

DARTMOUTH

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Engineer

THE MAGAZINE OF THAYER SCHOOL OF ENGINEERING

THE INNOVATOR

BIOTECH ENTREPRENEUR

TILLMAN GERNGROSS REVEALS HOW
HE TURNS THE IMPOSSIBLE INTO
MULTI-MILLION-DOLLAR COMPANIES.

- ENGINEERING BY DESIGN
- ALUMNI IN DESIGN
- THAILAND EXCHANGE

Partners in Success

BY DEAN JOSEPH J. HELBLE

WHILE PRIVATE COLLEGES AND UNIVERSITIES CONTINUE TO address the effects of declining endowments experienced in 2008 and early 2009, it is worth pausing to celebrate a financial success achieved through the generosity of our alumni and friends in the midst of a challenging economy.

On December 31, 2009, the Thayer School of Engineering successfully concluded its largest-ever comprehensive campaign, raising \$61 million to support graduate and undergraduate engineering education at Dartmouth. This effort, which launched publicly in November 2004, had set an ambitious \$60-million goal that was four times higher than that of any prior campaign, reflecting substantial opportunity for growth in engineering at Dartmouth and the urgent need for new facilities. More than 2,000 alumni, friends, parents, faculty, staff, and organizations contributed to this successful effort.

Most visibly, support raised in this campaign completely funded the construction and operation of the MacLean Engineering Sciences Center, dedicated in 2006 and adding over 60,000 square feet in integrated project laboratory, studio classroom, research laboratory, and office space to the School. It also provided funds to permit growth in the faculty, through addition of four endowed professorships that strengthen Thayer School's focus on engineering in medicine and innovation and entrepreneurship; additional funding for student scholarships and fellowships; support to encourage entrepreneurial projects among students and faculty, international exchange and internship opportunities, and distinguished speaker programs; and funds for the establishment of the Ph.D. Innovation Program—the nation's first doctoral-level engineering Innovation Program.

This campaign concludes at a critical time, with the School poised for growth due to a surge in interest in engineering. Since the fall 2004 public launch of the campaign, B.E. dual-degree enrollments and Ph.D. enrollments have grown by more than 65 percent, and M.E.M. enrollments have grown by more than 80 percent. While A.B. and overall B.E. degree numbers remained fairly constant, that will soon change, given significantly increased enrollments in our junior and senior classes. With the impressive new facilities and initiatives made possible by campaign donors, we are well prepared to provide the increased numbers of students with Thayer's close student-faculty contacts and interdisciplinary education. To all who share in this success, we extend our congratulations and thanks.

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Contents



18

6 The Innovator

Biotech entrepreneur Tillman Gerngross reveals how he turns the impossible into multi-million-dollar companies.

BY KAREN ENDICOTT

10 Travelers' Tales

Students learn more than technology in Thayer School's new Thailand exchange program.

BY KATHRYN LOCONTE

14 Engineering by Design

Professor Peter Robbie '69 adds art to the science of meeting human needs.

BY ELIZABETH KELSEY

18 Alumni in Design

Eight alumni discuss their perspectives on design.

BY ELIZABETH KELSEY

DEPARTMENTS

2 The Great Hall

24 Alumni News

32 Inventions

33 Random Walk

COVER

Professor Tillman Gerngross at the Adimab lab in Lebanon, N.H.
Photograph by John Sherman

BACK COVER

Students test robots they made in ENGS 76: Machine Engineering.
Photograph by Douglas Fraser

THE Great Hall

>>NEWS FROM AROUND THAYER SCHOOL

AWARDS

Students' Arsenic Removal System Wins National Prize

THREE RECENT GRADUATES CAME UP AS WINNERS in the National Inventors Hall of Fame's 2009 Collegiate Inventors Competition for a simple, inexpensive method they developed to remove arsenic from drinking water.

As students in Thayer School's capstone course ENGS 190/290: Project Design, Lindsay Holiday '07 Th'09, Dana Leland '09, and Philip Wagner '09 invented the system for use in rural Nepal, where arsenic, which occurs naturally in rock formations, is a major groundwater contaminant.

The device employs the same process—electrocoagulation—that is commonly used in large-scale water treatment facilities but in a scaled-down version

that can be made from locally available materials: three buckets, sand, a 6-volt battery, and two steel plates. Contaminated water is poured into one bucket, and an electrical current is sent through submerged steel plates to release iron precipitates. After the iron particles bind to the arsenic, the water is poured into a second bucket of sand. The sand filters out the iron-arsenic particles, and the clean water flows out a hole into the empty third bucket. The unit can purify 15-liter batches of water. When the students tested the process, they started with water containing arsenic levels of 200 ppb. When they were done, the treated water contained less than 1 ppb, well below the World Health Organization's 10 ppb standard.

Calling the worldwide need for this system "immense," the project's sponsor, David Sowerwine of VillageTech Solutions (VTS), says, "We are really pleased with the work of the design team from Thayer." Now VTS aims to raise enough funds to put a design and business team on the ground in Nepal, India, or Bangladesh. The goal: complete a manufacturable product, business plan, and donor-support agreement within 24 months.

"I hope that our work can help bring clean drinking water to people in need," says team member Leland.

The student trio also received Thayer School's 2009 Special Faculty Award for Engineering and Service to Humanity.

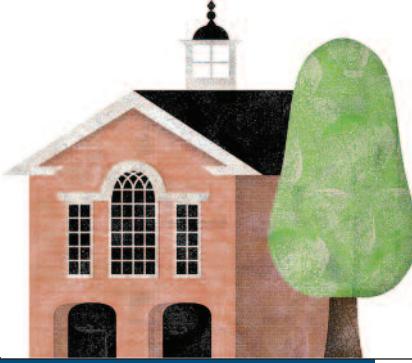
—Kathryn LoConte

▼
GETTING THE ARSENIC OUT
Left to right,
Lindsay Holiday,
Dana Leland, and
Philip Wagner
present their
arsenic removal
system during an
ENGS 290 class.



Partners in Innovation Campaign

Goal: \$60 million
Achieved: \$61 million



ENTREPRENEUR

Student Runs Energy Audit Company

FOR MOST STUDENTS, FULL-TIME STUDY IS enough work. Not so for M.S. candidate Matthew Christie. Having founded Radiant Energy Audits last summer with Will Davis, a civil engineer in Wilder, Vermont, Christie spends his spare time performing energy audits on houses in New Hampshire and Vermont to help homeowners lower energy costs, improve comfort, and reduce carbon footprints.

Christie was already certified as an energy auditor when he started his master's studies on energy technologies. After taking Professor Charles Sullivan's power electronics course and an entrepreneurship course at Tuck School of Business, Christie considered forming an energy auditing company. When he met Davis playing ultimate Frisbee, the two also tossed around business plans. "Eventually we said, 'Let's actually try doing this,'" Christie says.

Christie and Davis perform approximately four audits per month, assessing where a house is leaking energy and heat and looking at air quality and for advanced signs of water damage, mold, and other health and comfort issues. "Then comes the fun part," Christie says: inspecting attics and crawl spaces to check insulation and air seals. "What we're looking for is more cost-effective measures that you can do to your house right away without totally invasive or destructive reconstruction. The two simplest remedies: seal and insulate those attics."

Although he saves his clients money, making money isn't Christie's main objective. "A lot of the reason for starting Radiant was to learn how to start a business—figuring out insurance, accounting, and how to form an LLC," he says. "We're just trying to make enough money to pay for the equipment we bought."

Christie says that after he graduates, he will most likely turn Radiant over to Davis. His own goal is to work with a firm or start another business that offers reconstruction in addition to audits. "I really feel that in terms of battling climate change and reducing carbon footprints, efficiency is the first step, by far," he says, "and the technologies are here now."

—Elizabeth Kelsey



PHILANTHROPY

Thayer's Campaign Reaches Goal

THAYER SCHOOL RECENTLY ANNOUNCED the successful completion of its \$60-million Partners in Innovation Campaign. More than 2,000 donors contributed \$30 million for facilities, \$14 million for Thayer's endowment, and \$17 million for current use. Accomplishments of the campaign, which was chaired by Thayer Overseer Charles Nearburg D'72 Th'73, '74, include:

- Full funding of MacLean Engineering Sciences Center
- Four endowed professorships
- More than \$5 million for student fellowships
- Seed funding for Ph.D. Innovation Program
- More than \$7 million to encourage entrepreneurial projects among students and faculty

kudos

» A manufacturer of software that can help engineers determine a product's carbon footprint has agreed to donate funds from its sales to support **Formula Hybrid**, the annual international student competition based at Thayer. Dassault Systèmes SolidWorks Corp. will donate \$1 for every download of its SolidWorks SustainabilityXpress software, up to \$10,000, to Formula Hybrid, which encourages students to design high-performance fuel-electric hybrid vehicles. "SustainabilityXpress will aid in students' decision-making processes regarding sustainability and the life cycle of components or materials they use in building their plug-in hybrid or electric vehicles for the Formula Hybrid competition," says Formula Hybrid deputy director Wynne Washburn.

» *Scientific American* recently featured **Professor Victor Petrenko's** technology for de-icing car windshields, power lines, airplane wings, and bridge cables. Petrenko's IceController delivers a swift jolt of high-power electricity that immediately melts ice where it meets surfaces, letting the ice slide away. "The objective is to heat an interface in between the ice and the surface from ambient temperature to ice[s] melting point quickly and with a lot of power," Petrenko told *Scientific American*. His company, Ice Engineering LLC, has installed the technology on the Uddevalla cable bridge in Sweden and a 107,639-square-foot glass dome in a mall in Moscow.

STUDENT PROJECTS

I Want One of Those!

▼ Infared Navigator for the Blind



FIVE STUDENTS CREATED A WEARABLE infrared obstacle detector to help the visually impaired. Their prototype was designed to be inconspicuous, quiet, durable, and power-efficient, with a range of 1.5 meters and a low \$30 price tag. Inventors **Mncedisi Sikhondze '11, Harold Dansu '12, and dual-degree students Irina Cazan, Ermira Murati, and Qingyi Wang** won the Phillip R. Jackson Award for outstanding performance in ENGS 21: Introduction to Engineering. Their teaching assistant was Christian Ortiz '11.

▲
SEEING-EYE BELT
Qingyi Wang
models the
Infrared Navigator
for the Blind.

CLASSROOM

Technology Assessment

WHAT DO HIGH-SPEED RAIL, spinal implants, and lie detectors have in common? They're all among the technologies Thayer Master of Engineering Management (M.E.M.) students investigate in ENGM 178: Technology Assessment. By analyzing prevalent and emerging technologies, students can recommend and justify actions for the technologies' future development—and acquire analytical experience for future careers.

"A technology assessment task or function is likely one of the things they will get assigned to do early in their careers," says Professor and M.E.M. program director Robert Graves, who teaches the course. "The nature of technology assessment and the way we do the course causes them to sometimes move outside the specifics of their engineering discipline preparation. We might have a student who's a civil engineer in preparation but doing a technology assessment project on a chemical-related project area like methane hydrates, so it broadens their technical breadth."

The approximately 50 students in the fall-term course spent the first few weeks learning assessment tools, such as the Delphi method (querying experts on a problem until a consensus is reached), cross-impact analysis (identifying the effects that multiple events have on each other), and exponential smoothing for

forecasting data. Then teams got down to assessing actual technologies under the guidance of a faculty advisor and an outside mentor associated with the field.

For their project, students Prateek Reddy and Yiming Liu chose to study the LCD monitor technologies for General Electric Healthcare's C-Arm surgery device. The two worked on cutting costs by finding off-the-shelf LCD monitors to replace the current custom-made monitors that GE Healthcare has been using. "We've found a few alternative monitors that meet most requirements," Reddy reported during the term, "and we want to explore the future of these devices as well as the possibilities of using other technologies to make the monitors more user-friendly."

Reddy likes what the course demands. "The course blends my technological background and the skills that I wanted to develop in the M.E.M. program, like teamwork and communication," he says.

Reddy's project advisor, Professor Solomon Diamond, says he tries to prepare students for the competitive global marketplace. "I guide them to challenge the assumptions that they encounter and develop their own understanding of the technology," he says. "Then I guide them to envision the unanticipated future trajectories and consequences of the technology. I hope that the students learn how to think critically and operate intelligently in a world of complex technology, fiercely competitive markets, and multifaceted social, political, environmental, and ethical factors."

—Elizabeth Kelsey

Move from room to room and see Thayer School without even leaving your couch: engineering.dartmouth.edu/thayer360



VIRTUAL TOUR

Around the School with Thayer 360

EVER WONDER WHAT THE CEILING OF THE Couch Student Project Lab looks like up close? Now you can find out with Thayer360, the panoramic virtual tour of Thayer School. The tour, launched last September to give prospective students an insider's perspective of MacLean Engineering Sciences Center and Cummings Hall, provides 360-degree views of the spaces most widely used by students, along with videos, photos, and information about life at Thayer School.

So go ahead, open your browser window and play. Zoom in to see students at work in labs. Land in the middle of the bustling machine shop and hear the equipment roar around you. And let your mouse soar you up into the rafters of the Atrium. Move from room to room and see it all without even leaving your couch. You'll find the tour at engineering.dartmouth.edu/thayer360.

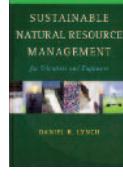
PUBLICATIONS

Faculty Books

>> Creep and Fracture of Ice by Erland M. Schulson and Paul Duval (Cambridge University Press, 2009)—Examining the physics of how ice creeps when loaded slowly and fractures when loaded rapidly, this analysis of ice deformation includes discussion of the behavior of glaciers and ice sheets in relation to climate change. Schulson is the George Austin Colligan Distinguished Professor of Engineering.



>> Sustainable Natural Resource Management by Daniel R. Lynch (Cambridge University Press, 2009)—The MacLean Professor of Engineering Sciences, Lynch uses applied mathematics to examine natural resource management and sustainability. He covers renewable and nonrenewable resources, including petroleum, fisheries, and water.



>> Scientists from around the world are joining forces to help resolve issues related to the sustainable production of energy from biomass. The Global Sustainable Bioenergy (GSB) project (engineering.dartmouth.edu/gsbproject), led by **Professor Lee Lynd**, kicked off in November with a meeting in Malaysia. "A key focus of our project is to look at future scenarios that are not continuous with current trends," says Lynd. "By showing that bioenergy-intensive futures that honor other important priorities are physically possible on a global scale, it is my hope that the GSB project will motivate and inform action toward this end." Lynd, the Paul H. and Joan A. Queneau Distinguished Professor in Environmental Engineering Design, describes the project—and his longtime passion for biofuels—in a Jones Seminar that is available on YouTube (keywords: Thayer School Lynd biofuels).

