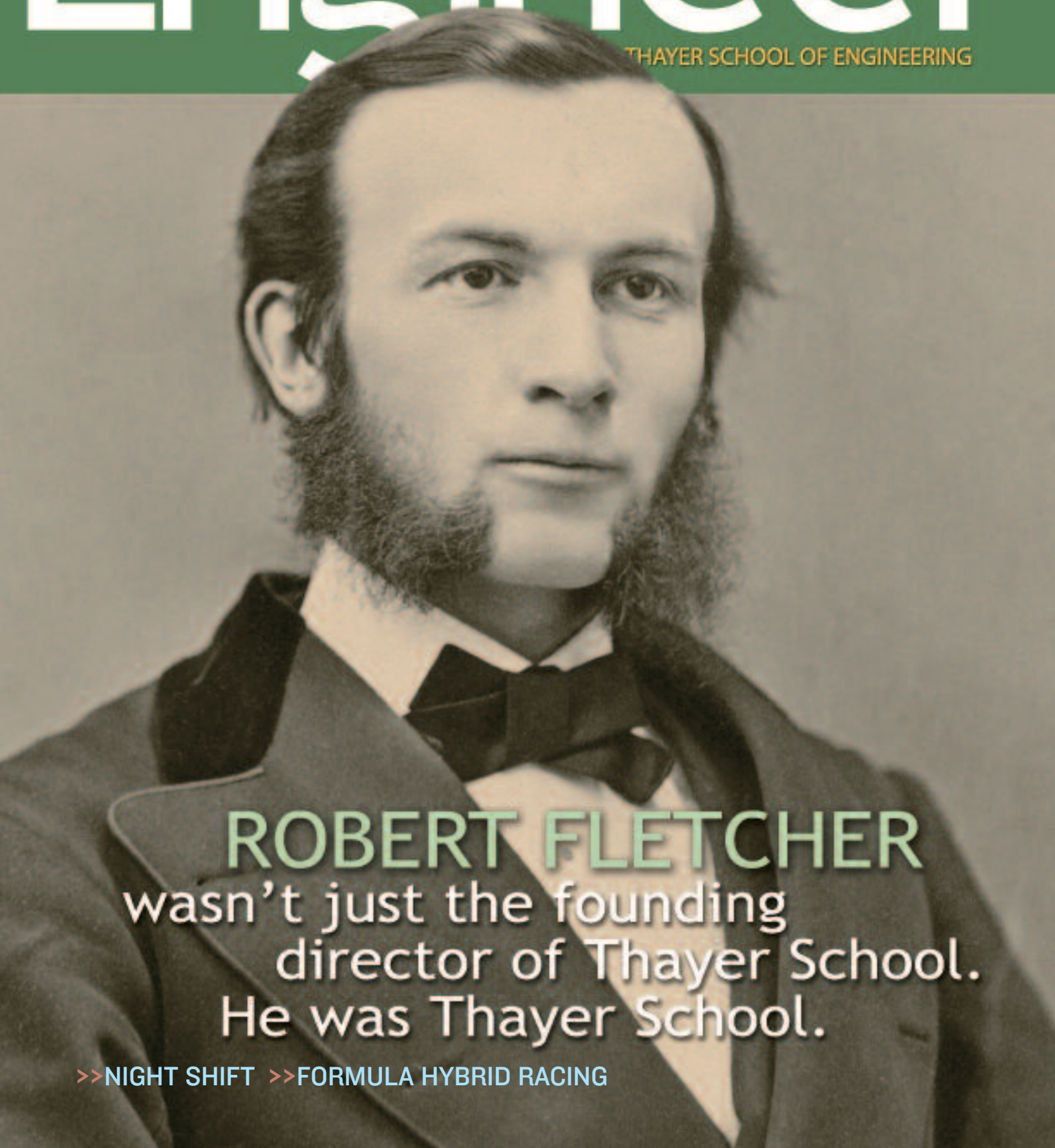
DARTMOUTH
# Engineer
SPRING 2006
THAYER SCHOOL OF ENGINEERING



## ROBERT FLETCHER
wasn't just the founding director of Thayer School. He was Thayer School.

>>NIGHT SHIFT >>FORMULA HYBRID RACING

DARTMOUTH ENGINEER
VOLUME 2 / NUMBER 2

# Inspiration is the Best Incentive

BY DEAN JOSEPH J. HELBLE

THIS PAST YEAR SEVERAL MAJOR REPORTS have argued that the development of engineering talent is critical to the continued competitiveness of our economy. From "Innovate America," published by the Council on Competitiveness, to "Rising Above the Gathering Storm," recently released by the National Academies, the message has been loud, clear, and consistent: We are a nation whose progress is driven by technology. To remain competitive, we need to support innovation. Supporting innovation means producing a technology-skilled workforce. And that means producing engineers.

This theme has echoed broadly, from op-ed columns in major newspapers to the halls of Capitol Hill. China graduates 600,000 engineers, we are told, while the U.S. only graduates 70,000. Even if one disputes these numbers—and many have—we know as engineers that the slope of the curve is also important, and investment in engineering in Chinese universities appears to be growing. Bills have been introduced in the U.S. Senate to encourage innovation—bills that include providing more funding for technology R&D and more scholarship aid for engineering students. In his recent State of the Union address, President Bush sounded many of the same arguments as he advanced the American Competitiveness Initiative and backed it up with funding. His proposed budget, currently working its way through Congress, calls for a 7.8 percent increase in funding for the National Science Foundation, the major source for research funding in engineering and the physical sciences, as well as increases in basic physical science

CONTINUED ON PAGE 31

FEEDBACK LOOP

Share your thoughts on engineering, Thayer School, or Dartmouth Engineer through a letter to the editor.

E-mail: dartmouth.engineer@dartmouth.edu
Write: Dartmouth Engineer, Office of Communications
8000 Cummings Hall, Dartmouth College
Hanover, NH 03755



**Office of Communications**
Thayer School of Engineering
8000 Cummings Hall
Dartmouth College
Hanover, NH 03755

E-mail:
dartmouth.engineer@dartmouth.edu
Telephone: (603) 646-3521
Fax: (603) 646-9133
engineering.dartmouth.edu

**Address Changes**
Thayer School Development Office
8000 Cummings Hall
Dartmouth College
Hanover, NH 03755

engineering.alumni.records@dartmouth.edu

DARTMOUTH ENGINEER is published twice a year for the Thayer School community.



thay6.5m4.06villanti

# Contents







## DEPARTMENTS



ON THE COVER
Robert Fletcher early in his long tenure at Thayer School. Photograph courtesy of Dartmouth College Archives.

BACK COVER
MacLean Engineering Sciences Center. Photograph by Douglas Fraser.


1919

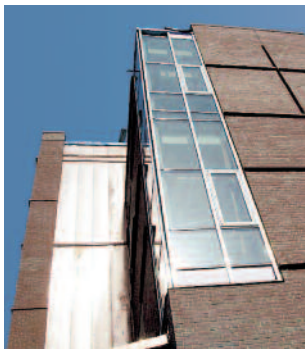
# Fletcher's Big Dig

ROBERT FLETCHER, first dean of Thayer School, constantly applied his engineering expertise outside the classroom. Numerous New Hampshire communities benefited from his interest in clean water systems. As a founding member of the Hanover Water Works, established in 1892, Fletcher oversaw the construction of the town's first reservoir. Enlarged in 1954, the 425-million-gallon reservoir still provides Hanover—and Dartmouth—with drinking water. Now one of three Hanover reservoirs, it carries the distinction of bearing Fletcher's name. For more on Fletcher, turn to page 10.

PHOTOGRAPH COURTESY OF DARTMOUTH COLLEGE ARCHIVES

# THE Great Hall

>>NEWS FROM AROUND THAYER SCHOOL

Finishing Touches
With gleaming copper and glass, MacLean Engineering Sciences Center nears completion.

CONSTRUCTION

## On the Move

AS THE MACLEAN ENGINEERING SCIENCES CENTER enters its final phases of construction, anticipation is rising for building plans of another sort: the move into Thayer School's expanded quarters. The move is expected to take six weeks, beginning in May and ending in June.

The task of determining who moves to MacLean and who stays in Cummings Hall has fallen from the start to five building committee members, professors William Lotko, Christopher Levey, and Peter Robbie, financial executive officer Lawrence McKinnon, and facilities manager Gary Durkee.

So who moves? Several labs and faculty offices, reception, the admissions office, the instrument room, and Dartmouth Formula Racing, to name a few MacLean occupants. There are other moves afoot, too. Several offices and labs gain breathing room by shifting into Cummings' vacated spaces. And Thayer School's development and communications offices return to Cummings Hall after three years off campus.

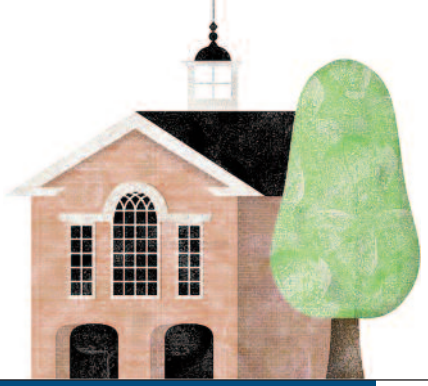
The move may sound like a nightmare, but Durkee, who is heading up the physical relocations, makes it seem like a logistical dream. "Hours of planning have gone into the move," he says calmly. "It's a matter of design, plan, and execute."

According to Durkee, he, his four staff members, and some additional movers will handle the physical work. He expects the job will continue through evenings and weekends. "We want the least interruption during the process," he says.

And when it's finally done, the celebrations will begin. Thayer School invites everyone to attend Dartmouth's official dedication of MacLean Engineering Sciences Center Friday, September 29.

THIS PAGE: PHOTOGRAPHS BY DOUGLAS FRASER; OPPOSITE PAGE: PHOTOGRAPH BY THOMAS AMES JR.; ILLUSTRATION BY JAMES O'BRIEN

Ecological footprints
average per American: 24 acres
average for most of the planet: less than 4 acres



Q & A

# Ecological Footprints

DARTMOUTH'S SUSTAINABILITY coordinator, Jim Merkel, recently delivered a Thayer School Jones Seminar on sustainable design. Merkel, who holds a B.S. in electrical engineering, is on a mission to embed ecological values and practices into the College's strategic planning, curriculum, student life, and community relationships. Much of his Jones Seminar centered on ecological footprints.

**What is an ecological footprint and why is it an important measurement?**

An ecological footprint estimates a human's impact on earth. It looks at all the inputs and outputs needed to support a lifestyle. If we want to be sustainable, we need to be able to quantify human consumption. Sustainability has no teeth unless we have a metric to measure against.

