.S. government while producing in excess of 2,000 helicopter units. Another important business area became the development and

production of highly specialized and sophisticated reconnaissance airplanes for the U.S. and foreign governments. In 2004 we sold the company to the Sikorsky Aircraft division of United Technologies Corp. I retired in 2007.

My advice includes: Have people around you who are ready to criticize the boss. Treat your employees fairly and your customers like gold. Recognize your mistakes as soon as possible and react. Constantly improve your products and technology. Really know your competitors. Work your butt off.

The engineering and liberal arts background that I acquired at Dartmouth helped me every day. I could solve tough engineering problems one minute and write an effective proposal the next. The most important thing I took from Thayer School was understanding that no problem was too tough for me if I put my mind and energy fully against it.

—Stu Schweizer '66 Th'67

The photovoltaic power systems and instrumentation company I founded almost 25 years ago, Irradiance (irradiance.com), grew out of projects I worked on and led at MIT. My advice: Follow a passion and teach others along the way—and be patient for the world to catch up. Staying in touch with Thayer is also a good thing to do.

—Edward Kern Jr. '67 Th'68

I've worked at several early-stage companies and groups over the years, but the British Flag Holder Co. is the first one I've founded. This is a very small group that we formed to make bronze memorial flag holders for British veterans. (My dad, Ken Chapman, was at university in London when World War II broke out. He enlisted and served in the British Army until 1946.) Even though this project is small, it has all the earmarks of a successful startup: an unmet need, passionate team, and long-term commitment.

—Mike Chapman '76 Th'77

I founded Advizor Solutions (advizorsolutions.com) as a spin-off from Bell Labs. We are currently about 20 people. The biggest challenge has been changing markets. As a technology spinoff (I was hired to spin the technology out of Bell Labs), we had technology but needed to find the market—sort of the reverse of the ideal startup. We first went after website analytics, but that market crashed around

2003. We then went after financial services, but that got pulled out from under us when a key partner with domain knowledge went into a downspin. We then targeted higher education, but that slowed up in the 2008–09 market slump. Now we have some good forward momentum. I think the biggest lessons learned were to stick in there and adjust as market conditions change, and to make sure you address key needs and pain points in unique and valuable ways.

—Doug Cogswell '77

I've been involved in two startups in the computer software industry. I co-founded Syntra Ltd. with a Columbia Business School friend while we were both at Columbia in 1983. The systems-oriented approach to engineering that was taught at Thayer and the project focus of classes such as ES 21 were excellent background for starting and growing a technology company because they made you realize that you could achieve much more than people thought if you just jumped in and tried to solve problems as they came up. I remember a number of occasions when we won competitive bidding situations because we were able to innovate around a roadblock while our competition did not. We grew the company from the two of us and \$50,000 of investor capital to revenue of \$6 million and a staff of 50. We sold to venture capital investors in the late 1990s, and they invested \$75 million into the company in a bet on the globalization of the Internet. The bet did not work out as desired, so the company no longer exists. My second startup was an industry-funded portal called INTTRA, a global portal for the ocean container industry. Our 2010 revenues were \$50 million, and we have about 300 people. Because containerized freight is a global industry, the Dartmouth global worldview was very helpful in the early days as we struggled with building a global team, culture issues, language issues, etc.

—Harry Sangree '79 Th'80

In 1995 I co-founded Intermind Corp., a startup focused on automating information exchange on the Internet, allowing info consumers to establish persistent links with info providers, such as vendors, in a way that enabled them to control the flow. It also allowed info providers to obtain anonymous, aggregate data on what consumers are seeking,

how they interact with the info, etc. The product shipped in 1996. We achieved adoption by more than 200 info providers, but the speed of the database engine proved a painful limitation. We ran low on money before we could solve the tech problems. After shedding more than 80 employees, we took the company back to just two people (myself and the co-founder), received more capital, and tried again. In 1999 I was invited to leave in favor of new CEO talent. The company is still trying to create value from the original IP. I am a co-author of one patent, and the company received several others, but patents mean little without large-scale application deployment. The startup was a wild ride. I'd do it again in a heartbeat, but differently.

—Peter Heymann '81 Th'83 Tu'83

My company is the Energy Emporium (energyemp.com), a renewable energy showroom and information center located in Enfield, N.H., in an 1860s renovation to zero-energy building. Zero-net energy means all of the energy needed to heat the house and provide electricity is provided from renewable sources; for us that means solar energy. We have four goals with this building: zero-net energy, LEED certification, no combustion (heating is done with all low-temperature distribution), and historical preservation. We provide information, a showroom, sales, installation, and maintenance for solar hot water, solar electric, grid-tied or off-grid systems, wind and water turbines, and composting and energy-efficient products. I hope to provide a place for people to research their own ideas in renewable energy and sustainable living.

—Kim Quirk '82 Th'83

None of the companies I have founded has bloomed, though products I initiated have made, well, maybe billions. Under the direction of Barry Richmond, I simulated the life of a person for my Thayer M.S. thesis. In 1984 my technical recruiter presented my proposal to turn that simulation into a game. Electronic Arts (EA) turned it down, saying simulation models do not sell. Human Edge Software moved me across the country to develop it, but the company went under, so I founded AI Consultants and tried to sell the idea to IBM, Apple, Hanna-Barbera, and venture capitalists. Meanwhile, I designed and wrote computer programs and expert systems for Apple, IBM, Pru-



PERSONAL TOUCH

Andy Wilson '88 founded Graphight, a relationship management system for business professionals.

dential, and other big companies. Now SIMS and SIM City are the core products of EA. Today I have two software products that will be great: one that heals the heart through individualized dialog and one that connects kids to the woods through smart phones. I still have no idea how to get a company going. Any advice?

—Sue Spencer Th'82

I am the CFO of Energy XXI Ltd., which I co-founded in Bermuda in 2005. We have a \$3.9 billion enterprise value (\$2.8 billion market cap) and produce about 43,000 barrels of oil equivalent in the Gulf of Mexico, of which two-thirds is oil.

—West Griffin '83 Th'85 Tu'85

In 2007 I co-founded North Bridge Growth Equity, a private equity investment firm. We help businesses manage rapid growth with the goal of taking the company public or selling to a larger firm down the road. Our first fund of \$547 million was raised from university endowments, foundations, and family offices.

After Thayer I started my career in the semiconductor capital equipment industry, working for Teradyne as a sales engineer. Since earning my M.B.A., I have spent the last 20 years in private equity focused on technology investing. My A.B./B.E. in engineering have been crucial to my career in so many ways. The beauty of the Dartmouth degrees is the breadth of exposure to technology combined with the opportunity to build great communications skills. I am at ease discussing technology with entrepreneurs, whether it is semiconductors, software, communications, medical devices, data storage—you name it. I couldn't possibly have succeeded in my career and started my company without it.

