DARTMOUTH

Engineer

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WINTER 2012

COLD TRUTHS

FROM THAYER'S ICE LAB TO THE EARTH'S POLAR REGIONS, THAYER RESEARCHERS UNCOVER WHAT SNOW AND ICE REVEAL ABOUT THE WORLD.

- COOL COMPANIES BY YOUNG ALUMS
- A SUSTAINABLE FAMILY PROJECT

DARTMOUTH ENGINEER
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INVENTIVENESS ON DISPLAY

BY DEAN JOSEPH J. HELBLE

INNOVATION AND ENTREPRENEURSHIP HAVE BEEN core components of a Dartmouth engineering education for half a century. From the pioneering efforts in the late 1950s and early 1960s of Thayer professors James Browning, Merle Thorpe, and serial entrepreneur Bob Dean—who's pushing ahead with his latest entrepreneurial venture at age 83—we have reached the stage where 25 percent of our faculty members have started a company in the past decade alone. While our absolute numbers may be small, on a per capita basis this is one of the highest levels of engineering faculty entrepreneurship in the country.

This spirit of entrepreneurship, of identifying pressing, real-world problems and then building solutions, is pervasive within our student body and alumni community. It is a natural outgrowth of a liberal arts-based engineering education that encourages students to think broadly about all aspects of a problem, yet use their technical skill to explore solutions deeply. It is a spirit and philosophy that we routinely associate with the Introduction to Engineering course, ENGS 21, that all majors (and another 10 percent of Dartmouth students who are non-majors) take every year. It is the core focus of our interdisciplinary Bachelor of Engineering capstone sequence. It is the reason the Ph.D. Innovation Program was created nearly four years ago to develop greater numbers of doctoral-level technology entrepreneurs.

It is this spirit that also underlies the Wall of Patents newly on display on the second floor of Cummings Hall at the Thayer School of Engineering (see page 33). Spanning four decades of innovation, the patents have color-coded frames to indicate whether they were the product of work by faculty, staff, students, or collaborative teams. Over the past few years, we have seen tremendous growth in the levels of invention, with the number of patents awarded in the 2000s more than twice that of the 1990s. And if the first 18 months of the 2010s are any indication, another doubling is well within reach. As we have told our entering engineering graduate students and freshmen alike, we are on track to completely fill the current patent display corridor by 2015. It is their challenge to make this happen.

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Photograph by John Sherman

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THE Great Hall

>>NEWS FROM AROUND THAYER SCHOOL

SHELTER FROM THE STORM
Thayer professors and students are helping to create alternatives to the tents Haitians still occupy in the Port-au-Prince area two years after the earthquake that decimated the country.

CHALLENGE

Engineering a $300 House

THAYER SCHOOL IS OFFERING engineering design expertise to the $300 House challenge to develop new housing solutions for the world's poorest.

The challenge began with a *Harvard Business Review* blog post by Tuck School of Business Professor Vijay Govindarajan proposing that the world's poorest population centers could be rebuilt into safe and dignified communities for only $300 a house. The post went viral, and the resulting Open Design Challenge generated more than 300 entries.

The six winning teams were invited to a design workshop, organized by Thayer Professor Vicki May and studio art senior lecturer Jack Wilson, at Thayer in January to collaborate on prototypes for the first houses.

May and Wilson, who have been consulting with Govindarajan, spent a week in earthquake-damaged Haiti in September searching for rural and urban sites for the first houses—and talking with Haitians to find out what they want in a home. "Other organizations have come in and built houses," says May, "but nobody wants to live in them" because they are too close to each other and lack features that Haitians prefer, such as separate cooking structures and large porches. According to May, people welcomed the prospect of houses built with local materials and according to community specifications. "They said, 'we will build the houses ourselves if you can tell us how,'" she says.

For the rural site, May and Wilson settled on Fond-des-Blancs, a community in the mountains outside Port-au-Prince. GHESKIO, a Haitian humanitarian organization, helped May and Wilson select an urban site in Port-au-Prince. The goal is to build a prototype in each setting in June.

May has found several ways for Thayer students to help with the $300 House project, including having them assist workshop attendees in the CAD lab and machine shop. May and Wilson are covering the $300 House in their course ENGS 2: "Integrated Design: Engineering, Architecture, and Building Technology." During spring term, students in May's course ENGS 71: "Structural Analysis" will test house prototypes. In addition, a group of Bachelor of Engineering students has devoted its ENGS 89/90 design course project to developing a composting latrine for the Haitian houses—an effort sponsored by the Dartmouth Class of 1980.

Can each house really be built for just $300? Probably not, says May, but the target focuses effort on the real challenge: developing clean, safe, and appealing houses that Haitians can afford.

—Annelise Hansen

"The goal is for people to understand that design is interdisciplinary, it is solving real problems, making real stuff."

STUDENT GROUPS

Design for America

ASK LUCAS YAMAMURA '14 where he sees Dartmouth's recently established Design for America studio in three years, and his reply is immediate: "On the cover of *The New York Times*."

It's a vision he shares with Sean Hammett '14 and Alison Polton-Simon '14. Design for America (DfA), founded by Elizabeth Gerber '98, is a national network of student groups focused on making a local impact with creative design solutions. After attending a DfA workshop at Thayer School last spring, Yamamura, Hammett, and Polton-Simon started a DfA chapter at Dartmouth.

"The goal is for people to understand that design is interdisciplinary, it is solving real problems, making real stuff," says Polton-Simon.

Each of the three co-founders is leading a two-term group design project. Polton-Simon's group is partnering with the Veterans Affairs Medical Center in White River Junction, Vt., to improve education and employment for veterans reintegrating into civilian life. Yamamura's group is working to improve dental health for pregnant women. Hammett's group is working with students at the Richmond Middle School in Hanover to gain insight into sources of and solutions for middle-school stress. "Our focus for the first term is on asking the right questions—not just, 'how can we reduce middle-school stress,' but questions with greater specificity, like 'how can we make a classroom more inclusive, how can we encourage all styles of learning,'" says Hammett.

Dartmouth's DfA chapter includes students from a wide range of majors beyond engineering, including economics, history, government, and studio art. The founders say they hope to expand DfA beyond the undergraduate level, hold annual innovation workshops, and pursue more projects.

"It's exciting to know that you don't have to feel powerless. You can make use of the knowledge you have been accumulating in class," says Yamamura. "To see the world, to be critical, and to know that you can have an impact—nothing in my day is as fulfilling as this."

—Annelise Hansen

Jason Stauth, left, and Ulrike Wegst

FACULTY

Two New Professors Join Thayer

>> ASSISTANT PROFESSOR JASON STAUTH TH'00 joined the faculty in October. He received his Ph.D. in electrical engineering from UC Berkeley in 2008 and also holds an M.S. from UC Berkeley, an A.B. in physics from Colby College, and a B.E. from Thayer School. His research interests include distributed energy systems and power electronics.

>> ASSOCIATE PROFESSOR ULRIKE WEGST joined the faculty in January. She studied physics at at the University of Göttingen in Germany, received her Ph.D. in engineering from the University of Cambridge in the United Kingdom in 1997, worked at the Institut National Polytechnique de Grenoble in France and the Max Planck Institute for Metals Research in Germany, and taught at Drexel University. Since 2005, she has also been a Faculty Guest Scientist at the Lawrence Berkeley National Laboratory. Her research interests include the mechanical performance of natural materials, biomaterials and tissue engineering, novel materials for nuclear fuel applications, multifunctional hybrid materials, eco-design, and science education through interdisciplinary projects linking music, arts, and sports.

kudos

>> Professor Lee Lynd Th'83 Th'87 has been named a fellow of the American Association for the Advancement of Science for his contributions to research, technology development, and policy work on renewable cellulosic biofuels.

>> The Minerals, Metals & Materials Society has named Professor Ian Baker a fellow for his "pioneering contributions to the characterization of microstructure and mechanical properties of metals and materials."

>> Professor Eugene Santos has been named a fellow of the Institute of Electrical and Electronics Engineers for his "contributions to decision support systems and reasoning under uncertainty." He also received the Best Paper Award at the International Defense and Homeland Security Simulation Workshop last fall for "Modeling and Simulating Dynamic Healthcare Practices," a paper he coauthored with Ph.D. candidates Keumjoo Kim and Fei Yu, Deqing Li Th'11, Elizabeth Jacob '11, project assistant Phoebe Arbogast, and Adjunct Professor Joseph Rosen, M.D.

>> The U.S. military has turned to a team of researchers led by Professor Fridon Shubitidze to help develop technology for tracking buried, unexploded bombs. "The goal is to dig up all the explosives—100 percent—and leave behind 75 percent of the clutter," Shubitidze told *Innovation News Daily* (innovationnewsdaily.com/unexploded-bombs-detector-2415). The Department of Defense gave the team a Project of the Year Award and a $1.4-million grant for a new three-year effort to boost detection of smaller and deeper-buried explosives.

OPPOSITE PAGE: BIGSTOCK. THIS PAGE: PHOTOGRAPH BY KAREN ENDICOTT; ILLUSTRATION BY JAMES O'BRIEN

"If you have all the engineering but you don't have the human part, it doesn't work. That's why this project is an incredible success for our group."

STUDENT PROJECTS

I Want One of Those!

Single-Firefighter Aerial Ladder Operation

EVERY FIRE STATION COULD USE THIS: a sensing device attached to the front of a fire truck ladder that measures distance from a building and relays the information to a computer below. The system makes it possible for a single operator to position a rescue ladder without the use of a spotter, an advantage during smoky, noisy emergencies. The Norwich, Vt., fire department gave it a successful test run at MacLean Engineering Sciences Center at the end of fall term. Inventors Frances Davenport '13, John Mascari '13, Noam Rosenthal '13, Maya Viavant '12, and Brynne Weeks '12 earned the Phillip R. Jackson Award for best performance in ENGS 21: "Introduction to Engineering." Their teaching assistant was Emily Mason-Osann '11.

HUMANITARIAN ENGINEERING

Students Upgrade Hydropower System in Rwanda

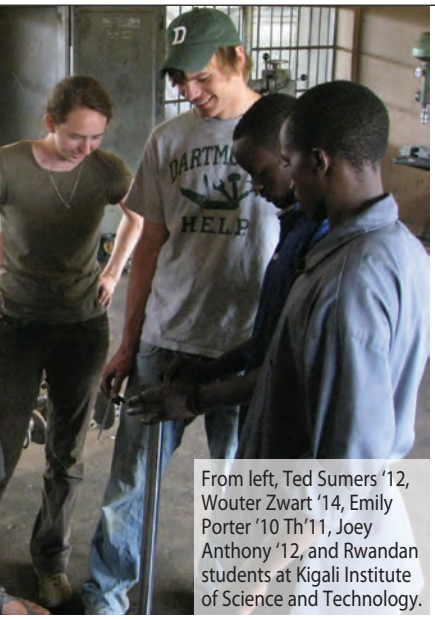
STUDENTS FROM DARTMOUTH Humanitarian Engineering (DHE) returned to Rwanda last summer to continue bringing small-scale hydropower systems to rural villages. Half the group went to Banda to check on the system installed by DHE in 2008. The other half worked in and around Kigali to assess sites for building more hydropower systems so people don't have to walk long distances to charge cell phones and batteries.

Since a previous student-built welded turbine had rusted away, the Banda team replaced it with a cast turbine that was made by Emily Porter '10 Th'11, Caitlin Johnson '10 Th'11, and Nicholas Edwards '10 Th'11 as an ENGS 89/90 design course project. The Banda team built a casing to protect the new turbine and electrical wiring from spray and leakage. The team also wrote a trouble-shooting and procedural manual for the hydropower system, which Kigali Institute of Science and Technology students translated.

Meanwhile, the Kigali team partnered with CARE International to install hydropower systems in other parts of Rwanda. "People recognized CARE International and were happy to see us," says Ted Sumers '12. He and Joey Anthony '12 assessed 30 sites before they earmarked one for a future turbine installation—which won't happen until DHE is certain that the new turbine design in Banda is reliable and maintainable and therefore worth duplicating.

Porter believes that DHE's work in Rwanda has already had an impact. "The fact that we came and did our best and showed our support for them as engineers inspired people," she says. "If you have all the engineering but you don't have the human part, it doesn't work. That's why this project is an incredible success for our group."

She's not the only one who thinks so. DHE's pico-hydro project won one of five Outstanding Student Humanitarian Prizes in the 2011 Institute of Electrical and Electronics Engineers (IEEE) Presidents' Change the World Competition. "Out of 209 entries your project



From left, Ted Sumers '12, Wouter Zwart '14, Emily Porter '10 Th'11, Joey Anthony '12, and Rwandan students at Kigali Institute of Science and Technology.

captured the true spirit of the competition 'to develop a unique solution to a real world problem using engineering, science, computing and leadership skills to benefit humanity,'" the IEEE stated in a letter to DHE. The prize includes $1,000 for future DHE projects.

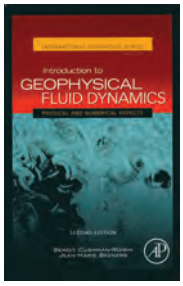
For more about DHE, visit engineering.dartmouth.edu/dhe.

—Annelise Hansen

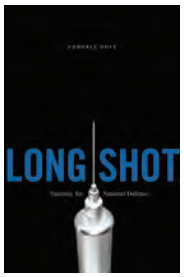
PUBLICATIONS

Faculty Books

>> **Introduction to Geophysical Fluid Dynamics** (Second Edition) by Professor Benoit Cushman-Roisin and Jean-Marie Beckers (Academic Press 2011). The greenhouse effect, global warming, and El Niño are some of the phenomena covered in this introduction to the principles governing atmospheric and oceanic flows and numerical methods for computer simulations. Aimed at students and scientists, the book won the 2010 Wernaers Prize from the National Fund for Scientific Research of Belgium.



>> **Long Shot: Vaccines for National Defense** by Kendall Hoyt (Harvard University Press 2012). Troubled that the rate of vaccination innovation has been falling despite the rise of biotechnology, Hoyt, a Thayer lecturer and Dartmouth Medical School professor, argues that "as man-made biological threats proliferate and new diseases continue to emerge naturally, we urgently need to understand the conditions that foster timely innovation." Her book examines the history of—and today's obstacles to—vaccine development.



Q&A about *Long Shot*
dartmouthengineer.com

ONWARD AND UPWARD

Thayer School is expanding again, adding 3,000 square feet to the third floor of MacLean Engineering Sciences Center. The $1.7-million extension includes offices for 11 faculty members and two administrative assistants.