**What's the average individual footprint in the U.S. and other parts of the world?**

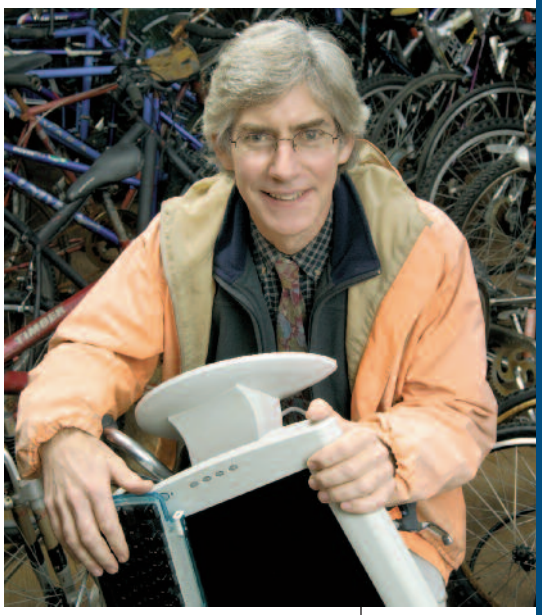
In the U.S., 24 acres per person is the average. Here at Dartmouth it's even larger. The strongest correlation is income. In Europe, the average is between 12 and 14 acres per person. What's interesting to note is that Europeans have a quality of life that's comparable to ours despite having a smaller footprint. The countries of Eastern Europe and the southern hemisphere average about 6 acres per person and really poor nations average 1 to 3 acres. About 4 billion people have footprints of less than 4 acres.

**How do you calculate your footprint?**

There are three methods. You can use a chart to correlate income to footprint. The second method is a questionnaire that is online at myfootprint.org. The third method is filling out a detailed spreadsheet with more than 100 items. It includes categories such as food, housing, transportation, long-lasting goods, and wastes. The big ones are car, house size, utilities, and diet. Eating vegetarian versus meat is a huge impact.

**What changes did you make in your own life to reduce consumption and waste?**

The biggest is that I have been car-free for 16 years. I'm judicious with my fossil fuel use by using bicycles and avoiding air travel. I've lived in spaces ranging from 150 to 500 square feet per person. That's



putting me closer to the global average.

**What was most difficult to reduce?**

Things like weddings and nieces and nephews graduating from college make me choose whether to travel. It's tough to hurt the Earth to see your family. It's not always a clear choice inside myself.

**Are there significant efficiencies to be gained by living in a community with people who are all trying to minimize their impact on the biosphere?**

Yes, for sure. When you share a refrigerator with three people, it's one-quarter the impact. When you share things you halve the footprint immediately. And then if you care for it by making it last twice as long, you're halving it again. And if you improve your technology, you can have multiplying benefits.

**Does your engineering background influence the way you approach sustainable living?**

Definitely. I'm a guy who loves

CONTINUED ON PAGE 7

**Less is More**
Merkel wants people to consider the global impact of individual choices.

## kudos

>> Elsa Garmire, Sydney E. Junkins Professor of Engineering, recently delivered Dartmouth's 19th annual Presidential Lecture. Selected for the honor by President James Wright, Garmire titled her speech, "Who Would Have Imagined? From an Idea to Reality—the Parallel Growth of Lasers and a Woman Scientist." In other news, Garmire has joined the board of advisors at Stellaris Corp, a Lowell, Mass.-based company that is developing low-cost renewable energy and energy conservation technologies.

>> Visiting Professor Ron Lasky has been appointed director of the Cook Engineering Design Center (CEDC) for a three-year term. He will build Thayer School's industrial design partnerships and expand CEDC activities.

>> Associate Professor Susan McGrath was appointed to the Personal Protective Equipment Committee at the Institute of Medicine. The committee will examine scientific and technical issues in the development and use of personal protective equipment and explore emerging research areas. She was also appointed to the Emergency Management Technical Committee, part of the Organization for the Advancement of Structured Information Standards, which will assist in the development of standards for emergency response data exchange and interoperability.

ONLINE

# Prof Podcasts

PODCASTS OF RECENT INTERVIEWS with Thayer School professors are available online. In "Blending Medicine and Engineering," orthopedic surgeon Dr. Michael Mayor, a professor at both Dartmouth Medical School and Thayer, talks about his focus on engineering within orthopedics. He describes a current study of how bones respond to artificial joint implants. "More and more engineering disciplines are being called upon to design and apply specialty technologies to the problems patients have," Mayor says.

He emphasizes the need for doctors with engineering backgrounds and engineers with medical knowledge. Engineering training, even if it's only a few undergraduate courses, Mayor says, is helpful because it emphasizes research. "If you have that depth of understanding, you can interact better with patients," Mayor says.

In another interview, "The WiFi Generation," Ted Cooley '82, Th'88, assistant professor and Thayer's chief IT strategist, talks about wireless on campus. He says improved wireless access helps students work more efficiently, as when they gather data in labs and plug it into lab reports on their laptops at the same time.

In one research project, Cooley, who says that "more, better, faster" is the theme for wireless on campus, is trying to gain a better understanding of how the wireless network works. "The idea is that if I know exactly what's going on in the network, then I can tune the amount of power that I transmit down to a more battery-friendly level," he says.

A third podcast features Visiting Professor Quintus Jett talking about open-source organizing—ways individuals and groups are able to organize outside of big, bureaucratic organizations. Jett, who recently made a research trip to New Orleans, is using one hurricane-devastated neighborhood as a test case for his ideas about organizing. He theorizes that large disasters attract outside help, but if a disaster is too big, the enormity can be a disincentive to get involved because people don't know where to begin. He says more people would do things in overwhelming situations if it were clear to them how they could be of assistance.

To download these and other podcasts, go to dartmouth.edu/~news/features/podcasts/.

Snow Job
Engineers pitched in with wintry know-how.

RITUALS

# Sculpting through the Snow

THAYER STUDENTS traditionally take their skills outside during winter and shoulder most of the design and construction of the Winter Carnival snow sculpture. "It's a typical engineer thing to do," says M.E.M. student Jon Kling.

This year's celebration, "The Stupendous Games: Mischief in the Snow," included a complicated design and a scramble for enough snow to get the job done. The sculpture was a 24-foot-high capital D embellished with cartoon characters Calvin and Hobbes bobsledding down the sloping curve. A 35-foot Olympic torch rose from one corner of the D. The torch was a nod to Dartmouth Olympians past and present and an acknowledgement of the 2006 Winter Games in Torino, Italy. A walkway lined with shelves was cut through the sculpture and stocked with memorabilia from Dartmouth Olympians. During Winter Carnival's February 9 opening ceremonies, flash burn paraffin wax was boiled to ignite gasses that shot flames up from the torch.

The biggest problem in snow-sculpture construction is the race to amass enough snow. In January students erected a base of plywood sheets, then started filling the base with snow one shovelful at a time. They hosed the snow down to freeze it into solid ice overnight. The next day they moved the plywood to the top of the ice block and repeated the process. After the icy mound was too high to reach, they used a pulley system to haul up trashcans of snow. Two weeks and 270 cubic yards of snow later, the fun began. Students, about half from Thayer, used chainsaws and ice tools to refine the sculpture.

About a week before opening ceremonies, rain and temperatures in the low 40s left the Green showing more grass than snow. Snow had to be imported from Dartmouth's Sculley-Fahey Field, and ice shavings arrived from Campion Ice Rink in Lebanon.

"We're really lucky it worked out," Kling says. "We had 30 people helping through the night the day before it was finished—standard engineer fare."

According to Kling, the engineers on the job didn't mind the endless shoveling and pressure to finish. It's like any engineering project, he says. "We do it so we can walk around the final product and give each other high fives and say 'Sweet.' "

THIS PAGE: PHOTOGRAPH BY JENNIFER SEATON. OPPOSITE PAGE: PHOTOGRAPH BY JOSEPH MEHLING '69

"By going international, we allow ourselves to really contribute to the engineering, not just the grunt work."

—EWB'S HANNAH MURNEN

## FOOTSTEPS CONTINUED FROM PAGE 5

numbers. Things have got to make sense to me in terms of flows of resources.

**Is there anything you wish engineers would keep in mind as they develop new technologies?**

I'd like them to think, "What are the unintended consequences of the project?" There are going to be negative unintended consequences, so widen your awareness. Think of the impact on ecology and on social systems. When you design considering social and ecological systems, the design is going to be much tougher. It will take creativity, but for an engineer it's just going to be more fun. For me, the harder the problem, the more fun I have with it. There's no reason today to be designing with non-renewable materials.

**When you talk to audiences about sustainability, what's the biggest objection you encounter?**

I don't encounter that much objection. People may slip into a discussion of whether others are open-minded enough to live sustainably. The question is: can you become the doctor who takes the medicine first? I would like to challenge the engineers to show that they can live sustainably, consuming an equitable portion of the biosphere.

**Of all the ways you've found to conserve, reuse, and re-engineer, what is your favorite?**

I really like the concept of share, care, conserve. Multiplication is amazing. When you can still have a car but its impact is 1/32 of what it would be if you jumped into your car by yourself every time, it's amazing.

ENGINEERS WITHOUT BORDERS

# Students Earn Social Justice Awards

THE DARTMOUTH CHAPTER of Engineers Without Borders (EWB) was among eight organizations and individuals honored with the College's 2006 Martin Luther King Jr. Social Justice Award. The award, presented January 27, recognizes members of the community who have demonstrated compassion, perseverance, courage, and leadership.

EWB designed and installed a machine-dug well and solar pump in Nyamilu, Kenya last summer to provide the village with clean water for drinking and irrigation.

EWB co-chairs Tia Hansen '05, Th'06 and Hannah Murnen '06, Th'07 accepted the award for the organization. Both say participating in EWB has influenced their career aspirations.

"It made me realize what a positive impact small engineering projects can have in the developing world," Hansen says. Drawn to renewable energy technology, especially solar power, she plans to pursue a Ph.D. in chemical engineering with a focus on renewable energy resources.

Murnen is also considering a Ph.D. in chemical engineering and wants to research ways to harness solar and wind power that could be used in developing countries. She says it would be gratifying to work in countries that are not already dependent on petroleum because those countries can still avoid eventual reliance on fossil fuels.

According to Murnen, Dartmouth's EWB has a proven formula for success: taking on simple projects that students can plan, execute, and oversee themselves. Although Hurricane Katrina prompted EWB to consider taking on projects within the United States, Murnen says, international projects seemed to yield the best results and help people meet their most basic needs. "In the U.S., engineering tends to be more sophisticated," she says. "By going international, we allow ourselves to really contribute to the engineering, not just the grunt work."