—Doug Kingsley '84 Th'85

My first six years out of Dartmouth were spent as a nuclear engineering submarine officer. The motivation for this service, back in the 1980s, was derived from my time in Leningrad (FSP in Russian language) that tapped a patriotic vein within, while at the same time looking for a challenging engineering experience. I was later able to lean on my double major in engineering and Russian studies in the early 1990s when I co-founded a company with two Russian scientists to lease a Russian nuclear-powered submarine for civilian science research under the Arctic. In 2000 I founded a company in Brazil of-

ferring energy services to electric utilities and large wholesale customers for their energy management and efficiency needs—services just now coming to the United States, as power finally becomes of interest to consumers. A year ago I co-founded SI Energy for the development, acquisition, and management of hydropower assets in the Republic of Georgia, once again utilizing elements of my double major. We have a partnership with a Norwegian utility, but I feel it hard at my age to pick up another language.

—Dale Perry '84

My partners and I have co-founded at least half a dozen companies focused on everything from oil and gas exploration and production to trucking. Some have been winners and some have been dogs. I think I am most proud of the fact that we have never gone bankrupt!

The most recent venture is Absolute Completion Technologies Ltd. (absolutec.com), started in 2002 and focused on developing and commercializing technologies for the down-hole control of solids and fluid in-flow in oil and gas wells. We have some exciting IP in this area that we largely developed ourselves. ACT's products are currently sold in 35 countries around the world, and we work in some very interesting and challenging environments—from deep water to high-temperature, in-situ combustion. ACT will double in size this year to about \$30 million in annual revenue and more than 80 employees. Schlumberger, the world's largest oilfield service company, took a minority stake in ACT in 2007.

Important things I have learned are:

- Knowledge and understanding really are two very different things, and there is no substitute for experience! Trumping all: the courage to take risks.

- Judge yourself on the progress you are making toward your goals, not on whether you have achieved them. Goals have a habit of getting bigger. It's better for your confidence to focus on progress.
- The 80-percent rule is a universal law—don't over-engineer. It is better to be moving in more or less the right general direction than in exactly the right direction.
- Simple is super.
- You need more capital than you think.
- If you enjoy the creative aspect of engineering, once you hear the words "market share," move on.
- Save the weekends for your family.

—Thane Russell '84 Th'85

I started a small company called Focus Embedded (focusembedded.com) to design electronics for deeply embedded systems. We do digital and analog electronic circuit design, programmable logic design (including field-programmable gate array design and synthesis), deeply embedded firmware and device driver design, some user interface software design, printed circuit card layout, and short-run prototyping for "design for manufacturability" feasibility studies. The company got its first big lease on life in late 2007, when I was handed a severance package at my position as a field applications engineer with a major semiconductor manufacturer. I was unemployed about a week when my phone rang. It was one of my former employer's customers. He'd hunted me down and became my first design customer. By the spring of 2008, it dawned on me that this was my next job. Having collected lab equipment for years (to do all my little "garage shop" projects) and having made innumerable contacts in the electronics industry, I pretty much had all the pieces to pull the plug on working for a large corporation. Now Focus Embedded is up to six and a half employees.

—Eric Overton '87 Th'89

After seven years of running an early stage/incubation venture fund (Momentum Venture Management) I returned to my operating roots and launched my newest venture, Graphight (graphight.com). I realized that great ideas must be surrounded with great people in order to build great companies. Graphight is a relationship management system that helps business professionals develop new contacts into valuable relationships while ensuring they don't neglect important existing relationships. I am also juggling five other board roles and two young kids (Spencer, 9, and Dylan, 6). I am super lucky to have a fantastic wife, Liz, who helps me keep all the pieces together.

—Andy Wilson '88

I had a fabulous experience founding a company. In 1994 I was working at SRI International on a team doing speech-recognition research, and we decided to spin out a company. I was one of four co-founders of Nuance Communications. I stuck with it for 10 years, during which we grew to \$50 million a year in revenue and went through an IPO in March of 2000. After I left in 2004, Nuance was ac-

quired. The acquirer took the Nuance name and NUAN ticker symbol and continued to roll up other companies in the speech space. Nuance is approaching \$1 billion in revenue. Today's Nuance bears little resemblance to the company I helped to create, but it's exciting to see it live on.

—Peter Monaco '89

In 2008 I founded B2B Venture Partners USA. We were a small team with considerable experience in business engineering, website design, and marketing. We set up an online social network at usaB2Bvp.com to attract experienced people for the creation and management of new public companies. Our biggest challenge was getting entrepreneurs and professionals to understand our business model. In 2010 we applied the business model in two areas: charter school funding and vegetarian fast food. I credit my Dartmouth experience for giving me the entrepreneurial guts to work on something that has never been done before.

—Ananda Glover '91 Th'92

A couple of years after I returned to Colombia, I decided to get into the digital post-production and computer animation business for two main reasons: 1) After two years in the innovation business of research in Thayer, I was bored in the manufacturing sector where I was required to comply with norms and guidelines without much room for challenges; and 2) my husband is a TV commercials director and I could see lots of room for growth in the computer animation and nonlinear editing areas. At first, taking advantage of the enormous experience I had acquired at Thayer in computer-assisted design, I became a digital effects designer for a production company my husband worked for. In 1993 we started our own production company, Metro Studio S.A., and I took on the job of designing software for managing the business. I also did computer animation, nonlinear editing, and digital effects. In 1997 we started our own animation and digital effects department inside the company. Since 2002 these areas developed enough throughout Latin America so that we could outsource them. Last year we had sales of \$2.5 million. We plan to double this sales figure by the end of 2012.

Thayer taught me how to become an entrepreneur, and I have enjoyed every second of it. I took a very special class



ENERGY EMPORIUM

Kim Quirk '82 Th'83 opened a renewable energy showroom and information center, in Enfield, N.H.

with Dean Hutchinson. He taught us the link between engineering and business that has helped me wade through stormy waters. My mottos are: Persistence is king. Never, never, never give up. The only constant is change. Failure is not an option.

—Doris Martinez '91

I recently co-launched eProfit Partners to provide Internet marketing services to e-commerce businesses. The New York City-based company works with clients to multiply online sales and profits through increasing website traffic and enhancing conversion rates. We manage search engine optimization, pay-per-click advertising, conversion rate optimization, and email marketing campaigns, and also advise clients on Internet marketing strategy. We work with web-based businesses that have the capacity to dramatically increase their profits through Internet marketing. Our typical client is an e-commerce website that is already generating sales online and is seeking to scale its growth through Internet marketing. We also advise pre-revenue Internet startups that have significant growth potential. Our report, "The 5 Fastest Ways to Double Your Online Profits," is available on our website, eprofitpartners.com.