>> The Eastern Snow Conference awarded **Si Chen Th'10** the Wiesnet Medal for best student paper at its conference last June. Chen presented the paper "In-situ Observations of Snow Sublimation Using Scanning Electron Microscopy."

>> A \$2-million award from the National Science Foundation will enable **Professor Simon Shepherd** to help expand the international Super Dual Auroral Radar Network, or SuperDARN, used to study the space plasma environment that surrounds the Earth. Shepherd is part of a collaborative project with colleagues from three other schools to construct an array of ground-based remote sensing instruments. "This data will help us better understand the near-Earth space environment and ultimately better predict geomagnetic storms and their effects on terrestrial and space systems," says Shepherd, who will oversee the construction and operation of at least one of four new radar sites. He will be joined in that effort by co-principal investigator Raymond Greenwald Adv'70.

the innovator



COMMAND POST

Tillman Gerngross directs a 45-member team at his Adimab lab in Lebanon, N.H.

BIOTECH ENTREPRENEUR TILLMAN GERNGROSS REVEALS HOW HE TURNS THE IMPOSSIBLE INTO MULTI-MILLION-DOLLAR COMPANIES.

Chapter 1: “You Are Crazy!”

As the human genome project entered its final stages of mapping and sequencing every human gene, Tillman Gerngross was among the thousands of scientists worldwide anticipating a new era of protein-based therapeutics—drugs that could treat anemia, cure inflammatory diseases like lupus, or stop cancer in its deadly tracks.

Gerngross, a bioengineer and professor of engineering at Thayer, was also anticipating the next question: How are we going to make all those drugs?

The year was 2000, and he was already thinking about an answer.

In the pharmaceutical industry, the culmination of the human genome project represented a beginning rather than an end. “With the human genome you had a blueprint of every human protein,” says Gerngross. But turning that knowledge into drugs would be a major challenge.

“Protein-based drugs have to be made in living cells,” Gerngross explains. Complicating matters further, about 70 percent of human proteins are coated with sugar structures that affect their function. Called glycoproteins, these sugar-covered proteins present a particular challenge for drug-makers. “If you want to make the proteins for therapeutic purposes, you have to make them in a system that puts the human sugar structures on them,” Gerngross says. That process is called glycosylation.

The conventional method for making protein-based drugs used animal cells—a slow and expensive method prone to uncontrollable variations and inconsistencies. Scientists were eager to come up with alternative methods that would yield more consistent results and could be scaled up in large manufacturing plants to handle the number of potential drugs that the human genome project was expected to unlock.

Gerngross saw flaws in most of those al-

ternative approaches. “People tried to solve the problem in a number of ways,” he says. “But if a hammer is all you have, everything starts looking like a nail. If you are a plant geneticist, you know how to put genes into plants. So people were putting human genes into corn and tobacco plants. I thought that approach was orthogonal to how the drug industry actually makes drugs: in a highly controlled environment, not a field. In addition, corn and tobacco were not able to put human sugars on the proteins they made. People were also putting human genes into goats, chickens, and cows to express the proteins in the milk, then purifying them from the milk. You can keep a goat farm clean, but that is very different from a manufacturing suite for a pharmaceutical drug. I thought those approaches were unlikely to succeed.”

Gerngross took a different tack. “If you could choose an organism that is very good at making proteins to start with and teach it how to put the human sugars on, you would have something much better.”

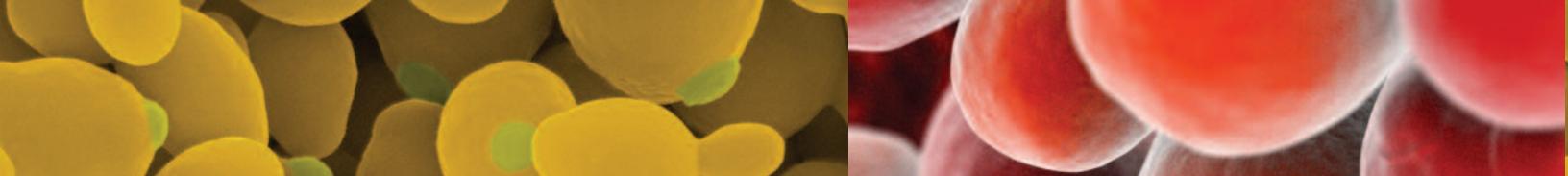
He had an organism in mind. “As a bioengineer I said, why don’t we take yeast, which is a very good organism to make proteins—it’s cheap, grows fast, and has very powerful genetic tools to manipulate it—and genetically engineer it in such a way that we can teach the yeast how to make proteins that have these human sugars on them.”

“And most people said: ‘You are crazy.’ At a minimum you’d have to put in about a dozen genes and knock out a whole bunch of additional genes in the yeast. It would be a cell engineering project of a magnitude beyond anything that had ever been done.”

But Gerngross thrives on matching wits with nature. Growing up in Austria, he loved to garden. “As a teenager I had a huge vegetable and herb garden. I liked working with plants, setting up the whole thing and having control over where you plant your

cucumbers, your tomatoes, and all that,” he says, with a chuckle. “There’s a lot of chemistry involved: the nitrogen cycle, issues related to chemistry. And I read a lot about science—biology, physics, chemistry.” He graduated from a science high school, and then headed to Paris to study French at the Sorbonne. But he soon returned to science, studying chemical engineering in Vienna. “Chemical engineering was generally viewed as a very hard subject matter, and I was attracted to the challenge,” he says. He earned a master’s degree in biochemical engineering from the Technical University of Vienna and then joined Arnold Demain’s microbiology lab at MIT while continuing to work on his Ph.D. in molecular biology. At the start of his professional career, Gerngross focused on making plastics from corn rather than fossil fuels, but concluded that the process would require too much energy and produce too much greenhouse-gas emissions. He published his analysis in *Nature Biotechnology* and *Scientific America* in 2000. “Both attracted significant media attention and demonstrated Gerngross’ willingness to ask hard questions even when they are unpopular, and more importantly, to deal with the consequences when the data do not support his assumptions,” reports Demain. Gerngross, who had begun teaching at Thayer School in 1998, says he did some scientific soul-searching. “The more I thought about what science is all about, particularly engineering, I saw it as a way of connecting science to human needs. The work you do has to benefit humanity in some way. My creativity ended up being more and more focused on how you make drugs, discover them, and ultimately on how you cure diseases.”

At the beginning of his work on yeast glycosylation, Gerngross took a traditional academic approach. “I went to the typical funding agencies—NIH, the Whitaker



Foundation for Bioengineering, NSF—and they said no, this is not something that is really feasible,” he recalls. He understood their reluctance to fund him. After all, people had been working on pieces of the glycosylation puzzle for a decade without much success. “It was pointed out to me that I was neither a yeast geneticist nor a glycobiologist,” he says, “There was more than a healthy dose of skepticism.”

Being turned down “forced me to consider other options,” he says.

The path led to former Thayer School Dean Charles Hutchinson, who had hired him in 1998. An experienced entrepreneur, Hutchinson had faith in the man and the idea. “Tillman is very smart, focused, and energetic,” says Hutchinson. “The concept of making biologics in yeast made sense. Of course we’d also have to have clear milestones and hit them and be on budget.”

Hutchinson and Gerngross co-founded GlycoFi in 2000. (That’s Glyco for glycosylation and Fi for the high-quality fidelity of the product.) As CEO Hutchinson was responsible for raising funds and overseeing legal and administrative matters. As chief scientific officer Gerngross led the scientific team and, as Hutchinson says, “set the tone and vision” for the company.

“I became an entrepreneur by default,” says Gerngross.

Chapter 2: Like a Fox

Gerngross taught himself what he needed to know. “The beauty of science is that you can read all the important papers and develop an understanding of what is really going on. It was months of reading to understand what people had done and speculating about why they had failed, then coming up with alternatives to overcome the deficiencies of their approaches.”

For example, he says, “the first enzyme that you need to make a human glycoprotein in yeast is an enzyme that takes off a form of sugar called mannose. In essence you have to ‘teach’ the yeast to carry out this reaction by introducing the right enzyme. All the prior work that had been done in Japan and Europe used an enzyme from a particular fungus that was engineered to go to a particular location in the yeast. They could prove the enzyme reached the right spot, but it had no effect on the removal of mannose. They argued that using more of the enzyme would solve the problem, but it still didn’t work.”

He discovered why. “I found an old paper from the ’70s where someone had taken that very same enzyme and described its activity

when it is exposed to different pH environments and found that the enzyme is only active in very acidic conditions.”

No amount of the enzyme would make a difference if it wasn’t suited to the environment, he concluded. “It’s like sending guys in bathing suits to the North Pole to perform a task. It doesn’t matter how many you send—they’re not equipped to do the job in that environment.”

He outlined his strategy: “We need to find enzymes that have different pH optima and match up each enzyme with the environment we’re sending it to.”

He was right. “Sure enough, we tried different combinations and when we tried ones that have a better pH optimum, all of a sudden the reaction worked,” he says. “We got something to work that other people had literally been working on for 10 years and couldn’t get to work.”

GlycoFi ran through a vast array of permutations at each step to discover how to eliminate the sugar structures the yeast normally makes and engineer it to produce the kind of sugar structures humans make. “We developed the tools to repeat this process over and over again to finally come up with a humanized yeast that makes fully human proteins,” says Gerngross. It had taken six years, but Gerngross and his team had done the impossible.

Gerngross credits GlycoFi’s achievement to the efforts of his scientific team. “Much of the success we’ve had is based on having been able to attract very strong talent early in their careers,” he says. “I’ve picked people based on raw talent. They may or may not have experience in this particular area, but it was clear to me that they stand out.” Then he lets people use their talents. It’s good for the individuals and for the enterprise, he believes. “Companies are a microsociety,” he says. “You have to articulate what your values are and you have to rally people around those values. And those values are: People will be treated fairly. People will be rewarded based on their contribution to the organization.”

Those aren’t just empty words. “Tillman is a true leader with self-reflection and a selfless commitment to the task at hand that people are eager to follow,” says Dr. Huijuan Li, a former post-doc in Gerngross’ lab at Thayer who worked with him at GlycoFi. “He is always willing to look to others for their opinion, open to change, and ready to go the extra mile to get the job done,” she says. “He helped me professionally to become more than I ever thought pos-

sible. He unlocked the potential of the scientists at GlycoFi to accomplish this scientific achievement.”

GlycoFi ended up being more valuable than either Gerngross or Hutchinson anticipated at the onset—because the company produced a more consistent product than conventional methods. “It turned out that when you made things in the conventional method in mammalian cells you got fairly heterogeneous mixtures of sugars on your protein. Yes, they were all sort of humanlike, but they were always different, and they all had different pharmaceutical properties. From a drug discovery perspective, it’s terrible,” Gerngross explains.

“Our engineering yeast gave us a level of control that wasn’t possible in the industry before. While GlycoFi was originally set up to solve a manufacturing problem, it ended up being a company that could make a drug more potent and more effective—and that is really what became the value, in addition to the manufacturing piece. If you can make a drug that is 100 times more potent, then you can dose it lower. That’s why Merck bought the company.”

Merck paid \$400 million for GlycoFi in 2006, the third highest price ever paid for a private biotechnology firm, according to the National Venture Capital Association.

Chapter 3: The Labyrinth

After selling GlycoFi, the man who had become an entrepreneur by default became an entrepreneur by choice. He zeroed in on another fast-growing pharmaceutical area: discovering and optimizing human antibodies that could be used to develop new treatments for tough conditions such as infectious, inflammatory, and auto-immune diseases, central nervous system disorders, and cancer.

The problem, however, was not purely technical. He also needed to maneuver around the maze of patents in the antibody area that would trap the technology in legal corners and costly third-party payments.

“A patent allows you to exclude others. It doesn’t necessarily mean you can practice your invention, because there may be elements of what you do that actually are patented by someone else,” he explains. “So while I have a patent, I still may need rights to this and to this piece so I can make my piece work. The end user ends up having to pay me and this guy and this guy. That makes it very cumbersome and costly, if you have a technology and you have to



go to five other people and ask for rights so you can actually use it."

By then Gerngross was joined by his former student, Errik Anderson '00 TU'07, who was finishing up his M.B.A. at the Tuck School of Business at Dartmouth. The two met regularly and started reviewing the patent literature, digging through hundreds of patents in their quest to come up with a better antibody discovery platform. A pattern emerged as they kept on stumbling over the same name: MIT Professor Dane Wittrup, whose work on displaying antibody fragments on the surface of yeast was legend. So Gerngross called him. "We had independently converged on the conviction that a comprehensive antibody discovery capability was sorely needed in the pharmaceutical industry, so when he called me we were basically completing each others' sentences," says Wittrup. "We went from first meeting to incorporating Adimab in just a couple of months."

Gerngross and Wittrup founded Adimab (it stands for Antibody Discovery, Maturation and Biomanufacturing) in 2007.

"In the GlycoFi case, the big hurdle was technical. In the Adimab case, the big hurdle was legal—coming up with a path that was legally unencumbered and then on top of that building something that is better than competing technologies," says Gerngross.

He and Wittrup wanted Adimab to be a new platform for identifying and delivering antibodies for drug companies. "We want them to be able to walk in and say, 'I want you to give me human antibodies against this cancer target,' and literally eight weeks later they will have a hundred antibodies against that target. Previous technologies would take half a year and they would give you five antibodies," says Gerngross.

While developing Adimab's technology, "we looked at close to a thousand different patents," he says. "We had five people working on this, with two legal consultants, for nine months, just understanding what other people had protected, what they didn't have protected, what you could do, what you couldn't do, and then based on those constraining factors, we came up with something very elegant that bypassed all that and was still better in the end. We seem to have come up with the optimal solution to our design problem."

"What they have accomplished in this short period of time is remarkable, and anybody in the business of developing antibodies should pay close attention—these guys are rapidly

changing the technological landscape of antibody discovery," says Mike Ross '71, managing general partner at SV Life Sciences, a venture capital firm that invested in Adimab and GlycoFi. Ross, a Thayer Overseer, is on Adimab's Board of Directors.

"It's staggering how much more effective this technology is, how short a time it takes, and how many drug leads it generates," says Terry McGuire Th'82, co-founder of Polaris Venture Partners, an investor in Adimab and GlycoFi. McGuire chairs Thayer's Board of Overseer and is on Adimab's Board of Directors.

The industry is responding. Adimab has already landed antibody discovery deals with pharmaceutical giants Merck, Roche and Pfizer and recently sold about 3 percent of the company to Google for more than \$8 million.