OPPOSITE PAGE: DOUGLAS FRASER. ABOVE: COURTESY OF DHE. THIS PAGE, BOTTOM: DOUGLAS FRASER

kudos

>> An international consortium led by Thayer Professor Margaret Ackerman and Galit Alter of the Ragon Institute of Massachusetts General Hospital, MIT, and Harvard has been awarded approximately $8 million to develop a new type of HIV vaccine. Funded by Partners Healthcare through a grant from the Bill & Melinda Gates Foundation-sponsored Collaboration for AIDS Vaccine Discovery, the project will focus on inducing production of antibodies that would recruit cells of the innate immune system to block HIV infection soon after viral transmission. The innate immune system is an early-response system that keeps pathogens in check until the more specialized adaptive immune system can respond. Ackerman and Alter have teamed experts from Beth Israel Deaconess Medical Center, Tulane University, University of Oxford, and Germany's Friedrich-Alexander Universität Erlangen-Nürnberg to collaborate on the vaccine.

>>Thayer School, DMS, and injury-prevention company Simbex will investigate brain injuries in contact sports with a $1.3-million grant from the National Operating Committee on Standards for Athletic Equipment. "This is a great opportunity to answer important questions related to the link between head impact biomechanics, brain tissue motion, and neuroimaging findings," says Simbex president and Adjunct Professor Rick Greenwald Th'88, a principal investigator with Professor Songbai Ji.

>>The National Science Foundation's Partnerships for Innovation program has awarded $600,000 in academic support to students in Thayer's Ph.D. Innovation Program, which provides skills for commercializing research findings.

>>The Dartmouth Aires singing group, including engineering major Will Hart '12, finished second on NBC's *The Sing-Off*. Hart discusses links between music and engineering at youtube.com/thayerschool, search dartmouth aire.

Cold Truths

FROM THE MICROSTRUCTURE OF SNOW TO THE MASSIVENESS OF ICE SHEETS, FROM FUNDAMENTAL SCIENCE TO PRACTICAL APPLICATIONS, FROM THAYER'S ICE LAB TO THE EARTH'S POLAR REGIONS, THAYER RESEARCHERS ARE UNCOVERING WHAT SNOW AND ICE REVEAL ABOUT THE WORLD.

BY ELIZABETH KELSEY, LEE MICHAELIDES, AND KAREN ENDICOTT

JOHN SHERMAN

FROZEN ASSETS
Professor Erland Schulson directs Thayer School's ice lab, which houses a unique multi-axial loading system for testing ice.

COLD TRUTH: ICE CREEPS AND FRACTURES

RESEARCHER: PROFESSOR ERLAND SCHULSON

Professor Erland Schulson opened his ice lab in the basement of Cummings Hall 29 years ago to study the basic physics and mechanics of ice. "The object is to understand the physical processes that lead to creep and fracture," says Schulson. "But this is not done in isolation of the world's issues. Issues are driving the work."

Shortly after arriving at Dartmouth, Schulson, who has a doctorate in metallurgical engineering, was intrigued by the work being done a few miles north at the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) and decided he wanted an ice lab at Thayer to do complementary research. Funding from Mobil Oil and the Army helped establish Dartmouth's Ice Research Laboratory (IRL), and a $7.2-million grant from the Navy funded a major upgrade in 1987.

Schulson still directs the IRL, which is currently outfitted with eight custom cold rooms, various presses, a cold-room machine shop, an electron microscope, cameras, an X-ray micro-CT scanner, and a multi-axial loading system that remains unique in the world.

What changed over the years are the issues driving the work. Originally the IRL worked on problems related to oil exploration and national defense. "The Navy was very concerned about submarines surfacing through the ice," says Schulson. Research related to the oil industry, dormant for a while, is back in the forefront. The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) recently awarded the lab $500,000 to study how Arctic sea ice breaks as it flows and pushes against engineered structures. Through micromechanical modeling and experimentation, the IRL will identify physical characteristics of ice conditions and quantify the rate at which ice becomes fractured and weakened. "The U.S. Geological Survey estimates that about 13 percent of the world's undiscovered oil and about 30 percent of the world's undiscovered gas are located above the Arctic Circle—most of which is beneath the Arctic Ocean. The ice forms a thick 1–3-meter mobile cover on the ocean, and therein lies the challenge to recovery," says Schulson.

Part of his research focuses on climate change. Given that polar regions are canaries in the global climate coal mine, scientists want to know what will happen as polar ice sheets melt and crack. Climate-change questions also circle

back to the work done for BOEMRE: as ice fractures, what will be the impact on the industrial infrastructure?

Schulson's ice expertise has interested NASA over the years. After the 2003 Space Shuttle *Columbia* disaster, NASA consulted Schulson about ways to prevent ice from building up on the external fuel tanks. Now the space agency is funding Schulson to study the icy surfaces of Europa, Jupiter's largest moon, and Enceladus, the second moon in the Saturn system.

It seems amazing that research done on ice blocks at Thayer applies to the ice crust of Europa some 367 million miles from earth. But comparing photos of ice in his lab, Landsat satellite photos of Arctic ice, and photos of Europa, Schulson sees similar fracture patterns. His conclusion: "Patterns of fracture are independent of scale."

As with many emerging areas of knowledge, not everyone agrees with Schulson. "Some geophysicists are skeptics," he says.

But NASA wants to learn more about the ice on Europa because "the conditions are there for a form of life," says Schulson. "NASA has engaged the IRL to get more information about the creeping, fracturing, and frictional sliding of ice because underneath the ice there may be an ocean. And where there is an ocean, the potential exists for a form of life."

Schulson, coauthor with Paul Duval of *Creep and Fracture of Ice* (Cambridge University Press 2009), the first complete account of these mechanical properties, brings his appreciation for ice into the classroom. "Ice is a wonderful teacher," he says. "Ice is a transparent material, and you can see cracks in ice, whereas you can't see cracks in other brittle materials. We can understand ice and relate it to other materials, like rock." (In fact, the National Science Foundation is funding Schulson and Dartmouth earth sciences professor Carl Renshaw to study faulting in ice for insight into how faults form and earthquakes develop in the earth's crust.)

"For someone learning about materials science, the clarity of ice allows students to see inside ice as it deforms under pressure," says Schulson. "This has been one of the most intellectually satisfying parts of this whole thing—to be able to relate what we see in ice to other materials and then what we see in ice in the lab to what we see in ice in the field."

—Lee Michaelides

COLD TRUTH: ICE RESEMBLES METALS

RESEARCHER: PROFESSOR IAN BAKER

Professor Ian Baker doesn't mind admitting that he fell into ice work at Thayer. "I started reading about dislocations in ice really because of Erland Schulson's work here, and then I got interested in this question about how ice deforms on a fundamental level," he says. "Nobody has answered it yet. Nobody knows for sure."

Baker applied what he did know—the physics of various metals and intermetallic compounds—to ice.

He began by using transmission electron microscopy to study how ice changes over time. Despite using liquid nitrogen (a frigid -346ºF) to keep the ice from melting, Baker encountered a technical problem. "Ice suffers tremendous beam damage in the electron microscope," he says. "Ionization damage breaks the bonds in the ice, and the bonds reorient themselves. You end up with voids that form very rapidly in the ice and change the defect structure."

Next he tried synchrotron X-ray topography. "The X-ray technique images the defects like the electron microscopy, but it doesn't use electrons, so it's less of a problem. You do need a synchrotron, so I used the Brookhaven National Laboratory's synchrotron," he says. "We could do real-time experiments, deforming the ice and looking at how the defects moved in the ice. That led me to look at the effect of impurities on the dislocations' motion. We added dopants, like hydrofluoric acid and hydrochloric acid, to pure ice to see how they affected the velocity at which these defects moved."

He moved on to studying the effects of an impurity that abounds in nature: sulfuric acid from decomposition, volcanic eruptions, and other phenomena. "It turns out that sulfuric acid has a really dramatic effect. It makes ice softer and more ductile, which means you can deform it more before it cracks," Baker says. "Then the question was: We can show this in the lab, but does this have any relevance to ice out in nature?"

For answers he looked at ice cores. "Natural ice consists of individual crystals that make up a big block of ice. A lot of people think that the impurities end up in the interfaces between the crystals. We found that the impurities are both in the interfaces and in the crystal itself," he says, giving credit to Daniel Cullen '86 Th'02, who was then his graduate student and is now a lab manager at Thayer.

The work necessitated creative lab techniques, including new ways of preparing ice

IMAGE MAKERS
Professor Ian Baker and Ph.D. student Kaitlin Keegan use a technique Baker developed to scan snow and and ice crystals without damaging them.

JOHN SHERMAN

specimens for scanning electron microscopy and using a confocal scanning optical microscope. "Instead of shining a light over something, you scan a beam over the surface. At each point you can get a signal; you can get the Raman spectrum from it so you can determine the impurities in the ice," Baker says. "Later we were able to get the electron backscatter patterns from ice. We were the first people to do that."

The work put Baker's ice lab on the map. "We've got a lab that can characterize ice microstructurally in the same way that people can do metals. We're pretty much the only lab in the world that does that," he says. "We've had a lot of collaborators in the last couple of years who come along because we can do things that nobody else has got that setup for."

A member of the ice core advisory group for the National Ice Core Laboratory in Denver, Baker is now studying ice from Greenland to learn more about the microstructural changes that occur when ice sheets flow. He's also collaborating with Professor Mary Albert on gases in firn, old snow that hasn't become ice. "People look at trapped gases to determine past climate. One question is: When were those gases actually trapped?" he says. "Pores are open to the atmosphere to quite a depth, so as the wind blows over the top of the ice sheet, the air goes into these pores and exchanges with what's in there, so the pores generally are much younger than the ice surrounding them. The pores are not all closed off at the same time. Some are probably closed off close to the surface and some are closed off 70 meters down, so we're trying to figure that out by relating permeability measurements to the microstructure."

Meanwhile, Baker works on metals as well, including iron oxide nanoparticles for use in cancer treatments and magnetic materials for energy applications.

There's no disconnect for him. "When I work on ice or snow I come at it from a materials scientist point of view," he says. "I look at things at the microscopic level to understand what's going on. The metallurgical literature feeds into a lot of the behavior. The details are different, but the overall concepts are similar."

—Karen Endicott

COLD TRUTH: ICE RECORDS CLIMATES

RESEARCHER: PROFESSOR MARY ALBERT

To understand climate conditions today, scientists can measure carbon dioxide, methane, and other gases in the atmosphere. To know what the earth's climate was like thousands of years ago, researchers can consult a natural archive: air bubbles trapped in polar ice sheets.

Professor Mary Albert studies those ancient gases in ice cores from the Antarctic and Greenland ice sheets. "I'm really interested in how we can decode the climate record that is in ice sheets to learn about atmospheric gases and their role of abrupt climate change from the past," she says. "We can better understand the present if we know what happened naturally in the past."

Albert, executive director of the U.S. Ice Drilling Program Office, does a lot of her work on firn, accumulations of old snow. She focuses on how the physical aspects of firn affect gas trapping. "The entrapment process affects what gases get trapped. How air mixes depends on the structure of firn," she says. "Understanding the snow physics and the mass transfer and the chemical transport allows us to figure out how the gases were trapped and what the gas concentrations mean."

When Albert and her students drill an ice core, they look for a site that is so cold that it is dry, has a lot of snow accumulation, and has the atmospheric circulation patterns to answer the problems they are trying to solve. "The atmospheric pattern from North America goes over Greenland," she explains, "so the Greenland ice sheet is a good indicator of chemical pollution from North America and from China. For gases that are globally mixed, we might go to Antarctica for carbon dioxide, for example, for records we know are in the atmosphere."

The depth of the drilling also depends on the question being asked. If the questions are associated with industry, Albert and her team only need to drill 100 to 200 meters. If they want to know what happened at the end of the last ice age, they must drill down two miles. "The oldest ice we've had in an ice core so far is 800,000 years," she says. "But we think there are other sites in Antarctica that go back a million years."

After Albert and her team drill ice cores—samples one meter long and 10–20 centimeters across—they bring them back to CRREL's cold rooms for analysis. (Albert previously worked at CRREL on snow physics and modeling of snow for army applications.) They view the cores on a light table to detect annual layering. They also measure the layers' density and permeability, assessing the interconnected pore space in the snow and firn, which is related to the transport of gases. Her group also does gas diffusion experiments and microstructure analysis at Thayer. Albert's partners at other universities measure the content of the bubbles for carbon dioxide and mercury levels. Interpreting ice cores "is a team effort because it's a complicated problem," Albert says.

"It's really amazing that snow and ice that falls in the polar regions in Greenland and Antarctica can serve as an archive of climate for over hundreds of thousands of years," Albert says. "The snow and ice on the polar ice sheets give us the highest-resolution climate record that exists." *—Elizabeth Kelsey*

CORE FOCUS
Professor Mary Albert summers in Greenland to drill ice cores.

COLD TRUTH: ICE AMPLIFIES CLIMATE CHANGE

RESEARCHER: PROFESSOR DONALD PEROVICH

Donald Perovich's 32 years of Arctic ice study have taken him cruising on U.S. Coast Guard icebreaker ships for weeks on end in the Beaufort Sea, diving under sea ice, and walking on ice floes.

Perovich, a glaciologist who works at CRREL and has been a longtime visiting professor at Thayer, studies sea ice as both an indicator and a potential amplifier of climate change.

Sea ice cover is a strong proxy indicator of climate change, Perovich says, "because it covers millions of square kilometers—but it's thin. In a warming climate we'd expect the ice to retreat. In a cooling climate we'd expect it to advance. By keeping track of how much area is covered by sea ice, month by month, year by year, we can get an idea if there's a net warming or net cooling in the Arctic."

For the past 30 years, satellites have monitored the sea and can show which areas are composed of ice or water. Predictably, Arctic ice expands in the winter, covering around 15-million square kilometers and retreats in the summer, shrinking to 5–8-million square kilometers.

But Perovich and his colleagues aren't interested in the change of seasons; instead, they want to know how the amount of ice has changed over time.

"The satellite data tell a really great story," he says. "If we look at the overall trend, there's been a decline. And what makes it really interesting is that the decline is accelerating."

The acceleration doesn't mean that the ice reliably decreases each year; just like harsh New England winters, Perovich points out, there can be variations from year to year. In 1980, Arctic sea ice covered 7.8-million square kilometers, roughly the size of the continental United States. In 2007 Arctic sea ice was at a record low of 4.2-million square kilometers. "In 2007 it was as though the entire U.S. east of the Mississippi had melted away along with all the states from Minnesota south to Louisiana, plus North Dakota and part of South Dakota," says Perovich. "That's a really strong signal that the area covered by ice is decreasing."

And of the ice that does remain, he says, records show that it is getting thinner. "As an indicator, the sea ice is sending a pretty strong signal that there's warming going on in the Arctic," he says.

Perovich explains that sea ice is also an amplifier of climate change through a process known as albedo feedback: the amount of light reflected off its surface. He studies ice-albedo feedback through models, satellite data, and field experiments in the Arctic, where he walks on ice floes to take measurements. "You get a detector, you measure how much sunlight is coming in, you measure how much is reflected, and you divide. It's important because the driving force of the earth's climate is the sun, and how much of that sunlight is reflected by the surface, the albedo, is the key parameter in climate change."