Murnen, left, and Hansen

After the success of its Kenya project, EWB no longer has to look around for its next project because suggestions are rolling in. A group member recently traveled to San Fidel, El Salvador to study the feasibility of a water project proposed by Kiva Wilson '04, a Peace Corps volunteer there. The group is also considering a follow-up project in Kenya.

# kudos

>> Thayer School career services director Chandlee Bryan represented Thayer School on Dartmouth's Service and Education Trip for Hurricane Katrina Relief in Biloxi, Miss., in December. She worked with a team of Dartmouth students to establish a temporary employment resource center that assisted Gulf Coast residents with résumé writing. Institute for Security Technology Studies staff member Jenny Bodwell also represented Thayer School in Biloxi. She worked with students and volunteers at Hands On USA on construction-related recovery efforts.

>> Visiting Professor Quintus Jett helped organize a summit to develop new ways to bring help to people affected by hurricanes Katrina and Rita. The event, hosted by the Louisiana chapter of the NAACP, was held in Baton Rouge in November. Jett and students in his fall-term course "Organizations, Technology and Management" also developed the MOSAIC Project (mosaic-nola.org), a resource for volunteers contributing to recovery efforts.

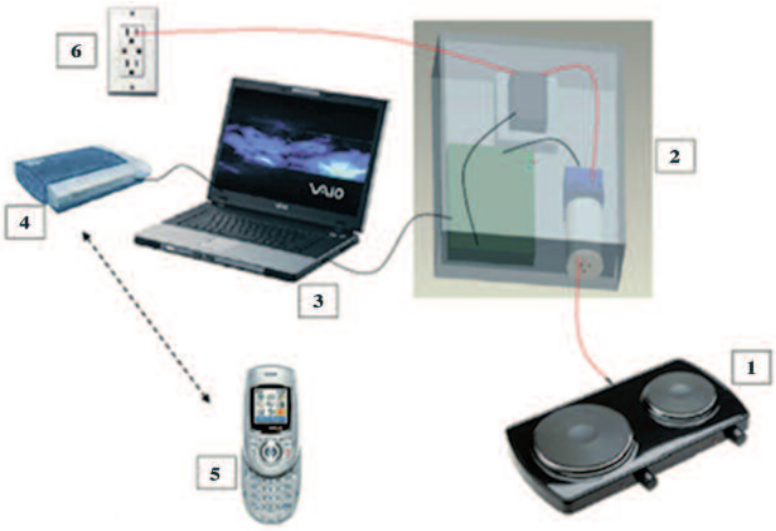
>> Assistant Professor Ted Cooley '82, Th'88 has been appointed chief IT strategist at Thayer School. His duties include identifying, reviewing, and evaluating software relevant to Thayer courses.

>> Mark Franklin '83, Th'85 has returned to Thayer School as director of computing services. A Thayer employee from 1987 to 1993, he worked for more than 10 years for Applied Microsystems, Cabletron Systems, and the Kiewit Center.

>> Ph.D. candidate John Hannon won the Golden Hammer-Best Presentation Award for his discussion of his research, "Applying Computational Fluid Dynamics to Model Industrial Fermenters" in Thayer School's Research in Progress Workshop for doctoral candidates, held in March.

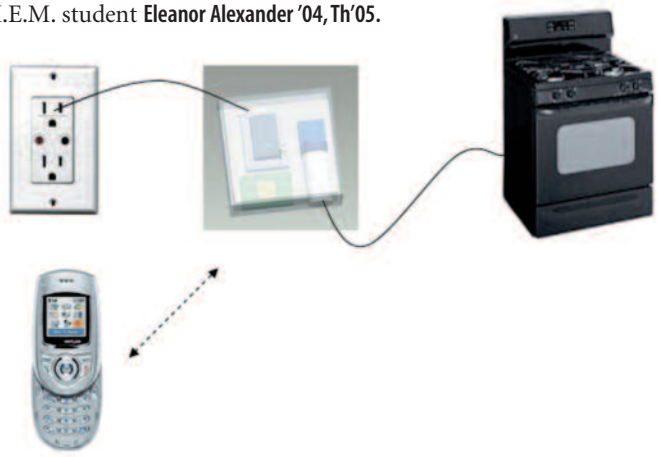
STUDENT PROJECTS

# I Want One of Those!




## Hot Stuff

Ever wonder if you remembered to turn off the burner on your kitchen stove? With the Remote Access Cook-Top Notification System, a left-on stovetop will alert you via cell phone. You'll even be able to shut the stove off by phone. The prototype is pictured above, the finished product below. Team members **Catherine Gaito '07, Marc Lajoie '08, Prahbu Perumalsamy '08, Kimberly Rocio '08,** and **Elisha Tam '07** won the Philip R. Jackson Award for the best project in ENGS 21 ("Introduction to Engineering"). Their T.A. was M.E.M. student **Eleanor Alexander '04, Th'05.**



CLASSROOM

# Biotechnology of Healthcare

STUDENTS ROUTINELY GET A HEALTHY dose of the future of medicine in ENGS 5, "Healthcare and Biotechnology in the 21st Century," a popular Thayer School course aimed at non-majors. The class takes students on a tour of technological challenges and possibilities, including regenerating missing organs and limbs, using robots as replacements for human parts, and cloning.

The course is co-taught by longtime biotechnology collaborators Peter Robbie and Dr. Joseph Rosen. Robbie, a Thayer School lecturer, is a product designer with a research focus on medical imaging. Adjunct professor Rosen is a practicing plastic surgeon at Dartmouth-Hitchcock Medical Center and an expert on neurological repair, tissue engineering, and artificial nerve grafts. The two share the podium with guest speakers who acquaint students with a wide range of technological advances. For example, guest lecturer Norman Badler headlined one class last spring with the topic "Representing and Parameterizing Embodied Agent Behaviors." Badler, a computer science professor at the University of Pennsylvania and an expert on modeling and animating human images in 3-D graphics, explained part of the difficulty involved in substituting virtual characters for real people: viewers need less than 10 seconds to judge the effectiveness of a computer-generated character.

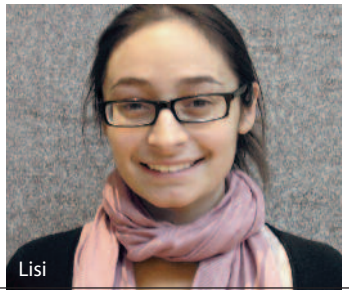
Student Kenneth Muigai '07, an English and film studies major, says that his favorite class focused on artificial limbs. The lecture was delivered by a man with a prosthetic arm—and by the doctor who fitted it to him. The patient showed the class his collection of artificial arms—manual, battery-powered, and cosmetic—and talked about the capabilities and limitations of each. "The lecture definitely made me think about the future," Muigai says. "The fact that doctors and engineers are designing limbs with the specific goal of getting the patients back to where they can participate in their normal activities is not only sensational but extremely uplifting."

The course explores issues behind such advances as well. The professors discuss the ins and outs of getting Food and Drug Administration approval of new treatments. They pose ethical questions surrounding cloning and other technologies. And they entice the imagination by examining what would be needed to create wings for humans or how to get virtual humans to follow instructions. From these flights of medical fancy to the current state of implants and robotics, the professors challenge students to think about how technologies could be used to solve real-world problems in the future.

"Unless you read Scientific American regularly, you're not going to know this stuff," says pre-med student Courtney Chau '08.

Biology major Jennifer Cech '08 likes the way the class meshes biology with engineering. "You're right at the cutting edge of what is going on in the world," she says.

THIS PAGE: CAD IMAGES COURTESY OF ELISHA TAM. OPPOSITE PAGE: PHOTOGRAPHS BY JENNIFER SEATON


Lisi


Conger

# lab updates

JUST ONE QUESTION

## What's Your Dream Job?

I'm going into consulting next year, and I'm hoping to switch to environmental consulting after a few years. I think it's important to get a good sense of business first. Environmental consulting has the engineering aspect, and also I really enjoy teamwork and talking to people.

**—Julie Lisi '05, Th'06**

I'd like to be chief science officer at a big drug company. I'd like to be able to direct research, and I think there's a lot of room for developing drugs that can really add quality to people's lives. The CSO is in the top spot without having to deal with all the economic issues the CEO deals with.

**—Grant Henderson, Ph.D. candidate**

I'd like to own a small design firm specializing in outdoor equipment. I've always enjoyed the design process, and it would combine with my interest in the outdoors.

**—Eben Sargent '05, Th'06**

I'd like to work in design and production of a high-end sports car. I'd like to be with a small car company so I could work on a broad range of products.

**—Jordan Desroches '03, Th'05**

I always thought being a pyrotechnics expert on movies would be sweet. But I'm doing the M.E.M. program so I'm focusing more on the business stuff. I have a job next year in high-tech consulting. My plan is to work for them for a year and


Desroches

see if I miss getting my hands dirty with engineering. As long as it has a lot of variety and is challenging, I'll be happy.

**—Jeff Hebert '04, Th'06**

It might be doing business strategy at a biotech or pharmaceutical company. I really like that industry because of its basis in science. I'd like to be involved in how the company is positioning itself. The industry is growing and changing so much I want to see where it goes. I think it will be a very big part of our lives.

**—Maaza Mehzun '04, Th'06**

Astronaut. It's applying exciting aspects of nature and the world plus engineering. It represents success in the field and also in life. You have to be in top physical as well as mental shape.

**—James Joslin '05, Th'07**

I don't know yet if I want to do engineering or more of engineering management. What would make me happiest is to see people who I don't know using my product and having it work.

**—Gus Niles '07**

I don't see myself as an engineer for the rest of my life. I know I'll be in technology. I'm trying to get an internship with Apple or Microsoft doing product design. That would bridge the gap between the technical aspect of engineering and business.

**—Ryan Conger '05, Th'06**

### ANTIBODIES FROM YEAST

Researchers from Thayer School, Dartmouth Medical School, and biotechnology firm GlycoFi recently reported a major advance in protein bioengineering. The team made a breakthrough in using yeast to produce antibodies with human sugar structures. Antibodies are proteins with sugars attached to them.

The team's latest work shows that antibodies with increased cancer-killing ability can be produced by controlling the sugar structures that are attached to them. The finding is important because antibodies are emerging as a significant class of cancer drugs. This research shows that an antibody with human sugar structures can be produced in the lab. GlycoFi's approach can be applied to other glycoproteins, a growing class of therapeutic proteins.

The research was published in the February issue of Nature Biotechnology. GlycoFi was founded in 2000 by Thayer School professors Tillman Gerngross and Charles Hutchinson.

The March issue of Nature Biotechnology includes Gerngross in its shortlist of researchers who have made the most significant contributions to biotechnology in the past 10 years.

**—Sue Knapp**

### BREAKING THE ICE

Professor Victor Petrenko's Icenabled™ icemaker may soon freeze old machines out of the $1 billion icemaking business.