"It's really a game-changing way of doing this kind of drug discovery," says Gerngross.

One thing that hasn't changed is his management style. "People love working with Tillman because they know that he is supremely ethical and fair," says Errik Anderson, who is now Adimab's chief operating officer. "Every decision he makes is grounded in the facts of the situation. He doesn't let his personal ambitions get in the way of doing the right thing, which is probably why he's been so successful."

Gerngross is too busy running Adimab—now up to 45 employees—to stop and reflect for long on his successes. He rarely takes time any more to go sailing or skiing. His one obvious indulgence is a machine that matches his own sense of precision performance—a silver Porsche that he drives between Adimab and Thayer School, where he continues to teach courses on biotechnology and biochemical engineering. The real rewards, he says, are in the work. "Making money becomes a minor issue over time," he says. "Having changed lives in a meaningful way, giving people opportunities to do something big—those are the things I cherish much, much more than the economic impact of the companies I've started."

In the end, Gerngross ties his entrepreneurial accomplishments to the reason he became an engineer. As he puts it, "Entrepreneurship is an extension of my academic career that allows me to take basic discovery into a realm where it actually impacts real people."

Karen Endicott is editor of *Dartmouth Engineer*.

Entrepreneur Tillman Gerngross on founding a successful company

Establish clear milestones. "When you want to put together a complex scientific program or project with many moving pieces, you have to articulate a strategy of how you're going to do that. You can't just say we want this and hope for the best."

Hire smart people. "Much of our success is based on attracting strong talent early in their careers. I've picked people based on raw talent. They may or may not have experience in this particular area, but it was very clear to me that they stand out. They have to be scientifically strong, but beyond that they also have to be able to work with other people, and recognize their own strengths and weaknesses."

Articulate company values: "People will be treated fairly. People will be rewarded based on their contribution to the organization."

Be clear about what you do and don't know. "We didn't know exactly how some things worked, but we knew what some of the influencing factors were. And that was enough. We could say let's change all the parameters and see how that impacts the system."

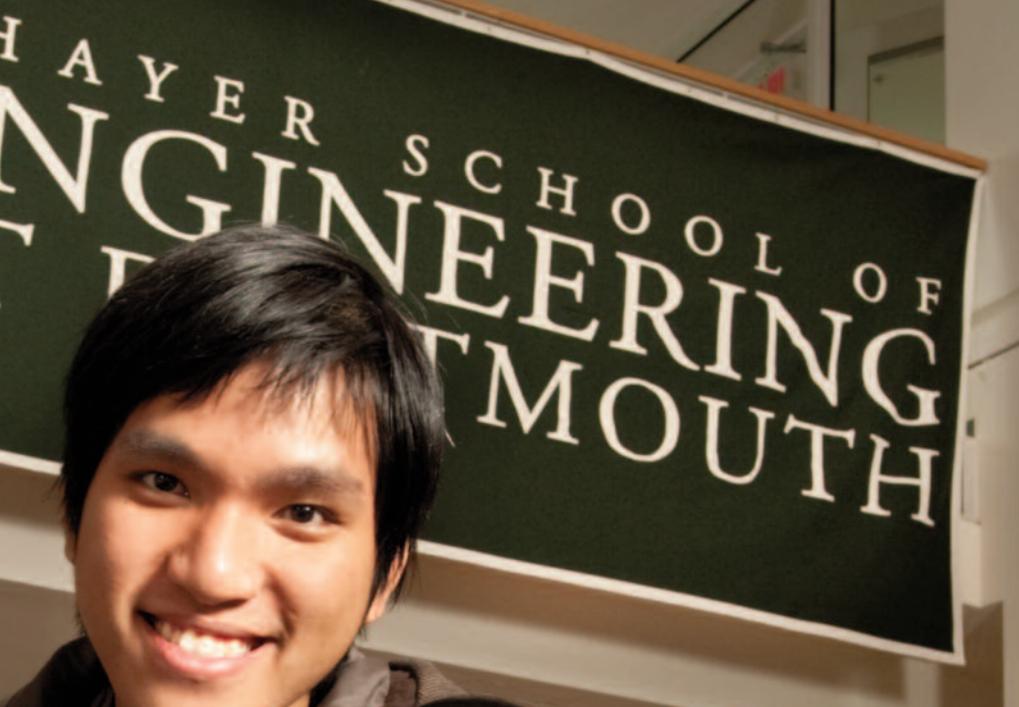
Analyze everything. "In the process of entrepreneurship—creating something of value—you cannot limit your analysis just to technical superiority or improvements. It has to hit all levels. It has to be technically better, you have to have freedom to operate, you have to have a legal path forward, and on top of that you have to be able to protect what you have. It has to be sufficiently novel that there are elements other people can't reproduce. All these things have to come together to make something of utility and value."



THE
EAT

EXCHANGE STUDENTS
From left to right, Chaya Chansmitmas, Worapol Ngamcherdtrakul, and Wannaporn Dechpinya gather in the atrium of MacLean Engineering Sciences Center.

Travelers'



Tales

STUDENTS LEARN MORE
THAN TECHNOLOGY IN
THAYER SCHOOL'S NEW
THAILAND EXCHANGE PROGRAM.

BY KATHRYN LOCONTE

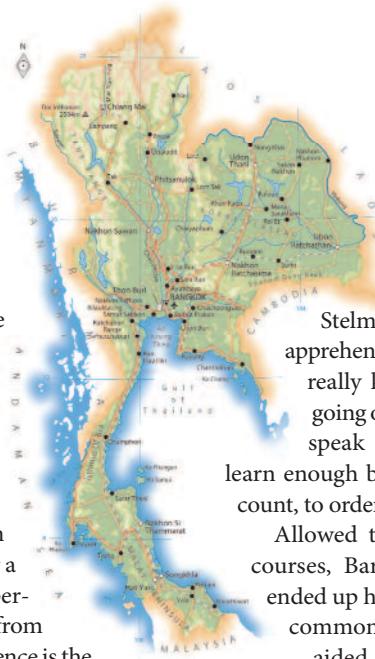
It's

on the other side of the world, and culturally, Bangkok could not be more different from Hanover, New Hampshire. But that didn't stop Professor Francis Kennedy from establishing an undergraduate engineering exchange program with Thailand's Chulalongkorn University—a.k.a. "Chula." In fact, for a program that aims to broaden the perspectives of engineering students from both Thailand and Dartmouth, difference is the point.

"The Thai students feel that studying successfully in the United States will be a big plus for them. For the Dartmouth students, it broadens their engineering program and more importantly their cultural awareness," says Kennedy. "And with the rapid increase in globalization, which has significantly affected both our workplace and our daily lives, it is important for everyone, including engineers, to be aware of the cultural differences and similarities between people from different backgrounds. A period spent in a foreign country can make us better citizens of the world and may well open up career opportunities that might not be as available to people whose horizons are more limited."

When scouting locales for an engineering foreign exchange program, Kennedy brought his longtime familiarity with Thailand into play. While working there on a collaborative research project sponsored by the Thai government, Kennedy investigated Chulalongkorn. "Chula is arguably the best university in the country," he says. "For 90 years or so they've been in business as an engineering school." He arranged for the Thayer program to be based at Chula's International School of Engineering, where classes are taught in English.

In January of 2009, Charnice Barbour '10 and Casey Stelmach '10, the first Dartmouth students in the program, hopped a plane for Bangkok. "At first, I was a little nervous," admits Barbour. "I really didn't know anything and I didn't know anyone besides Casey. But Thailand was attractive to me because I'd never seen that part of the world. After I got there and learned the numbers and some Thai for bargaining with the street vendors, I kind of figured things out on my own. The weather was also really nice. It was a good break from the snow up here. Once I got used to the place, I really enjoyed it."



Stelmach had similar apprehensions at first. "I didn't really know much about it going over," she says. "I don't speak Thai, but I tried to learn enough basics to say hello, to count, to order in a restaurant."

Allowed to choose their own courses, Barbour and Stelmach ended up having a few classes in common, such as computer-aided design and failure mode and effect analysis.

"Some of the classes that Chula offered weren't offered at Dartmouth, like the failure mode class," says Barbour. "The class looked at examples of why real-life structures like bridges and buildings failed."

"It was different adapting to the class structure, it being primarily an exam-based curriculum rather than a project-based curriculum like it is at Thayer," says Stelmach. "I think I learn better with projects and homework to reinforce that learning."

"The program is a good way to experience engineering outside of the United States, just to see how it compares to us," says Barbour. "Besides how the classes are structured, I found that it wasn't much different. It's good to know that they're teaching the same stuff in that part of the world. It's good to know that if I wanted to get a job outside of the United States in engineering, I'd be okay because I know that we're basically learning the same concepts."

Barbour and Stelmach made time to experience life outside the university. They took Thai cooking classes, explored Bangkok, and traveled the country. "We went to a temple that started as a wildlife refuge," says Barbour. "For two hours during the hottest part of the day, when the tigers are sleeping, you can have your picture taken with them and pet them. It was pretty exciting to pet a huge tiger like that."

"I learned a lot of engineering and learned a lot outside of engineering," says Stelmach. "It was great to see a completely different culture than my own and gain some understanding of it. I met some really wonderful people who I still keep in touch with. But I think what I took away most, though, was more of a level of comfort in the world. I'm now able to go into a strange situation, a strange place like Thailand, and thrive."

IN SEPTEMBER OF 2009, THREE THAI STUDENTS began fall term at Thayer School.

"I feel very excited to be here. It is the best exchange program we had in Thailand," says Wannaporn Dechpinya.

"I chose to participate in this program because I plan to do my master's in the United States," says Chaya Chansmitmas, an information communication engineering major at Chula. "My goal is to use my engineering background and then apply it to business." The Tuck School of Business factored into his decision. "We all know that Tuck is one of the top business schools in the country. And so I chose the courses that are taught by the Tuck professors, the types of courses I will be taking in business school, such as marketing, optimization, and finance. I want to test myself."

"I knew that it would be a great thing, to experience living abroad away from family," says Worapol Ngamcherdtrakul. "You live more independently, get to know more people, get to have roommates. I knew I'd get to learn something new because there are many courses offered here that are not offered at my home university. But the main reason that I chose here is that it is one of the most prestigious colleges in the world."

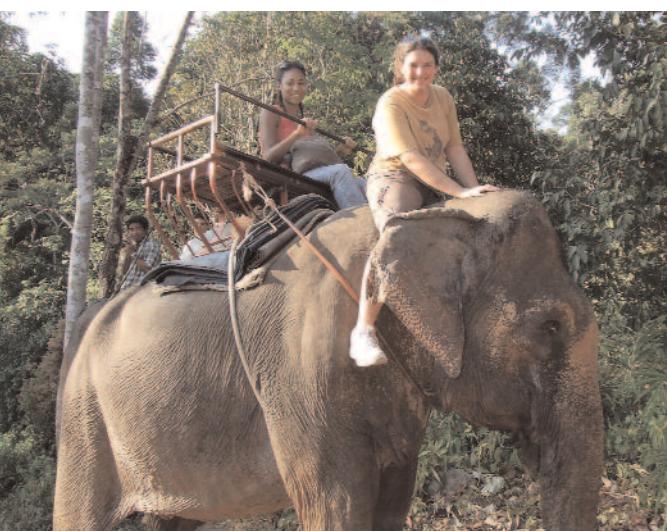
The students had to get used to a different academic style at Dartmouth.

"In Thailand, we have a semester system, so we have more time per semester," says Ngamcherdtrakul. "I do not have as much spare time as I did in Thailand. The courses are pretty intensive, and I have to spend more time on campus, on engineering, and in libraries."

"One big thing that is different here is that the bulk of my classes are based on class participation," says Chansmitmas. "In my finance class, class participation counts for 30 percent of the grade. In Thailand the most important thing is to do well in the midterms and the quizzes."

"In Chula, we don't have this much homework," says Dechpinya. "In one of my classes here, the homework is worth 50 percent of your grade. If you don't practice and do the homework, you will fail. We need to be responsible for ourselves."

Classes brought other discoveries as well. For example, in ENGS 100: Methods in Applied Mathematics, Dechpinya dispelled stereotypes on both sides of the cultural gap. "All the rumors I'd heard about Americans said that they're bad



EAST AND WEST

Top left: Casey Stelmach, left, and Charnice Barbour at Chula. Left: Barbour and Stelmach try local transport. Right: From left to right, Chaya Chansmitmas, Worapol Ngamcherdtrakul, and Wannaporn Dechpinya at Thayer School.

at math," she says. "And this course proves to me that, no, Americans are not bad at math at all. They are all great! And this math is so hard! I used to feel like, 'Okay, I'm Asian, I am so good in math.' But no! I'm not that good. The course is very hard to me, but it's still fun."

Ngamcherdtrakul likes the scope of his Dartmouth courses, ENGS 35: Biotechnology and Biochemical Engineering, ENGS 13: Virtual Medicine and Cybercare, and a biochemistry course. "They fit in well with my bio-nano engineering major. At my home university, my courses focus mainly on biomaterial and biomedical engineering, but here I get introduced to biotechnology, gene cloning, and protein engineering. I get a bigger picture of the field and its applications," he says.

"I think that the type of class environment here is good," says Chansmitmas. "For example, the professor in my finance course likes to make cold calls during class. He calls it the Wheel of Fortune. He presses a button and a wheel keeps on rolling. If it stops at your name, you answer

the next question. The light is on you, and the whole class is waiting. For the first few classes it was quite intimidating. He's always asking us, 'Really?' and 'Why?' We have to defend our answers using all the knowledge we have learned, and not just in textbooks, but in the newspaper, too."

Chansmitmas says that the whole Thayer community made him feel welcome. Alums gave him career advice, for example. "I'm not a student of Dartmouth but they were willing to help so much," he says. "They talked to me for a half hour and gave me really great insight. It's not only alumni who have been friendly, but also the students. The friends and people I've met here at Thayer, they know my name, they know my face."