—Philip Frost '04 Th'06

I have co-founded startups within large companies like Cisco and have started a new solutions unit in Cisco called Healthcare Solutions. We are looking to do \$25 million next year and scale to \$100 million in three years. The key challenge is to build a team that has both the urgency and focus of a startup but also can leverage the big company engine as we scale.

—Vishal Gupta Th'94

I formed a medical device manufacturing company, Surgical Planning Associates. It is nearly a "virtual company" insofar as it has no employees, only subcontractors for manufacturing, regulatory, marketing, sales, CAD, software development, web interactivity, billing, and quality control. Our primary product is the HipSextant (hipsextant.com).

—Steve Murphy '94

I founded Audio3 Ltd. (audio3.co.uk) in 2007. At the moment it is one person and not really making money, as most rev-

enue, when it exists, is invested back into R&D. I also do consulting.

—Bradford Backus '95

I co-founded ZSX Medical, LLC in 2009. ZSX Medical is reinventing surgical closure in women's health, developing alternatives to sutures for major surgeries women encounter, such as caesareans and hysterectomies. We have two full-time employees and an army of consultants and advisors. Our biggest challenge has been raising financing in these difficult economic times. I'm not sure we've had "success" yet, but two things that stand out to me are: 1) you should know what you're doing and why you're doing it; and 2) when the facts change, you need to revisit your assumptions to make them match the facts, and then draw new conclusions and change course as necessary.

—Dan Mazzucco '98

I co-founded a company called Liquid Light. We are developing catalysts, initially discovered at Princeton, that allow carbon dioxide to be converted to a variety of chemicals and fuels with high efficiency. To date, we've synthesized 19 different chemicals. The process can take place using only sunlight (artificial photosynthesis) or it can be powered by any source of electricity—preferably a low-carbon source! We have built a team that includes some of the best chemists in the world and believe we have the first credible platform technology for using CO₂ as a chemical feedstock. I always wanted to work in clean tech, but was sidetracked by a 6.5-year stint in the Army.

—Kyle Teamey '98

In 2010, I co-founded Frontier Capital, an alternative investment firm to acquire and manage illiquid credit and equity assets from hedge funds. Our first transaction was purchasing a \$258.7-million portfolio from a Greenwich, Conn.-based hedge fund. We expect to acquire an additional \$100 million of assets during 2011. An engineer at heart, I always look for high-quality, tech-related assets.

—Rahul Vaid Th'98

I founded Mundy Technical Communications in 2009 to provide marketing and communications support to companies in technology. Where engineers have a tough time whittling down their message, I help them identify and promote that message. I'm still in startup mode, so

the biggest challenge is remembering to focus on sales almost constantly. My goal is to develop a strong enough base so that I can set aside time to help technology startups, a group that usually can't afford marketing support but needs it greatly.

—Marty Mundy Th'99

I started Bynum Design Build, LLC, in Boulder, Colo. We do design, landscaping, and excavation work. Our five employees are expected to perform a multitude of tasks, from CAD to backhoe work. I believe that in order to truly understand what you're designing, you must have perspective of the implementation of that design. Therefore, time spent in the field is paid at the same rate as time spent in front of a computer—and real-life experience is reflected in design.

My thesis project at Dartmouth set the foundation to my career. I worked on a project for Costa Rica involving the design of low-cost housing. With the help of alumni donors and the Tucker Foundation, funding was available to head to Central America and put the plans into action. The project was completed on time and on budget in 2001, and I am very happy to report (upon returning to Costa Rica this past February) that the houses are looking great and the previously struggling families are thriving!

—Casey Bynum '00

I co-founded Flurry (flurry.com) with two other Dartmouth grads in 2005. Today Flurry is the leading provider of services to developers of mobile applications for iPhones, Androids, etc., with more than 40,000 developers using our services to manage more than 70,000 applications on more than 250 million mobile devices. We have offices in San Francisco and New York and soon will expand into Europe. I credit all of my Thayer classes with teaching me one simple lesson: There is always a way to make it work.

—Sean Byrnes '00

I opened Mighty Yoga in Ithaca, N.Y. I have a successful career working in energy efficiency as an engineer, and started the studio as a small, low-risk business because I love teaching yoga and there weren't any other heated yoga studios in Ithaca. I discovered that the niche market I was looking to serve is much larger than I had anticipated. I run the studio like a business, using my engineering and M.E.M. experiences from Thayer. My

engineering background has helped me to appreciate the value of and create clear procedures, a website (mightyoga.com) that is easy to navigate, and a professional presentation of the business. My engineering career and yoga studio are a great match.

—Heather Healey '00 Th'02

I'm the CEO of PlotWatt (plotwatt.com), which I co-founded with John Cunningham '02 in 2008. PlotWatt helps people reduce their energy bills. Our cloud-based algorithms analyze smart meter data to figure out appliance-level energy cost without monitoring the individual appliances. The PlotWatt Energy Dashboard then boils that insight down into easy-to-understand feedback and recommendations. Users (in 22 states and counting) have cut their electricity bills by as much as 50 percent. Today we are a small team of (mostly) engineers. We are hiring.

In a scrappy startup, slow decisions are not an option. We look for non-utility, fast-moving customers that help us become profitable quickly while providing a platform and proof points that entice the big guys and open doors for massive future opportunities.

—Luke Fishback '02 Th'03

I have started a few companies. I started a business improvement and coaching company called 1 Group Inc. in 2010. I started and was president of a solar technology company, AxiSol, until early 2011. We were awarded a N.H. Innovation Research Center grant working with Thayer Professor Jifeng Liu. I'm forming a new Maine-based company, Beltane Solar Inc. (beltanesolar.com), which is commercializing technology that will concentrate the sun's energy to create power and hot water. The design has a total efficiency of more than 60 percent, yet is simple, scalable, reliable, and low-cost. Future accessories will allow energy autonomous water desalination and sanitation. We believe that you can and should get more from the sun.

—Steve Musica Th'05

The drug-authenticating company I founded, Sproxil (sproxil.com), has seven full-time employees and five contractors. It has implemented technology from my Ph.D. research. We have two of the world's five largest pharma companies as clients.

—Ashifi Gogo Th'09

REUNION

Classmates meet at Thayer in June. Left to right (all '61 Th'62 unless otherwise noted): Donald Bake, Daniel Paradis, William Berneking, Peter Tuschak, Arthur Beatty '61 Th'62 Tu'67, George Whitehead, John Willis, Andrew Urquhart '61 Th'64 '71, George Breed, Pablo Gome, Lowell W. Bauer, and Ralph Spencer Jr.