Utilizing his pulse electrothermal de-icing (PETD) technology, the Icenabled icemaker "will be more productive, more space efficient, more energy efficient, more reliable, and will make ice faster and of higher quality than ever before," he says. "This technology can increase an icemaker's production capacity by 70 percent while decreasing its energy consumption by up to 30 percent."

Conventional commercial icemakers, ubiquitous in hotel hallways, restaurants, and hospitals, consume enormous amounts of power. They cycle through a process of cooling to make the ice and heating to release the ice as many as 100 times a day.

An Icenabled icemaker uses PETD to virtually eliminate the heating portion of the cycle. PETD removes the ice instantly using a high-power electric pulse that lasts less than a second. This same technique can also eliminate the need for conventional hot gas defrost systems.

PETD could ultimately transform the entire $40 billion refrigeration and air conditioning industry, which, according to Petrenko, has struggled with the challenge of keeping cold evaporator coils free of frost and ice. PETD has proven its ability to de-ice these coils in seconds using a fraction of the energy required by conventional coil defrosters.

Petrenko and his company, Ice Engineering LLC, are working on several other applications for PETD, including de-icing buildings, bridges, car windshields, airplanes, windmills, ships, and power lines. To learn more, visit iceengineering.com.

**—Catharine Lamm**

# Robert Fletcher

## wasn't just the founding director of Thayer School.

## For 65 years, he was Thayer School.

"WE ALL LOVE OUR BOBBY—MANY OF US received our life's inspiration from him," wrote a Thayer School alumnus on the occasion of Dean Robert Fletcher's retirement in 1918. It was difficult to imagine Thayer School without Robert Fletcher, for from the beginning, Fletcher was Thayer School.

Fletcher's service to Thayer began in 1871, when he came to Hanover as Thayer School's founding director and sole faculty member. He retired only because he reached Dartmouth's mandatory retirement age of 70. He didn't actually leave, however. He stayed on as a lecturer and overseer until his death in 1936 at the age of 88. Clearly, Dartmouth loved Fletcher, and Fletcher loved the College.

Dartmouth and Fletcher's relationship was not quite love at first sight. It grew from a complicated courtship that eventually required White House intervention.

In 1867 General Sylvanus Thayer, the "Father of West Point" and a member of Dartmouth's class of 1807, bestowed on Dartmouth the means to establish a school of civil engineering. Dartmouth President Asa Smith announced that the engineering school would open the following year. Thayer tapped a trusted friend, West Point professor Dennis Mahan, to suggest a suitable candidate for the position of director of the new school. The search proved harder than expected. By 1870 nearly a dozen candidates had turned down the job and its paltry $1,500 salary. Then Mahan suggested an "industrious and reliable" young second lieutenant, Robert Fletcher.

Only 23 years old, Fletcher was teaching math at West Point, his alma mater. Mahan asked him if he would consider taking on the headship of Thayer's engineering school. "Fletcher replied that not only would such a career suit him," Mahan wrote Thayer, "but that, in coming on duty here, he had looked forward to qualifying himself for some such place."

Fletcher made mixed first impressions on both

BY LEE MICHAELIDES

ALL PHOTOGRAPHS COURTESY OF DARTMOUTH COLLEGE ARCHIVES

Thayer and Smith. Thayer worried about "a defect in his speech." Smith thought twice about Fletcher's age and bearing.

"He is young, but if that be a fault, time will surely correct it. His presence is not very imposing, but as [English preacher Isaac] Watts said, 'The mind's the standard of the man.' I think there will be no intellectual deficiency," Smith wrote Thayer. "If you are satisfied, I think it would be well to appoint him."

A relieved Thayer replied, "We must take him for better or for worse, at least so as to give him a fair trial; right glad shall I be if he prove to be the right man."

Fletcher, too, had reservations about linking himself to Dartmouth. There was no guarantee that the College was committed to him or to the nonexistent engineering school, and he was reluctant to resign his Army commission. He decided to keep his options open by seeking a leave of absence from his duties at West Point.

Getting the leave wasn't easy. Fletcher had to bring his request all the way up to President Ulysses S. Grant. Grant approved the leave. But, claiming that the President didn't understand the request, Grant's Secretary of War overruled him and revoked Fletcher's leave. Fletcher resigned from the Army, committing his future to the uncertainty that awaited him at Dartmouth.

Once Fletcher moved to Hanover, the doubts about his appointment vanished. Within a week of his arrival, Fletcher began preparing three students for entrance into Thayer School. After Fletcher's first two months, Smith wrote Thayer, "We are delighted with him. We have been directed to the man for this place."

Neither Fletcher nor Thayer actually expected the school to open in 1871. They had planned to spend a year or two writing the curriculum. But President Smith wanted the school to open immediately, and he prevailed.

Fletcher had to build the school from scratch. He secured five rooms scattered around Dartmouth Row's Wentworth, Thornton, and Reed Halls. He bought books, tables, and other supplies. And, most time-consuming of all, he developed Thayer's ideas for entrance requirements—the general's "Program A"—and for the engineering curriculum—"Program B." Finally, on September 20, 1871, Fletcher wrote Thayer, "I have the honor to report that the Thayer School of Civil Engineering has fairly opened."

Fletcher was not only director of the new school. He was the sole professor. And upon Thayer's death in 1872, Fletcher shouldered the full responsibility for upholding Thayer's goals. In his first report to the Thayer overseers in 1873, Fletcher wrote, "Gen. Thayer intended the Thayer School to attain, in a few years, the very first position as an Institution for the training of engineers."

Fletcher continued to develop the course of studies. The curriculum he introduced in 1879 formed the mainstay of Thayer School until 1918. During that time courses were updated,

LEADING BY EXAMPLE
Fletcher set Thayer School's academic and moral tone.

but with the exception of new classes in electrical engineering and the dropping of a class called "Masonry and Foundations" the core remained constant.

*The 1879 Curriculum:*
Surveying
Mechanics
Resistance of Materials
Properties of Construction Materials
Materials and Structural Elements
Bridges and Roofs
Hydraulic Works
Heat and Heat-Engines
Sanitary Engineering
Rivers and Harbors
Rockwork, Tunneling, and Mining
Masonry and Foundations

The administrative efficiency gained by Fletcher's one-man-band status was more than offset by the time it took to prepare for the 14 different courses he was required to teach. Even after the College administration cut Fletcher's teaching load in half, it was still too heavy even for a man with Fletcher's energy. "Four recitations or lectures per day on different topics is too much for one professor, who must prepare himself in each subject by hard study," wrote Fletcher to the College administration. "Add to this the keeping of records and general oversight of the Institution and the duty cannot be properly done without assistance."

What motivated Fletcher to work so hard? It wasn't money. His starting salary in 1871 was $2,500, and he worked 39 years before the College gave him a raise. More likely Fletcher, a devout Christian, was driven by a biblical mandate for his success in his chosen profession. A lecture titled "The Durable Satisfaction of the Civil Engineer," which Fletcher delivered in 1928, offers an insight into his sense of purpose. He told his audience:

"In the spiritual realm God works through human agency; through the conscience and intelligence and energizing spirit of man. In the very beginning of recorded history the command went forth to mankind to subdue the earth, 'to have dominion over the fish of the sea, and over the birds of the air and over every living thing that moveth upon the earth.' Reverently we may say that the civil engineers are assistants to the Creator and the upholder of the universe in creating (as the French happily express it) 'works of amelioration' for the betterment of the world."

In addition to tending to Thayer School, Fletcher embraced the civic side of civil engineering, bringing the same limitless energy to public works projects all over Vermont and New Hampshire. He was a member of the

FIELD DAY Surveying, the first course Fletcher taught, was a curricular staple for decades.

## Fletcher's Hall Of Fame

Robert Fletcher frequently lectured students on the need to draw lessons of inspiration from history's great engineers. Famous in their time, some of their names and accomplishments have been forgotten as technology advanced. More important, however, is the fact that all the engineers Fletcher singled out reflected his beliefs in what made a great engineer: education and hard work.

John Seaton (1724-1792) Seaton was the most famous engineer of his time. He is remembered for his design of the Forth and Clyde Canal and for improving the steam engine. Seaton won a gold medal from the Royal Society. The key to Seaton's success was time management, Fletcher wrote. "From an early period he carefully divided his time, allotting so much for study, so much for practical experiments, so much for business and so much for rest and relaxation."

James Watt (1736-1819) "The name of Watt," wrote Fletcher, "is inseparably connected to the steam-engine. His genius and persistent study developed it from a wasteful and hence nearly impractical motor, to a working success." Fletcher noted that Watt studied German and Italian so he could remain current with the latest works in his field.

Robert Fulton (1765-1815) "Although Robert Fulton is not entitled to distinction as an inventor," Fletcher wrote of the steamboat builder, "he was one of the ablest, most persistent and most successful of those who have done so much for the world by the introduction of the invention of others. He was an intelligent engineer…whose skill, acuteness and energy have given the world the fruits of the inventive genius of all who preceded him."

George Stephenson (1781-1848) English coal miner Stephenson was made a mining engineer at age 17 because of his inventions. One project reduced the number of horses required in the mine from 100 to 16. In 1825 he built a railroad line and a locomotive capable of reaching 36 mph. Fletcher was impressed that the self-taught Stephenson had achieved so much—and that Stephenson believed in formal engineering education despite lacking one. Stephenson made it a primary project of his life to send his son Robert, who also became a famous engineer, to the University of Edinburgh.

Hanover School Board for 17 years. He was the project leader for determining the exact boundary between Vermont and New Hampshire. He had a hand in building Wilder Dam and was the consulting engineer for the iron bridge across the Connecticut River in West Lebanon. He was a founder, president, and chief engineer of the Hanover Water Works and was consulting engineer for water projects throughout New England. During 40 years as a member and chair of the New Hampshire State Board of Health, Fletcher spread the use of septic tanks and other marvels of sanitary engineering, inspecting hundreds of septic tanks, sewers, and cesspools along the way.

Ironically, while the Thayer School was chronically under-funded during its early years, Fletcher was able to convince skin-flinted Yankees to pony up tax money for water, sewer, and transportation projects. Evidently Fletcher's simple, direct, and logical prose had a greater impact on the common man than on the likes of Andrew Carnegie, who turned down a funding opportunity at Thayer on the grounds that "General Thayer's attempt to start an engineering school at Dartmouth was unwise" and that "no effort should be made to perpetuate same."

Carnegie's opinion notwithstanding, Fletcher took great pride in the achievements of the graduates he sent off into the world. He visited alumni working on engineering projects all over the country. He toured the Panama Canal during its construction and recorded the Dartmouth men engaged on the project. In public forums, when he recounted the projects managed by Thayer alumni, he often included a sly reference to the fact that Harvard brought in a Thayer grad to direct the construction of its stadium after the project fell behind schedule.