Snow-covered ice reflects 85 percent of the sunlight, Perovich explains, but melting ice results in open ocean that reflects only seven percent of the sunlight. "You go from a very good reflector to a very poor reflector," he says. "The ocean absorbs more sunlight, more water gets heated, more ice is melted, the albedo lowers, and you get a feedback system that is really significant."

Perovich, whose projects are funded by the National Science Foundation, NASA, and the National Oceanic and Atmospheric Administration, says, "The polar regions really give a lot of insight into climate change. They offer a prism to the past, present, and future. My ultimate goal is to understand climate feedback processes, because what happens in the Arctic doesn't necessarily stay in the Arctic."

—Elizabeth Kelsey

SUN AND SEA ICE
Professor Donald Perovich measures ice-albedo feedback in the Arctic to assess rates of climate change.

OPPOSITE PAGE: COURTESY OF MARY ALBERT. THIS PAGE: COURTESY OF DONALD PEROVICH

COLD TRUTH: ROBOTS MAP CREVASSES

RESEARCHER: PROFESSOR LAURA RAY

ROBOT ON ICE
Professor James Lever tests Yeti's crevasse-detection abilities in Antarctica.

Enabling technology. That's the key to understanding why Professor Laura Ray started thinking about robots for polar environments in 2004. Previously she did pure research on artificial intelligence for robots. Then, she says, Thayer colleague Mark Lessard brought her an idea for "a solar-powered rover that could be on the ice sheet all summer under its own power and carry instruments for what others want to study." Lessard, now a professor at the University of New Hampshire, wanted to gather data for studies of the ionosphere and the magnetosphere. Ray got interested in engineering a robot that could do the job.

"They do their work in Antarctica where the observation points are so few and far between it's like having the biggest lake in the world and putting a thermometer in one place and saying what the temperature is," says Ray. "You can't just do that."

You can, however, build a robot to do the job. She secured a National Science Foundation grant to develop a proof of concept for a robot that could rove the ice sheet 24/7. Ray and Thayer Adjunct Professor James Lever, a mechanical engineer at CRREL, concluded that they could build a prototype for about $15,000.

The result—known as the Cool Robot—looks like a box on wheels. "For the Cool Robot our ultimate goal is to demonstrate that it can go several hundred kilometers trouble-free and collect scientific data that are useful. The roving scientific platform would be a significant achievement," says Ray.

Ray's lab built a second robot, called Yeti, in conjunction with CRREL, to negotiate around crevasses, a danger to anyone working on ice sheets. Traveling in front of a convoy, Yeti takes the burden off human interpretation of ground penetrating radar (GPR) measurements. "GPR is almost like taking an X-ray of the ground. A radar operator working as long as 10 hours per shift must interpret the radar," says Ray. If the operator detects danger ahead, "you have a couple of seconds to stop the vehicle."

But a 10-hour shift is nothing for a robot. It never gets tired. Moreover, when Yeti spots a crevasse, its software can direct it to execute a series of turns to map the direction of the crevasse.

Lever wasn't available to speak with *Dartmouth Engineer* about Yeti because he and the robot were busy surveying the old South Pole Station. The abandoned station is covered with 30 feet of snow and people now need to traverse it. Lever and Yeti are mapping the hollow spaces under the snow. The Dartmouth team was called after another survey team working with a PistenBully tractor found a void by falling into it. The situation then got worse. "They sent another vehicle out to rescue it, and that one fell in," says Ray. "They said, 'We need another way. Can we borrow your robot?' "

Yeti has also gained attention in Greenland. Last spring *Popular Mechanics* sent a writer to the Greenland Summit Station to watch the robot being tested. The magazine ran a story about Yeti in July and posted video of the robot to its website. In August Cool Robot and Yeti both made it into *The New York Times*.

Ironically, Ray herself hasn't seen either robot in action in either Greenland or Antarctica. "I have four kids at home. It is a little hard to get away for three or four weeks. Someday maybe," she says.

This spring Yeti heads to Greenland again with the National Science Foundation's Greenland Inland Traverse team to ensure the team's safety and map crevasses. Follow Yeti's progress at yetibot.blogspot.com.

—Lee Michaelides

ON THE ANTARCTIC MAP

Two sites in Antarctica officially bear the names of members of the Thayer community.

› MOUNT ARCONE (81°43'S, 161°2'E), a horseshoe-shaped mountain in the Nash Range, honors Steven Arcone Th'77 for the ground-penetrating radar (GPR) and airborne radar surveys he conducted during six seasons on the ice. Having recorded and interpreted thousands of kilometers of GPR data, Arcone, a geophysicist at CRREL and former Thayer adjunct professor, has not only kept research convoys from falling into crevasses, but has also published numerous papers on the firn and ice stratigraphy GPR reveals.

› ACKLEY POINT (77°47'S, 166°55'E), an ice-covered point near McMurdo Sound, honors Stephen Ackley, an adjunct professor at Thayer from 1985 to 1999, for his extensive work on sea ice in McMurdo Sound and the Southern Ocean. The former CRREL researcher is a now a professor at the University of Texas at San Antonio.

ICEBREAKER
Professor Victor Petrenko develops technologies for changing the bonds between ice and other materials.

THIS PAGE: PHOTOGRAPH COURTESY OF STEVEN ARCONE; MAP COURTESY OF GOOGLE EARTH. OPPOSITE PAGE: CHRIS MILLIMAN

COLD TRUTH: ELECTRICITY FLIPS ICE'S GRIP

RESEARCHER: PROFESSOR VICTOR PETRENKO

"I'm a semiconductor physicist, not an ice researcher," says Professor Victor Petrenko. That statement is something of a surprise coming from the coauthor of *Physics of Ice*, the authoritative text on the subject.

Petrenko entered the field of ice research by coincidence 25 years ago. He was working at the University of Birmingham in England while on sabbatical from the Soviet Academy of Sciences. He saw a door marked "Ice Physics Lab" and opened it. Inside he met ice researcher John Glen. Glen told him three things about ice that changed Petrenko's career. First, ice is a semiconductor. Second, ice is a protonic semiconductor—protons, not neutrons, transport electrical current. Finally, and this was the game changer for Petrenko—the physics of ice, unlike the semiconductors he had been working on in Moscow, was still being discovered. Petrenko wanted in on the new discoveries.

Making the switch, however, wasn't easy or quick under the Soviet system. When Petrenko returned from sabbatical he asked his lab director about shifting his focus to ice. "He suggested I apply ice to my head," Petrenko recalls. "He said 'Victor you are crazy. You want to trade the wonderful semiconductor physics for that dirty stuff—ice?' " Nevertheless, Petrenko spent 15 years working in both fields.

But that was then. Today the science of ice physics is a mature subject in part because of discoveries made by Petrenko and former Thayer researchers Valeri Kozlyuk, Michiya Higa, and Cheng Chen. Because of that, Petrenko has turned his research toward practical applications. He found that by applying short pulses of electricity across an ice-coated surface it is possible to break the bond between the ice and whatever material it covers. The process, which Petrenko calls pulse electrothermal de-icing (PETD), can be used to de-ice car windshields, airplanes, ships, power lines, bridges, and many other structures.

There's a complementary aspect to Petrenko's de-icing research. By reversing the polarity of the electrical current, the grip between ice and the material gets stronger. It is possible to make shoes that won't slip on ice, skis with brakes, and car tires that can handle ice as if it were dry pavement.

Petrenko's work has yielded 60 domestic and international patents, and 100 more are in the pipeline. Research funding has come from the military, the National Science Foundation and Fortune 500 companies such as BFGoodrich and GE.

Some of Petrenko's inventions have moved out of his lab and into the field for trials. Tests for de-icing power lines are run in China because that country has two key elements: a problem with ice on power lines and a state-of-the-art power grid that enables PETD technology, something the older U.S. power grid can't handle. Most recently, Petrenko's work has been in refrigeration, a technology that has seen only incremental advancement in the last 100 years. Petrenko estimates that his de-icing technology can cut the electric bill of commercial users by 40 percent. Since Petrenko's system provides uninterrupted cooling rather than cycling between warmth and cold, residential users would benefit from better food storage as well as lower electrical costs.

Petrenko sees a hot future for de-icing technology. "The applications based on ice physics have not been finished," he says.

—Lee Michaelides

GOOD SP

MASTER STROKE
Former Olympic rower Judy Geer prepares the way for a new breed of athlete at Craftsbury Outdoor Center.

PHOTOGRAPHS BY JOHN SHERMAN

ORTS

JUDY GEER ’75 TH’83 AND HER FAMILY COMBINE NATIONAL-LEVEL ATHLETIC TRAINING WITH SUSTAINABLE LIVING PRACTICES.

BY KRISTEN LAINE

ENERGIZER
Geer encourages athletes to pursue environmental as well as personal bests.

IN THE SUMMER OF 2009, a half-dozen elite collegiate cross-country skiers embarked on the sort of grueling training regimen required of any Olympic hopeful. In two- and three-a-day workouts, the young men and women cranked through five hours of roller-skiing on mountain roads, double-poled sprints on a Ski-Erg machine, and had their maximal oxygen consumption tested by their no-nonsense Bulgarian trainer. Among them, they'd captained teams, earned top-10 finishes in Eastern Intercollegiate Ski Association races, stood on medal stands at winter carnivals, been named NCAA All-American. None wanted to stop there, though. All had raised their hopes higher: the World Cup in 2012, the Winter Olympics in Sochi in 2014.

They were committed in ways that went beyond skiing. Their base was Craftsbury Outdoor Center, a rough-hewn former boys' academy along the shores of Lake Hosmer in Vermont's Northeast Kingdom. When they weren't training, members of the ski team could be found drawing up plans for a commercial-size composter or meeting with wildlife managers to protect a critical habitat corridor. They called themselves the Green Racing Project. They'd come to Craftsbury for intensive training and an equally intensive internship in environmental stewardship. In the world of driven, focused, national-level competitors, they represented a unique take on an emerging concept: the green athlete.

The visionaries behind the project, Judy Geer '75 Th'83 and her husband Dick Dreissigacker, had bought the outdoor center in 2008 through their family foundation, turned it into a nonprofit, and immediately expanded its purpose. (The nonprofit status "allows us to be more driven by mission" yet still follow a strong business plan, says Geer.) To its well-known summer rowing camps and annual ski marathon, Geer and Dreissigacker added a threefold mission of nurturing lifelong sports, community, and the environment. The Green Racing Project was their first attempt at that kind of cross-pollination.

Geer and Dreissigacker understood that athletes in endurance sports such as rowing and Nordic skiing rarely reach their full potential before their late 20s. They had been introduced to the competitive world of Nordic skiing while their three children raced in the

Geer with son Ethan and daughter Hannah

junior program at Craftsbury. And both had been Olympic rowers. Yet after college, they knew, little infrastructure in the U.S. supported full-time training. Geer, in particular, who had been a pioneer in women's rowing and a three-time Olympian, knew how difficult it was to piece together a life that had to include both work and training. She and Dreissigacker believed their foundation could fill the gap—provide room and board, pay for instruction, travel expenses, even health insurance—and help develop great athletes. More than that: a mission-driven program could help develop great citizens.

The couple were no strangers to innovating. Dreissigacker and his brother, years earlier, had taken bicycle parts and metal frames and fashioned a machine called an ergometer that simulated the slide and pull of a rowing shell in water. Geer joined them as their company's sixth employee and, using her Thayer master of engineering degree, helped develop the business into the world's premier provider of rowing exercise equipment. They called the company Concept2, a name that reflected its philosophy. In engineering, rarely is the first idea the final idea: "Concept 1" can always be improved and refined before fully taking shape.

They carried that philosophy over to their family life, too. Geer and Dreissigacker didn't talk about their hands-on, creative problem-solving approach that much, or even try to demonstrate it, but Hannah '09 Th'11, Emily '11, and Ethan Dreissigacker '13 absorbed it anyway. Ethan, an engineering major, lists some of the lessons he picked up from his parents: "not settling for the first idea that comes to mind, not making assumptions or jumping to conclusions, thinking outside the box, looking for simple, efficient, and sustainable solutions."

The Green Racing Project is a family case in point. Hannah, a committed environmentalist who had just graduated with a combined major in engineering and studio art and wanted to compete internationally as a cross-country skier, had helped form her parents' ideas for the new program. For her contribution to the team's sustainability goals, she analyzed the team's carbon footprint—the impact of their travel to ski races, of applying petroleum-based ski waxes to the bases of their skis—and catalogued ways to offset those impacts. Ethan, also a skier, continued working with his father on a woodchip-burning furnace for the family home, an outgrowth of a high school project on biomass energy.

"THE CHALLENGES FACING OUR WORLD ARE WAY TOO BIG TO BITE OFF," GEER SAYS. THE WORK GOING ON AT CRAFTSBURY FELT LIKE "THE RIGHT SIZE."

Getting the Green Racing Project underway, Geer, the team's employer and mentor, occupied a role familiar to her from Concept2. She served as translator between problem and solution, between analysis and the messiness of getting something done. Racing season began, and the big composter existed only in blueprint. Grappling with the huge carbon footprint of flying to the national championships in Alaska, the team decided to send only their coach and three skiers. If the skiers needed any reminder of the importance of their mission, the earliest spring on record in the Northeast Kingdom forced them to cancel a final weekend of races in which they'd also planned a talk by global-warming activist and writer Bill McKibben.

Through all the delays and disappointments, Geer could see the team working through the iterative process, learning how to identify problems, then improving the solutions. She recognized that, even at its early stage, the program gave her "a way to do more than I ever could on my own," solving more problems and reaching more people on a community and regional scale. "The challenges facing our world are way too big to bite off," she says. The work going on at Craftsbury felt like "the right size."

By 2011, the Green Racing Project was a regular fixture on the national and international ski-racing circuit. GRP skiers—including Susan Dunklee '08 and Ida Sargent '11—earned spots on national and World Cup teams. Hannah made the national biathlon team in 2010 and competed at the U-26 World Championships in Estonia. Ethan, still a member of the Dartmouth ski team, trained with the Craftsbury skiers on the way to earning a spot on the 2012 U.S. Junior Championship Biathlon Team.

Craftsbury's rowing program has also produced results. Half of the rowers from the small-boat training program, including Emily Dreissigacker, made the 2011 National Under-23 Rowing Team.

The World Cup and the Olympics are still out there, still possibilities.

But when Geer says, "They've picked up speed," she means that the GRP's environmental work has gained momentum. Ski racers with forestry degrees work on the center's trails. The team broke ground on the composting project and presented a case for improving the energy efficiency of the center's buildings to Geer and Dreissigacker. Hannah's update of the team's carbon footprint spreadsheet helped frame the decision to install snowmaking equipment for the center's trails. Ethan, who had conducted a thermodynamic analysis of his woodchip furnace in an independent study at Thayer, helped tweak the snow-delivery system as yet another winter got off to an unseasonably warm start.