►thayer notes

1940s

Henry Keck '43 Tu'44 Th'44: Three years ago I retired from the firm Keck-Craig Inc., which I founded in 1951. Since then I've been very busy with inventors from all over the United States who need help in getting their inventions ready for production. I write business plans for them to help raise money. I've also written a new book, *How Design Changed America*.

Robert Sundblad '44 Th'48: I retired from active engineering work in 1989. I moved to Florida in 1994 from Marion, Mass. I have served as president of our local engineering society for several years here in Florida. Otherwise, I enjoy a quiet retirement watching boats and the world go by from our waterfront property.

Bob Pretat '46 Th'48: I just returned to Virginia from Dartmouth, where we drove for the class of 1946 65th reunion. I have only been to my 50th reunion, previously living farther away in Texas and Florida. I live in the Tampa area six months of the year but now have a home in southwest Virginia during the summer and fall. I called **Paul Lacle '46 Th'48** about the reunion, but he couldn't make it. I haven't been involved in engineering since I retired from a cement company in 1989, starting there in 1948 when I left Thayer School. Lafarge ended up being the largest cement company in the world—I helped a little. My life has been recently blessed with a new soulmate, Carol, after my wife of almost 52 years died in 2002. Between travel and hobbies—mine is genealogy—we keep busy. I'm working on my fourth book, and more beckon me.

Charles Quinn '47 Th'47: I was one of the approximately 25 Navy and Marine Corp V-12 members, all Thayer classmates, who received our degrees in early 1946. It was a wartime program that compressed the eight college semesters into less than three years. Dartmouth, the Navy, and engineering have always been wonderful, happy memories for me. But after two more years in the Navy, I felt that I was being called to the priesthood. I was ordained as a Catholic priest of the Dominican Order at Washington, D.C., in 1955. My first assignment was to Pakistan, where I stayed for 16 years. I was

then elected the superior of the Dominicans of New York Province. Following eight years as provincial, I then did much parochial ministry in the States (mostly in Jersey City, N.J., and Pleasantville, N.Y.). I also had another foreign mission assignment to the Solomon Islands and Papua New Guinea. For the past year, I have been at the Dominican Priory in Cincinnati, Ohio, helping out at a large parish, but also being present for the young men who are here in our novitiate, beginning their years of study for the priesthood. I have not remained in engineering, except for those memorable years at Dartmouth and the great group that made up that V-12 portion of the class of Thayer School 1947.

Tad Comstock '48 Th'48: We have moved into a very nice continuing care facility in Exeter, N.H., known as the Boulders at Riverwoods. I have met a number of Dartmouth grads here. We are looking forward to making my class of '48 mini-reunion next fall.

1950s

Pete Knoke '55 Th'56: I'm a full-time associate professor of software engineering at the University of Alaska, Fairbanks. I teach graduate and undergraduate courses in computer science and software engineering, conduct and publish research in software engineering, mentor students, and perform the usual other university service activities. I'm working on a book titled *Legal Issues for Software Engineers*. For several years I have performed volunteer work for the Institute of Electrical and Electronics Engineers (IEEE) Computer Society (test development for the IEEE computer software development associate and professional as well as the evolving nationwide software engineering professional engineer program). I do this work because I believe more professionalism might help in improving software quality. I am 77 years old and am thinking of retiring; my children and grandchildren in Florida complain that we don't get to see each other very often.

Stanley Sklar '55 Th'56: My first engineering job was as a summer intern at the Bell Telephone Laboratory, working on a vac-

uum tube project. After graduating from Thayer in 1956 my engineering career moved on to the design of aerospace data processing and display systems based on digital transistor logic circuits, then integrated circuits, then microprocessors, hybrid circuits to reduce size, and finally custom integrated circuits. In 1972–73 I designed the command/control display system for Boeing's AWACS airplane that was based on the first 1,024-bit (128 byte) memory chip. We received the serial number 1 chip from National Semiconductor Corp. in 1973. Today chip capacities reach one megabyte and beyond. Since I graduated at a time of transition from vacuum tubes to the digital world, the components and digital system design techniques were not yet taught at Thayer. They had to be learned on the job and through night courses at local universities. I think there is a message here. In retirement my technical activities are limited to keeping up with the ever-growing advances in personal computing and communications. I am an avid follower of national and international affairs. Also, I have become obsessed with ballet. I attend a performance every week when one is playing in N.Y.C. I go to Broadway shows and museums and take long walks. When my wife was alive we took yearly trips, to Russia, China, Spain, England, Israel, Malta. For the last seven years I have been taking yearly trips to Europe with my youngest daughter. I have four grandchildren, ages 13 to 17.

Rick Burkhardt '56: I am owner and CEO of RMB Consulting, which I started 12 years ago after retiring from ExxonMobil Chemical (with more than 32 years of service). The consulting business continues to thrive and that, along with being the president of our local American Contract Bridge League duplicate bridge studio, keeps me active. My wife of 43 years and I enjoy travel and look forward to many more years of semi-retirement.

G. Leonard Neely Jr. '56: For the past four years I have been confined to home and the local Kaiser health facilities. I now do not drive or take long vacations, so I couldn't attend my class 55th reunion. For the same reasons I did not attend my 50th M.B.A. reunion at Stanford.

Jerry Allyn '59 Th'60: I have been retired from engineering activities since 2003. Other than keeping all my equipment running (I take care of 10 acres of land) and maintaining my sailboat, I am not active in any engineering endeavors. Nevertheless, life

is good, and I spend time with family, friends, and church. I enjoyed attending my 1959 class reunion in Hanover and found that most of my classmates have retired, too.

1960s

Peter Tuschak '61: Other than doing university teaching for several years, I have been an employee of the DuPont Co. for the last 38. Sometimes a person can prepare for one type of career for years and then circumstances move him into a somewhat different field, which ends up being the perfect fit. I was training to do research, accumulating two bachelor's, a master's, and a Ph.D. degree in engineering. I worked about 14 years in research, development, and teaching, but due to circumstances out of my control, I ended up in marketing. It still involves some engineering consulting, but the nature of this is quite different from pure engineering. It turned out to be the perfect fit for me. One never knows what lies ahead.

Mel Meyers '63 Th'64: I own my own manufacturing company, Bry-Air Inc. We manufacture large equipment to precisely control humidity and temperature in mostly manufacturing operations. I have three children and two granddaughters. My youngest, a daughter, is a junior at Ohio State University. I have stayed in touch with the College through the alumni fund. Plans have been made to spend a week in Portland, Ore., with a group of my Phi Gamma brothers.