Despite his fondness for the stadium anecdote, Fletcher was not a fan of sports. He was contemptuous of "football fever" and was unambiguous in his dislike of baseball: "I am opposed to the baseball business as to the matches between colleges. The raising of so much money for such a purpose, the interference with study, the loss of time, the rivalry, etc, are demoralizing and detrimental to the best interests of all."

Fletcher did not support the performing arts either. Her skipped a famous 1879 performance

## FLETCHER'S ERA

> June 20, 1870 West Point professor Dennis Mahan recommends 2nd Lieut. Robert Fletcher to Gen. Sylvanus Thayer for the post of Thayer Professor of Civil Engineering.

> July 1870 Fletcher makes his first visits to Dartmouth President Asa Smith in Hanover and Gen. Thayer in Braintree, Mass.

> December 31, 1870 Fletcher resigns his Army commission.

> January 1, 1871 Fletcher takes Thayer School appointment.

> January 1871 En route to Hanover, Fletcher visits scientific departments at Yale, Harvard, and M.I.T.

> January 23, 1871 Writing from Hanover, Fletcher informs Gen. Thayer, "I have made a beginning of business here."

> September 20, 1871 Fletcher writes Gen. Thayer, "I have the honor to report that the Thayer School of Civil Engineering has fairly opened." The sole professor, Fletcher teaches 14 courses.

> June 23, 1873 Albert Porter and Thomas Greenlay become Thayer School's first graduates.

> 1873 Fletcher's 26-page report on Thayer School causes the Board of Overseers to recommend that he "reduce his official writing to the least volume necessary."

> 1874 Thayer School expands into rooms in Thornton hall.

> 1875 Fletcher acquires space in Culver Hall for a "physical laboratory" and a "room for rough work where the young men may do little jobs of repairing, etc.… and thus save the School items of expense while acquiring for themselves useful manual dexterity and mechanical skill."

> 1875 Fletcher outlines the Thayer School philosophy: "to give the civil engineer an indispensable training which must be fundamental in character, thorough as to principle and general in its scope."

> 1876 Fletcher gets some teaching relief as Charles H. Pettee, Th1876, becomes a Thayer School instructor for one year. Between 1877 and 1882, three more graduates hold one-year instructorships.

> 1879 Fletcher adds courses in "Sanitary Engineering" to the curriculum.

> 1883 Hiram Hitchcock, Th1881, joins the faculty.

> 1885 Fletcher takes students to Boston to visit the Boston Bridge Works, Meigs Elevated Railway Contruction Co., and other engineering firms.

> 1892 Thayer School moves into its own building on Park Street. Fletcher pays part of the purchase price himself. Dartmouth reimburses him two years later.

> 1892 Fletcher becomes a founding member of the Hanover Water Works Co.

> 1893 Dartmouth allows students to take first-year Thayer courses during their senior year.

> 1902 The Thayer School catalog notes that each graduate should have "the habit and method of keeping himself well-informed as to the progress of engineering science and progress."

> 1904 Toot Worthen, class of 1904, skis down the stairs of Thayer School and crashes into Fletcher.

> 1907 Fletcher lobbies for a bigger building but advocates frugality. "The newly instituted Tuck School has managed to spend $125,000 for its building, I am informed, which, to my mind, is at least $50,000 too much."

> 1910 Thayer School moves into Bissell Hall.

> 1910 The Thayer School catalog states: "Instructors give personal supervision from three to eight hours daily….The principle of close personal supervision has always characterized Thayer School."

> 1913 Fletcher visits Thayer School graduates working on the Panama Canal.

> 1916 Fletcher travels around the country visiting Thayer School graduates.

> 1918 Fletcher reaches Dartmouth's mandatory retirement age of 70. The College awards him an honorary Doctor of Science degree. He joins Thayer School's Board of Overseers.

> January 9, 1936 Robert Fletcher is buried in the old Hanover cemetery. Three years later Thayer School moves nearby, to Cummings Hall.

> 1975 Thayer School institutes the annual Robert Fletcher Award, given to a graduate or friend of Thayer School in recognition of distinguished achievement and service in the highest tradition of the School. The first award is presented posthumously to Robert Fletcher.

of "HMS Pinafore" staged by Dartmouth students (Little Buttercup was a tackle for the football team) because he did "not think it consistent with my Christian profession to attend such a play." In 1886 he grudgingly attended a student production of "Julius Caesar." "Except for the fact that the entire affair was gotten up and managed by the students and all the parts taken by them, I would not have stepped inside the building," he noted.

A lifelong Republican and prohibitionist, Fletcher regularly lectured students on the evils of drink, tobacco, and swearing and on the importance of attending church. Fletcher's status on campus was so high that although students failed to comply with his views, they respectfully listened. They knew he cared deeply about their welfare. Years later former students would recall his pearls of wisdom with great affection. One member of the class of 1910 remembered Fletcher telling him "the body is like a steam boiler, feed it regularly and rake out the clinkers and you will always be able to get up steam."

Even the few students who didn't like Fletcher admired him. "Bobby Fletcher was a didactic fussbudget who early each winter would get all of us together on a Sunday afternoon and instruct us in what underwear to use for winter," one alumnus wrote. "But he was a fine teacher."

Fletcher and his family were also pillars of the community. He kept a daily diary spanning the 65 years he lived in Hanover. In it he recorded all the facets of town life involving the Fletcher family: wife Ellen, son Robert, and daughter Mary. The diary is filled with accounts of teaching Sunday School, croquet games, and New Year's visitations. Although known for exhaustive reports to Thayer School's Board of Overseers, Fletcher didn't waste words. His diary entry for Oct 14, 1871 simply says, "Engaged to Ellen."

It would be easy to think of Fletcher as someone who was all work and no play. But that's probably a mistake. To be sure, he had a strong moral compass, high professional standards, and a biblically inspired hobby—the study of ancient engineering projects in the Holy Lands. The truth is that Fletcher enjoyed his work so much that it doubled as a form of play. How else might one interpret why the eminently practical Fletcher drew up plans in 1899 for a subway line running between Hanover and White River Junction? □

Lee Michaelides is managing editor of the Dartmouth Alumni Magazine

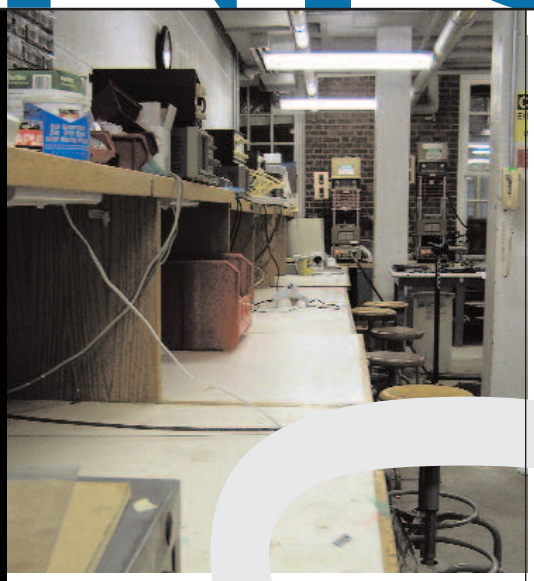
## "Shooting the Moon—It Can't be Done."

By all accounts Robert Fletcher was a methodical, down-to-earth engineer whose main interest was the improvement of the lives of the citizenry. Bridges, roads, water works, and septic systems were his primary concerns. Dartmouth's archives are filled with articles he wrote promoting the civic, health, and economic virtues of sensible civil engineering.

Writing an op-ed in 1929 for the Boston Transcript in response to its article on "Aspiring to the Skies," Fletcher used clear prose to explain the mathematical calculations that led him to conclude that a spacecraft couldn't leave the earth's gravitational field, much less make it to the moon. Although Fletcher was aware of German and American experiments with rockets, Fletcher dismissed their efforts, saying, "the low efficiency of rocket propulsion is well-known."

Was Fletcher unable to imagine the kind of improvements to a rocket on par with what his hero James Watt did with the steam engine? Possibly. More likely space exploration was at odds with the old engineer's faith. He concluded his Transcript op-ed by writing, "But why dwell upon impossibilities? It is evident that the Almighty Creator created man, as to his body, to have dominion only in his present environment, where he has more than ample scope for all of such science and skill as he may acquire."

# NIGHT SHIFT



## A PEAK INSIDE THAYER SCHOOL AFTER HOURS.

BY JENNIFER SEATON

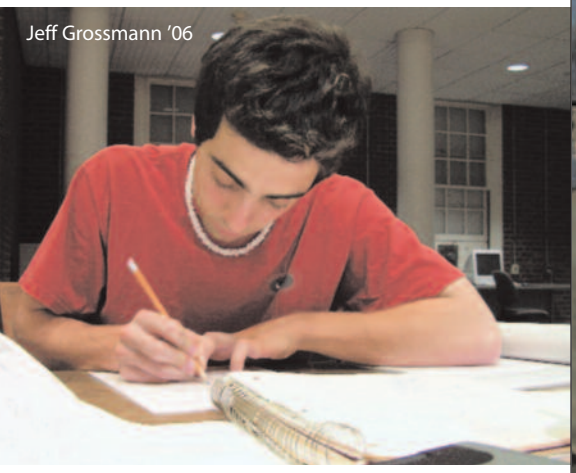
Walk into Thayer School at night and you're greeted by stillness. But wander upstairs and through the empty halls and you'll discover pockets of activity—spurts of laughter coming from labs, pairs of students huddled over problem sets. Head down to the basement, follow the clanking and blaring music, and you'll find yourself in the Dartmouth Formula Racing team's workshop, where someone is invariably firing up a blowtorch.

After several months of dropping in at Cummings Hall at all hours of the night, we can tell you that most Thayer students spend at least some time at school after dark. They all have their reasons. Take Luis Carrio '04, Th'05, winner of the "Most Hours Spent Sleeping on a Thayer Couch" award last spring. "I don't want to miss out on any interaction during the day," Carrio says. "It's nicer to work at night when it's quieter. I'm definitely not a morning person."

In fact, after midnight Thayer School experiences a collective second wind. Some students optimize every second before a deadline. Some tinker at a leisurely pace in the student projects room. Others just seem to be hanging out. But whether under pressure or not, students agree that the biggest thrill of any Thayer night is finishing the task that brought them there.

OPPOSITE PAGE: PHOTOGRAPH BY JOHN SHERMAN. ALL OTHER PHOTOGRAPHS BY JENNIFER SEATON.