Five-hour roller-ski loops around Lake Willoughby continue as before. The center sometimes feels like a European Nordic village, with its state-of-the-art systems—or, when sustainability projects are underway, an environmental institute. Looking closely at some of the hands-on problem solvers, you might think you are also watching a family business, and a family mission, taking shape.

Kristen Laine has written about environmental issues for *Yankee, AMC Outdoors*, and other publications.

COOL COMP

RECENT GRADS BRING NERVE AND VERVE TO THEIR STARTUP

YOUNG ALUMNI ARE FOUNDING COMPANIES THAT OFFER INNOVATIVE SOLUTIONS TO A RANGE OF CHALLENGES, FROM SHRINKING UTILITY BILLS TO PROVIDING EMERGENCY LIGHTING, FROM RECYCLING CARBON DIOXIDE TO STORING WIND AND SOLAR ENERGY. THEY ARE DELIVERING HIGH-PERFORMANCE ELECTRIC MOTORCYCLES, EXPOSING COUNTERFEIT PILLS, AND CHANGING THE WAY WE PURCHASE ART.

"TOO MANY GOOD IDEAS THAT HAVE REAL POTENTIAL FOR HELPING PEOPLE END UP ON A PIECE OF PAPER IN A LIBRARY," SAYS ASHIFI GOGO TH'10, THAYER'S FIRST PH.D. INNOVATION PROGRAM GRADUATE AND FOUNDER OF THE DRUG-AUTHENTICATION COMPANY SPROXIL.

IN THE FOLLOWING, GOGO AND OTHER ALUMNI TELL HOW THEY TURNED THEIR GOOD IDEAS INTO GREAT COMPANIES.

BY ANNA FIORENTINO

ANIES

VENTURES.

COURTESY OF BRD MOTORCYCLES

CHARGED UP
Marc Fenigstein '01 Th'04 wants to make BRD Motorcycles the Honda of the 21st century.

BRD MOTORCYCLES

Cofounders: Marc Fenigstein '01 Th'04
David Drennan Th'09
faster-faster.com

Marc Fenigstein '01 Th'04 compares the moment he first rode the BRD motorcycle prototype to the first time he rode shaped skis instead of straight skis, or used an Apple iPod instead of an MP3 player. "I knew on paper that it was extremely capable. What completely surprised me was just how easy it was," he says.

One taste of the bike's combination of performance and design erased his initial concern that riders weren't ready for a high-performance—and quiet—electric motorcycle.

"All great motorsports brands, from Honda to Porsche, were built on high-performance racing first, and eventually they reach beginners," says Fenigstein, BRD's chief executive officer. "There is a $50 billion market of existing riders just waiting to transition to electric motors."

In August 2011, BRD Motorcycles released the RedShift, a second-generation fully functioning prototype, now in field testing. The RedShift's instant throttle response and flat, endless torque curve makes the bike easy to ride and fast—an expected 90 miles per hour, which matches the most powerful of gas equivalents. And at about 250 pounds, this 40-horsepower bike weighs about 150 pounds less than most street legal bikes. "It will have the power and the battery capacity to outperform most of its gas-powered equivalents," says Fenigstein.

Based in San Francisco, BRD Motorcycles has already received more than 700 pre-order inquiries, and plans to be in production by late 2012 with a 2013 model. Several motorcycle dealerships are already lined up to sell the bikes. With a price tag of approximately $15,000, the RedShift MX and SM models cost more upfront than most gas bikes, but less once additional expenses for oil changes, maintenance, and gas are factored into the equation. According to Fenigstein, the bike has piqued the interest of top-tier investors, including Mike Donoughe, formerly of Tesla Motors and now chief operating officer at electric vehicle startup Bright Automotive, and advisors from Ducati motorcycles and Google.

BRD Motorcycles was the brainchild of Jeff Sand and Derek Dorresteyn, who approached Fenigstein in 2009 while he was at frog design in San Francisco. Fenigstein was an established product design consultant, with mechanical engineering and startup experience. "Derek and Jeff were looking for someone to evaluate their design and create a viable business, someone who knew outdoor and action sports as well as design and engineering," says Fenigstein.

By the time Sand, now chief design officer, got the ball rolling with BRD Motorcycles, he'd already invented Switch step-in snowboard bindings, created the Sutro Vision line of eyewear, and designed furniture featured in the San Francisco Museum of Modern Art. Dorresteyn, chief technology officer and a former professional motorcycle racer, owned and operated a high-end machine shop manufacturing everything from fine architectural pieces to industrial mining equipment. Mechanical engineer David Drennan Th'09, who built hybrid race cars for Dartmouth Formula Racing during his Thayer Master of Engineering Management studies, became the fourth cofounder.

"We expected a backlash because it wasn't a loud, gas bike, but there has been an overwhelming positive response not just to the bike's aesthetic but to the bike itself," says Fenigstein.

With the goal of producing bikes that are faster and more powerful than anything else on the market, Fenigstein eyes a global road. "We're looking to build the next great motorcycle company, to become the Honda of the 21st century," he says.

LUMINAID

Cofounder: Anna Stork '08
luminaidlab.com

A student strains to see her schoolwork inside a dim Guatemalan classroom. A hiker runs out of flashlight batteries on the Appalachian Trail. Both scenarios could benefit from an inexpensive, compact, solar solution: a hand-held inflatable, rechargeable LED lamp called LuminAID.

Anna Stork '08 and Andrea Sreshta developed the LuminAID solar light prototype while classmates at Columbia University's Graduate School of Architecture. Designed in the wake of the Haitian earthquake, LuminAID is the world's first inflatable solar light. Waterproof and easy to ship, it lasts longer than a battery-powered flashlight, is safer than a kerosene lamp, and doesn't require expensive rechargeable batteries.

"At the time there was a lot of clean water, shelter, and food being shipped to Haiti, but most people in informal settlements were without a light source," says Stork. "There were many cases of rape and kidnapping because it was so densely populated. We saw a need for a portable light source to improve safety of people living in tents."

Stork and Sreshta's LuminAID Lab has since received more than 2,000 pledges to donate the solar lights to community partners in Haiti and also Nigeria, Peru, Ghana, India, and Bolivia, and pre-sold about 1,000 additional lights. The simple solar technology earned LuminAID awards and startup cash from business competitions, including the WalMart/Net Impact Better Living Business Plan Challenge and the Global Social Venture Competition.

LIGHT TOUCH
Anna Stork '08 designed LuminAID to be a compact inflatable solar lantern.

"It's just a solar panel with a thin rechargeable battery connected to LED lights, with the circuit integrated into the plastic. The innovation is the combination of the solar with the inflatable," says Stork, who filed for a full patent under the offices of Columbia Technology Ventures.

LuminAID produces four to six hours of light and can be recharged in five to six hours. The device can be recharged up to 800 times and has a total shelf life of two to three years, says Stork, who first began thinking about merging sustainability and design while at Thayer.

"I took away a lot from my course in materials science at Thayer. I also learned about solar and renewable energy," says Stork, who incorporated LuminAID Lab in 2011 with the intent of providing an immediate lighting solution for individuals in regions affected by natural disasters and wars. Her goal has since expanded as more and more hikers and campers want the solar lights for outdoor recreational use.

The LuminAID Lab "Give Light, Get Light" campaign on the crowd-funding site IndieGoGo, which was launched in late 2011, combines the two uses. For $25, customers pre-buy one light and send a gift of another light to a partner foundation in a developing country. Another LuminAID Lab partner, Solar Sister, equips budding female entrepreneurs with the marketing and sales skills

REALITY CHECK
Ashifi Gogo Th'10 founded Sproxil so people can tell if medicines are real or fake.

to sell LuminAID solar lights in Uganda. Elephant Energy follows a similar model in Namibia, and Pencils of Promise is outfitting schools with LuminAID lights in Laos, Nicaragua, and Guatemala.

According to Stork, the two-for-one approach makes sense. "We're combining smart design with simple solar technology to provide solutions for developing countries as well as for other markets," she says.

LIQUID LIGHT

Cofounder: Kyle Teamey '98
liquidlightinc.com

As entrepreneur-in-residence at Redpoint Ventures, Kyle Teamey '98 wanted to find a way to make fuels from renewable energy without relying on biological feedstocks. In 2009 he cofounded Liquid Light, an early-stage startup based on discoveries in the fields of catalysis and artificial photosynthesis stemming from research by Emily Cole in the lab of Professor Andrew Bocarsly at Princeton University. Liquid Light licensed the technology and began research and development in Central New Jersey with Bocarsly, Cole, and nine other scientists from around the world.

Liquid Light uses energy from light or any electric power source to convert waste carbon dioxide into industrial chemicals and transportation fuels, in a process similar to artificial photosynthesis or reverse combustion. While the company won't be doing large-scale production for several years, it has made a handful of key breakthroughs in catalysis that can eventually lead to improving energy security and reducing oil imports and greenhouse gas emissions.

Liquid Light has successfully made 20 household chemicals from carbon dioxide, including butanol, which contains four carbon atoms. According to Teamey, other companies pursuing artificial photosynthetic routes have generally only been able to make single carbon atom products.

"Our catalysts allow us to lower the activation energy for carbon dioxide reduction and initiate it very near the thermodynamically reversible potential. This gives us a huge advantage in energy consumption," says Teamey, who is president of the company. "We've been able to make a lot of basic building blocks for doing industrial chemistry."

As an undergraduate, Teamey broke into lab work at Thayer under Professor Lee Lynd, whose research on cellulosic ethanol launched the renewable fuels company Mascoma Corporation. "Even though I was researching a biological process, I was able to do chemistry and biochemistry that gave me a feel for how labs operate," says Teamey, who also holds a master's in finance and energy policy from Johns Hopkins University. "The hands-on experience I received at Dartmouth was hugely important to my career."

That career includes six years as an active duty officer for the army, with a year in Iraq. He served as director of renewable energy at Dunia Frontier Consultants, cofounded the Switch Renewable Energy company, and became a consultant for the Defense Advanced Research Projects Agency (DARPA). "My experience with DARPA taught me there are a lot of interesting technologies that have not yet found commercial application for one reason or another," says Teamey.

The DARPA approach helped Teamey create Liquid Light. "Instead of waiting for a startup to come to us like most venture capitalist firms, like DARPA we went looking for scientists to solve a technical challenge," says Teamey. "A great team is often one of the key missing pieces for solving very hard problems in science."

SPROXIL

Founder: Ashifi Gogo Th'10
sproxil.com

In the United States you might end up with a knock-off bag or a non-organic piece of fruit, but in developing nations, the implications of purchasing a counterfeit product are often much more grave.

"The growing trade in fake pharmaceuticals is of great concern in the developing world because of the large impact it has on human life," says Ashifi Gogo Th'10, the first graduate of Thayer's Ph.D. Innovation Program. More than 700,000 deaths a year result from fake and substandard tuberculosis and malaria drugs alone.

ABOVE: COURTESY OF ANNA STORK. RIGHT: COURTESY OF ASHIFI GOGO

While at Thayer, Gogo says, he was shocked to find out that the most populous city in Africa—Lagos, Nigeria—reported that 80 percent of prescription drugs available in 2003 were fake. He set up Sproxil to combat counterfeiting through a cell phone-based product verification service. Thousands of people are already using this technology to verify the authenticity of their drugs.

"Sproxil empowers consumers to make smart decisions so they don't buy fake pills unknowingly," he says. "Our goal is to reestablish trust between patients and their pharmacists and make counterfeiting more challenging for rogue retailers."

In 2010 Sproxil became the first large-scale, crowd-sourced, anti-counterfeiting text message system deployed in Africa. When people buy medications, they can scratch off a label on the blister pack containing the drug to reveal a unique PIN, which they text to Sproxil's secure short code free of charge. The consumer then receives an instant response from Sproxil's Mobile Product Authentication™ technology confirming or denying a product's genuineness. Sproxil's cloud-based computing service automatically checks the code and provides the right response to the end user. Pharmaceutical companies paying for the medication verification service can then send relevant targeted offers to the consumer, and benefit from brand protection, real-time market insight, and increased sales.

Sproxil currently operates in Ghana, Kenya, Nigeria, and India, and is already working with pharmaceutical giants such as Johnson & Johnson, GlaxoSmithKline, and Merck's distributor in Nigeria. Merck's Glucophage global sales, which had fallen 75 percent since 2008 due to loss of profits from counterfeit drugs, increased by more than 10 percent in just 100 days of working with Sproxil. "We helped rescue Merck's Glucophage brand in Nigeria, and today four additional Merck products have been added to our service," says Gogo.

The Ghanaian native says that the Ph.D. Innovation Program prepared him for running Sproxil. "Thayer gave me the entrepreneurial training I needed," says Gogo, who in the past started a VoIP (Voice over Internet Protocol) company in Ghana. "The program fosters a new pedigree of engineers who are capable of solving global problems through tangible solutions."

By the time Gogo graduated, his enterprise had received global accolades. In 2009 Sproxil won an Outstanding Commitment Award in Global Health—and a $10,000 grant—from the Clinton Global Initiative University, and a year later Gogo shared the stage with Bill Clinton in front of world leaders to highlight the progress Sproxil had made since receiving the grant. In 2010 Sproxil won IBM's SmartCamp competition in Boston and received honorable mention at the IBM Global SmartCamp in Dublin. The company has been featured in *The Wall Street Journal*, *The New York Times*, and *The Boston Globe*.

Gogo oversees employees across three continents from Sproxil's headquarters in Cambridge, Mass. To date, consumers have sent more than a million messages to Sproxil to verify that they are not buying fake products. With the global pharmaceutical industry losing $200 billion annually to the counterfeiting epidemic, Sproxil has established itself as a healthy antidote.

SMARTER METER
Luke Fishback '02 Th'03 set up PlotWatt to lower electric bills.

PLOTWATT

Cofounders: Luke Fishback '02 Th'03
John Cunningham '02
plotwatt.com

Luke Fishback '02 Th'03 was looking for a viable business plan after building monitoring systems for missiles and satellites at Lockheed Martin. He had just purchased his first house. "I wanted to save money on my monthly electric bill and coming out of a great lab and engineering environment, I was used to building whatever tools I needed," he says.

So he created a monitoring system that photographed his own electricity meter every 30 seconds over the course of a day, and then converted the pictures into a spreadsheet. By auditing his own electricity use through a real-time lens, he tweaked his appliances and systems to save money.

He knew he was onto something. "Who wouldn't want to reduce their utility bills by as much as 50 percent—especially if it was as simple as turning off the auxiliary heat on your thermostat or cleaning dirty refrigerator coils," he says.