John Kunz '65 Th'66: I teach and lead a center in the civil and environmental engineering department at Stanford. I just finished an inspiring 100-person workshop on integrated facility asset planning and management that is enabled with virtual design and construction methods.

Steve Smith '66 Tu'68 Th'68: I am president of the board of Chikaming Open Lands, a nonprofit land trust in southwest Michigan. We have protected 1,000 acres in the 11 years since four neighbors formed the land trust in 1999. We now have a small staff of three. I also have started a home energy inspection business in southwest Michigan. I conduct energy audits for homeowners that give them an analysis of the energy efficiency of their home and what they can do to improve the energy performance and consequently reduce their energy costs. Most owners of homes over 25 years old can usually save 25 percent of their utility costs if they follow up on my recommendations.



1970s

Bob Stevenson '74 Th'76: I am the COO for TerraSpark Geosciences, a software provider to the oil/gas industry.

Will Fraizer '78: I am continuing in my senior project engineering role with Chevron in Houston. We are completing the front-end engineering (FEED) phase for our new Wheatstone liquefied natural gas project, which will be built in northwestern Australia. Since Bechtel is providing the engineering support for our FEED, I spend most of my workdays in the Bechtel office near the Houston Galleria. I traveled to Australia for several weeks to assist our staff there in making presentations to the local regulatory authorities on our project. A Greenfield LNG project is a multibillion-dollar development, with a construction phase typically lasting around four years. I enjoy the challenge of continuing to work on world-scale projects. Outside of work, I take advantage of the various cultural activities in the Houston area, like the symphony, museums, and musical performances at the local pubs and clubs. I don't see too many Thayer alums here in Houston, but I do participate in the periodic Dartmouth alumni events. The various alumni clubs of the Ivy schools, "Seven Sisters," MIT, etc., also collaborate to sponsor a monthly "InterClub" social hour. I took advantage of my Australian trip to catch up with old friends in Perth (I had two prior work assignments in Perth and lived there a total of about four years). A pleasure of working in the international energy business is that you have friends in many corners of the world.

Martin Sklar Th'78: Presently my company, Automated Medical Instruments Inc., is in the early stages of developing a "game-changing" instrument for treating a major cardiac arrhythmia. We are presently seeking early financing. As we progress through this process I have seen a few Dartmouth alums referenced, and plan to connect with them soon. We will also be trying to connect with electrophysiologists (Drs. Gerling, Greenberg, Holzberger, and Sangha) at Dartmouth-Hitchcock Medical Center. Any contacts within Thayer or the greater Dartmouth community are appreciated. My wife, Janis, is helping along with a team of colleagues. Medical Development Group, which I co-founded in 2001, is the leading grassroots med-tech business organization in New England, with more than 30 pro-

grams per year, almost 2,000 individuals in the network, and more than 400 dues-paying members. This June I am stepping down from the governing board, after serving on it as the organization's first president and then as a board member for the past seven years. Our offspring Adam is heading back to school to learn and obtain a master's in project management. Our daughter Jennifer and her husband, Evan, are doing well in a Boston suburb. She works as an account manager for a growing telecom firm and Evan for his dad's healthy vending company.

Bill Hooper '79: I'm married to Christy Reid Hooper and have two sons, Will (28) and Christopher (21). I'm a professor of computer science at Belmont University—not exactly engineering, but close!

1980s

Pat Guiney '80: I just finished a nine-year stint at Hologic, managing new product development programs for the diagnostic division. Hologic focuses on women's health, and my teams developed imaging/microscopy systems for cervical cancer detection as well as an analyzer for quantifying risk of pre-term birth. Next, I am moving on to Philips Medical Systems, where I will be senior program manager in the emergency care and resuscitation division.

Laurie Komornik Hartman '80 Th'80: I did some engineering early in my career. However, in my journey I branched into a few other areas. I started my own baking business providing desserts for a natural food store. I then got an M.E. in counselor education with an emphasis in community counseling. And I am now working in pastoral care—and have been privileged to work with a few trauma survivors who suffer from dissociative identity disorder (DID). My Thayer education gave me tremendous tools and orientation that I use to this day. Someone with DID is someone with a system—albeit in a human body rather than in a machine.

Donald "Brad" Bradshaw '82: I run a high-tech clean-energy company in the Boston area that manufactures systems used to power cell towers in developing countries. We manufacture hydrogen purifiers and hydrogen generators that feed pure hydrogen to fuel cells that deliver electricity to the radio transmitters in cell tower installations. The market for our technology is focused in areas of the world where power is either non-existent or unreliable. For context, about 1.5 billion people in the

world have no electricity, but want cell phone service. The greatest growth in cellular subscribers in the world is in areas where power constraints are the most significant, especially in Africa, India, and Southeast Asia. The only alternative to fuel cells is diesel generators, which are expensive to operate and unreliable, hence the interest in fuel cell power systems. The company I run, Hy9 Corp., manufactures a system that efficiently and cleanly converts liquid methanol into pure hydrogen, which is fed into polymer electrolyte membrane fuel cells to generate electricity. My engineering education at Dartmouth has helped me work with engineers to shape and integrate advanced technologies into practical business products and strategies. Applying sound engineering principles and process in a purposeful and focused manner is critical to overcoming technical challenges in high-tech startups.

Peter Lambert '82: I am senior VP of Nordson Corp., a multinational company with direct operations in 30 countries. I lead the company's adhesive dispensing segment, which includes the packaging, product assembly, nonwovens, and web-coating systems product lines. I joined Nordson in 1993 as product development manager in the powder systems group and in 1997 became managing director of Nordson Australia. In 2001 I was named director of corporate development and global business information, responsible for the company's acquisition activities as well as the integration of information systems across all of Nordson's geographic locations and businesses. I also chaired the company's technology strategy committee. In 2003 I was named vice president of packaging and product assembly and was responsible for engineering, product development, product line management, marketing, and communications activities. I was named vice president of EFD Inc. in 2005 and served in that position for four years before being named to my current position in 2009.

Mike Adams '83: I have been working for Bechtel, the global engineering, construction, and project-management company, for the past 20 years. I am a main board director and president of one of Bechtel's five global business units, the civil infrastructure business. I am responsible for a number of exciting projects around the world, including a new airport in Qatar, a new offshore port and related industrial zone in Abu Dhabi, a new motorway in

Kosovo, an extension of the Washington, D.C., metro toward Dulles Airport, and a new rail line across London. I have lived in London for the past 11 years with my wife and four sons. I have enjoyed my career at the sharp end of building infrastructure around the world, and in so doing, helping enable countries achieve stronger economic growth.