THAYER SCHOOL



Jeff Grossmann '06


Tietjen Hynes '06

**6:20 pm** Tietjen Hynes '06 builds a remote-control robot that she hopes will be able to pick up trash strewn around a makeshift bleacher in the Great Hall. Tired from this morning's 6:00 wake-up for rowing practice, she is working on the gripping hand. And even though the "Machine Engineering" competition is almost a week away, she has a long way to go. "I may be here all weekend," she sighs.

**7:30 pm** M.S. candidate Pablo Fernandez rewards himself with an after-dinner break. Faced with a "Systems Identification" exam tomorrow morning, he says it's still early to be worried. "I'll probably stay until 12:30 tonight," says Fernandez, who already has a Ph.D. in physics. "I've had worse, but I'm sure it'll be pretty demanding tomorrow."

**7:38 pm** Donald Bly '07 sits in the Great Hall working on a problem set for "Analog Electronics." Although he enjoys engineering, Bly's favorite class outside engineering is a social science class called "War and Peace." The Cleveland, Ohio native spent two hours on the problems last night and plans to put in another four tonight. He gets up to stretch his legs about once an hour and goes for a vending-machine snack if he feels drowsy.

7:30 pm


Joe Horrell '04, Th'06

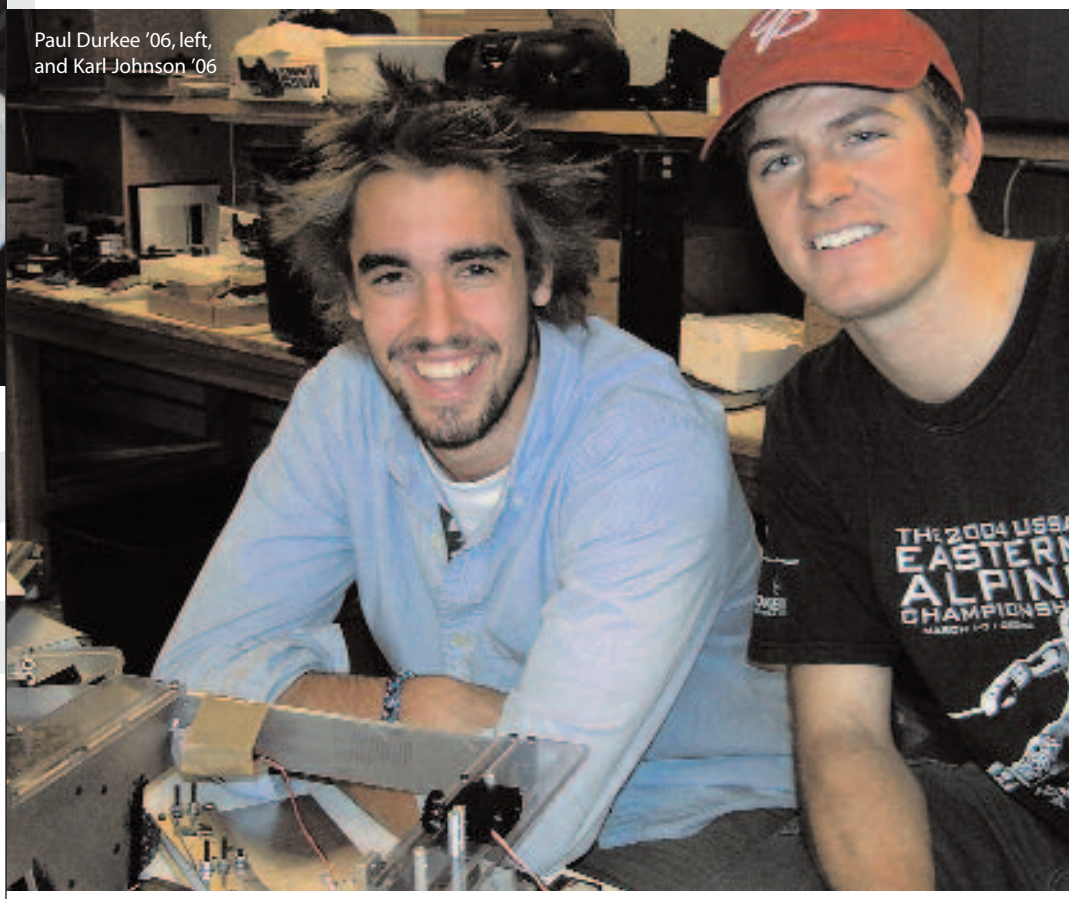

Nick Schaut '05, Th'06

**7:40 pm** Jeff Grossmann '06 is halfway through a problem set for "Electronics: Introduction to Linear and Digital Circuits." Undecided on a major when he arrived at Dartmouth, Grossmann first considered math and then looked at departments that applied math. He took "Introduction to Engineering" and decided engineering was just the thing for him. He says that after working late at school, "sometimes you're just wandering back to your room to go to sleep."

**7:45 pm** Margaret Martei '07 and Nicola Mootoo '06 talk strategy for their "Intermediate Solid Mechanics" assignment. Their routine is to discuss the problems, agree on a method for solving them, and then compare answers once both are finished. "Between class, reading, and doing problems, you begin to pick up on the best way to approach these problems," Mootoo says.

Martei, an exchange student from Colby College who is from Ghana, and Mootoo, from Trinidad and Tobago, say this particular assignment—analyzing stress and strain on structures—requires about 15 hours. Today is Tuesday and the problem set is not due until Friday, but Martei and Mootoo deflect compliments about their time-management skills. They explain their true motivation: the International Club's Margarita Night on Thursday, which means they have two evenings to wrap up the problems before the blenders start whirring.

Matt Hodgson Th'06



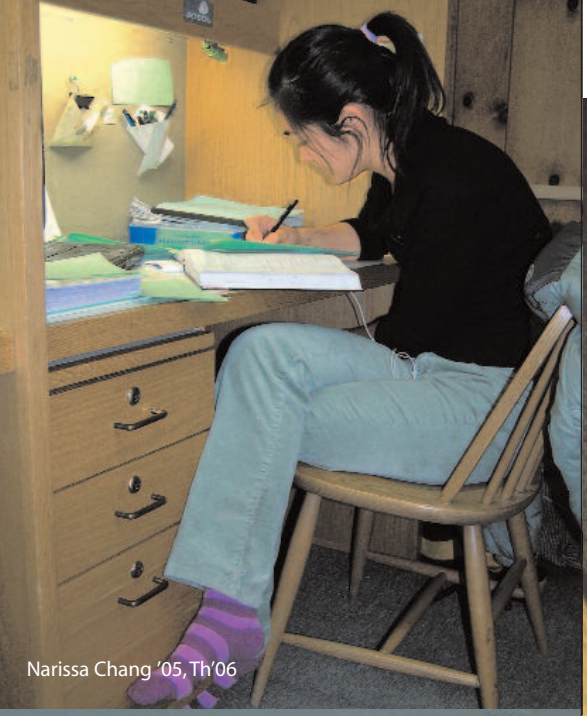
Paul Durkee '06, left, and Karl Johnson '06

**8:00 pm** Mike Madson '05, Th'06 faces an eight-hour open-book "Intermediate Solid Mechanics" exam in the morning and a homework assignment due for the same class. "I have the philosophy that if I don't know it by now, I'm not going to teach it to myself by tomorrow," he says. "I'd rather sleep."

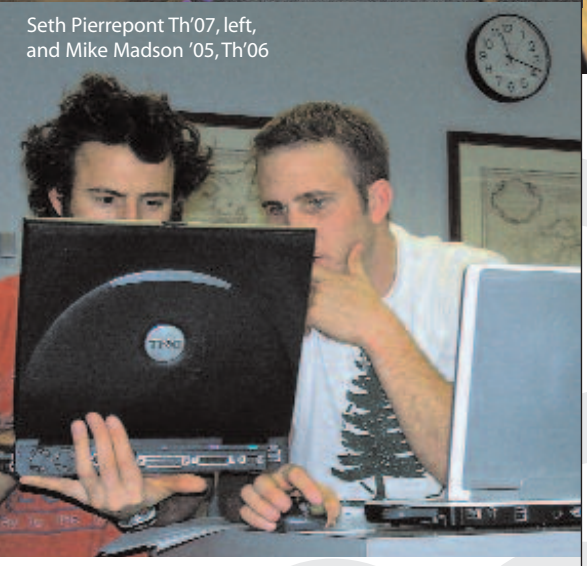
**8:30 pm** Allie Fecych '07 perfects the arm of a remote-control robot for "Machine Engineering." She is experimenting with materials to try to make the arm as light as she can.

**9:00 pm** Paul Durkee '06 and Karl Johnson '06 are modifying their remote-control robot for "Machine Engineering." They say the biggest problem is the ticking clock. They are 75-percent finished, but the design has eaten up most of their time. "Every element of design you change is going to affect everything else as well," Johnson says. "It's challenging, but it's one of the only classes where we spend a lot of time in the machine shop."

**10:50 pm** Laughter and clanking fill the Dartmouth Formula Racing team's workshop. Aleks Israels Th'06, Cliff Orvedal '05, Th'07 and other students who wander in and out are finishing the frame of this year's racecar before sending it out for a fresh coat of black paint tomorrow. Tabs for the seatbelt and the roll-bar mounts need to be finished. The team is spending long hours on the car because it is going to Texas for Spring Break for a warm-weather test drive. Chief Engineer Nick Schaut '05, Th'06 says the team's focus is on reliability and aesthetics. The team is clearly having a good time, and no one seems to care that they are spending most evenings of the month at school. "I like building stuff," says Matt Hodgson Th'06. "Going out drinking isn't as fun as coming in here and building. A lot of what drives me is that there's a competition."



Narissa Chang '05, Th'06



Seth Pierrepont Th'07, left, and Mike Madson '05, Th'06

Jon Shea '03

## 11:30 pm

Sally Smith '05, Th'06, Mike Madson '05, Th'06, and Seth Pierrepont Th'07 work on a problem set for "Statistical Methods in Engineering." Coffee cups and snack remnants are good gauges of how long a group has been assembled—in this case, just a few hours. Smith's dog, Griswold, lounges on the floor and makes do with the occasional scratching from a student who needs a break. The book Freakanomics pops up in the discussion. Debbie Sperling '06 says she had the problems finished when she came in today but she wanted to check her answers against her classmates' answers and ended up chatting and hanging around for hours.

## 1:30 am

Members of the Dartmouth Formula Racing team weld mounts for the car's differential housing. Joe Horrell '04, Th'06 says he expects to wrap things up for the night in an hour.

## 2:05 am

Narissa Chang '05, Th'06 is alone in the student offices, though other students are still scattered around the building. "I'm still up because I'm really enjoying it," Chang says. "This term I'm just more excited about my classes; they're worth the time. When you spend the time to solve the challenges it's really gratifying." She listens to her iPod and works on homework for "Intermediate Solid Mechanics." The class has just finished going over torsion, and she's now doing problems that deal with how stress acts on cylinders. "I'm a bit of a night owl," Chang says. "There are definitely times when you have to pull an all-nighter to get the work done. But I don't mind them. You know they're coming."