Fishback sent the data from his webcam to his friend and former classmate John Cunningham '02, who was finishing his Ph.D. at Stanford. "I told John there was cool stuff to be gleaned from this crude initial data set," Fishback says.

In 2008 he and Cunningham launched PlotWatt, a company that helps reduce utility bills by analyzing costs for running individual appliances.

"Many companies offer energy monitoring and feedback, but we're the only company out there that figures out appliance usage without having a homeowner put a monitor on every appliance," says Fishback, PlotWatt's chief executive officer. "Instead of just telling you usage in unhelpful units like kilowatts and kilowatt hours, we can tell you exactly how much you can save tomorrow if you turn your thermostat down one degree, for example."

Cunningham, PlotWatt's chief scientist, helped create the algorithms the company uses today. When a customer signs up for PlotWatt online, the company's cloud-based software analyzes data from their energy meter to trace appliance-level energy cost without monitoring individual appliances. The PlotWatt Energy Dashboard has already given feedback and personalized, money-saving recommendations to thousands of customers.

"Once we started to get word out, we had a community of early adopters who gave us a warm reception," says Fishback. The current beta version of PlotWatt is free for residential users who have an enabled smart meter.

With $1 million in seed funding led by Felicis Ventures and $100,000 from General Electric's GE Ecomagination Challenge, PlotWatt is scaling up to serve a larger residential customer base and expand into commercial markets.

"We are solving real problems that don't just apply to geeks like us," says Fishback, who likes to joke that PlotWatt has even saved a life. "Our system once diagnosed a faulty heater on fish tank. A customer was slowly cooking his fish and didn't even know it."

SUSTAINX

Cofounders: Dax Kepshire Th'06, '09, Ben Bollinger '04 Th'04, '08, Troy McBride Th'01, Professor Charles Hutchinson
sustainx.com

Renewable energy struggles to compete with fossil fuels in part because the wind doesn't blow and the sun doesn't shine on demand; storing energy for use on demand can improve the economics of renewable energy.

A group of Thayer alumni has created an isothermal compressed air energy storage (ICAES™) system that can do just that. SustainX is the first to develop a fuel-free compressed air system to efficiently capture and store inexpensive power generated during off-peak hours to use on the electrical grid during peak hours—capable of acting as a sort of renewable energy reserve.

"If we can store excess wind and solar energy, we can allow these resources to become more

PICTURE THIS
Jason Gracilieri Th'00 created TurningArt as a Netflix for art.

reliable and predictable," says Dax Kepshire Th'06, '09, who cofounded SustainX in 2007 with fellow engineering Ph.D. graduates Ben Bollinger '04 Th'04, '08, and Troy McBride Th'01, and Thayer Professor Charles Hutchinson.

SustainX is positioned to make a significant market impact over the next decade, according to Cleantech Group, a company that evaluates new approaches to sustainability. By 2013 SustainX, which recently relocated 24 employees from Lebanon, N.H., to a 42,000 square-foot building in Seabrook, N.H., plans to roll out a commercial prototype system for large power producer AES Energy Storage, using $5.4 million in funds from the U.S. Department of Energy. So far SustainX has eight patents protecting its technology.

According to Kepshire, what sets SustainX apart from the few existing traditional compressed air energy storage (CAES) facilities is the company's ability to eliminate inefficiency that had been caused from gas heating up when compressed and cooling down when expanded. SustainX controls the temperature in its compression and expansion cylinders through heat transfer by injecting a constant mist of water, which captures and then returns the heat.

SustainX's patented isothermal megawatt-scale storage system has several advantages over other approaches. It doesn't require additional fuel input and is cheaper than large-scale classic systems that require natural gas. It isn't restrictive geographically, whereas traditional air storage options rely on limestone or salt caverns. SustainX's ICAES is also lower maintenance and has a longer lifetime than energy-storing sodium sulfur batteries. "Most people working on this problem are focused on batteries, which don't last long and use toxic substances," says Kepshire. "We're the first company in the world to go after this approach with a system using almost exclusively steel, water, and air."

This technological distinction has helped SustainX gain funding from the National Science Foundation and General Electric's GE Ecomagination Challenge, as well as $24 million in private financing from several investors, including Polaris Venture Partners, RockPort Capital Partners, Cadent Energy Partners, General Catalyst Partners, GE Energy Financial Services, and Angeli Parvi.

"Dax is the one who suggested we actually start a company instead of taking an academic research path. He brought on Ben, an extremely talented engineer, and Charles Hutchinson, a highly successful entrepreneur and invaluable mentor," says cofounder McBride. "Our goal is to develop the best energy storage system out there—and in the process make a difference in the world of renewable energy for generations to come."

TURNINGART

Founder: Jason Gracilieri Th'00
turningart.com

Jason Gracilieri Th'00 was 28 when he purchased his first home and felt he had matured past most of the art he owned. "I was done with framed posters, but like many people my age, I didn't have the money, time, or knowledge to buy original artwork," says Gracilieri, now 34.

He responded by founding TurningArt, an art rental service with the option to buy—a business he now refers to as a Netflix for art. In August 2010, Gracilieri became his own first customer.

On turningart.com, Gracilieri rents limited edition quality prints for as little as $10 a month to individuals for their homes and offices. Each dollar spent on this monthly fee earns his customers a dollar in credit toward the purchase of an original work of art.

Today, Boston-area-based TurningArt is experiencing strong growth after raising $750,000 in funding, led by NextView Ventures. Gracilieri's eight-person "dynamic coalition of art-loving geeks and technology-loving artists," as he calls his colleagues, includes chief technology officer Matt Hodgson Th'06 and director of marketing Jason Pavel '04. Gracilieri's wife, Julie, a painter and former gallery owner, helped recruit some 300 artists whose work now constitutes the company's growing collection.

After earning his Master of Engineering Management degree from Thayer, Gracilieri worked for an aerospace startup called SpaceDev, a social network for high school students called Sconex, and a consumer deposit search engine called BankFox before founding TurningArt.

"The ultimate driving mission of TurningArt is to connect people with artwork they love and do it in an innovative way," says Gracilieri. "Like engineering, art is about individuals creating things. I'd rather have the work of today's artists on my wall than mass-produced reproductions."

Anna Fiorentino is a contributing editor at *Dartmouth Engineer*.

OPPOSITE PAGE: COURTESY OF LUKE FISHBACK. THIS PAGE: *BOSTON GLOBE*

Alumni News

spotlights


Trumbull Barrett '96 Th'98

Consumer rating service Angie's List has named **Trumbull Barrett '96 Th'98** one of the "Top Ten National Best Contractors." The owner of Barrett Tree Service East Inc. (barretttreeeast.com) was chosen from among 18,000 contractors in the country. He started his business three years ago in Somerville, Mass. "I enjoy the challenges of tree care in an urban setting," says the certified arborist, who has both cared for individual trees and managed large wooded tracts.

Phil Wagner '09 took the Shuffling Transformers to Denver, Colo., to help them set their robot, Thing 1, loose in the state competition of the FIRST LEGO League. The team of eight students faced off against 60 teams in a challenge in which each group programs a robot to accomplish various tasks. "There's no remote control, and that's what makes it so interesting," says Wagner, a chemical engineering research associate at startup OPX Biotechnologies. "The students have to make use of motors and sensors so that the robot can find its way around the playing field. Once you push 'Go,' the robot is on its own." This isn't the first LEGO competition for Wagner, who has been volunteering with the students at Casa de la Esperanza, a Boulder County residential center for agricultural workers, since last March. "I was introduced to the program by **Kristen Lurie '08**, who mentored a LEGO League team at an elementary school in Lebanon, N.H., in 2006. She liked the program so much that she reached out to other students at Thayer School to set them up mentoring local teams," Wagner says. In 2008 he and **Caitlin Johnson '10 Th'11** organized Thayer's first LEGO League regional qualifying tournament for more than 200 kids. "That day remains one of my favorite Thayer memories," he says. Although his team didn't bring home a trophy from the state competition this year, Wagner says that one student "told me that he wants to be an engineer when he grows up."

John Chae Th'86, M.D., a professor and vice chair of physical medicine and rehabilitation and a professor of biomedical engineering at Case Western Reserve University, has been elected to the Institute of Medicine of the National Academies and to the College of Fellows of the American Institute for Medical and Biological Engineering (AIMBE). Chae, whose research focuses on the use of functional electrical stimulation for reducing post-stroke shoulder pain and improving the upper- and lower-limb function of stroke survivors, was cited for "outstanding contributions to the clinical translation of neurotechnology for stroke rehabilitation and leadership in rehabilitation research."

U.S. Army Lt. **Chris Koppel '09 Th'10** is stationed at Camp Buehring in Kuwait, after serving in Iraq, *The Dartmouth* reported in November (thedartmouth.com/2011/11/11/news/kuwait). "I'm very proud to serve my country and am very thankful for the opportunity to serve as a platoon leader," Koppel, commander of the Dartmouth ROTC during his senior year, told *The Dartmouth*.

Catalin Picu Th'96 has recently been elected a fellow of the American Society of Mechanical Engineers (ASME). Picu is a professor and associate department head for undergraduate studies in the mechanical, aerospace, and nuclear engineering department at Rensselaer Polytechnic Institute. ASME cited him for his research in the field of mechanics of materials: "His work on multi-scale aspects of deformation and fracture has been published in over 100 journal articles and book chapters. He made advances in the understanding of the nature of rate sensitivity in metals and polymers and of stress production in polymeric materials."

Hanover, N.H., selectboard chair **Brian Walsh '65 Th'66** announced that after 15 years of service he was stepping down from the board so that, as he told the *Valley News*, he and his wife, Linda Patchett, can "take a big bite out of life." During his 36 years in Hanover, Walsh served on more than 15 boards and committees for organizations throughout the Upper Valley. A businessman and engineer who retired in 2003, he founded FUJIFILM Dimatix in Lebanon and holds three U.S. patents.

Jake McCarter Th'09 admits to having "the most fun you can have at a job." Since he started working as the head of business strategy with Bossa Nova Robotics (iloverobots.com) a few months ago, he has been spending a lot of time playing with toys. The San Francisco-based company, a spinoff from the Carnegie Mellon Robotics Institute, has been developing increasingly sophisticated robot toys that interact with children. CNNMoney named two of the firm's creations—an interactive dragon named Skylee and a series of alien robots called Mechatars—to its 2011 list of "7 Toys You Gotta Have." "Mechatars are robot toys that are really fun to play with as a standard remote-control toy," says McCarter, "but they are also connected to a free online game. The whole concept is to have a toy that evolves as you play with it, so kids play the game online, fight battles, complete missions, and level up their character online. But then everything they do with their physical toy is also stored on flash memory and uploadable to the game so you earn experience and credits for completing missions and battles offline as well!"

William Davidow '57 Th'58 warns of the downsides of being online in his recent book, *Overconnected: The Promise and Threat of the Internet* (Delphinium Books 2011). The former senior vice president of Intel argues that while being connected has made systems more efficient, it has also intensified risk. "It is becoming evident that markets have become more volatile, financial innovations mushroom in size and become dangerous, computer viruses and junk email are beyond control, identity theft is rampant, social networking has the potential to cause big problems. The Internet, the world's most powerful interconnection technology, facilitates all of this," he says. "It is an unindicted co-conspirator." During a lecture at Thayer School in October (youtube.com/thayerschool, search overconnected) and at the Aspen Ideas Festival last summer, Davidow elaborated on the hazards and challenges facing governments, social institutions, businesses, and economies. His solutions include redesigning systems to function more effectively, increasing regulation, and taxing certain activities such as financial transactions.

USS NAUTILUS
Lloyd Smith '47 Th'48 helped ensure safe operation of the U.S. Navy's original nuclear-powered submarine.

just one question

Q. What is the coolest, most exciting, or most fulfilling job you've ever done?

My nuclear experience began in 1951 in the desert near Idaho Falls, Idaho. The facility consisted of a pressurized, water-cooled and moderated power reactor as a heat source contained in a huge "sea tank" simulating conditions at sea, coupled to a "half mock-up" steam-turbine powered engine room for the *Nautilus*, our first nuclear-powered submarine. The facility and programs were operated by the Bettis Atomic Power Laboratory (BAPL) under Hyman G. Rickover, the "Father of the Nuclear Navy." The facility was designed to confirm the ability to safely operate a nuclear power reactor as a heat source for steam generation, and subsequent use of the steam, in a steam-turbine powered propulsion plant. Another purpose of the facility was to provide skills and training of the submarine personnel. This experience lead to similar roles in providing nuclear power to the first nuclear-powered aircraft carrier, *Enterprise*, the first nuclear-powered cruiser, *Long Beach*, and several subsequent nuclear-powered attack and ballistic missile submarines. I spent 17 years with BAPL and the naval reactors programs.

I subsequently joined the U.S. Atomic Energy Commission (AEC), which allowed me to apply my expertise to many other types of reactor designs and moderators, including fluidized bed cooled and moderated gas reactors, liquid-sodium-cooled reactors, and various organic-moderated types. In all these endeavors, public and nuclear safety was of paramount consideration. My last task involved nuclear and public safety issues, since a radioactive isotope was part of a power supply designed specifically for the Galileo satellite launch to Jupiter. The launch required a stable, long-life power source because the interplanetary transit time was slightly greater than two years. Jupiter's distance from the sun precluded the use of solar power. The power supply, a radioactive isotope thermoelectric generator, contained fuel pellets of plutonium 238 oxide encapsulated with iridium to contain the fuel. The thermoelectric generator converted the isotope decay heat into usable electric energy. Extensive research and measures were undertaken to assure integrity of the capsules under all plausible conditions. Since the space shuttle was used in the launch, these included any failure during ascent that could lead to dispersion of the capsules, either over any thickly populated area or possible immersion and corrosion in salt water should the shuttle fall into the ocean.

I spent many fulfilling years with the AEC, retiring after 20 years of service. All of my experiences were both exciting and challenging.

—Lloyd Smith '47 Th'48

I worked for six companies during my 40 years of employment. There was something significant at each company in completing the various projects; however, the one at the last company was the first time I used software to control machine functions. The company was Rockwell International and the division I was in was Goss, which manufactured newspaper printing machines and all the related handling equipment. A press produces newspapers at 48,000 per hour, almost a blur as they stream off onto conveying equipment to take them to an area where they are bundled for distribution. The spacing between newspaper "noses" is two to three inches. To create a bundle to convey to a truck, a stacker intercepts the flow on the conveyor to collect one second's amount of papers. For many years, sensors were mechanical devices that bumped along the stream and sent a signal to relays that controlled the stacker operations. I developed a stacker design that had software-compatible sensors sending information to a computer to control motorized devices, thereby operating the stacker more smoothly and on a one-second cycle. After the bundle is tied, it is conveyed to a truck that distributes it and other bundles to areas of the city or outskirts. This may require that a given truck have bundles with different news or advertising content that would be produced on a different press, a different stacker, a different conveyor that probably doesn't go directly to the truck. I designed a bundle distribution system that used a computer to identify a given bundle and send it to the appropriate truck. Goss had installations in many countries, and I was fortunate to be able to travel to those locations to insure proper installation and operation of the handling equipment.