Dechpinya has similar feelings. "I went on a Dartmouth Outing Club hiking trip and sprained my ankle—and everyone was so very nice to me! The rescue team carried me on their backs. It took three hours to get me off Mount Moosilauke. The people brought me to the hos-

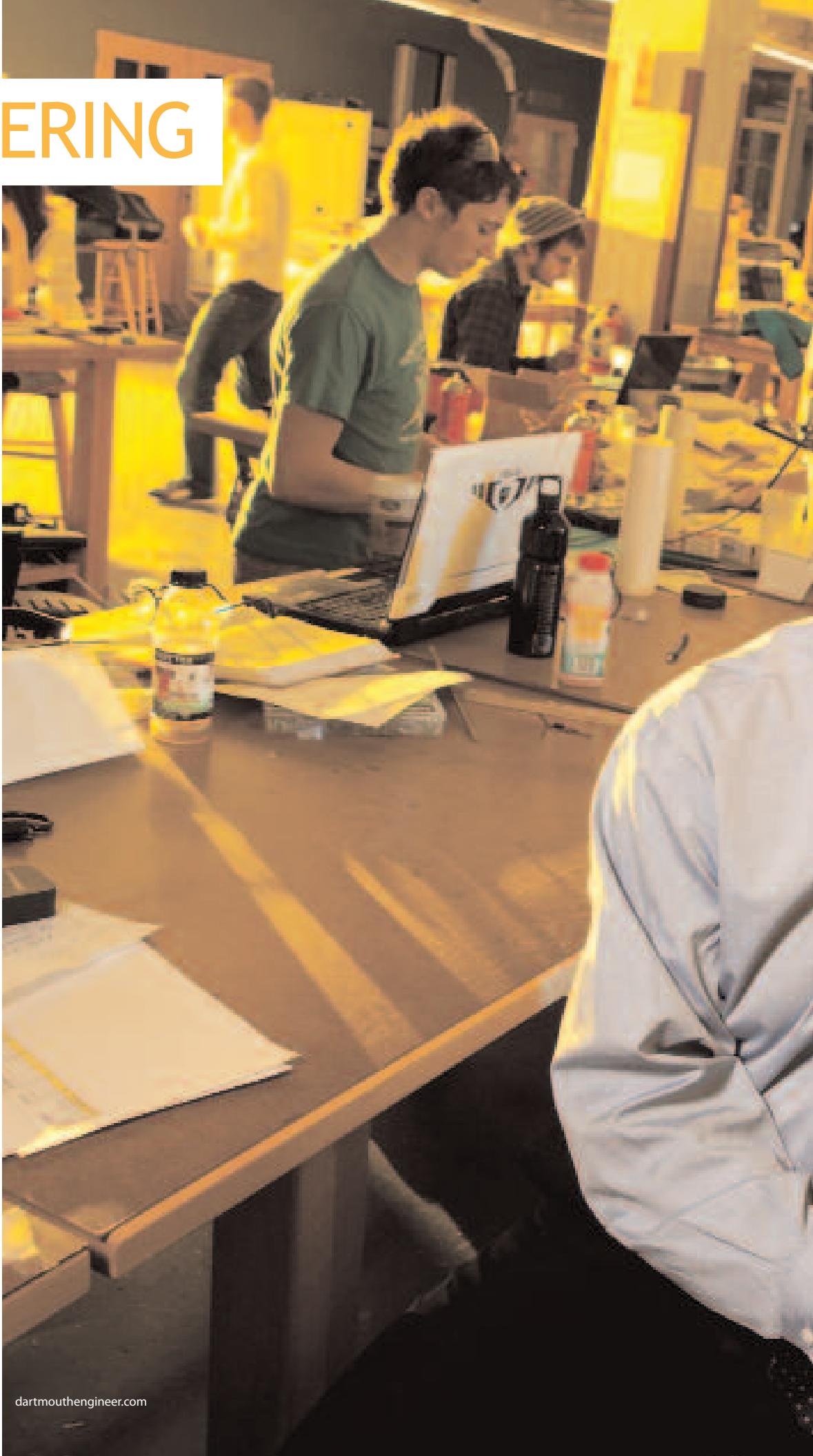
pital, to dinner, and everyone really cared about me. These people were so cool. I mean, why did they have to care about me? I'm just an exchange student who got a sprained ankle because I didn't wear hiking shoes and I don't exercise. But no one blamed me at all. I felt very impressed by that."

The program helped Dechpinya see a lot of things differently. "Being here has taught me that I'm not always the best person at everything," she says. "Back in Thailand, I'm always at the top of the class. But here, there are people that push my efforts even more to succeed in everything in my life. Before coming here I didn't know what I would like to be. I just knew that I was good at engineering and calculations. But they have taught me how to picture my future and find the things that I really love to do. I've learned from these people a lot."

Kathryn LoConte is assistant editor at *Dartmouth Engineer*.

ENGINEERING

Z G — DESIGN BY B





PROFESSOR PETER ROBBIE '69 ADDS ART TO THE SCIENCE OF MEETING HUMAN NEEDS.

BY ELIZABETH KELSEY

PHOTOGRAPH BY JOHN SHERMAN

THE CHAIRS have been rearranged to make space for an impromptu stage. One by one, the actors leave their seats to join their classmates at the front of the room to enact a restaurant scene. One student eats with an imaginary knife and fork, while another stirs an unseen pot of food. Others heft invisible trays to wait on tables.

It's an improv exercise, but it's not taking place in the Hopkins Center for the Performing Arts. Instead, it is in Professor Peter Robbie's Design Thinking class in Thayer School's McLean Engineering Sciences Center. "This class on improv is a tool for brainstorming," he explains. "I've always thought that the quickest and smartest folks at the brainstorming phase of design have been those who do standup and improv. They never say no. They never miss a beat. Improv requires players to accept what they are given, build on the ideas of others, and encourage wild ideas."

This improv class may be unusual for an engineering course, but then again, Robbie is an unusual professor for an engineering school. His creative background and vision have steered numerous students into successful careers in product design, deepened the emphasis on design in engineering that former dean Myron Tribus introduced to Thayer School in the 1960s, and helped Thayer School earn a spot on *Business Week* magazine's list of the top 60 design schools in the world. Not bad for someone who's not an engineer.

CREATIVE PATHS

Robbie took a circuitous route to Thayer School. At Dartmouth he majored in English while also loading up on psychology, art history, and design classes before graduating in 1969. He completed an M.F.A. at Cornell, concentrating on sculpture and showing his work at New York's Aquavella Gallery. He returned to Dartmouth in 1972 to teach visual studies and later became director of the design workshops at the Hopkins Center. All the while, his thinking about design was expanding. "Through my design teaching I became really interested in design problems that influenced people's lives," he says. "Instead of simply making objects that were visually beautiful and meaningful, I began to focus on addressing meaningful human needs."

Robbie's design collaborations at Thayer began in the mid-1980s. At Professor John Collier's invitation, Robbie lectured on creative product design practice, began working with

student groups, and served on the professional review board for Thayer School's project-based introductory course, ENGS 21. "Peter focuses on the need for engineering students to go beyond function and performance and to include aesthetics, feel, quality, etc.," says Collier.

Robbie also collaborated with former dean Carl Long, who, says Robbie, wanted to find ways to inspire students' creativity before they dove into advanced design projects for the capstone course ENGS 190/290. In 1987 Robbie and Collier presented Thayer's first product design course as an experimental offering. Attracting a mixture of studio-art majors and engineers, the course was the beginning of a curricular series that now includes ENGS 12: Design Thinking and ENGS 75: Product Design. Robbie also brings design innovation into two courses he co-teaches with plastic surgeon and adjunct professor Joseph Rosen—ENGS 5: Healthcare and Biotechnology in the 21st Century and ENGS 13: Virtual Medicine and Cybercare.

Robbie has extended his design expertise into research at Thayer as well. Collaborative work on medical imaging technologies for treatment planning led him to co-found a company that became Medical Media Systems (which later became M2S). More recently he has consulted with Thayer professors Keith Paulsen and Paul Meaney on a microwave imaging system for detecting breast cancer.

Thayer's physical plant also bears Robbie's influence. Serving on the building committee for MacLean Engineering Sciences Center, the expansive addition to Thayer that was completed in 2006, Robbie and other faculty members worked with architectural firm Koetter/Kim to refine building specifications. According to Professor William Lotko, who chaired the committee, Robbie pushed for the new student project lab in MacLean to function like a design studio—with movable furniture, whiteboards for brainstorming, a wide array of creative tools, and lots of flexible space. The result: Couch Student Project Lab is itself a model of designing to meet the needs of real users.

Lotko counts on Robbie to convey that kind of design insight to students. "For years he has given a number of guest lectures in ENGS 21 on the artistic side of design but also on the human-centered aspect of design," says Lotko. "Technical aspects of design really have to meet human needs, and Peter has this really interesting perspective that he brings to any classes that

he's taught here having to do with design. He lives between the fine arts and engineering in his outlook and perspective and the kinds of things he brings to our courses. He's a unique individual in that sense."

WHY DESIGN MATTERS

According to Robbie, design is crucial for engineers. "Design begins with the recognition of need and follows an intentional process by which you apply knowledge and actually make products to effect change," he says. "It is central to innovation. It essentially is the process of innovation."

Not all design is created equal, however. In addition to the aesthetic side of design, Robbie distinguishes between technology-driven design and human-centered design. "Technology-driven design often results in products looking for a need. Human-centered design always keeps the needs of end users in mind," he says. "Design for humans needs to begin with developing understanding and empathy for human experience. It applies science and technology but also includes insights from the humanities and the social sciences. Engineers often love to jump right into making things, but early in the design process it's often preferable to focus on deeply understanding the needs of end users."

Human-centered design ups the engineering ante. "Making a product that looks great requires designers with a good eye and artistic skills. Making a product that is a pleasure to use requires that designers consider all aspects of user interaction with the product," Robbie says. "In addition to a pleasing look and feel, human-centered design explores opportunities for innovation in interface design, ergonomics, function, and use. Great designs do it all."

Design increasingly makes a difference in the marketplace, he adds. "In the period of scarcity after World War II in America, companies could essentially sell anything they could make because people were happy to have whatever they made," he says. "But since the explosion of competition globally, design has become the best way—or only way—that companies differentiate their products. It has developed into a key aspect of innovation and a requirement for success."

DESIGN IS A PROCESS

"The most surprising thing to me about design is the fact that you can learn it," says engineering major Francis Fortin-Houle '10. "When I

RAVES AND FAVES

Peter Robbie on examples of great design

ONE LAPTOP PER CHILD XO LAPTOP

Designers: Fuseproject (Yves Behar), MIT Media Lab (Nicholas Negroponte, et al.)

"The mission of One Laptop per Child (OLPC), formed at MIT in 2005, is to provide all children in the developing world with a rugged, low-cost, low-power, connected laptop with content and software designed for collaborative, joyful, self-empowered learning. Governments purchase the laptops directly and distribute them to their schools. Beautifully designed for children and challenging conditions, the laptop is sunlight-readable, shock and moisture resistant, easily portable, and energy efficient. OLPC is a great example of taking a compelling need and thinking big."

See all of Robbie's Raves and Faves at dartmoutheengineer.com



first came to Dartmouth, I thought it was a skill that you either have or that you don't have. Little did I know how wrong I was."

Robbie demystifies design by breaking it into systematic steps. "I believe it's important to create classroom experiences that will increase students' confidence in their own creative design abilities," he says.

Using improv to get students comfortable with brainstorming is a case in point. "Everyone thinks that they know how to brainstorm, but in fact, brainstorming is usually plagued by problems like self-censoring, competitiveness, and ridicule," says Robbie. "Improv is a great way for students to learn to defer judgment."

Acting out the user experience of a product or service also gets students thinking about human-centered design, he adds. Then, because "good designers are astute observers of human behavior," he sends students out in the field as anthropologists to notice, question, and analyze what they might otherwise ignore. One recent assignment, for example, required students to watch how fellow Dartmouth students carried books and other belongings around campus. Then the class had to design and make better gear-toting solutions—such as bags that can be used easily by students on crutches or packs that comfortably distribute weight.

"As with learning foreign languages, fluency and flexibility in design thinking come from repeated practice, so my design courses include multiple projects that allow for iterative practice of design processes," says Robbie. "Because every design problem is different, it is important for students to be flexible and know how to use different methods and approaches."

Dartmouth's approach to engineering lends itself particularly well to human-centered design, Robbie maintains. "Engineering in a liberal arts environment is not just about science. It includes the opportunity to apply science from a humanist perspective and to integrate insights from many other disciplines. Dartmouth students understand this challenge and are well prepared to use all the knowledge and talents they have."

That's why Robbie's design courses appeal to non-majors as well as engineers. "Designing is all about invention, creation, and brainstorming, which people from all different fields and backgrounds can contribute to," says Amanda Marston '10. "I am a psychology major and art history minor. Before I took Design Thinking, these two disciplines seemed unrelated. But during Design Thinking, I began to realize that the two actually connect at the intersection of product design."

Design thinking becomes a way of life, according to Robbie. "I think students who become really good at design become experts at a process that they can apply to anything, from designing medical devices to improving the lives of infants in their car seats. The same process can be applied, no matter what the problem is," he says.

Meredith Lunn '06 Th'07 agrees. An analyst at the management-consulting firm McKinsey, she says she regularly uses the design processes she learned at Thayer. "With free brainstorming, we end up with a really big list. Some of the ideas are totally unfeasible but they get us thinking outside the box. This has been very helpful when looking at a huge global health problem

that doesn't appear to have a solution at first. Another thing I use all the time is hypothesis-driven thinking. At Thayer, we did a lot of prototype building, and we do this exact same thing with business concepts. The third step is being able to break down problems. Usually when I start a project there's a huge issue—we're trying to save lives in a country that has no health system in place. Being able to look at the problem from start to finish and identify main points makes a huge difference. The fourth step is always remembering your end user, always remembering the people you're trying to help."

The process of design thinking is increasingly critical for meeting the ultimate need of humanity: finding ways to live sustainably. "Everything that's man-made has to go through some design process," says Robbie. "The world is at the point where we can't just keep doing things the same way. There's going to have to be more emphasis on rethinking the design of everything with a focus on life-cycle analysis and searching for radical new solutions."

Engineering students equipped with both comprehensive technical knowledge and creative design abilities will be in great demand—and will have wide-open opportunities in the next wave of technology innovation. "Going forward, these students know that they'll be required to rethink assumptions about how we make everything in the built environment," says Robbie. "It's going to require an enormous creative effort."

Elizabeth Kelsey is a writer at *Dartmouth Engineer*.



Balancing chairs
by Emilie Fetscher



Emilie Fetscher '03 Th'04

Co-founder, Veranda Solar, San Francisco, California

Design is an amalgamation of psychological needs and desires, engineering function, tactile and visual detail, and user experience. How we interact with products and experiences is all a result of design by some individual. Design can manifest in a new way of presenting information, a new product, or a change to a common experience.

8 ALUMNI DISCUSS THEIR PERSPECTIVES ON DESIGN

At Dartmouth I was interested in sculptural art and the concepts of engineering but not necessarily in being a typical engineer. Once I understood what design could be, it was a no-brainer to try to pursue it.