Thane Russell '84 Th'85: We live in Alberta on a small ranch about halfway between Calgary and the Rockies. My lovely wife Kerri runs an equestrian center that we started about five years ago now and we have 65 horses that board and train there. We also have a small but growing herd of purebred Black Angus cattle. I work in the oil industry at Absolute Completion Technologies (absolutect.com) when I am not feeding animals, fixing fences, or haying. Every once in a while my partners and I seem to be able to come up with a new bit of kit that people want to pay for, so that's what covers the bills. However, most of the people who want it seem to live in places like Venezuela, Indonesia, or West Africa, so I spend quite a good deal of time on airplanes. Kerri and I have two children, Paige (18) and Matthew (16). Paige is a freshman at Texas A&M and a member of the equestrian team there. Matthew is a gentle soul who was born with autism. He has a great sense of humor, attends high school (where he is in regular classes with the help of an aide), and generally keeps us smiling. His was a gift of a very unexpected sort, but a blessing all the same.

Mark Gies '86 Th'88: John de Papp '86 Th'88 and I were good friends at Dartmouth and Thayer, and we have been working together since 2009 at PanelClaw (panelclaw.com), a solar energy startup making commercial roof and ground-based solar panel mounting systems. I was the third employee and am VP of Technology and Innovation. John is VP of Western U.S. sales and is employee No. 5. The company is based in Massachusetts with more than 30 employees and offices in Texas, Vermont, and California. We're always looking for people interested in a career in renewable energy.

John Rajala '88: I have been keeping a blog, northwoodsnotebook.blogspot.com, as part of my role with Rajala Companies in Bigfork, Minn.

1990s

Durward Sobek '91: I am a professor of industrial engineering at Montana State



STUDY BREAK

While in Denmark on a Fulbright Scholarship, Emily Koepsell '09 Th'10 visits Legoland.

University, completing my 14th year here. I've been doing work in the areas of product development and healthcare delivery systems, applying lean and other industrial engineering principles to those sectors. Starting in September, I'll be on sabbatical as a visiting professor at Chalmers University of Technology in Gothenburg, Sweden. My wife, Sarah Robbins Sobek '91, and I would love to connect with Dartmouth folks who may be in the area.

Maureen McGrath Hahn '92 Th'93: What have Steve Hahn '92 Th'93 and I been up to? Brendan (13), Clara (11), Eveleen (9), Maeve (7), Delia (5), Quinlin (4), and Tilley (2). We love our crazy life in South Carolina. **Takami Kihara Th'93:** I work for Accenture as senior manager and am based in Tokyo. My current responsibility is to lead Asia-Pacific process improvement activities, such as quality assurance, high-risk engagement management, and Capability Maturity Model Integration appraisal and training. As everyone knows, Japan had the worst natural disaster in March. I had to stay at the office in Tokyo since all transportation was stopped. Luckily we are recovering from the disaster; however, we face an electronic power-saving challenge in the summer since we are heavily using air conditioning due to the hot and humid weather. Each company must establish some policies, such as shifting working hours or dates, forcing employees to take longer vacations, or adding extra days off during the summer to save the electronic power as much as possible. I have a wife and three kids. My hobbies are working out, fishing, and reading.

Michael MacAvoy '93 Th'94: I am a hand surgeon and orthopedic surgeon in south San Francisco. I use my engineering skills both in surgery and in my publications pertaining to fracture fixation and muscle strength testing.

Jim McClellan '93 Th'95: I'm the bald guy with glasses and blue shirt sitting next to Katherine Knapp Carney in the TIME video of Pratt & Whitney Co., "What it Took to Create a Job for One Bright Engineer," at time.com/time/video/player/0,32068,950658343001_2072667,00.html.

Ted Arons Th'94: After graduating from Thayer, I spent three years working as a research scientist for the Cold Regions Research and Engineering Laboratory, doing geophysics fieldwork in polar regions. Then Fish & Neave, a major New York patent law firm, asked me for assistance understanding petroleum exploration technology. I went to work for the

firm in 1998 and have been practicing patent law ever since. I spent about 10 years working for the firm and its successor, Ropes & Gray. For the last four years, I've been practicing in New York at my own firm, which I founded with a colleague. I advise major international corporations and startups regarding intellectual property in connection with product development, fundraising, litigation risk, and patent portfolio development. My Thayer education proves its value every day in both legal and technical analysis, whether I'm dealing with telecommunications, energy, mechanics, bioengineering, quantitative analysis, or finance. I invite fellow Thayer and Tuck community members to be in touch.

Ryan Braude '94: I am the cultural affairs officer for education and exchanges for the U.S. State Department, based at the U.S. embassy in Dhaka, Bangladesh.

Jim Bradley '94: Even though I retired almost four years ago, I continue to work on patents for Navistar. I also continue to use and study the Russian Theory of Inventive Problem Solving. When we are able to slow down, Sue and I love to travel.

Dan Frem '97 Th'97: I am starting off on a new career, my third, and I hope, last. I recently graduated with a doctorate of veterinary medicine from the Cummings School of Veterinary Medicine at Tufts University and will be an intern next year in Ventura, Calif. I hope to obtain a residency in small animal surgery afterwards. I had worked at Ford Motor Co. with Chris Dorros '97 Th'98, Sharon Spatz '96, Jeremy Crane Th'98, and several other Thayer M.E.M. graduates, but after two-plus years I left Ford to return home to Massachusetts to help manage the family business, Cyprian Keyes Golf Club, a public golf and reception facility in Boylston, Mass. After seven years there, I needed a dramatic change and took post-bac classes and applied to vet school. Professor Kennedy wrote a recommendation for my application.

Jan Lammerding Th'97: I just accepted a joint faculty position between the Weill Institute for Cell and Molecular Biology and the Department of Biomedical Engineering at Cornell University in Ithaca, N.Y. The research in my lab combines engineering and microfabrication approaches with cell and molecular biology techniques to probe the physical properties of cells and how they modulate cellular function under physiological conditions and in disease, with applications ranging from muscular dystrophy and cardiomy-

opathies to premature aging and cancer.

Stephen Lee '99 Th'00: I'm working at a stretchable electronics startup, MC10 Inc., in Cambridge, Mass., as their senior electrical engineer. We have several projects but I spend most of my time developing stretchable circuits that lie on an elastomer. In one case, the elastomer is a polyurethane balloon catheter. Our electronics can stretch with the balloon. We map electrophysiological data and perform ablation at the same time on a balloon catheter, simplifying a pulmonary vein isolation procedure. I'm happy to note that we've had several Thayer interns here this year. They include Andrew Ceballos '12, Robert D'Angelo '08, Roja Nunna Th'12, and Nishan Subedi Dual-Degree '12.