—Robert D. Eckerson '48 Th'49

Our company melts and refines and produces alloys of copper, tin, lead, zinc, nickel, aluminum, manganese silicon, antimony, silver, and iron. We sell the copper-based alloys to foundries to make valves, plumbing goods, pumps, bushings and bearings, glass molds, bells, bronze sculptures, pole line hardware, plaques, and ship propellers. Our tin- and lead-base alloys and products are used in plating, soldering, extrusions, sound attenuation, X-ray shielding, and counterweights, among other end products.

What is fulfilling about 55 years of doing this: About 90 percent of our raw material feed is recycled from scrap. Reuse of scrap bypasses mining and smelting to produce metals, thus saving energy, the landscape, and the atmosphere. It supports the scrap-metal industry and provides high-quality finished products more efficiently and at lower cost and with less waste to landfills. Through the years I estimate about 7,000 truck/rail carloads of scrap have been converted to useful alloys and products at our plants. We were in the "green" sector long before green entered the vernacular.

—Jack Avril '53 Tu'54 Th'54

Computer modeling of a close-in weapon system for the Swiss firm Contraves in 1986–87, when I worked in Switzerland with Computer Sciences Corp. (CSC). Because of my expertise in modeling weapon systems (such as the Mark 50 torpedo) for the U.S. Navy, I was able to fill the position for CSC there. A close-in weapon system is a gun that is used to shoot down sea-skimming missiles. The Mark 50 torpedo became the latest lightweight torpedo for the Navy. The greatest challenge was being able to conduct an accurate evaluation of the torpedo vs. very capable foreign submarines.

—William Pierce '54 Th'56

I have had quite a few exciting and fulfilling jobs in my 35-year career in telecommunications/datacom, but the most interesting assignment took

OPPOSITE PAGE: LEFT, COURTESY OF TRUMBULL BARRETT; RIGHT, COURTESY OF WILLIAM DAVIDOW. THIS PAGE: COURTESY OF U.S. NAVY

EASY RIDER
Bob Mighell '85 Th'86 recently completed a 3,200-mile trip with the tilting front end he designed for his Harley Davidson.

place in the early 1980s: the creation of a worldwide market analysis/forecast common language guide for ITT, similar to the guide used by every comptroller worldwide to speak the exact same financial language. (A comptroller in Germany could phone a comptroller in the United States and, when referencing an item on page 8, line 22, they would be working with the same definition.) At the time, product managers and market forecasters from each country had their own set of definitions and methods of analysis and forecasting. My friends and associates said, "It will never happen!" Not discouraged, I created a first draft of the common language guide. I visited our international units to improve it, and it was implemented worldwide on a confidential basis. Two or three years later, the Korean Telecommunications Research Institute wished to determine the future of telecommunications and data for the country in 2000. Billions of dollars in sales would be awarded to the supplier whose forecast was accepted, and I was selected to be the team leader for the ITT proposal. My strategy for winning was simple: Share the common language guide methodology with the Koreans and let them do the forecast (with our guidance). It worked. We got the business. In ITT, that was the true measure of success.

—Joel Ash '56 Th'58

The most significant work I did in my career was at Los Alamos in 1964, a time when the mechanism of the monoclinic-tetragonal phase transformation in zirconium dioxide was a matter of wide controversy. We made a movie showing the rumpled surface of the formerly smooth surface of a sample of zirconium dioxide. The movie, along with other data, confirmed that the mechanism of the transformation was so-called "martensitic" or shear-type. I was a lieutenant on active duty at the time, serving at the Air Force Materials Laboratory, Wright-Patterson Air Force Base in Ohio.

—Loren Jacobson '60 Th'61

In 1966 implementing the interactive brand information system at Procter & Gamble was one of the first interactive uses of computers in a practical business application. The technology was called "time sharing," and utilized a teletype machine as a terminal. The terminal communicated with a mainframe using dial-up telephone lines. This was a precursor of the personal computer, Excel, and the Internet revolution. I implemented it for the advertising department at Procter & Gamble 45 years ago. It was used by brand managers to manipulate sales and market-share data by regions and time periods using a matrix-oriented programming language called Matran (a matrix-oriented version of Fortran, proprietary to P&G.)

—Dennis Crumbine '62

My current role as a professor of sustainable business practices at the Ohio State Fisher College of Business. Eight years ago I was given the opportunity to design a course for M.B.A.s. I now have a package of five courses that I offer to both M.B.A.s and undergraduate business students. This experience has allowed me to combine everything I have learned in my career into a timely curriculum to which students are not exposed in other courses. Next year Ohio State is launching a campus-wide major in sustainability that will incorporate two of my courses. Another plus to this experience is the sense of legacy that it creates.

—Neil Drobny '62 Th'64

My coolest project: building from scratch—every nut and bolt—a replica of the 1966 Shelby Ford AC Cobra. I have more than 2,000 hours in this car. I completed the project during a single calendar year while running my company, Plastic Technologies Inc., during the day! I purchased a rebuilt 1969 Ford 351 ci Cleveland engine. Because the 351 is a 302 cc with larger cylinder diameters, it generates a lot of heat, so I installed a double-sized radiator and wired the cooling fan to run all the time. The 351 is a perfect engine for the Cobra because it is a small block V-8 that is several hundred pounds lighter than the 427, which Shelby used when he finally beat the Porsche on a race track back in the mid-1960s; and a small block engine is much easier to work on under the hood. I used a brand new T-5 Ford Mustang five-speed manual transmission with a short Hurst gearshift, and I cut a normal Mustang driveshaft down to a length of about 12 inches to connect the Ford 8.8-inch differential to the transmission. I did the project in an old two-car garage on jack stands. Today I have a cool nine-car garage with two parking lifts and a working scissors lift. I've restored a 1971 VW Beetle convertible, 1966 Ford Mustang, 1972 Jaguar V-12 XKE 2+2 coupe, and 1997 Jaguar XK-8.

—Tom Brady '66 Th'68

The best was as venture manager of a new thermoplastic composite for the auto industry. In the late 1980s I headed a team of engineers and sales folks to introduce a plastic composite to auto companies in the Detroit area. We built a team of sales and technical folks, moved sales from nothing to commercial volumes, established a technical center with testing of these materials for automobile specifications, and eventually built a commercial manufacturing plant in Virginia. Along the way our technical team won several awards sponsored by the Society of Plastics Engineers for part design. It was a great experience, one that I'll always remember fondly.

—Rick Burkhart Th'66

One of the most challenging and fulfilling projects I have undertaken is that of the first marina on our island of Cyprus. As the owner and managing partner of my firm, A.F. Modinos and S.A Vrahimis, I am the project engineer in charge of the design and supervision team of the Limassol Marina. The Limassol Marina is an exclusive waterfront development that involves the creation of islands extending for almost half a mile into the sea and is designed by our architects and engineers in collaboration with the French marine master planner Xavier Bohl. It combines elegant residences and a state-of-the-art marina with an enticing mix of restaurants and shops to create a lifestyle uniquely shaped by "living on the sea." Our Greek heritage is reflected in the sunlit terraces, the flowering pergolas, and the elegant stone work. Combined with the breathtaking views of the sparkling Mediterranean this is the most challenging, demanding, and inspiring work I have recently undertaken.

Trying to create islands and buildings in the middle of the sea is a daunting engineering project, in which many challenges have to be met and overcome. As the consultant company you must deal with a great many people from different trades on a daily basis; as an engineer you must never underestimate the problems that can be created by forces of nature; as a project manager you have the responsibility to make the quick, right decisions based on your experience and training in order to keep the project moving. Designing the buildings to withstand earthquakes and differential settlement of the newly created islands was one of the most challenging issues faced. Reclaiming the land from the Mediterranean Sea was a first for me as an engineer and a first for our country. We anticipate that the end result will be a beautiful and inviting marina that will reflect the warmth of our Greek hospitality and cultural heritage combined with innovative engineering and state-of-the art technology.

The broad engineering spectrum and also the valuable general education received from Thayer has been instrumental in shaping my actions and career from the very beginning of my professional life. The education received has been pivotal in the way

EASY USER
Krispin Leydon '99 Th'01 designed the graphical user interface and sound scheme for the Tesla Roadster.

I manage people from different fields and in the way tasks are completed—from the smallest project to the largest complicated design.

—Saverios Vrahimis '71 Th'73

The construction of a veterans monument (soledadmemorial.com) on Mt. Soledad in La Jolla, Calif., is one of those projects that had a lasting impact on my life. A lawsuit was filed by atheists seeking to have the original monument to Korean War veterans torn down. (It is in the shape of a cross and was located in a city park—it was a question of separation of church and state.) The organization that I head submitted a bid to purchase the property from the city and develop it as a multi-faceted, world-class veterans memorial. We won the bid and came up with a great design that fits into the landscape and includes about 3,200 black granite plaques, each a tribute to an individual veteran. Each plaque includes a photograph of the veteran etched into the granite along with details of his service record. Annually we hold services for veterans during Veterans Day week and on Memorial Day. We also hold private flag-raising services for the families of veterans honored on the walls. This project has been incredibly meaningful to thousands of families who want to have their veteran remembered for posterity.

—Bill Kellogg '73

Leading and successfully turning around a small (less than 150 employees) heat exchanger company based in Toronto, Canada. The job was a rare amalgam of challenges: financial, engineering, procurement, customer relations. The memories of a diverse workforce and a great city are priceless as well.

—Mike Onderick '73 Th'74

I spent 20 years in marketing and sales for the telecom industry. Recently I have been teaching high school physics for eight years, and it's the most enjoyable job I've had. I work with high school juniors and seniors, helping to launch them into college and beyond. The material is wonderful and the people I work with are great. I recommend teaching high school science as a career after an engineering career.

—Richard Cavanaugh '81 Th'83

Working on the construction of the Channel Tunnel between England and France. I worked on the construction of the Channel Tunnel in the early 1990s. It was my first construction project where I had commercial responsibility, and I spent quite a bit of time in complex negotiations to settle massive contractor claims on behalf of the owner, Eurotunnel. The cultural challenges were interesting, and I drew upon my French language skills acquired during my foreign study program in Toulouse while at Dartmouth. I attended Eurotunnel board meetings that were conducted in a mixture of French and English, which led to frequent misunderstandings! There was a great deal of complex litigation—a whole new world to a young engineer. When we finally reached a commercial resolution that enabled the project to be completed, it seemed like a miracle. I learned that commercial considerations can be much more complicated than "simple" engineering and construction.

—Mike A. Adams '83

Right now I am working to bring to production a two-wheeled tilting front end I designed for motorcycles. The front end was designed to be a bolt-on conversion for a standard motorcycle. The additional wheel up front significantly improves the motorcycle's braking and traction. The two wheels up front steer, lean, and handle just like a standard motorcycle. I have been working on this project for the last seven years and currently have two issued patents (7,487,985 and 7,967,306) and a third patent pending. I was originally told by the head of the vehicle design program at a local university that my idea had been tried before, would be unstable, and would not work. A couple of years ago I worked with a student engineering team at Thayer to help me with some design work on my project. I completed a 3,200-mile trip to the Harley-Davidson Sturgis gathering last August. More information and video of my bike in action can be found on my Tilting Motor Works website, tiltingmotorworks.com.

—Bob Mighell '85 Th'86

Probably the coolest job I've done recently was one my company, Focus Embedded, picked up a couple of years ago to design the guts of a handheld video projector for 3M. What made it fun was the fact that it came with the interesting technical design challenges that go with making electronics run at video speeds, the economic constraints that go with knowing it would be produced for the consumer market, manufacturing issues related to building the things offshore, and the overall "wow" factor of designing a cool product that would stop people in their tracks when they saw it.

Technically what made the job such fun was that the entire projector runs on something of an optical illusion. The imager module is a small reflector made of a polished silicon substrate covered with an array of ferroelectric material that can rotate the polarization state of incident light from zero to 90 degrees. If you held the imager in normal room light and looked at it, even with an image displayed on it, all you'd see is a roughly 1-by-1.25-centimeter mirror. But inside the projector, the lamphouse shines incident light onto this imager only after it's been through a polarizing filter. And as the focused image exits the projector through the imaging optics, it passes through a second polarizer. Pixels that haven't been rotated pass right through. Ones that have are stopped cold if they've been rotated 90 degrees. And anything in between goes through at some intermediate luminance.

The imager module is also monochrome. The image you see is full color because the lamphouse contains three LEDs (one red, one green, and one blue, or R, G, B) that are turned on sequentially as the red, green, and blue portions of the image are put on the display. "Persistence of vision" causes the viewer's brain to reassemble the three in a full color. Turning on the LEDs for only part of the time (when their corresponding monochrome color image is on the display module) means that they can be dramatically overdriven in order to get high brightness. While the LEDs are "off" (and other colors are "on"), the silicon die has time to cool enough to make driving them with about four-times overcurrent possible. Additionally, most of the time none of them is on, and the viewer's brain, which is only recording peak brightness, thinks they're still on and fills in the "gaps." As a result, the power-hungry lamphouse is only sucking down electrons (at the 500mA rate required to drive the LEDs) for a small fraction of the time the device is perceived to be running. Since the rest of the unit only consumes about 25mA total, battery life is extended to the point where a single charge on a cell phone battery will allow the unit to play a feature-length movie.

3M came to us originally asking for the logic design for a chip to get the video content out of a small fast memory, deliver it to the imager, and synchronize the R, G, and B portions of the picture with the lighting of the R, G, and B LEDs. But when we got that working in simulation and it needed to be tested on a real circuit board, we were asked to design the printed circuit board as well. We were further given the job of developing the switch mode power supplies to run the device at extreme high efficiency.

We were pleased that when 3M decided to do the next generation of projectors with higher resolution and faster refresh rates, they could reuse all of our code and recompile our work with nothing more than a few changes. Our lasting gift to them was that their next projector was designed in about one-third the time the first one was, since we'd set things up with a development path ahead. Their lasting gift to us has been a lot of repeat business.

—Eric Overton '87 Th'89

OPPOSITE PAGE: COURTESY OF BOB MIGHELL. THIS PAGE: COURTESY OF KRISPIN LEYDON

WINDFALL
Harley McAllister '94 Th'95 (in light blue shirt) and his ninth-graders built a windmill in the Dominican Republic.

My first job in a micro-sized startup. It was the combination of inventing a technology, winning formal recognition for the technology (R&D 100 Award), and then exploring commercialization options, all under the security of a steady paycheck. The commercialization attempt required me to learn about marketing and venture capital funding while maintaining a small operations side of the business to generate revenue numbers for investors. All in all, it gave me a broader end-to-end view of what it means to be an entrepreneur. The job made me feel I can make a difference. As I moved into more defined roles in larger companies, I never had the same experience again.