In my work, I enjoy interacting with people, and I feel motivated to improve their lives in often small or simple ways. I have always had the desire to make people smile but never felt the need to save the world. Through design, I hope to give people moments of happiness.

The common thread in my design work is in design research involving consumer insights. I spend time talking to people with target topics in mind to learn how a group of people views the world, and then I design modifications of new products.

My design work ranges from sculptural pieces like bent-ply balancing chairs to the **Mighty Mitad**, a project that resulted in a very engineered, simple, cost-saving solution for Ethiopians by making their clay cooking surfaces more durable. [View the Mighty Mitad on YouTube, keywords Mighty Mitad - Google Project 10^100].

My master's thesis at Stanford and collaboration with Capra J'neva resulted in the company **Veranda Solar**, which makes solar panels that hang out windows or clip to gutters and balconies. Veranda Solar won second prize—and 100,000 Euros—at the 2008 PICNIC Green Challenge, a competition for new green products and services. [See Veranda Solar panels at dartmoutheengineer.com.]



Kiersten Muenchinger worked on the Long Now Millennial Clock, designed to last 10,000 years,

Kiersten Muenchinger '93

Associate Professor and Director,
Product Design Program,
University of Oregon

Design is a quantitative and qualitative mix of analysis that will lead you to a conclusion. You have to have both of those together in order to have a complete analytical process.

Peter Robbie led me into the design field. He told me about some leading companies in design especially well suited with engineering, including IDEO, which is where I went to work after leaving Dartmouth. I've worked in a lot of design consultancies all over the United States as well as in Italy. I've worked on paper products, gift boxes, and refrigerators—and the development of the Long Now Millennial mechanical clock (longnow.org/clock) designed to last 10,000 years.

Design education is a relatively new discipline. There aren't a lot of people who get a master's or Ph.D. in design with the thought of teaching the subject, though there is a long history of professionals with design experience who want to teach, who want to be inspired by young designers, or who want to give back. I wanted to have a discourse about what was going on in design.

My absolute favorite product is the Louis Ghost Chair by Philippe Starck. It's a lovely chair but what I really love about it is that the manufacturing of this object is so precise. It's complexly transparent and to get it transparent with so little witness marks from its manufacturing process is extremely rare.



The Flip video camera is a joint project of Pure Digital and Smart Design.

As designers we can work with our clients to facilitate an evolution in product marketing and consumption by promoting solutions that embed small reductions in material and energy use across the huge numbers of mass-produced objects. We can encourage sustainable consumption by changing what people expect when buying something.

While I was at Smart Design, I helped launch a sustainable design initiative for the company. We became an early adopter of sustainable “cradle to cradle” thinking—championed by green architect William McDonough ’73—and of the guidelines of the Designers Accord, a global coalition dedicated to creating positive environmental and social impact.

I pursue sustainable and responsible design by seeking out green projects, applying the idea of downscaling to my own process, and collaborating with groups such as Design In Kind, which provides design services for under-funded and needy societies throughout the world.

Clay Burns '87

Product Development Consultant,
clayburns.com, New York City
Product Developer, Design In Kind

We need to go beyond human-centered design to life-centered design. My goal is to bring to life meaningful ideas that promote social and ecological sustainability. By using tools we already have and focusing on building long-term value for society, we can make things that people enjoy while protecting the earth.

After years of considering the paradox of designing new consumer goods and saving the planet from over-consumption, I began to explore the idea of downscaling in design. Downscaling in design involves adopting a routine practice to reduce the size, features, and disposability of the products we develop. It's similar to optimization, but it keeps the needle pointed at sustainability, not just cost.

If, as designers, we really want to help the world go green, we need to make an impact immediately. We can do this without waiting for new zero-footprint green materials. We already have the tools and know-how. We just need to shift the game from cost reduction to reducing the amount of materials and energy used on large-volume consumer goods.

Elizabeth Gerber '98

Assistant Professor, Segal Design Institute, Northwestern University

Peter Robbie's product design course set the direction for my entire career—both the content of his course and the way in which he taught the material.

Design is conscientious intervention into the environment to improve the way we live. Design is everywhere but rarely recognized as such.

I love that I can make an impact in people's lives using my creativity and analytical thinking. I've designed toys for kids to encourage exploration and expression. I've designed medical devices to slow the development of brittle bones. I've designed educational experiences to teach kids about human-centered design.

I've founded an organization, Design For America, that calls on students to use human-centered design to make a positive social impact in their own environments. The organization is less than a year old but is taking off. It clearly is meeting a need for students to engage in human-centered design outside of the classroom in ways that improve their communities.

Two products of which I am fond are the pen and paper. Simple but profound, they allow designers to express ideas visually and instantaneously. No software needed. No complicated technology. At times it feels that we could make more progress in design—especially in the earlier stages—if we were limited to a pen and paper.

Watch Elizabeth Gerber's recent Thayer School Jones Seminar on design on YouTube (keywords: Thayer School Gerber).

Brian Mason helped create the Aquaduct, a water filtration bicycle prototype that won Google's first Innovate or Die contest.



Brian Mason '03 Th'04, '05
Project Leader and Mechanical
Engineer, IDEO
Palo Alto, California

Professor Robbie's advanced product design class sparked my love for product design. In class, he showed a *Nightline* video in which the design and innovation firm IDEO was asked to redesign the shopping cart. As I watched this video I said in my head, "That's where I want to work."

At IDEO, we focus on human-centered design, where we put the user first. Our process includes going out into the field to observe potential users (or, many times, extreme users) and bringing back those stories to inform and guide the design. Then we dive into the design process by brainstorming, prototyping, and testing things out. This process allows us to

deliver cutting-edge designs, new-to-the-world experiences, and new market opportunities.

Design is about elegantly solving human needs. Design is the microwave that is easy to use, the laptop that you don't want to set down, the website you keep going back to, or the medical device that changes your life. Sometimes good design isn't even noticed because it fits so well into our lives.

For the past three years, I have been involved in product development projects in the health arena. I have designed and developed a transcutaneous drug delivery device, several in-home injection devices, a body temperature measurement device for surgery, and a patient recliner chair for hospitals. In between my focus in the health sector, I have been involved in projects ranging from early-phase concept generation around charcoal barbecues to detailed manufacturing and molding of a playground structure. Recently, I worked with a team of designers to create a water filtration bicycle prototype, the

Aquaduct, that won the grand prize in Google's first Innovate or Die contest (check it out on YouTube, keyword Aquaduct). I am passionate about all opportunities where design can be used to genuinely improve people's lives.

Design faves: The bicycle, because it is so simple. People keep trying to redesign the bike, but the basic cog and chain works so well. Experiences are also candidates for good design. I love that whenever you call L.L.Bean, someone picks up within three rings. That's a conscious decision they've made to design a positive experience for you. The website Mint.com is another designed experience where they rethought how individuals could interact with their finances.

Orbit Baby strollers get design pushes from Colter Leys.



Colter Leys '96

Product Development Lead, Orbit Baby
Newark, California

Design is a way of combining pleasure and utility. The job of a designer is to make the back-end human research, manufacturability, and business side of products seem effortless, so all that's left for the customer is pleasure and utility.

I enjoy design for its variety. One day I dive in and learn about how metric bolts and nuts are specified; the next day I'm talking to a mom about how her child sleeps; the next day I'm working with a fabric mill on a new dobby weave.

Orbit Baby is unusual, especially in Silicon Valley, for its physicality. The majority of product designers in this area put electronics in boxes for medical devices, mobile devices, or server farms. Everything that Orbit works on can be prototyped out of plywood, a couple of drywall screws, and some laser-cut delrin. This easy relationship with hands-on shop work, instant testability, and human scale is enticing.

Baby travel gear is a tremendously constrained problem. The government has a two-inch thick binder of regulations concerning kids and cars. Our products get driven over cobblestones, thrown up on, fitted into hundreds of kinds of cars, shoved down plastic chutes off airplane holds—it's the big time for mechanical design.

Orbit designs from the napkin sketch to the final product. It's a full-spectrum design experience. We get so involved in the details of everything that by the time a product launches I visualize every radius on every part, dream about alloy contents, and have memorized many of the standards that govern our products.

Design Fave: The Trangia alcohol stove. It was designed during the Second World War for Norwegian ski troops. It's quiet, efficient, simple, elegant, and bombproof. One of the first things that drew me to my wife was her love of this little stove that I had also grown up with.

Jonathan Kling '04 Th'06

Mechanical Engineer and Project Lead,
Synapse Product Development
Seattle, Washington



Synapse created this medical monitor.

Marc Fenigstein '01

Senior Strategist, frog design inc.
San Francisco, California

I had always assumed the design field was disconnected from technology and business innovation. It was great to find out I was wrong. At frog my two most recent products to hit the market are the HP SkyRoom Collaboration Suite (hp.com/united-states/campaigns/skyroom/), which is the first product to bring the rich graphics and interaction of dedicated video conference systems to desktops and laptops, and Carmanah Technologies' Evergen 1710 Solar Area Light (carmanah.com/Products/Area_Lighting/EverGEN_1710.aspx), which has the potential to completely alter the way we plan and install lighting for sidewalks, parking lots, parks, and other public spaces. Both of these products combine disruptive innovation across markets, technology, and user experience.

My favorite products simultaneously solve business, technology, and user challenges. One is Project Masiluleke (poptech.org/project_m), a project to address HIV/AIDS in Africa. It's an extraordinarily complex, systemic challenge that requires a deep contextual understanding and consists of products, services, technologies, and market innovations. It's a wonderful example of how design thinking has evolved and what it can accomplish.

Marc Fenigstein worked on the HP SkyRoom Collaboration Suite.



In 2005 I came upon Professor Robbie's first advanced product development class. Every surface and space held the evidence of people iterating on their designs. There were project boards with pictures drawn on napkins connected with pieces of string, Post-it notes, and exclamations pinned everywhere. Cool! Students had gathered into groups and everyone was clamoring to get their ideas out on butcher paper. Watching the design process made me think that pretty much any problem has a better solution. All it takes is some butcher paper and the freedom to put all the options on the table—literally.

Working at Synapse, I make daily use of many of the design control and collaborative brainstorming methods that Professor Robbie taught us. His class influenced me to pursue a career in product development.

Synapse was started by Christoph Mack '88 and operates very much like Thayer. We combine mechanical, electrical, software, and industrial design with the goal of changing the marketplace with our products, including the next wave of remote monitoring and body-integrated medical devices.

I like any physical product in which the physical parts are highly interdependent and integrated while being simple or elegant in design. Air directors for the passenger cabins in commercial airliners are an example. They only have three parts. They're self-cleaning and elegant. If you say, "Well sure, air direction is an easy problem to solve," I invite you to look in every car you've ever ridden in and see how that car's particular designer solved the problem of directing and controlling the flow of AC. There are a bazillion different solutions, some good, some bad, but none outstanding as "the" way to do it. However, every plane has the same air-director design! It might not be glamorous, but I'm geeked about it. Perhaps this is what makes me suited for a career in product design—a childlike excitement for elegant and purposeful engineering.

—Interviews by Elizabeth Kelsey

Alumni News

► spotlights



LOOK MA!
The Gyrobike wheel,
invented at Thayer
School, is for sale at
thegyrobike.com.

THE GYROBIKE IS ROLLING OFF the production line—six years after a team of students in ENGS 21 tackled the eternal problem of learning to ride a bike. “This will really be the fun part: to finally get to see children out there riding the bike,” says co-creator **Debbie Sperling ’06 Th’07**, who is in medical school at the University of Michigan. “I have a lot of friends and family who are eager to finally give the Gyrobike a spin.” The stabilizing bike—heralded with a Breakthrough Award from *Popular Mechanics* in 2006—was created by Sperling, **Hannah Murnen ’06 Th’07**, **Nathan Sigworth ’07**, and **Gus Niles ’07** in 2004. “I think the Gyrobike’s success as a classroom-to-market project is

really the success of the Thayer/Tuck entrepreneurship potential,” says Niles, pointing to the collaboration between the Gyrobike team and **Errik Anderson ’00 Tu’07** and his venture capital firm, Seven West Ventures. “He was pivotal in bringing crucial media attention to the product and found **Daniella Reichstetter Tu’07** to be the startup’s CEO in April 2007.” Reichstetter drew on her previous start-up and consumer-products experience with Method Home and Jetboil to lead the design through two years of product development. The original design used a disk to spin independently inside the wheel; modifications have revved up the speed of the disk, enabling it to

create enough force—gyroscopic precession—to help stabilize a bike at a low speed. “The design improvements have been significant, and I think we are all quite proud of the product that is now available to buy,” says Murnen, who now focuses on the self assembly of biomimetic polymers as a grad student in the chemical engineering department at the University of California, Berkeley. The final product, which easily replaces the front wheel of standard kids’ bikes, comes with an enclosed, motorized disk and is available for \$100 at thegyrobike.com. “Seeing children use the bike has always been the most satisfying part about this project,” says Niles, a modeling and simulation engineer at the Charles Stark Draper Laboratory in Cambridge, Mass. “But it is also great to know that all the team’s work on the product design and business proofing will all be worth it.”

A few days after setting one streamliner motorcycle speed record at the Bonneville Salt Flats world finals last October with a 382-mph run, **Charles Nearburg ’72 Th’74** pushed it even harder, averaging 394.1 mph and exiting the track at 402.9 mph. With this, the *Spirit of Rett*—named after Nearburg’s son, who died of cancer in 2005—set a 392-mph record at Bonneville and became the first single-engine, normally aspirated car to go over 400 mph. Nearburg plans to return to Utah’s salt flats this summer with a new supercharged, 2,000-horsepower V-8 engine and break a 19-year-old 409-mph world speed record for wheel-driven cars. “Rett and I did a lot of gearhead stuff together—we rode dirt bikes and sport bikes together and built up a hot-rod Mustang,” says Nearburg. “His death was partly the catalyst that got me to think about what in life I hadn’t done. Every run I make, I feel him there with me.”

Thierry A. Blanchet Th’88, a professor of mechanical engineering at Rensselaer Polytechnic Institute, has been named a fellow of the American

Society of Mechanical Engineers, the highest elected grade of membership in ASME. Fellowship is conferred upon a member with at least 10 years of active engineering practice and who has made significant contributions to the profession. Blanchet is noted for his contributions in the area of materials tribology, particularly self-replenishing solid lubrication. His models of vapor phase lubrication have been adapted to DLC coatings and MEMS environmental tribology. He has chaired the ASME/Society of Tribologists and Lubrication Engineers’ International Joint Tribology Conference, serves as associate editor for the *Journal of*



Thierry Blanchet

Tribology and Tribology Transactions, and has earned the National Science Foundation’s Young Investigator Award.