2000s

Joe Brown '00: I finished a Ph.D. in mechanical engineering at the University of Colorado at Boulder in 2010. I'm currently employed as a post-doc research associate there. My research areas include microelectromechanical systems for nanomaterial tensile testing and mechanical and electrical characterization of nanoscale structures and materials. The company I helped start in 2004, NanoComp Technologies Inc., continues to improve its capabilities to produce bulk quantities of high-quality carbon nanotubes and is currently based in Concord, N.H.

Jonas Akerman Th'01: I work for AGA Gas AB (a member of the Linde Group) and market liquified natural gas (LNG) as a fuel for shipping. A major activity included in this work is the distribution net of LNG and being able to supply vessels with LNG from ship to ship. Coming regulations (from International Maritime Organization and the European Union) force shipowners to run their vessels on fuels that reduce sulphur emissions close to zero. The LNG environmental impact is also reduced for CO₂ (25 percent), nitrogen oxide (85 percent) and particulate matter (about 0 percent) emissions as well. Apart from AGA, I'm trying to get involved in "early-bird" projects at the Royal Institute of Technology in Stockholm.

Family life dominates my spare time, with our daughter and two sons, 8, 6, and 3.

Mara Winn Th'01: I live in Alexandria, Va., with my husband, Rob Winn '99, two children, and new puppy. I work for Zeichner Risk Analytics, a small cybersecurity and risk and security governance analysis government consulting firm. I act as the principal program manager, directing

programmatic and strategic management support for Department of Homeland Security's supply-chain risk management program and the management of programs within the Comprehensive National Cybersecurity Initiative.

Zac Carman '02: I'm the CEO of Consumer Affairs.com.

Gabe Farkas Th'02: We had our first child in September 2009 (a son, Jacob). In October 2010 I accepted a new position as coordinator of basketball analytics with Spurs Sports & Entertainment. It's a bit of a divergence from engineering. My other grad degree is in statistics, which is what I'm using more in this position.

Jiali Li Th'02: After a few years working as an electrical engineer at Apple headquarters in Silicon Valley, I was assigned by the company to Shanghai, China. I helped establish the first local engineering team and am now the China office's engineering manager. I manage a team of both hardware and software engineers and look to continue to grow the team in the region. When I'm not busy tinkering with Apple's next cool gadgets, I devote my time to my twin toddlers, Jennifer and Andrew.

Bob Neill '03: I spent the last four years working for an energy consulting firm in Atlanta. I left at the beginning of the year to travel in South America and am headed to MIT in August for a master's in logistics. Although in my last job it varied a lot by project, I think you could say I'm still working in engineering.

Tom Byron '04: Since my years in law school, I've been working as in-house counsel at the MathWorks, a company familiar to all Thayer engineers as the makers of MATLAB. (And Dartmouth is certainly not unfamiliar to us at MathWorks—we've got a conference room named Dartmouth, right next to conference rooms MIT and Stanford.) In my spare time, I write intellectual property law review articles. My latest offering was chosen for inclusion in Thomson West's 2010 *Intellectual Property Law Review* publication, a collection of what they deem the best intellectual property law review articles of the year. Personally, I'm living in Allston, Mass., with my wonderful wife, Elise Robinson '05, and two dogs, a 10-year-old Lab hanging around from my days at Dartmouth and a 3-year-old snaggletoothed terrier mutt that does half marathons with me.

Erik Dambach '04 Th'05: I completed my Ph.D. in aerospace engineering at Purdue University. My dissertation's title is "Ignition of Hypercyclic Propellants." I moved to Los



INTERNATIONAL TEAM

Andrew Herchek Th'09 (center, in the dark blue shirt) works with engineers in Pingtung City, Taiwan.

Angeles to join SpaceX as a propulsion development engineer working on the Dragon capsule.

Tara Ryan Rahemba Th'04: In 2009 I joined the law firm Axinn, Veltrop & Harkrider LLP as a patent attorney. I practice in the firm's Hartford, Conn., office and my focus thus far has been on patent litigation relating to pharmaceuticals and medical devices, as well as FDA/regulatory issues unique to pharmaceuticals.

Riad Khan '05 Th'06: After graduation I spent five years outside of the engineering field and one and a half of those years searching for a job during the recession. In mid-June, I started a new position in energy management at Toronto Hydro, where the M.E.M. is certain to come in handy. **Min Song Th'05:** I became a full professor in Central South University in Changsha in September 2010. And I was also named a New Century Excellent Talents in University by the ministry of education of the People's Republic of China.

Adams Baker '06: Improving the energy efficiency of commercial and industrial infrastructure can be a lot like buying a new hybrid car: It can be difficult to determine how much energy and money you're actually saving. I work as an energy engineer and am developing statistical models for our customers who make large investments in energy-saving technology (often based upon our recommendations) so we can show them how much money and energy they are actually saving on an ongoing basis, even as conditions change going into the future.

Josh Jenner Th'06: After four years of doing energy and daylight simulation and research at an architecture firm, I'm going back to school to become an architect. I'll be starting school at the University of British Columbia in the fall.

Chuck Rosenwasser '06: I earned a master's of engineering in product architecture and engineering from the Stevens Institute of Technology in Hoboken, N.J., in 2010. The program is part of the mechanical engineering department and is directed by John Nastasi, a practicing architect. The program operates as a design studio, encouraging students to work on self-directed projects while applying theory from the coursework. Courses I took outside the core studio work were sustainable engineering, physical computing, numerical optimization, parametric design, and active and passive heating and cooling analyses. I am currently a product engineer at OXO, where I am part of a team

that develops water bottles, travel mugs, thermometers, scales, baking tools, and other consumer products. It's a great place to work and I'm really enjoying it! **Mukta Acharya Th'07:** I use quantitative and analytical skills that I gained from my engineering education to solve real-world problems in the healthcare industry. I have been working with CVS Caremark since 2010. I started off working as an analyst in the retail strategic product development group, performing analytics to understand the performance of various pharmacy products and then help implement strategies to improve these products. Just this month, I was promoted to a senior analyst role in a different group, called enterprise strategy and analytics. I am working on a program called pharmacy advisor, which is focused on improving healthcare outcomes and reducing the overall healthcare costs. So far I really enjoy my job.

Jing Tan Th'07: I'm currently working in Bonn, Germany, for the logistics company DHL. I'm working on lean projects (Six Sigma, continuous improvement, etc.) in warehouses.

Wei Xing Th'07: I am currently working as a client manager at a Swedish financial technology firm in New York.