## 4:30 am

M.S. candidate Jon Shea '03 hunches over his computer on the third floor of Feldberg Library. He is the only person in the building. Next door at Cummings every classroom and lab is empty and the desks are covered with the unfinished assignments other students have left until tomorrow. Shea is writing a computer program modeling the magnetic fields at the surface of the earth. He is presenting at a conference in a month, and he is meeting with his advisor at 10 a.m. He has been parked at his post since 6 p.m. and plans to work until the meeting and then go to class at noon. When asked what he likes best about space physics, or space in general, Shea slowly lifts his eyes off the screen and says, "I couldn't give you a good answer right now."

# >> Start Your

## THAYER SCHOOL DRIVES A NEW COMPETITION.

BY RANDY STEBBINS '01

PHOTOGRAPHS BY DOUGLAS FRASER


PACE SETTER
Overseer Charles Nearburg '72, Th'73, '74, longtime Formula racing enthusiast, takes Thayer School's first hybrid racecar for a spin.

# Hybrid Engines

Pull over conventional racecars. Thayer School is driving hybrid technology to the fast lane by holding the nation's first collegiate Formula Hybrid competition.

The May 4 event at the New Hampshire International Speedway in Loudon is so revolutionary that only Thayer School and McGill University have hybrids ready for racing. So Thayer School devised a way around that roadblock: this year's race will be a demonstration. Teams from schools around the country will participate in a Formula Hybrid conference at Thayer School May 3 and enter the race next year.

The Formula Hybrid competition and conference are the brainchild of Thayer School research engineer Douglas Fraser, faculty advisor to Dartmouth Formula Racing (DFR) since 1995 and to the two-year-old Hybrid arm of it. Formula Hybrid has already won endorsement from the Society of Automotive Engineers (SAE), which oversees conventional Formula racing, and from

the Institute of Electrical and Electronics Engineers (IEEE). Both organizations have signed on as Formula Hybrid sponsors to support this year's efforts and build momentum for next year's events.

"Formula Hybrid builds on the Formula SAE program and takes it to the next level," says Fraser. "It adds a layer of complexity and provides an additional technical challenge to student teams."

Formula Hybrid challenges undergraduate and graduate college and university students to design, build, and race an open-wheel, single-seat car. Each racecar must conform to a formula that emphasizes drive-train innovation, fuel efficiency, and high performance.

At the inaugural Formula Hybrid conference, race team advisors will determine the racecar formula and the rules of future competitions. They will define what qualifies as a hybrid, work out testing methods, assess safety issues, and thrash out details of hybrid design.

The aim of the Formula Hybrid program, says Fraser, is to spur student creativity in high-power electronics, regenerative electric/hydraulic braking systems, and other areas of engineering useful not just on the track but on the real-life road. "We hope to be turning out engineers who will design new hybrids," he says.

## Hybrid Vigor

Hybrid automotive technology replaces a conventional drive train with a smaller, more efficient gasoline engine coupled with an electric motor. The system cuts fuel consumption, saving money and resources. But in a nation used to muscle cars, hybrids are often seen as anemic weaklings.

Thayer students want to give hybrids a shot in the arm.

"Hybrids are associated with low performance as well as a box-like image," says Dana Haffner '06, Th'06, a member of the Hybrid mechanical team. "We hope to challenge this stereotype by creating a hybrid race car that could potentially be capable of outperforming its gasoline counterparts. Americans like powerful cars, and this is often a more important factor in buying a car than gas mileage and environmental concerns. With our car and new competition we hope to contribute toward bridging the gap between performance and fuel efficiency."

The team's recently appointed captain, Sally Smith '05, Th'06, '07, sees the Formula Hybrid program as a vehicle for working toward sustainability. "Racecars aren't a sustainable technology in themselves, but the things we are optimizing are the same things that are sustainable," she says, ticking off the team's goals: reducing fuel consumption, boosting electricity generation and transfer, and delivering power to the car's drive wheels in the most efficient way possible.

Many of the engineering challenges facing students in the hybrid competition are similar to those of the current Formula SAE program. Students must design robust mechanical systems for suspension, steering, and braking; create innovative chassis and body designs; improve ergonomics; develop race strategy and management; plan for computerized systems control and data acquisition; modify the intake, exhaust, and ignition systems of internal combustion engines; manage fuel consumption; and learn how to oversee a large project, all the while keeping an eye on the economics of automobile engineering, manufacturing, and marketing.

Thayer's Hybrid team is hard at work on hybrid racecar-specific challenges. Whereas commercial hybrids use heavy nickel-hydride batteries, Thayer's hybrid lightens the load by using an array of 106 soda-can-sized ultra-capacitors. The team must also design and make a DC-to-DC converter—no mean feat—to boost the voltage coming out of the hybrid's generators. Commercial automakers have solved that power problem but hold their methods close. With no off-the-shelf solutions to turn to, Thayer students have to come up with one on their own.

"The hybrid is more open-ended, in the sense that we get to choose all the major components and how they work together," says Hybrid electrical team member Arne Kepp Th'06. "We have to find our own way, which I think is exciting."

## Road to the Future

Although the first hybrid auto was designed in 1905, the American auto industry has been slow-moving in its approach to hybrids. Japanese automakers, however, weren't asleep at the wheel. Toyota introduced the hugely successful Prius in 2000. Since then hybrid cars have moved steadily onto American roads, with more than 200,000 hybrids of various makes sold in the United States in 2005. Federal tax breaks for hybrids take effect this year. Twenty states already offer incentives for hybrid car buyers, ranging from free rides in the carpool lane for solo drivers to tax credits and emissions-tax exemptions. Some cities offer free parking and other perks to hybrid owners, and a number of corporations are giving employees some financial incentives to help buy hybrids.

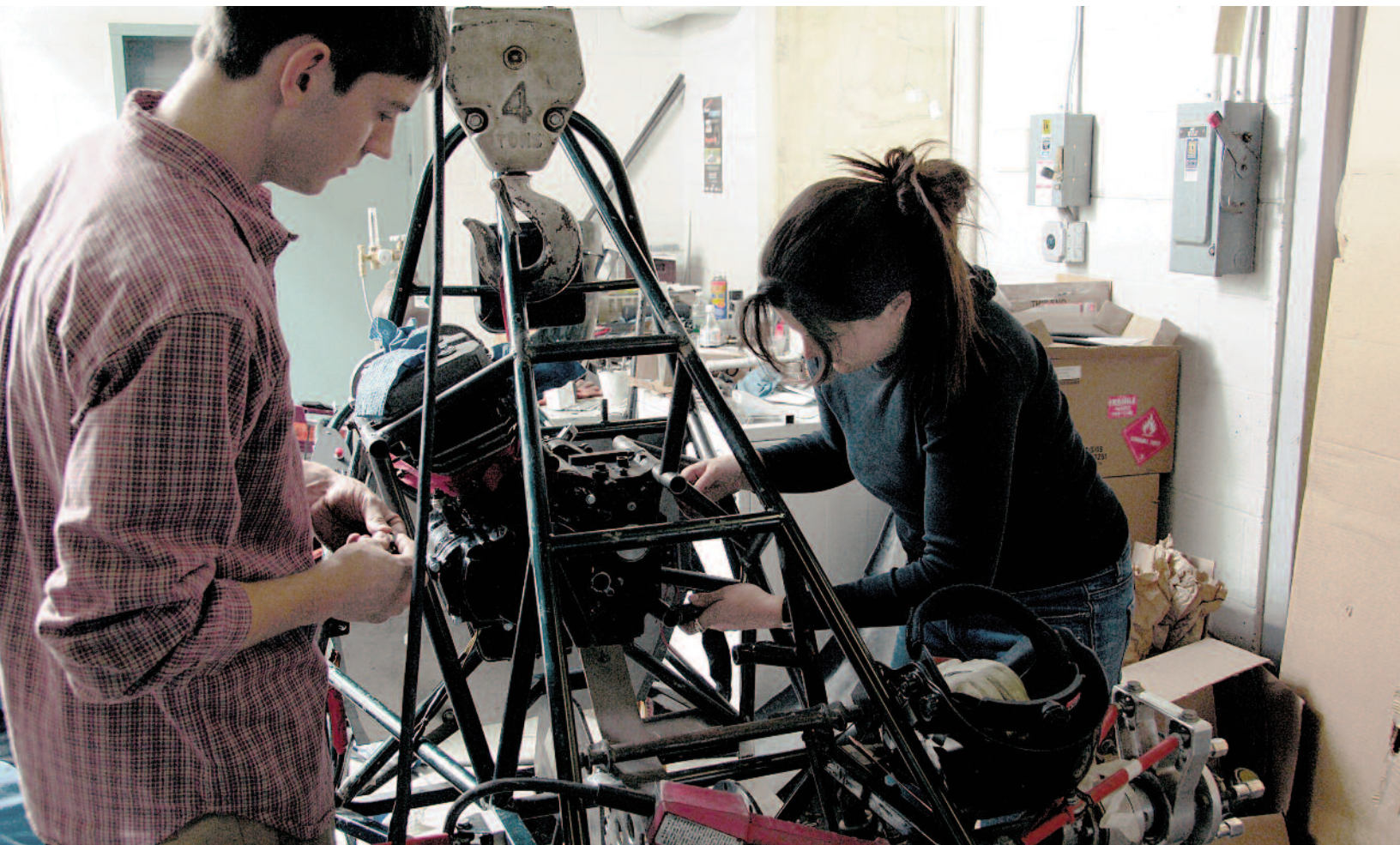
While Japan has beaten Detroit thus far on the hybrid road, Fraser, who drives a Prius, hopes Formula Hybrid ideas will benefit American carmakers. "We're doing our part to help them," he says.

Just as hybrids and conventional cars are likely to co-exist in the commercial world for the foreseeable future, Thayer and other engineering schools around the nation have no plans to abandon the Formula SAE program. "We expect that one path of entry to the Formula Hybrid competition will be for teams to construct a vehicle, develop the chassis and related systems in the Formula SAE program, and then replace the internal combustion engine with a hybrid drive train the following year for the Formula Hybrid competition," says Fraser.

Fraser expects the new Formula Hybrid team to be as successful in competition as DFR teams have been in Formula SAE contests. Thayer students have been competitive even against many of "the big schools with a whole department devoted to auto engineering," he says.

Other engineering schools, large and small, are revving up to participate in Thayer's Formula Hybrid program. In the hybrid race, Thayer is setting the pace.