Ben Koons ’08 is a powerhouse on the slopes—when he’s not bringing a different kind of power to Africa. Koons, who appeared in the Winter 2009 issue of *Dartmouth Engineer* in a story about his efforts to bring hydro-power to the rural village of Banda, Rwanda, became the first male cross-country skier to represent New Zealand at the Winter Olympics. Ben, who was born in Dunedin, New Zealand, and moved with his family to Maine eight years ago, captained Dartmouth’s cross-country ski team while studying mechanical engineering at Thayer. After graduation, he and brother **Nils Koons ’11**, also a Dartmouth skier,



OLYMPIAN

Ben Koons made New Zealand's Nordic skiing Olympic team.

embarked on some “altitude training”—a two-month cycling trek across Tibet.

Hypertherm, a top manufacturer of plasma cutting tools with almost 900 employees working in Hanover and Lebanon, has been feeling the international slowdown in the production of heavy equipment. Ship-builders, auto manufacturers, the construction industry—any field that would use Hypertherm products to cut flat steel—have slowed production in the last year, and orders for the cutting systems are down 50 percent. But, as National Public Radio highlighted in November (www.npr.org/templates/story/story.php?storyId=120097251), the company is sticking to its no-layoff policy. It has put employees to work doing other things: ground maintenance, training, on a team to rejigger the production line. The goal is to emerge from recession in a better position to compete. “Once you have a highly skilled workforce, the last thing you want to do is lay them off,” says Dick Couch ‘64 Th’65, the company’s founder and CEO and a Thayer

School Overseer. “This isn’t altruism. It’s good business.” It’s probably also a reason why *Business New Hampshire* magazine recently named the firm the Best Large Company to Work for in New Hampshire.

John Ballard ‘55 Th’56 has earned a Dartmouth Alumni Award for his extensive volunteer service to Dartmouth. In addition to leading his class as vice president and on its executive committee, the Los Altos Hills, Calif., resident has served on the Thayer Board of Overseers since 1989 and chaired it from 1998 to 2007. While chair, Ballard joined with fellow Thayer Overseers and a former chair of the Medical School Board of Overseers to form Angeli

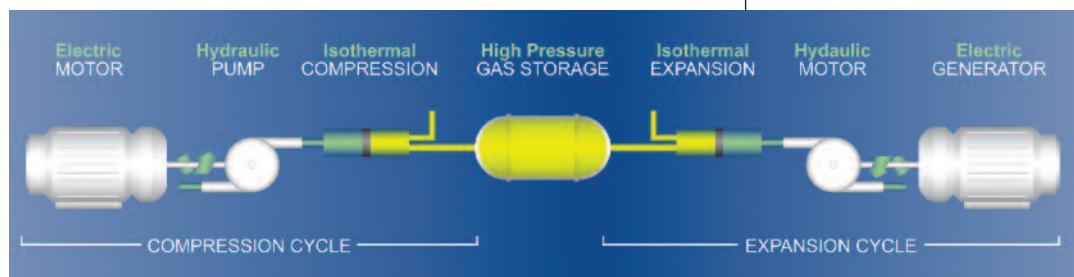
Parvi (little angels), a group of industry leaders who mentor aspiring Dartmouth entrepreneurs by guiding development of business plans and strategies. So far, the group has helped found, co-found, fund, or advise 10 companies, earning \$1 million for Thayer in the process. “The real pay-off came as a pleasant surprise,” he says. “Most of these enterprises are largely run by recent Dartmouth graduates. They generally ask for guidance when they feel the need, generally accept the guidance, and then execute with amazing energy and skill. We really do produce graduates who can change how health science, energy storage, signal processing, and environmental issues are addressed, and all very much for the better.” Ballard’s advice for fellow alumni interested in giving back: “Try and help students and alumni in ways that require some hands-on time. You’ll be rewarded.”

Start-up SustainX Energy Solutions (sustainx.com) is trying to find better ways to compress and store air to help utilities take full advantage of intermittent sources of energy such as wind and solar power. As Ph.D. students, Dax Kepshire Th’06, ’09 and Ben Bollinger ‘04 Th’04, ’08, with previous grad Troy McBride Th’01, began engineering and entrepreneurial work on SustainX, joining with Professor and Dean Emeritus Charles Hutchinson to launch the company. “The initial vision was for an inexpensive, reliable, clean energy storage system to pair with wind and solar to allow these renewables to perform as reliable, totally clean non-intermittent energy generation technologies,” says

McBride. Existing small- and moderate-scale energy storage technologies tend to be expensive, short-lived, and use toxic or rare materials. By using air, off-the-shelf industrial components, and core thermodynamic innovations, SustainX can cut costs and offer a long lifetime. SustainX’s novel approach allows higher efficiency and pressures, so air can be stored in off-the-shelf tanks rather than in underground caverns (the traditional method). To store energy, the SustainX system uses an electric motor driven hydraulic conversion system to isothermally compress and store air. To make electricity, the process is repeated in reverse; the air is released and run through the SustainX conversion system, turning an electric generator to make electricity. The team is aiming to pack a megawatt-hour worth of stored energy in a 40-foot-long container, says Kepshire. The company received \$4 million in funding from Polaris Venture Partners and Rockport Capital last summer and \$5.39 million from the U.S. Department of Energy in November to develop its technology and eventually deploy a full-scale demonstration of its method. The company spun out of Dartmouth last year and now employs 10 people at its site in West Lebanon, N.H. Says Bollinger, “Starting SustainX feels like having stepped aboard a roller coaster that keeps on going.”

THE SUSTAINX SOLUTION

Start-up company SustainX has developed a new way to store wind and solar energy as compressed air—and then turn it into electricity.





AMAZING APPLE PEELER

I hope that any mechanical engineer who has ever used one of these gadgets to simultaneously peel, core, and slice an apple was as amazed as I was.

—Chuck Horrell '00 Th'01

I have three choices for visually beautiful structural solutions:

- Hopkins Center, with its wonderful boomerang reinforced concrete work that is so optimistic and encouraging in its form. The entrance, fireplace, and windows suggest that the latter half of the 20th century would be fun.

- The Leonard P. Zakim Bunker Hill Bridge at the northern approach to Boston is simple, elegant, inspiring.

- The Buckminster Fuller Dome, built for the Montreal World's Fair (1967). Fuller once said he did every bit of research possible, tried every alternate iteration, tested every possible concept many times based on engineering logic and accuracy and if, in the end, the structure was not beautiful, he had failed.

—Roc Caivano '66

Naming the problem is the most critical act in design. I was recently hired as a planning and design consultant by the directors of a large youth camp. They were embarking on a capital improvement project and were worried that the necessary approvals and permits might be jeopardized by neighbors who had complained of noise created by the camp. The directors had resigned themselves to conventional responses to noise—altered schedules, relocated or eliminated programs, and expensive sound walls. At my first meeting with the directors I asked them three questions: Why they had named the problem noise, if that was the best name for the problem, and what is “noise.” My point was that the words we use to describe what we perceive can constrain what we are able to perceive. By consciously reflecting on the meaning of the word “noise,” I felt we could probably

find a different and much more elegant way to name the problem. After discussions, the problem statement became: How can we shift our neighbors’ perception of our children’s activities and energy from unknown and undesirable to understood and desirable? This was no longer a problem for architects and engineers, it was a problem for community organizers and diplomats. Through this process of re-naming the problem we avoided solutions that would have limited the camp’s activities and diverted scarce financial resources into unproductive assets such as sound barriers. Instead, we moved into strategies that would bring the community together and increase the resources available to the camp.

—Bruce Corson '70 Th'73

I think the most incredible creative design for innovation, efficiency, and elegance in this decade is the Apple iPhone.

—Randy Lunn '73 Th'75 Tu'75

A few years ago I directed a project to develop a clean air bulk material handling system, which ended up being patented (No. 5,639,188). In the manufacturing process for the insulated cables used in an electrical grid system, it is crucial to keep the dielectric material clean to eliminate premature failure of the cable. The weak link in the manufacturing process was the transfer of the dielectric from the railcars used to deliver it to the cable production equipment. State-of-the-art procedures in the mid-1990s called for vacuums to convey the dielectric material out of the rail cars using a single paper filter to remove all the contaminants from the ambient

►just one question*

Q. What engineering project excites you because of its innovative, efficient, or elegant design?

A project that I have been involved with in a peripheral way is a hydrogen fuel cell/electric hybrid transit bus now undergoing initial trials. It has innovative engineering features not only in the power system, including its battery technology, but also in its composite body structure. Made of a combination of fiberglass and carbon fiber, the bus has a low profile, easing passenger entry and exit. One of the most revolutionary parts of our vehicle is its propulsion system. It is powered by a combination of advanced technology batteries and hydrogen fuel cells. There is a website by Proterra (hydrogenhybridbus.com), primary developer of the bus, that tells more.

—John Kennedy '53 Th'54

Six years after graduating from Thayer, I was working for the Bendix Corp. research labs in Southfield, Mich. Bendix had received a contract from NASA Huntsville for the development of a prototype lunar vehicle. I was project engineer responsible for the traction and steering drives. The mission profile called for a mobile laboratory in which the astronauts could live and also drive across the lunar terrain. One of the

most significant technical challenges we faced was how to create a high torque-low speed traction drive system that would “float” the vehicle on loose lunar dust. We didn’t have any insight on the lunar soil characteristics, so we assumed we needed a vehicle with a large footprint for low soil-bearing pressure. Our wheel design consisted of a series of titanium rings or loops that, under vehicle load, would deflect. Essentially, we’d be running on a flat tire. A scale model of our design was on the cover of the December 1964 issue of *Aviation Week*, along with a story. Wernher von Braun drove a full-scale vehicle chassis and the “flat tire” wheel design at the Bendix Aerospace Systems test track in Ann Arbor, Mich. NASA got a lot smarter about the lunar soil characteristics and the final 1971 *Apollo 15* Boeing-designed “dune buggy” did the job. Maybe someday we’ll get back to the moon or Mars, and the mobile lab concept could come alive again.

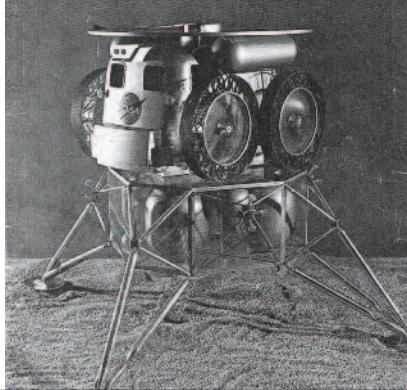
—Ron Read '57 Th'58

The elegant iPhone sets the standard for new products in its simplicity, ease of use, and intuitive design.

—Bill Allyn '58 Th'59

* Want us to ask you just one question?

We email our question to alumni. To be included, send your email address to dartmouth.engineer@dartmouth.edu.



MOON BUGGY

Ron Read '57 Th'58 helped design a mobile lunar lab prototype for NASA. Though the lab never got off the ground, this model of it appeared on the cover of *Aviation Week* in 1964.

air. This added significant contamination to the dielectric materials. To eliminate contamination in this process, a large enclosure was built to house the railcars that contained the dielectric material. Using a series of HEPA filters, the air in the enclosure was controlled as a Class 10,000 environment. But the very elegant portion of the design was to pipe the output of the HEPA filters directly to the discharge valves on the rail cars and pressurize the air supply for conveying. This change reduced the contamination in the conveying air from approximately 10,000 to less than 1,000. The change made a measurable difference in the dielectric strength of the polyethylene material used to insulate the cables.

—Jack Howanski Th'75

I was the inventor and business sponsor of the website and results page for oceanschedules.com. The design seems commonplace today, but when we did it in mid-2006, it was considered quite impressive for its simplicity and ease of use. Go to oceanschedules.com and enter an origin port of New York and a destination port of Antwerp. The design was a finalist for the 2007 CSCMP Innovation Awards. The results page had many firsts: use of context-based ads, use of filters and sliders, and use of AJAX programming in the ocean transportation space. The multidiscipline style of the Thayer education was ideal preparation for this type of role. The site has attracted almost 13,000 registered users, with only 15 percent being in the United States.

—Harry Sangree '79 Th'80

At my last company, we reproduced how people make credit decisions and created the fifth generation of automated decision making. Making car loans is a very complex process. In addition to applying the five C's of credit—capital, collateral,

al, capacity, character, and conditions—the credit grantor must consider deal structure, portfolio health, and capital sources. For each credit application, a credit "buyer" must keep in mind thousands of potential combinations of related data, and then trillions of potential slices or tranches of data level combination. Using a decision tree as an example, if you have 13 data elements each with 10 slices or gradations, you might have 10,000,000,000,000 potential data level combinations. My solution was to relate together 10 data elements (by borrower-assigned values) that might actually affect repayment of the loan and combine these building blocks together to deliver answers. After we bring the data element together, the user assigns various combinations of data slices together to make scenarios the user feels are predictive. The market proof of the power of the decision engine is that the owner, World Omni (which handles Toyota financing in five southeastern states), has been able to sell its portfolio of collateralized securities for 90 cents on the dollar when others have been struggling to get 70 cents. If only I still owned the company! Venture capitalists forced the sale of the company in the years following 9/11, netting me a few thousand dollars after eight years of work. Five years later, the decision engine I built is like the recipe for Coke: They make hundreds of millions of dollars on two to three sales per year. It turns out that taking venture capital was the most expensive business decision I ever made.

—Toby Reiley '81

I didn't work on it, but I want the new Ducati Multistrada bike.

—Nash Ogden '82

I worked on an integrated circuit design for a novel self-calibrating analog-to-digital converter (ADC) with

Michael Coln of Analog Devices Semiconductor Inc. (ADI). The novel aspect of the design was essentially to split the ADC into two similar but not quite identical halves, with each checking the other ADC's output. With some digital processing the ADC continuously calibrates itself in the background. I got the idea to split the ADC in this way from a few lines in Robert Frost's poem "New Hampshire," where he says:

She's one of the two best states in the Union.

Vermont's the other ... And they lie like wedges,

Thick end to thin end and thin end to thick end,

And are a figure of the way the strong

Of mind and strong of arm should fit together,

One thick where one is thin and vice versa.

The design team received the best paper award for "A split-ADC architecture for deterministic digital background calibration of a 16b 1 MS/s ADC" at the 2005 International Solid-State Circuits Conference. There's a full description in the December 2005 issue of the *IEEE Journal of Solid-State Circuits* —perhaps the only IEEE article ever to cite Frost's "New Hampshire" as a reference!