—Sumit Guha Th'88

The coolest, most exciting, and most fulfilling job I had was 10 years ago. I became an architect after finishing my B.E. I had my own firm, and I spent two years with two close friends designing a brand new university, Ashesi University in Ghana. The project included the campus master plan and all the buildings. It just finished construction this year. We made very little money (we did receive earned income credit) and worked an insane amount of hours, but we had so much fun and it was a fantastic opportunity.

—Sofia Veniard '93 Th'94

The most fulfilling job I have ever had is where I am working currently, as a high school math and science teacher at Doulos Discovery School in the Dominican Republic. The country has the lowest investment and performance in academics of all of Latin America and the Caribbean, with the possible exception of its island neighbor, Haiti. The need for education here is desperate. That is why Doulos Discovery School, a Christian school, seeks not only to equip the kids here with a first-rate education, but also train them to become leaders who have a servant's heart. In this way, when their hard work and preparation enable them to rise into positions of leadership, they will use this influence to bring about lasting, needed, and meaningful changes that will benefit Dominicans at all socioeconomic levels.

Being a teacher is the most challenging job I have had. Sure, some other jobs demanded more intellectual rigor and training, but no other job has required constantly putting my own needs second, being patient with students who are at times disrespectful or lazy, or simply seeking to serve others in the way that teaching has. Doulos utilizes the expeditionary form of learning pioneered by Kurt Hahn, founder of Outward Bound. It is hands-on learning with a service focus. Recently my ninth-grade science class built and installed a windmill using materials that cost less than $150. It gave our students a good taste for renewable energy.

—Harley McAllister '94 Th'95

Designing the graphical user interface and sound scheme for the Tesla Roadster—and seeing it out there, "in the wild." (I worked alongside **Matt Senesky '98 Th'99** and **Diarmuid O'Connell '86**.) The narrative surrounding electric cars has changed so much during the past five years. It was exciting to be at the center of the action and rewarding to feel like I was making a (small) impact on oil dependence, climate change, and national security—while honoring the legacy of an undersung inventor who died penniless, talking to pigeons (Tesla).

—Krispin Leydon '99 Th'01

The job I have now: working at Google as a software engineer on a to-be-named project that aims to handle hundreds of thousands of queries from online ad exchanges for dynamically generated bids on ads from thousands of advertisers. Right now my job involves understanding issues as big as how data flow from company to company all the way down to how the HTML needs to be modified. And figuring out how we can work together as efficiently as possible to make this happen! It's been crazy at times, but definitely exciting.

In contrast, the job that got me the most "cool" points from people I've talked to was working on Microsoft's Flight Simulator game for five years. It seems like everyone you meet over the age of 25 who has ever played a computer game has played that one at some point during its 25-year history. Getting to see some of those planes in real life was pretty fun, too!

—Susan Ashlock '00

Each day medicine provides interesting and unique challenges. The most recent challenge for me was delivering a baby in an elevator. (Go to lenoxhillhospital.org/press_releases.aspx?id=2224 to read about the unexpected delivery.) I'm currently a chief resident in orthopedic surgery at Lenox Hill Hospital in Manhattan. I've been here for the past five years training since I graduated from Dartmouth Medical School in 2007. Next year I'm headed to the Mayo Clinic in Minnesota for a yearlong arthroplasty (joint replacement) fellowship. When I was an undergraduate engineering major, Dr. Mayor and Professor Collier were very influential in my pursuit of a career in medicine and orthopedic surgery. After the fellowship I hope to find an attending surgeon position where I can combine my interests in engineering and medicine. As an aside, I rented a room from Dr. Myric Wood in Lebanon during medical school and became close friends with him. He was a general practitioner for 45 years. He was one of the most amazing physicians I have ever worked with, and I learned a lot about general practice from him. His wife, Lois Wood, was one of the past Thayer School magazine editors. The Dartmouth community is a very special place to learn, for which I am grateful.

—Derek Jenkins '02 DMS'06

Banging my helmeted head against a concrete pillar to calibrate an early head impact telemetry prototype with a mouthguard accelerometer. It occurred at Brown University in the summer of 2002, for a summer internship with Simbex LLC (and Adjunct Professor Rick Greenwald Th'88). It helped shaped my graduate studies in orthopedic biomechanics. I'm currently an assistant professor of mechanical engineering at Montana State University. My lab studies cartilage, osteoarthritis, and how mechanical loading is transduced into biological signals.

—Ron June '02

I would have to say my current job, developing the new BMW X5 in Munich, has got to be the coolest project I've worked on. Between the design in context and vehicle validation processes, there is always something interesting going on.

—Matt Wallach Th'09

My most fulfilling project so far is the process improvement project for my Lean Six Sigma Black Belt training with Professor Lasky and Dr. Cheung at the radiology department at DHMC. Goal: process at least one more patient through the radiology department. Challenges: lots of details in the process to capture in mapping. Highlight: finding data captured by the software that the department had been using to track patient check-in and processing info. Result: found the solution to processing two patients through the department.

—Wei Peng Th'11

SHIPSHAPE
Miral Anoop Shethia Th'08 built a large-capacity barge at his family business, Shethia Enterprise, in India.

thayer notes

1940s

Sam Florman '46 Th'46: I have my seventh book coming out in March. It's a bit different from my others, a personal memoir telling of a career in the construction industry. The title is *Good Guys, Wiseguys, and Putting Up Buildings: A Life in Construction.* I speak briefly of the early experiences that set me on my way—Dartmouth, Thayer, and the Seabees—and then tell of adventures that followed, mostly in New York City.

Bob Craig '47 Th'48: I have been retired for 36 years. Just when I want to do things, my body says, no way, pal. I sing with a group of people at nursing homes in the area, do Meals on Wheels once a week, and read on Sundays at my church. I have a female friend and we eat out a couple of times a month.

Hjalmar Sundin '47 Th'47: I retired from Baxter & Woodman, a civil and environmental consulting firm, in 1989. I am thoroughly enjoying retirement in Glenwood Springs, Colo. (near Aspen), skiing December into April and hiking in the Rocky Mountains the rest of the year. I have been writing a biweekly opinion column for the local newspaper for the past 13 years and recently published a book, *Law & Disorder in Crested Butte*, chronicling the humor, satire, and ribaldry that appeared in the newspaper in the town marshal's reports during the 1970s "hippy" era, when Crested Butte was the center of an unconventional, free-spirited lifestyle in which no one took themselves or anyone else very seriously. It was fun to compile.

On a sadder note, after nearly 56 years of marriage, my wife died in 2006, followed by my son and daughter in 2008.

1950s

Abdul Bahrani '53 Tu'54 Th'54: Lately I am up to 9/11 trauma therapy. There are many children, citizens, and soldiers of many nations who are traumatized by the 9/11 event and subsequent wars. There may be about 1 million people who have died, but hundreds of millions have been traumatized; some by fear, some by anger, some by guilt, some by the loss of loved ones, some by damaged body parts, some by being labeled terrorists. From an engineering perspective, the human being is structured of hardware and software; either or both can be traumatized, i.e., physically and mentally. The therapy can be approached from a structural engineering point of view. Based on personal experiences, I know there are expedient structural therapies such as muscle activation technology and rapid therapy for mental anxiety pain. These therapies address the basic root cause rather than doping the systems with medical and media remedies. My wish is to get help from other professionals to develop supplementary therapies based on this approach to heal the scars of the 9/11 event and subsequent wars. My effort may be the result of a Dartmouth humanities education that was etched in my granite brain.

Joel Ash '56 Th'58: I spend the largest slug of my time pursuing my lifelong project of stock market forecasting and managing my investments. While I was pursuing my 35-year career in telecommunications I worked on the side on the Pytho Project (a reference to the oracle at Delphi) and when I retired in 1992 at the age of 57 I was able to devote proper time to this effort. I have two Dartmouth sons (class of '85 and class of '88) and hope to bring the project to the stage where they will want to carry on my life's work.

With an undergraduate degree in modified art and a postgraduate degree in engineering, I view myself as an arts and science guy. My arts project is poetic limericks. I have written close to 600 poetic limericks, most with four, five, or six five-line stanzas and some longer. I have published two hardcover and four online books, maintain the PoeticLimericks.com website, and send out my "Poem of the Month" to more than 200 friends and poetic limericks lovers via e-mail. I have been an amateur magician since the age of 8, and after moving to New Hampshire in 2002 I founded the Wizards of the Upper River Valley magic club, which I run. I am documenting all of this in an opus titled *Diary of a New Hampshire Wizard*. Other activities include running the Dartmouth at Eastman men's group, fishing, and acting as secretary for the class of 1956.

Em Houck '56 Tu'58 Th'58: After I retired from Eli Lilly and Co. as executive director of engineering, I have written two books and enjoyed signings all over the states of Indiana and in Illinois. The first book, *Go Huskies! Beat Felix the Cat!*, tells the story of unique high school mascots around the country. The second, *Hoosiers All*, tells the story of Indiana high school basketball from the beginnings of the sport in this state. I would argue that to understand Indiana you must understand basketball. The experience has been great fun.

1960s

Jerry Greenfield '61 Th'62 Tu'65: Retirement has been almost too busy! I have a part-time job serving and selling wine at a local winery, Kiona, in Benton City, Wash. I'm active in Kiwanis, having served in several officer positions through time in my club, division, and district. I'm an amateur historian and have been asked to give lectures on various topics. After I got off the Richland City Council, I joined Toastmasters to learn how to speak better—I guess I do things in reverse order. My wife, Corky, and I try to go to Victoria, B.C., three or four times a year to see our daughter Katrina and her family. She has two small boys, Willem (5) and Tyler (2), and her husband, Jay, is in the Canadian Navy.

Mark Tuttle '65 Th'66: I'm the teaching assistant for what is probably the largest cyberspace class in the world—Stanford's online "Introduction to Artificial Intelligence," taught by Sebastian Thrun and Peter Norvig (ai-class.com). There are 160,000-plus students enrolled from 160 countries. Some observations: The artificial intelligence paradigm has changed completely from 20-plus years ago, and it continues to evolve. It's much more data-driven and engineering oriented, so as to leverage cheap, pervasive computing and more readily available data. I am in awe of the amount of energy and sense of community created in various class forums—such as social media—especially when an assignment is due or a post-lecture quiz proves problematic. The instructors have taken the Khan Academy paradigm—short videos that are typically example driven—and moved it to a new level with quizzes, homework, and exams. I am very impressed by the multilingual talent out there in the world. Dartmouth needs to get on this bandwagon.

Richard Livingston '68 Th'69: I am an adjunct professor of materials science in the department of materials science and engineering at the University of Maryland (UMD). I will be teaming up with the Smithsonian Institution's Museum Conservation Institute for a feasibility study of a device that could be used to assess buildings, monuments, and artifacts in danger of deterioration from the effects of moisture. Funded by a UMD/Smithsonian Seed Grant, I'll help develop a portable prototype system that uses prompt gamma neutron activation for the nondestructive measurement of moisture in porous construction materials such as brick, sandstone, and marble. We'll use test samples representative of the masonry used in the museum's buildings. This matters because moisture is a threat to the preservation of both art and architecture. Corrosive chemical reactions, cracking, staining, erosion, and the growth of bacteria and mold represent some of the serious and sometimes irreversible damage it causes. The ability to accurately measure moisture in an object over space and time is crucial to conservators' need to understand the source of the moisture, how much it has penetrated, and the mechanisms by which

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GROUP PROJECT
Brian Mason '03 Th'05 and Jocelyn Mason '05 display Lynn, their newest joint venture.

it causes damage. Our strategy is to improve a device called a neutron probe, which uses prompt gamma neutron activation for elemental analysis. The device is able to provide a visual representation of the gamma ray spectrum produced by the subject. This spectrum can be analyzed for the characteristic peaks revealing the composition, condition, and moisture content of the material. Our ultimate goal is to produce a portable, prototype instrument calibrated for moisture measurement in porous materials.

1980s

Laurie Hartman '80 Th'80: I have moved from solving mechanical problems to helping with people problems. I am a pastoral counselor at a large church. Many people have commented that I think like an engineer, being able to step back and see a person as part of a system as well as move in to see the various components of that individual's challenge. Some of my most exciting interactions are working with couples who are in open conflict. I also find great satisfaction in helping people with Dissociative Identity Disorder.
John Graves '85 Th'86: I was recently promoted to senior engineer at General Electric Co. I am a materials application engineer in the materials and process engineering department at GE Aviation's facility in Lynn, Mass. I am involved with industrializing aircraft engine components manufactured from ceramic matrix composites for military and commercial applications.
John Rajala '88: I went back to the 100-year-old family forestry and sawmill business shortly after graduating. Our family owns and manages 25,000 acres of timberland in northern Minnesota. We also operate two sawmills, two planing mills, a veneer mill, and a millwork facility. We are trying to be world-class stewards of our lands. I'm proud to say that Minnesota forests are in many ways the model for better forestry in the world, and that through our private business and our involvement in broader efforts, my family and I have played a significant leadership role in that effort. I currently serve on the Minnesota Forest Resources Council, probably the most organized and effective statewide forest sustainability effort anywhere. To understand a bit more about our forestry and forest products, feel free to go to my blog: northwoodsnotebook.blogspot.com.

Every five or so years a group of '88s comes to visit and enjoy fishing and relaxation at our most prized property, Wolf Lake Camp. That group of dear friends represents medicine, law, technology, and finance. I have drawn heavily on the experience of these guys and little do they know how they have both directly and indirectly aided our efforts at being a positive contributor to better forestry and significant employer to our rural community. I've employed the software created by Smartsheet founder **Brent Frei '88 Th'89**. We work together regularly, with his organization providing solutions to mine, and my organization providing real-world critical feedback to his.

My daughter Sarah is applying to Dartmouth. My dream is that someday I can lend my resource and real-world wood engineering knowledge to the Dartmouth/Thayer community. Dartmouth has a significant timber resource in northern New Hampshire, and I'd love to provide our experiences to the people who manage it.