Ada Danaher Th'08: After graduating from the M.E.M. program, I was hired by Eaton for their engineering and technology leadership program. I was a product engineer for Eaton Automotive, supercharger division, for one year in Michigan, functional excellence product engineer for Eaton industrial sector in Minnesota for one year, and now I'm the lead design engineer for Eaton Aerospace, conveyance systems division, in Warwick, R.I.

Elizabeth Jensen Th'08: I just completed my third year of graduate school (out of five) for a Ph.D. in aerospace engineering at Princeton University. This summer I married George Young. I look forward to returning to Dartmouth next year for graduation to see friends graduate.

Watson Sallay '08: For a little more than a year I've been working in Seattle at a company called Electroimpact. We specialize in providing assembly automation

for aircraft manufacturers, both in tooling and robotics. The project I'm working on is an assembly line for the wings of a new business executive jet for Embraer. It has allowed me to work abroad in Brazil and Portugal and has provided some excellent design challenges.

Matt Wallach Th'08: After completing a two-year development program with BMW MC in Greenville, S.C., I moved over to Munich in January for an 18-month expat assignment. I'm working on engineering development for the next generation X5, which should be released to the market around the end of 2013.

Katie Gray '09 Th'09: I graduated in 2009 with the B.E. from Thayer and have been working as an engineer ever since. I currently work as a development engineer for Encana Corp., Canada's largest natural gas producer. My current role is in the regulatory and government relations group where I am able to work across the company on many different projects. In my latest project I helped to submit 11 applications to the Ministry of Energy and Mines in British Columbia requesting \$55 million under its infrastructure program. This program promotes putting production from stranded wells online by granting 50 percent of the project cost to the producer, which greatly helps the economics of certain projects within the Encana portfolio. We will hear back in early September on the results of the projects that we submitted. I hope they will grant us at least \$30 million!

Andrew Herchek Th'09: I have been working in Taiwan for the last six months for their government, refurbishing and upgrading various government-owned equipment. Because of the island's hot and humid climate, the mechanical equipment requires specialized maintenance and technology in order to keep operational. In addition to maintenance, we work with their government to install and upgrade communications equipment, hardware, and software to modernize their older equipment. Some of the challenges we face are collaborating between our offices in the United States and in Taiwan, time zone (12-hour difference, EST) and travel time (about 30 hours), and, of course, the lan-

guage barrier and cultural differences. I'm grateful that I'm able to work directly or indirectly with fellow Thayer alums Andrew Pitts Th'08, Jason Rathbone Th'02, and Chris Castonguay '06 Th'97.

Emily Koepsell '09 Th'10: I'm finishing up my Fulbright Scholarship studying sustainable energy with a focus on energy savings in the built environment at the Technical University of Denmark. I've had an incredible year here studying engineering, learning Danish, visiting museums and historical sites, and making friends with Danes and other international students. This opportunity has enabled me to learn a lot about a field of engineering that greatly interests me, but I think that the most valuable part has been the intercultural experience.

Lauren Miller '09: I've been living in Chicago since last September and finished up my first year in a Ph.D. program at Northwestern University studying mechanical engineering (yes, still in engineering!). I'm working in the laboratory for intelligent mechanical systems there.

Nolan Reis Th'09: I live in San Francisco and work as an engineer for Tesla Motors. I am on the propulsion team designing the motor for our next electric car, the Model S. I am loving it.

Steve Walker '09: I started a new position as a project engineer for Stanadyne Corp. in Windsor, Conn., as of June 6. Previously, I was working as a management trainee for Praxair in Austin, Texas, so this new job marks my transition back to engineering after a short hiatus to develop my project management skills. Stanadyne is a fuel systems manufacturer, and I'm working on developing their line of common-rail diesel injection pumps.

2010s

Claire McKenna '10: I am enthusiastically employed as an energy engineer at Solar Design Associates in Harvard, Mass. We specialize in custom photovoltaic (PV) system designs, but we also work on solar thermal and wind power systems. It's my job, as part of a small team of architects and engineers, to design PV systems from the feasibility stage through many iterations to construction documents. At home I'm attempting to make rustic furniture and assembling a portfolio for my application to M.Arch. programs.



OBITUARIES

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inventions



CAMERA ON A CHIP
Eric Fossum's 1995 CMOS image sensor refocused photographic technology.

CMOS IMAGE SENSOR

>> CO-INVENTOR:
PROFESSOR ERIC FOSSUM

What ubiquitous consumer product came out of the space program?

The right answer isn't Tang, but CMOS: complementary metal-oxide semiconductor active pixel image sensor. You may not recognize the name, but chances are you've got several

around the house. Practically every cell phone, digital camera or laptop computer that creates a digital image uses one. The CMOS sensor not only spawned a digital revolution, but also earned its co-inventor, Thayer professor Eric Fossum, a place in the National Inventors Hall of Fame.

Back in the 1990s Fossum led a team at NASA's Jet Propulsion lab that came up with CMOS technology as a way to reduce the

size of cameras launched on interplanetary spacecraft. Fossum also foresaw the terrestrial uses for his invention, and in 1995 he and lab colleagues started Photobit, a company that licensed the CMOS technology from NASA. A decade later Photobit's successor company sold its 1 billionth sensor.

Today Fossum, who joined the Thayer faculty in 2010, teaches classes in electronic devices and circuits and the

"Introduction to Innovation" class in Thayer's Ph.D. Innovation Program. He's also credited with more than 240 publications and 135 patents. (And he has a dozen more pending.) His most recent patent, No. 7,916,193 B2, for an "Interpolator for a CMOS image sensor using a digital register" was granted March 29, five weeks before his May 4 Hall of Fame induction.

— By Lee Michaelides



RANDOM WALK

At 6 a.m. one Wednesday in May, students entered an operating room at Dartmouth-Hitchcock Medical Center to try their hand at robot-assisted surgery. Professor Ryan Halter Th'06 wanted his ENGS 57/169: "Intermediate Biomedical Engineering" class to literally get the feel of a da Vinci surgical system, using handles in a console to control robotic arms set above an operating table on the other side of the room. "It was incredibly rewarding to sit behind the actual instrument where, just a few weeks prior, we saw a prostatectomy being performed—and actually use the same device as the surgeon used," says Alex Engler '12. "Within five minutes I was successfully 'suturing' a rubber ring to a foam-core base. It gave a real sense of appreciation for the engineering that went into creating this device." The experience aided students in developing solutions to real clinical needs: an LED-based technique to guide ultrasound during robot-assisted kidney surgery, a probe for sensing surgical margins during robot-assisted prostate surgery, a fixation system for jaw surgery, and a vacuum-attachment device for use in laser ablative skin procedures. According to Halter, the groups that worked on the jaw and vacuum devices are pursuing patent protection.

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