—John McNeill '83

In my previous job I was in charge of procurement for three countries (Turkey, Israel, and Palestine) at Ericsson. The items we spent the most money on were GSM Towers (which are what we hang the base stations antennas off). I initiated a redesign project that made our towers 40-percent lighter with the same deflection standard (.5-degree deflection at 140 km/hr wind speed) as the previous design. We accomplished this redesign by making the base of the tower wider. Increasing the base size

initially raised the cost of the foundation and site rental cost because the tower now took up more space on the ground. We then redesigned the foundation, and that ended up being cheaper because we did not have to dig as deep for a wider foundation. Ultimately, the weight of the foundation is what matters, and since the foundation was now broader, we could make it thinner. We managed to keep the rental cost the same as before and the ultimate tower construction cost came down by half. One unexpected advantage was that we were able to make the towers simpler to erect, hence construction time came down as well.

—Kaya Kazmirci '84

For several years I've been working as an engineer in the aeroelasticity group at MTU AeroEngines in Germany. We have several projects together with Pratt & Whitney in the United States and at the moment we are working on the next generation of aero engines based on the geared turbofan concept. This new engine generation—PurePower PW1000G—has been recognized by *Popular Science* magazine with a 2009 Best of What's New Award in the aviation and space category. I'm proud to have contributed to this project.

—Harald Schoenenborn Th'91

I designed the Plast-toilet as a great low-cost toilet, water tank, and solar warmer for Third World countries. I'm the CEO of dvb Design + Engineering in Hyderabad, India. The Plast-toilet is an innovative solution to India's sanitation problems. (Only one of three Indians has access to improved sanitation facilities, which presents a major health risk. It was estimated in 2002 by the World Health Organization that around 700,000 Indians die each year from diarrhea.) The Plast-toilet had to be easy to manufacture in a viable, low-cost, sustainable manner. I have used



CHICKEN CRIB
Kate Tooke '02 likes the urban chicken coop designed and built by Andreas Stavropoulos '02.

innovative ideas to build several features into the product. They are: integral wash basin; one-piece water closet, foot rest, shower tray, and toilet floor; replaceable bowl; integral towel holder, soap dish, shower shelves, mirror frame, ventilators, and window; and a door cut out of a vacuum-formed side panel.

—Darshan V. Bhatia '92

There is one design effort that I'm still proud to have been a part of, even though it was eight years ago. It was an effort to address an extremely high warranty cost problem on the Ford F250/350/450 truck lines during the early 2000s. The problem was that the pinion seal of the rear axle was designed in a way that it actually enabled the ingestion of dirt and contamination. I was lead design engineer from Ford working with suppliers from Dana Axle and Chicago Rawhide seals. The effort we completed was a redesign of the seal lip to a triple lip design that essentially created a triple redundant protection system for the seal. We also added a metal deflector onto the axle that was a stamping. Eventually in 2003 we changed the stamping so that it wrapped around the seal itself, which deflected dirt and contamination. The total costs of all upgrades in 2001 were just over \$1 per unit (while the cost of repair before the fix was more than \$100). I am proud of this effort, as I see the results of it on American streets every single day even now!

—Ike Anyanwu-Ebo '94 Th'95

On a recent trip to Dublin, Ireland, I was struck by the elegance, simplicity, and functionality of the Sean O'Casey pedestrian bridge. It adds an element of grace and a sense of texture to the waterfront area.

—Jeanne Townsend Th'97

For flat-out brilliant design, I think it's hard to beat the AC induction

motor. The induction motor has one moving part, uses two common materials (copper and steel), and requires only high-school-level physics to understand. An accurate analysis of its operation takes only one side of a sheet of paper. And yet, more than 100 years after its invention, it is still utterly ubiquitous and almost unchanged from its original form. Nikola Tesla clearly understood good design practice: Combine deep physical insight with extreme simplicity to create something fundamentally useful.

—Matt Senesky '98 Th'99

My choice for efficient and elegant design is the direct fuel cell. It is elegant because it converts the chemical energy of natural gas directly into electricity with no moving parts other than an air intake fan. The electrochemical process in a direct fuel cell is 47-percent efficient versus 35-percent efficient for a gas turbine generator with complex moving parts. In spring 2009, my employer, FuelCell Energy Inc., sold to South Korea a 5-megawatt power plant, currently the world's largest fuel cell power plant.

—Joe McInerney Th'99

I hope that any mechanical engineer who has used an apple corer to simultaneously peel, core, and slice an apple was as amazed as I am every time I use it. I hope that at some point in my life I am able to design something as elegantly functional as this thing.

—Chuck Horrell '00 Th'01

I've always been amazed by the Rabbit wine bottle opener (rabbittcorkscrew.com). With one quick motion it pulls out the cork. And then by repeating the same motion, it somehow pushes the cork back off the corkscrew. I know this sounds a bit like an ad for the product, but as an engineer I am really fascinated and impressed by it!

—Gabe Farkas Th'02

I have been amazed by the Chicken Crib, an urban chicken coop designed and built by **Andreas Stavropoulos '02**. This product reflects a growing interest in and need for producing food easily in small, urban spaces. The design is simple but elegant, blending efficient use of basic materials with precision crafting to create a durable, smart-looking coop that keeps chickens safe and healthy. Andreas will be selling Chicken Crib kits to assemble on site. More info coming soon at chickencribkits.com.

—Kate Tooke '02

As a design engineer for utility-scale solar photovoltaic projects with Q-Cells International, I have to reconcile aesthetics with optimized power production based on site conditions and power purchase contracts. Further, large-scale renewable energy projects undergo strict permitting and environmental review processes, which forces me to think beyond the "fenceline" to include permeable boundaries to promote wildlife corridors, incorporate dual-use strategies for power production and agriculture, design for earth- and water-balanced sites, and to specify native grass species as ground cover.

—Adam Han '03 Th'04

As a former ice hockey player for the Big Green and current product developer for Bauer Hockey, I'm probably a little biased in my selection of the recently launched Vapor X: 60 hockey stick. Our development team was responsible for taking high-performance materials developed for jets and racecars, incorporating the biomechanics and customization needs of elite players, and creating a high-performance carbon fiber ice hockey stick weighing less than a pound. While innovation in sporting goods continues to raise questions about the role of technology in sport, there are tremendous opportunities for creative problem solving and technology

transfer that make product design and development both a constant challenge and a lot of fun.

—Carolyn Steele '03

I was recently introduced to the Clock of the Long Now (longnow.org)—an effort to build a mechanical clock that will keep accurate time for 10,000 years. They have prototyped most of the key mechanisms and even built a precursor to the final design that was started before midnight of January 1, 2000. It is a wonderful design challenge. Stainless steel may not actually be stainless over such a long time, but precious metals and high-performance alloys may be plundered. Gears can wear down and lose teeth, so they instead keep track of time using a serial adder that counts days. An electronic clock may be impenetrable to a post-apocalyptic civilization, so the works are open and entirely mechanical—with the grasp of the human mind with enough time to ponder it. The best pendulums are imprecise even over the course of a few days; this clock can resynchronize itself to local solar noon to correct itself. The engineers' solutions are at each turn elegant and wondrous pieces of design and craftsmanship. The key thing about the project, however, is to encourage humans to think in time scales far beyond our everyday lives: not just next year or next generation but next millennium and beyond.

—Alex Streeter '03 Th'05

As a Ph.D. student in chemical propulsion, I am always in awe of Wernher von Braun's team and the creation of the Saturn V rocket. The development of launch vehicles is ongoing, but the current generation pales in comparison to this 1960s innovation that sent men to the moon.

—Erik Dambach '04 Th'05

As a participant in Eaton Corp.'s engineering and technology leader-



THE PUCK STOPS HERE

Carolyn Steele '03 helped develop the Bauer Hockey's Vapor X: 60 carbon fiber ice hockey stick, which weighs less than a pound.

ship program, I worked on an emerging hybrid technology for trucks called Series Hydraulic Hybrid. It is designed to replace the conventional transmission on vehicles with a "stop-and-go" duty cycle. The system consists of an engine-mounted hydraulic pump, a hydraulic drive motor, and accumulators (tanks filled with gas that are pressurized by pumping in hydraulic fluid) for energy storage. The efficiency gains arise from the ability to run the engine at its peak efficiency point (since it is not directly connected to the wheels) and from the ability to recapture braking energy by turning the hydraulic drive motor into a hydraulic pump and refilling the accumulators. We have already delivered two vehicles to UPS for evaluation.

—Adams Baker '06

I am currently working on developing an AC solar module at Enphase Energy. Basically, it is an "intelligent" solar panel that can be connected directly into the grid, which eliminates a lot of the complexity involved with installing solar panels. Additionally, because each panel now handles its own power, there is panel-by-panel monitoring. Each solar panel sends data over existing power lines to a central server, which monitors performance.

—Donny Zimman '07 Th'08, '09

Vertical farming is a fascinating concept. It involves large-scale agriculture in urban high-rises or "farm-scrapers." Using recycled resources and greenhouse methods such as hydroponics, these buildings would produce fruit, vegetables, edible mushrooms, and algae year-round. This would allow traditional outdoor farms to revert to a natural state and reduce the energy costs needed to transport foods to consumers.

—Laura Weyl Th'08

►thayer notes

1940s

Henry C. Keck '43 TT'43: Thayer, with its teaching of fundamental principles, has been of profound importance to me in my more than 50 years of product development and machine design. I am semi-retired from Keck-Craig Inc., the company I founded in 1951. I am writing a book about product development in the United States since the 1920s, including chapters about the work of my firm. I still work with companies and inventors developing new products.

Bob Sundblad '44 Th'48: I'm retired for some 30-odd years now and live by the water in southwest Florida. My wife, Eleanor, and I have had reasonably good health since moving south in 1994. I was president of our local engineering society for a period in which we tried to help our fair city with some expansion problems.

Tad Comstock '48 Th'48: Highlights in 2009 included a cornea implant—it works!—and renewal of my driver's license for another five years. I still play golf, and Rotary remains one of my longtime favorite organizations. My wife, Georgie, and I are looking into moving into a continuing care facility but nothing is definite yet. Meanwhile, we enjoy our camp on Bow Lake in New Hampshire.

1950s

Charlie Schneider '57 TT'58: I have been retired for 13 years and am active as a part-time caregiver for my wife, very much involved in a local education program called Vistas For Lifelong Learning, and as a board member for a new nonprofit called Center For Successful Aging. I keep physically active with tennis, lawn bowling, golf, and cycling. Jane, my wife, and I are lucky with accessible culture in Santa Barbara, Calif., and

have subscription tickets to theater and music organizations.

1960s

Harris McKee '61 Th'63: Our civic and volunteer activities continue. My wife, Mary, is off the Bella Vista, Ark., library board but on other boards and still edits the weekly Rotary newsletter. I finished Rotary and Master Gardener presidencies, became a Rotary assistant district governor, and continue as treasurer of the Literacy Council of Benton County and as webmaster for four websites, including for my Dartmouth class of 1961. I also serve as the 1960s chair for the Thayer School Annual Fund. I enjoy playing golf all year here in Arkansas. Thayer continues to influence me every day in my approach to problem solving and analysis and my curiosity. This influence is more obvious to my friends than it is to me. They frequently call attention to my approach to almost any issue.

Neil Drobny '62 Th'64: I enjoy what I am doing now more than anything I have ever done. I divide my time between teaching in the Ohio State Fisher College of Business and running a small nonprofit organization. Both focus on sustainability, which I now understand was my interest at Thayer, but at that time there was no language to express it. The teaching started about six years ago when I approached the dean of M.B.A. programs about teaching M.B.A. students about sustainability. I knew other business schools were doing so, and in 30-plus years of environmental consulting had concluded that my clients' "environmental" problems were really business problems. I got the go-ahead to teach one course and now teach six courses per year—both graduate and undergraduate. This

year Fisher's sustainability curriculum was ranked 24th in the world by the Aspen Institute and our student chapter of Net Impact (an international organization for business students interested in sustainability) was recognized as Chapter of the Year. The nonprofit is the Waste Not Center (wastenotcenter.org). It is a place where businesses and individuals donate gently used and new things that are no longer needed and that fall into the general category of arts, crafts and school supplies. We give the donated materials and supplies to teachers, artists and nonprofits that have after-school programs for kids. We take in and distribute about 2,500 pounds per week of stuff that would otherwise end up in the landfill. It is a membership-based organization that I have grown from about 300 members four years ago to more than 2,000 today. The members who take our stuff estimate the value of what they receive from the center to be about \$300,000 per year. Every city should have one! Perhaps the one thing that Thayer instilled in me that has served me well is the courage to pioneer new initiatives. Myron Tribus was probably a major source of that.

John Kunz '65 Th'66: I have served as the treasurer of the Dartmouth Outing Club of northern California and Nevada for a number of years. A few years ago, when the stock market was running wild, one of my fellow DOCers suggested I move our hard-won assets from the money market place to a stock fund. I recalled the decision-analysis class I took as an undergrad from Myron Tribus and reflected on the upside of greater return, which had financial appeal but would not change the option set for a major renovation we had planned but not scheduled. I also reflected, as we had been taught in that class, on the downside, which would be that I would feel really awful if the market crashed and we could not do the ren-

ovation. A few years later the market crashed and I felt lucky and appreciative of that class I took so many years ago. As an undergrad I got to build simple computational implementations of similarly simple mathematical models of many of the systems we were discussing in classes. The computer hooked my interest and now, years later, I teach computer modeling and analysis in the engineering school at Stanford. I finally am able to do some of the things I dreamed of with the teletype clacking away slowly late at night in Cummings Hall.

1970s

Jack Howanski Th'75: The Dartmouth setting, individual attention, and academic challenge I experienced made me a more complete and better engineer and person. The Thayer education instilled in me two basics. First, always look at the total problem; at times the technical portions of an issue may be the least important. Second, always take time to reflect on alternative solutions. The one course at the Thayer School that has stayed with me through my career was the internship program taught by Professor Robert Dean. Professor Dean essentially gave us a real-world problem with the simple instruction to solve it. The value in the course came from Professor Dean challenging us at every step in the process and constantly asking us to understand the thought process we used. Since taking this course, I have continually challenged my own thinking and the route chosen to solve a problem. Since leaving Thayer in 1974, I have held several positions in industry, ranging from a research-and-development engineer designing equipment to measure heat transfer in various building sections to doubling the output of a major wire and cable facility as the general manager of one of the largest medium-voltage cable producers in the United States. My most recent position was as vice president of

technology for a group of wire and cable plants that stretched from Honduras to Thailand. After spending substantial time in China, Thailand, and Chile, I decided to leave the corporate world and teach high school for a few years. I recently obtained teaching certification in physics and mathematics and expect to be in the classroom very soon. My intention is to return some of my education to today's youth. I am also bringing to life our family farm in Justus, Pa., which my great-grandparents purchased in 1921. We are trying to raise grass-fed beef and free-range chickens and turkeys along with growing various types of berries for jelly and jam production. The challenge is to raise the various food sources with a minimal carbon footprint. My great-grandfather operated the farm with two draft horses and no electricity. I just need to figure out how he did it as we enter a world where the words "eat local" take on new meaning.