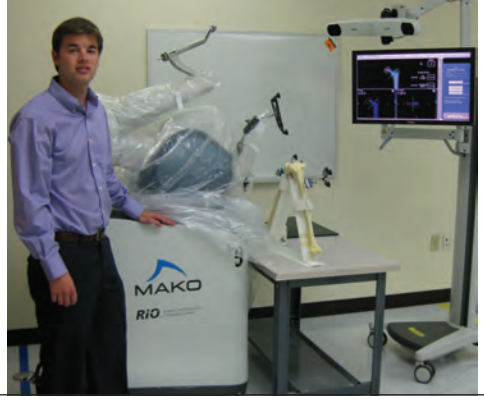
1990s

Ron Faith '90: I have been a software entrepreneur living on the West Coast for the past 20-plus years. I am the CEO of Datacastle in Seattle, Wash. Datacastle provides cloud-based data protection to companies for their employees' laptops, desktops, and mobile devices. Prior to Datacastle, I was the VP and general manager of mobile and broadband commerce at Qpass (acquired by Amdocs) and also was at Apple. I am the former president of the Dartmouth Alumni Association of Silicon Valley. I live with my wife and three children in Woodinville, Wash.
Xilin Jia Th'93: After Thayer, I have worked in the greater IT industries. Initially I was involved in software development in various companies. One job was developing 3D capabilities (with earth, landscape, etc., rendered) for weather presentation software. That can still be seen on many TV weather shows (including The Weather Channel). Then I went on to do business development and general management for various companies. There have been successes and failures along the way. One memorable thing I did was lead a U.S. business in China to influence and guide the entire TV broadcast industry to transition to digital services. Since 2005 I have been trading securities using algorithmic techniques for myself and some other people. I now live in China.

I would like to use this opportunity to share some lessons I have learned in life. One thing is what you probably can call a success formula. Obviously success has different meanings to different people, but regardless of what it means, one's overall successfulness (OS) can be expressed in terms of a few other factors. OS = SR * ASM - FR * AFM, where SR is the success rate, ASM is the average success magnitude, FR is the failure rate, AFM is the average failure magnitude, and SR + FR = 1. This formula is key in trading successes, but I think it can be generalized to anything we do in life. The fundamental thinking behind this is that everyone does a million things in life and *no* one does them without failures. The formula tells us that increasing SR is not your only way of achieving more OS. You might as well focus more on increasing ASM and reducing AFM, which perhaps can be done more easily. The second thing is: don't pay too much attention to your fears. Common knowledge is that fear is a mechanism of the brain that naturally protects for our safety. However, the "safety" there only relates to that in the wild, not in the modern world. So, whenever you have a thought about doing something, ignore the fear and think only rationally.
Damien Shulock '94 Th'95: I'm a mechanical engineer in the medical device field. For the last three years I have worked on a project that has been both challenging and exciting. The project is a lumbar spine implant that can be inserted between vertebrae in a collapsed state, then expanded using hydraulic pressure and locked in place. This type of device gives the surgeon certain advantages during the procedure, while improving the patient's outcome as well. The upside for me is that I get to work with exotic materials and use lots of high-tech assembly methods, while (I hope) advancing medicine and helping patients. The methods of problem solving that I first learned at Thayer are the foundation of everything that I do.
Larry Clifford Gilman Th'95: Since 2000 I've lived in Sharon, Vt., with my wife, Priscilla '94, an artist. I use skills from my engineering background—as well as my M.A. in English from Northwestern (1996)—in my work as a freelance editor and writer for technology companies, architects, and medical-research clients, typically on grant applications, patents, and articles for publication. Dartmouth connections have been essential to developing my business. For years in grad school, I lived across the river in Norwich, and many winter mornings shortened my walk to campus by walking over the frozen river to Ledyard. There can't be many campus commutes more beautiful.
Johan Tegin Th'99: I became clinical innovation fellow at the Royal Institute of Technology and Karolinska Institutet in June 2011. The project is inspired by the Stanford biodesign program. I married Anna Pia Beckerman in 2010 and am now the father of two, André and Idun.

2000s

Robbie Barbero '01 Th'02: I just finished my Ph.D. in biological engineering at MIT. I'll be staying at MIT as a postdoctoral researcher for a few months to transition my projects while I look for jobs in biotech or cleantech. MIT has been great, but I'm really excited for the next step.
Brian Mason '03 Th'05: Jocelyn and I welcomed our daughter Lynn Heather Mason on July 29. She was born a few weeks early at 5 pounds, 15 ounces, a beautiful little wide-eyed girl. Everyone is doing well. We are still living in Menlo Park, Calif., where I work as



HELPING HAND
Jeff Forsyth Th'11 programs the robotic arm of MAKO's knee and hip surgical system.

a mechanical engineer in our medical product business. Jocelyn teaches first grade. We look forward to taking Lynn to a Dartmouth homecoming soon!

Keith Dennis '03 Th'05: After leading the Policy and Guidance team for a $3.2-billion stimulus program at the Department of Energy to implement clean energy across the country, I am on detail to the White House Council on Environmental Quality, where I work on energy and climate issues.

Miral Anoop Shethia Th'08: I left my job as project analyst at Kantar Retail at Wilton, Conn., last year and moved to Mumbai, India, to join my family business. My family business, Shethia Enterprise (shethiaenterprise.com), is one-stop shopping for all marine equipment and materials for all marine vessels. When I joined I saw that few clients have barges (mini-ships) with 1,000-metric-ton capacity with a draft of 3.3 meters (the minimum height needed near the coastline of India is 3.6 meters). We decided to build a larger-capacity barge (2,700 metric tons) with a draft of 3.3 meters to help in fuel savings, as more material could be carried per trip. The main purpose of this barge is to carry cargo from big-bulk carrying ships, which cannot come close to shore since the water is too shallow, to the port. This barge was designed in such a way that even during monsoons it will be able to transport cargo from the carriers to port and vice-versa. All materials, such as the steel, engines, gearbox, pumps, and anchors were procured by us and fitted/assembled on a labor charge basis. Hence the costs of the barge came down substantially. The barge was built in a record time of seven months with a cost of around $1.5 million. We plan to offer this barge on a hiring basis to the ports at a steady rate of $1,700 per day. Assuming a 12-month hiring period, the return on investment for this barge is approximately three to four years. The life of this barge is 25 years.

Laura Weyl Th'08: I'm continuing my education daily as I design earthquake-safe, high-tech facilities and seismic retrofits for existing buildings. I just received my LEED certification and will be taking my P.E. exam this spring, so let the studying begin! I completed my first two century rides and my first triathlon this year, and I also had the pleasure to return to Thayer this fall to participate in the B.E. Advisory Committee meetings. To no one's surprise, I was impressed by (and jealous of) the stunning changes to the facilities in Thayer as well as the continued quality of coursework and projects. I always get a little nostalgic being back there!

Andrew Jean-Louis '09 Th'10: I'm working at Navigant, and the primary client I work with is the U.S. Department of Energy. I've been working on their ENERGY STAR verification program testing household appliances to ensure they meet required performance specifications. I am also working to update the old test procedure for residential refrigerators to account for new compressor and heater technologies that have emerged recently. In an effort to create cost-efficient curves, I also get the chance to tear appliances apart to find out how manufacturers put their products together. We have this 6-foot crowbar that we find any excuse to use!

Kyle Sherry '09 Th'10: I moved to Somerville, Mass., from New Jersey in January to take a process development engineer position at Midori Renewables, a startup developing a new technology for converting lignocellulosic materials into renewable fuels and chemicals. I'm very excited!

2010s

Shahen Huda '10, Th'11: I'm in grad school at the University of Colorado at Boulder, studying the mechanisms by which streams incise into bedrock. In addition to appreciating the breadth and depth of education I received in Hanover, being here for a semester has made me appreciate even more the openness to resources, the faculty, and the collaborative spirit that defines the Thayer and Dartmouth student body. More than expected, I miss late nights in the CAD lab and Couch and the radiantly heated floor in the Atrium.

Benjamin Meigs '10 Th'11: I am designing commercial aircraft interiors at C&D Zodiac in Huntington Beach, Calif.

Jatin Nema Th'10: This year has brought a lot of changes. I took up the senior business analyst position with TE Connectivity (formerly Tyco Electronics) within its global procurement function. I worked there for seven months before I decided to step back and find opportunities more aligned with my career ambitions. After searching for about a month, I found a temporary to-hire position with Harsco Corp. as a global supplier relationship manager. I enjoyed working on two business process improvement projects. I worked with them for three months. Recently, I took up a full-time job with a data analytics consulting group, Mu Sigma, and relocated to the Seattle, Wash., area. My current title is associate, and I solve clients' problems through my Indian offshore team. I have enjoyed this year and it has been a great learning experience. I cherish the time I spent at Thayer and with my friends during school. I am planning a trip with my Thayer friends **Kartik Vittal Th'09, Kaushik Prabhakar Th'09, Akhil Gokul Th'10**, and **Ramkumar Jayasankar Th'10** to the Grand Canyon, Las Vegas, and San Francisco.

Jeff Forsyth Th'11: Since graduating from Thayer, I have begun my engineering career at a medical device company, MAKO Surgical (makosurgical.com), in Fort Lauderdale, Fla. MAKO is a fairly young company that markets a robotic arm system for knee and hip surgery. The resurfacing procedure is less invasive than a full knee or hip replacement and often reduces recovery times. At MAKO I have joined the electrical engineering team and am responsible for embedded programming and customer support. The robot runs C code and is interfaced via MATLAB scripts, so I have been programming in both languages. In the case of robot issues in the field, I work to troubleshoot by phone and, when necessary, travel to resolve them. My company feels small and its culture allows good interaction between people of different backgrounds, including electrical, mechanical, systems, and quality.

Anson Moxness Th'11: I spent the summer working at Kathmandu University in Nepal teaching SolidWorks basics to students and professors and conducting research into the efficiency of improved wood cooking stoves for rural areas of Nepal.

Christian Ortiz '11 Th'11: I have a couple of projects in progress. I just finished organizing and running Dartmouth LEGO League, which hosted more than 200 elementary and middle school students, educators, families, and visitors. I think that it was a great success and a lot of fun! I am helping to run Dartmouth Formula Racing in what is expected to be a great year. We already have had the entire team drive the car and feel how it handles. The team is months ahead of schedule compared to years past. I am very excited about the enthusiasm and ambition that this team has. As a Thayer design fellow, I have created several side projects for professors or research groups, including an earthquake simulator for Professor Vicki May and an all-in-one laser instrument for Professor Brian Pogue's research group. Finally, I had the pleasure of assisting all of the project-based, design courses (ENGS 12, 21, 76, 89) with everything from mock-ups to CAD work, presentations, and research papers. Overall, I think that this kind of help was beneficial for the teams and can only increase as the design fellow position becomes more defined over the years.

Wei Peng Th'11: I have been working with ZS Associates in Philadelphia, Pa., since March in sales and marketing consulting. I have found my skills (optimization, statistics, marketing and sales strategies, etc.) from the M.E.M. program to be highly applicable and useful in my current position and in a way have been making it more enjoyable.

Garrett Simpson '11: I just got an engineering fellowship with PharmaSecure in Delhi, India. I'm going to be there starting January 7 for six months to a year, traveling around to factories and helping get PharmaSecure's code-printing machinery installed in the automated packaging assembly lines.

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inventions

THERMOBLASTER
James Browning '44 drilled through Antarctica's 1,400 feet-thick Ross Ice Shelf in nine hours.

THERMOBLAST
FLAME-JET DRILL

>> INVENTOR:
JAMES A. BROWNING '44

Scientists drilling into the Ross Ice Shelf of Antarctica can look back at millions of years of the frozen continent's history. Probably few researchers, however, know of a more recent bit of ice shelf history.

Thirty-five years ago a new kind of drilling technology, dubbed "Thermoblast" by its inventor, Thayer Professor James A. Browning '44, was successfully field tested on the polar ice. In 1977 Browning's high-temperature rocket drill pierced the 1,400-foot-thick ice shelf so scientists could study the ocean underneath. Drilling time: nine hours.

Though the drilling was quick, the development of the invention took a few decades. As early as 1955 experiments were being conducted to speed up drilling in frozen material using flame jets. Browning began a series of experiments in 1962 "to gain a better understanding of the principles governing the 'cutting' action of jet flames and to evaluate burning designs already available," as he reported in a paper, "Use of Internal Burners for Working Permafrost and Ice" at the 1963 Permafrost International Conference. The idea was that once the process was better understood, burners could be customized for the task. Browning, who had already founded Thermal Dynamics with Thayer colleague Merle Thorpe Th'53 to produce plasma torches, ran tests on blocks of ice and in frozen silt at the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover. As he gathered data, Browning computed the most efficient combinations of fuel, mass, and jet size for drilling in ice and frozen earth. After his success in Antarctica, he secured nearly $240,000 in funding from the National Science Foundation to develop a suspension core drill that would make it possible to use flame-jet technology for another tricky task: studying rock formations under ice caps and glaciers.

—Lee Michaelides

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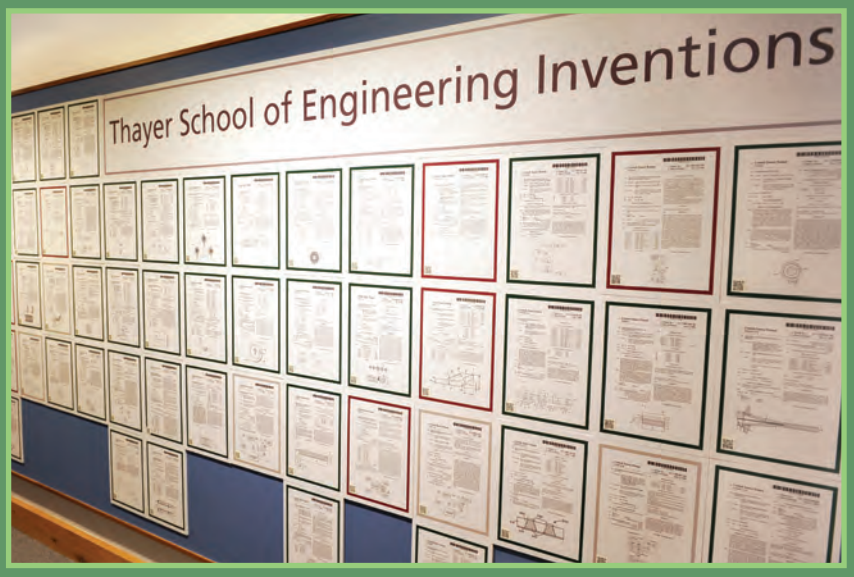

RANDOM WALK

A walk along the second floor of Cummings Hall is now also a stroll down memory lane. A Wall of Patents documents the flow of inventions from research and course project work done by Thayer School faculty, students, and staff since the 1970s. The first, U.S. Patent 3,605,843, was granted September 20, 1971 to former professor and prolific entrepreneur Robert Dean Jr. and Hypertherm founder Richard Couch Jr. '64 Th'65. Their invention: a cashew nut sheller. The most recent, U.S. Patent 7,994,786 B2, granted August 9, 2011 to Professors John Weaver, Ian Baker, and Eric Hansen, protects an innovation aimed at treating cancer: System and Method for Use of Nanoparticles in Imaging and Temperature Measurement. From a total of 134 U.S. patents, 94 are held by faculty, 20 by students, and 20 by teams of faculty, students, and staff. Another 39 patent applications filed since 2009 are awaiting their place in Thayer history.

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