Fred Kriebel '75, Th'76: After 33 years in the San Francisco Bay Area working as an executive for contractors, corporate owners, and developers in the building industry, I have started my own company (kriebelandassociates.com) as a real estate development/construction management consultant, serving owners, developers, and banks that need outside expertise to deliver their projects. My background in commercial, multi-family residential and medical projects, from steel to wood-framing, and from the contractor's and owner's perspectives gives me the ability to see and resolve problems from all angles. This diversity and ability to work people with different viewpoints is a skill first nurtured at Dartmouth, and in the B.E. year at Thayer.

Martin Sklar Th'78: With children Adam and Jennifer out of college and moving on in their lives, I have focused on my major professional interest: medical devices. Luckily, my wife, Janis, understands my passion for this in-

dustry. In the past year and a half, in addition to my consulting since 2001, I and a small team of savvy business and technical professionals have been researching the market and developing an innovative product to help cardiac surgeons perform an improved atrial fibrillation ablation procedure. We welcome any Thayer or Dartmouth alumni or Dartmouth physicians with relevant experience in this area to contact us. At Thayer I learned how to run a project, from defining the project goals to planning activities and implementing the plan. Professor Francis Kennedy was instrumental in helping me develop a friction and wear test apparatus, which was used to simulate various ASTM friction and wear tests. I understand from more recent Thayer students, whom I met at alumni gatherings in Boston, that it ran as a test instrument until a few years ago. It was also designed for implant testing. That experience was critical to my future work and has served me well when leading the development of other medical products. I can be contacted at linkedin.com/in/martinsklar and am a member of the Thayer School group.

1980s

Toby Reiley '81: Other than re-engineering the used-car finance business, I just bought a clean diesel car that gets 50-plus miles-per-gallon, burns cleaner than a gas engine for particulate emissions, and is certainly more fun to drive than a Prius.

Steve Morris '84 Th'85: In the news I always hear how this country does not have enough engineers, yet in our society engineers are considered expensive overhead. Often engineers in their 50s are put out to pasture. I was able to avoid this by starting my own successful business, Accuware Inc. (accuware-inc.com), 10 years ago. Although my children are not yet at the age where they will be choosing paths for their futures, I struggle with recommending engineering. Most of

us have witnessed the engineer becoming merely a necessary resource. It is no wonder that the economy no longer has any traction.

Jack Oswald '84: Today I am entirely focused on establishing an intelligent clean energy strategy for the United States and beyond. The strategy has three main thrusts that all need attention today but bear fruit at different intervals. Phase 1 is all about energy efficiency. Focus on getting every light bulb in America changed. Blanket every city and town and just provide them at no cost. Seal homes and place reflective paper in attics. These few things alone will reduce the country's energy used in buildings by 20 percent. Given that buildings use about 45 percent of all energy, we can get a very quick national 18-percent overall reduction—just like that. Phase 2 is about "drop-in" renewable fuels that are fully compatible in the existing fleet and infrastructure. Today, we make about 8 billion gallons per year of ethanol that must be brought to market either in specialized rail cars or trucks because the fuel is incompatible with existing pipelines and other distribution methods. It's also not very compatible with existing vehicles. That means no more ethanol, cellulosic or otherwise. Several companies, SynGest Inc. (syngest.com) and Optinol Inc. (two of my startups) among them, are making such fuels at lower cost than any ethanol produced or contemplated. The issue isn't even so much about the cost. It is an infrastructure issue. We just can't build out specialized infrastructure fast enough and it just doesn't make sense unless it has many uses. Phase 3 is all about achieving an abundance of solar energy. There is more than enough solar energy hitting the planet every day to meet our needs many times over. The fact that we don't collect enough of it is simply an engineering problem. As soon as we can achieve a five-times increase in solar collection, we will have an abundance of energy,

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engineering.dartmouth.edu/alumni/DSE | dartmoutheengineer.com

even if we do not solve the energy storage problem as elegantly.

John Chae Th'86: My professional life is focused on medical research. I credit Thayer for sparking this interest in me. I am a professor of physical medicine and rehabilitation (PM&R) and biomedical engineering at Case Western Reserve University. After med school and clinical training at New Jersey Medical School, I completed a rehabilitation medicine scientist training program fellowship at Case Western. I am director of stroke rehabilitation and director of research for the department of PM&R and associate director of clinical affairs for the Cleveland Functional Electrical Stimulation (FES) Center. My research focuses on the application of FES for neuroprostheses, neural plasticity, and shoulder dysfunction in hemiplegia. On a more personal level, I married Linda Oyer, Ph.D., who I met at Dartmouth. We have two wonderful sons, 17 and 15. We live in Strongsville, Ohio, a suburb of Cleveland. My favorite activities outside of work include spending time with family, church, and mentoring young men.

1990s

Ike Anyanwu-Ebo '94 Th'95: I am an engineering supervisor at Ford Motor Co. working in engineering design and testing on budget, service, and prototype development for the six-speed auto transmission for the Ford Fiesta, scheduled to be launched in May (fordvehicles.com/cars/fiesta). However, I have just given my notice that I'll be leaving the auto industry after nearly 14 years to enter the renewable energy field of wind turbines. I'll be taking a position at Vestas A/S in Denmark as a senior quality specialist charged with improving product and process quality and reducing waste, working with both product design and our supplier partners. The change was driven by the personal desire to meet the biggest challenge we

face today: the environment. Building fuel-efficient cars is important, but I wanted to do something more directly tangible to addressing global warming. Reading about the fine work led by outstanding researchers such as Lee Lynd inspired me in part. My wife of nearly 10 years, **Carmen Harden '96**, and I have two children, Nnamdi, 6, and Amara, 8 months. My passion is working out and staying healthy, a legacy of being on the Dartmouth varsity track team for two years. Thanks to Dartmouth, I also have a love for languages. Throughout my career at Ford I used the Japanese I learned at Dartmouth. I strongly recommend that all Thayer engineers leverage their language skills! Dartmouth has influenced my life, personally and professionally, beyond belief. Thank you!

Dan Mazzucco '98: I am the president of a start-up medical-device company called ZSX Medical. We are developing surgical closure products. Our company is small, new, and growing. The problem-solving skills I learned at Thayer School continue to guide my approach to new problems, whether technical or strategic. I've always found that working in small, collaborative teams, as we did in bridges, systems, controls, thermo, etc., is the most efficient way to solve these new challenges.

2000s

Tom Campbell '01 Th'02: I'm working as a composites applications engineer at Fiberforge, where I've been since 2003. My work is generally to make things from thermoplastic composites, though it also extends to developing new manufacturing processes to work with the composite materials as well as creating new machines with which to do that processing. My projects are in a variety of industries, from consumer goods and recreation equipment to aerospace and the military. I live in Glenwood Springs, Colo., and just got engaged

to Meghan Palmer. I'm in the mountains and get to play outdoors a lot!

David Koch Th'02: Our second child was just born, so we're excited! I am continuing DFR project in a way, developing heavy-duty truck engines for Daimler Trucks (Mercedes-Benz, Freightliner, Western Star, EvoBus). **Keith Dennis '03 Th'05:** I was married to Allison Bellins in June on the beach in Chatham, Cape Cod. In attendance were M.E.M.s **Brian Henthorn '04** and **Dan Tadesse '03 Th'05**. Dartmouth alums **Christian Haines '01**, **Dave Pereira '03**, and **Sergey Polissar '04** were also in attendance. Allison and I met at Vermont Law School, where we both earned a master of studies in environmental law, a program I became involved in while taking a class that counted toward my M.E.M. Allison is director of communications for EPA's green power partnership. I work for First Environment on issues related to energy, climate change, and greenhouse gas management. I also recently earned my professional engineering license.

Brian Mason '03 Th'05: Jocelyn and I continue to love California. I am in my fifth year at IDEO and have spent the last year working on a medical product that began as a technical investigation and has moved all the way to final industrial design and clinical trials. Jocelyn and I will be back in Hanover in June for her five-year reunion. We hope to catch up with many friends.

Elizabeth Jensen Th'08: I am in my second year as a Ph.D. student in mechanical and aerospace engineering at Princeton University. My research focuses on directly imaging planets around stars (besides our sun). My work allows me to use the world's largest telescopes in Hawaii. Thayer provided me with a fantastic background of engineering and science courses that I can apply to my courses and research at graduate school. In my free time, I play the oboe in the Princeton University orchestra and

enjoy traveling all over the world.

Laura Weyl Th'08: Having gone to three different schools now, it's interesting to see which one seems to follow me and continue to shape and change my life. Dartmouth connections got me my last two jobs, Dartmouth friends and friends of friends have become my main social scene in this new city, and my current relationship is with a Dartmouth grad I met recently. Thayer is also the only school I'm still involved with as far as alumni activities and annual fund volunteer work. I live in Palo Alto, Calif., and am getting my environmental structural engineering degree. I spend time in San Francisco with friends I made while living there last year. I worked at Oliver Wyman with several Dartmouth and Thayer grads and then at ATDynamics, a small Thayer/Tuck startup in the South Bay.

Katie Gray '09 Th'09: I work as a development engineer at Talisman Energy Inc. in Calgary, Alberta. I play hockey for the Strathmore Rockies in the Western Women's Hockey League and coach my community Pee wee 5 boys' hockey team. I have also taken snowboarding up again.

OBITUARY

Adjunct Professor **Robert D. Collier** died August 14, 2009, at his home in Lebanon, N.H., at the age of 85. A researcher, lecturer, and entrepreneur, he had a long career that included pioneering work in underwater acoustics, sonar, noise, and vibration for the first U.S. nuclear submarine fleet. At Thayer School, he enjoyed teaching about acoustics and collaborating with students and Professor Laura Ray on active noise reduction. In 2004, he Ray, and Christopher Pearson Tu'03 founded Sound Innovations Inc., a company that develops advanced noise-reduction technologies. He is survived by his wife of 59 years, Marguerite, three children, three grandchildren, and a sister.

inventions



QLS REACTOR

>> CO-INVENTOR:
PROFESSOR PAUL E. QUENEAU

When the National Academy of Engineering honored Professor Paul E. Queneau with membership in 1981, the citation noted his “innovative leadership in the invention and commercial development of efficient technology for extraction of nickel, copper, and cobalt.” In the world of smelting, he’s also known for getting the lead out.

Queneau devoted his entire career to metal. During the

Depression, the Columbia grad labored at the International Nickel Company’s (INCO) alloy furnaces in West Virginia. “It was hard, dangerous work,” he says, but metallurgy hooked him, and he moved up in the company.

Army service—he rose to colonel—in the European theater during World War II galvanized him. “What I saw and experienced over there has driven me ever since,” he says. “Who do you think designed all those tools of mass destruction? It was engineers! We as engineers now have a responsibility to modernize technology, save energy, and

protect the environment.”

Returning to R&D at INCO, Queneau helped develop energy-efficient, environmentally friendly smelters with breakthrough oxygen technology that reduced the needed amount of coal and decreased sulfur emissions.

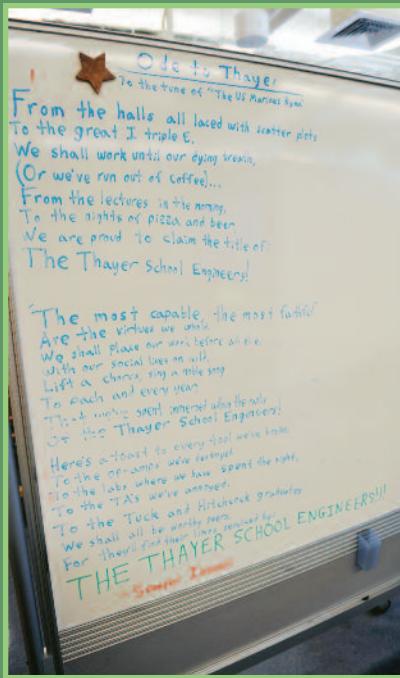
Soon after becoming a professor at Thayer School in 1971, Queneau joined with Purdue University Professor Reinhart Schuhmann Jr. and the German firm Lurgi to invent a continuous smelter that boosts efficiency and cleanliness. Compacted pellets of sulphide concentrate and flue dust dissolve in a molten

bath that is injected with oxygen, producing lead and lead oxide. The lead sinks to the bottom and is siphoned off. The lead oxide flows to the far end of the reactor. Along the way, submerged injectors blow powdered coal into the lead oxide to reduce it to lead. Sulphur dioxide in the off-gas is converted to commercially usable sulphuric acid. Remaining flue dust is mixed into new pellets, and the process starts again.

Queneau Schuhmann Lurgi, a.k.a. QSL, reactors are in use in Canada, Korea, and Germany, churning out lead without spurning the environment.

LEADER OF THE PACK

A QSL reactor, co-invented by Professor Paul E. Queneau, below, produces 150,000 tons of lead and lead alloys and 100,000 tons of sulphuric acid annually at the Berzelius plant in Stolberg, Germany.



RANDOM WALK

Strolling through Couch Student Project Lab, we came across a whiteboard that held a bit of anonymous late-night student creativity:

ODE TO THAYER SCHOOL (To the tune of the U.S. Marines' Hymn)

From the halls all laced with scatter plots,
 To the great I triple E.
 We shall work until our dying breath,
 (Or we've run out of coffee)...

From the lecture in the morning,
 To the night of pizza and beer,
 We are proud to claim the title of
 The Thayer School Engineers!

"The most capable, the most faithful,"
 Are the virtues we uphold.
 We shall place our work before all else,
 With our social lives on hold.
 Lift a chorus, sing a noble song
 To each and every year,
 That we've spent immersed within the ranks
 Of the Thayer School Engineers!

Here's a toast to every tool we've broke,
 To the op-amps we've destroyed.
 To the labs where we have spent the night,
 To the TAs we've annoyed.
 To the Tuck and Hitchcock graduates,
 We shall all be worthy peers,
 For they'll find their limos serviced by
 THE THAYER SCHOOL ENGINEERS!

—Semper Insomnis

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