ASSEMBLY LINE Dana Haffner '06 (in dark blue), Reed Sibley Th'06 (in red), and Abigail Davidson '05, Th'06 (in light blue), install a 250 cc motorcycle engine in Thayer School's hybrid racecar. Colin Ulen Th'05 (wearing hat) confers with Davidson about the car's wiring. A section of the hybrid's 106-unit ultra-capacitor appears on the opposite page.



# Alumni/ae News

## spotlights

Seth Smith and Jason Taylor

### Business Ventures

Frustrations with work drove **Seth Smith '02, Th'03** to look at the chasm between his job and his interests, namely his fondness for Toyota Land Cruisers. "If I'm so passionate, why am I not doing this?" he said.

So Smith decided to use his day job in Los Angeles as a vehicle to do what he really loves. Along with his friend **Jason Taylor '02**, Smith launched PVCRUISERS, a company that buys Toyota Land Cruisers and then modifies and resells them.

Smith and Taylor grew up helping Smith's dad work on his Toyota FJ40 in his garage and they never grew out of their enthusiasm for tinkering with the engine. The first year of business has been bumpy and Smith has had to shift the focus of the business from parts to vehicles because the margins on parts are so slim.

Still, Smith never expected to start his own business, especially so soon after graduation. "During school, I thought starting a business sounded so painful, it sounded too risky and crazy," he says.

Since starting PVCRUISERS, Smith has traveled to Australia and the Middle East for the business. He has sent CAD drawings to China to have parts manufactured there. The toughest hurdles, he says, have been defining his niche, fine-tuning his Web site, and figuring out pricing strategy. As Land Cruiser aficionados are do-it-yourselfers who have no problem jumping in and modifying their own engines, PVCRUISERS targets the type of middle-aged folks who want a fun truck to ramble around in on their sprawling vacation properties.

"I love Dartmouth and Thayer but I've learned so much more rolling up my sleeves and getting dirty," Smith says.

Smith says he has learned about the prohibitive cost of holding too much inventory and the tangle of rules and fees that go along with international banking. He scours online bulletin boards and buys old factory manuals to learn about more ways to tweak cars for his customers. "There's so much to know," Smith says. "I'm learning about Land Cruisers but at the same time I have to learn about business. I'm out there buying the Dummies books."

Between evenings and weekends Smith devotes about 20 hours a week to his side business and hopes to eventually quit his day job to focus on PVCRUISERS full-time. In the near future he wants to feature an interactive schematic of a Land Cruiser on his Web site that allows viewers to click on any part of the car to go to a page with information about that specific part.

One of the things that has stuck with Smith since starting his business is Professor John Collier's comment in ENGS 21 after the students finished crafting financial models. Collier said he didn't want to see rosy cash-flow scenarios because most new companies don't start making money in their first year of existence.

"Once you get out here it's really sink or swim," Smith says. For a closer look at his venture, visit pvcruisers.com.

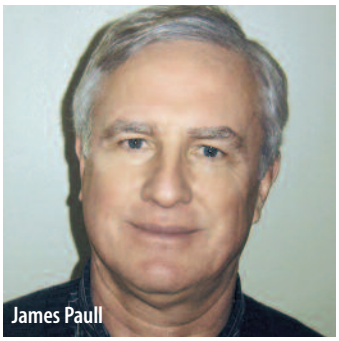
**Michael Ferchak '99, Th'00** started Fusion Manufacturing in 2005 after working in product development for digital control circuits for two years in Shanghai, China. While Ferchak was designing circuits he was also involved in the manufacturing process, experience that gave him the confidence and contacts he needed to open his own manufacturing company. Ferchak started studying Chinese during his undergraduate years at Dartmouth and is nearly fluent after living in Shanghai for four years. Fusion Manufacturing is a U.S. company with operations based in Shanghai. The company specializes in manufacturing for electronic assemblies and plastics. Ferchak has relationships with factories in the Shanghai area and outsources manufacturing to them. For more information, see fusion-manufacturing.com.

**Shannon Magari Th'94** recently became a principal owner of Colden Corp., based in East Syracuse, N.Y. Magari joined the company in 2002 as a senior scientist and has served as vice president of health sciences since 2004. In her new position as principal she will continue to serve as vice president of health sciences and co-chair of Colden's litigation support practice. Colden Corp. is an occupational health, safety and environmental consulting firm.

**Christopher McConnell '75, Th'76** visited campus February 3 to talk to undergraduate and graduate Thayer students about what he thinks it takes to be a successful entrepreneur. He good-naturedly shot down suggestions that tolerance for risk and an innovative idea are crucial. Instead, he emphasized the virtues of honesty and patience and the harsher requirements of connections and cash.

In 1984 McConnell co-founded CFM Technologies Inc., a semiconductor capital equipment company that subsequently went public. He helped found a second company, Mi8 Corp., in 1998. He currently assists Philadelphia-area entrepreneurs through his role as principal of The Founders Group, an organization that helps launch new technology-based ventures with IPO potential.

Recently McConnell co-founded Adondo Corp., a new enterprise that combines voice-


James Paull


Lee Johnson

over-IP, speech recognition, and artificial intelligence. With Adondo software, PC users can call their computers and access information including e-mail, calendars, and contacts; customer, product, and enterprise data; and information from the Internet, such as traffic reports and sports scores.

Over lunch at Thayer School McConnell emphasized finding places in the market that are not well-served and then having the guts and confidence to create a solution. He said entrepreneurs are masters at creating their own luck.

"Entrepreneurs think about how to invite fortune," McConnell said. "You don't necessarily need to have an invention in mind."

**James Paull '67, Th'68** and **Lee Johnson Tu'05** teamed up to found Stellaris Corp., an early-stage sustainable energy company, in 2005. Their goal is to market new technologies that make renewable energy more affordable. The company's concentrating photovoltaic glazing (CPG) uses passive optics to concentrate light, reducing the amount of photovoltaic material required and, therefore, the cost of photovoltaic modules and building-integrated systems. Paull invented and patented the system, which produces electricity even in cloudy conditions. Stellaris's CPGs can be incorporated into a standard photovoltaic module, in a building's curtain wall or spandrel, as sloped glazing or skylights, or made into a shingle in a roofing system. The company's board of advisors includes Thayer School Professor Elsa Garmire and Gregg Fairbrothers, executive director of the Dartmouth Entrepreneurial Network.

## In The News

**Max Rayner '84** was recently named a winner of CIO magazine's "Ones to Watch Award," a global competition to identify rising stars who have the proven record and highest potential to lead the IT industry as CIOs, visionaries, and thought leaders. He joined SurfControl in October 2005 from salesforce.com, where he was responsible for the architecture and service delivery of salesforce.com's award-winning, on-demand customer relationship management service. Prior to salesforce.com, Raynor headed Sun Microsystems' global datacenters and infrastructure, Internet engineering, and e-commerce application delivery, where his team was recognized in an independent META Group benchmark for providing IT operations services at 42 percent below market costs with availabilities above 99.99 percent.

# thayer notes

thayer notes not available online

## Let Us Know

If you've seen news of Thayer School alumni/ae, please pass it along to Dartmouth Engineer. We welcome articles, press releases, and websites that feature the professional or personal accomplishments of Thayer School graduates

E-mail: dartmouth.engineer@dartmouth.edu

Write: Dartmouth Engineer
Office of Communications
8000 Cummings Hall
Dartmouth College
Hanover, NH 03755

# thayer notes

thayer notes not available online

# REUNIONS

Class of 1956 >> 50th Reunion Luncheon: June 9
Classes of 1946, 1951, 1961, 1971
>> 60th, 55th, 45th, 35th Reunion Luncheon: June 12

thayer notes not available online

# REUNIONS

Classes of 1976, 1981, 1985-86-87, 2001
>> 30th, 25th, 20th, 5th Reunion
Reception: June 16

thayer notes not available online

funding for the Department of Energy and intramural funding for the National Institute of Standards and Technology (NIST) in the Department of Commerce. The drumbeat is steady: Globalization means new competition. We must train more engineers to keep ahead. And we must provide scholarships to entice students to study engineering.

Increased investment is welcome and needed. It provides critical funding for universities, national labs, and industry alike to push the frontiers in areas such as the interface between engineering and medicine—a new research and educational thrust at Thayer—and in nanomedicine, biotechnology, communication, and renewable energy. Investment is critical for refining and expanding our knowledge in core areas such as combustion, fluid mechanics, and environmental transport, all of which bodes well for the engineering enterprise.

But I think this misses the point when it comes to student recruitment.

Arguing about U.S. economic competitiveness is hardly the way to entice more students into science and engineering. Do we really think that students are not studying engineering because there isn't a scholarship incentive to do so, or because they somehow didn't know that it was important for national competitiveness? And if we are truly concerned about broadening diversity in engineering, do we really believe that young girls, recent immigrants, or members of minority groups will be inspired because it is "in the national economic interest?" If we as a profession seek to increase our numbers and our diversity, we need to inspire young people, to show them that engineering can help them make a difference in people's lives. And we need to give them a college engineering education that embraces this ideal.

Colleges and universities need to take a hard look at their programs and ask whether they provide the opportunity for students to explore things creatively, to understand innovation, and to see the connection of their work to people's daily lives. Most American engineering programs are structured into rigid departments—departments that were organized around the industrial problems of the day, 50 or more years ago. I have been paging through some engineering college catalogues dating back to the 1950s, and I find that in many universities, in many programs, little has changed. Most offer basic science and math, perhaps a survey course that "exposes" students to the different branches of engineering in a lecture or two, then asks them to choose a departmental major, often freshman year, so they can take introductory courses that have changed little over the past five decades. Finally, as seniors—if they make it that far without dropping out—students take electives that remind them why they chose engineering in the first place. And then, and only then, they might work on an applied project in a team environment and experience the joy of tackling an open-ended, challenging intellectual problem.

We know that much of this is different at Thayer. From ENGS 21 to the absence of departments, from students patenting their ideas to using their technical education to solve basic water supply problems in the developing world, Thayer students experience the promise of engineering to create a better world. A few other schools take a similar approach, but change at universities is slow. I have heard colleagues elsewhere argue, for example, that electrical engineering students don't need chemistry or biology—or other engineering, for that matter—because those subjects won't help them in their careers. I couldn't disagree more. At the undergraduate level, students *need* the breadth of exposure to different fields. After all, how many of them will spend an entire career designing circuits or sensors without needing to know about the biological, or mechanical, or chemical system at the interface?

At Thayer, we view it as our responsibility to constantly examine our programs and ask how we might do things better. For example, we are exploring ways to provide students with a hands-on "innovation" experience outside the walls of Thayer. With every new initiative and every programmatic refinement, Thayer works to ensure that inspiration remains at the heart of engineering education. □

thayer notes not available online

## Obituary

**Joseph Ermenc**, professor emeritus of mechanical engineering, died December 31, 2005 in Hanover. He taught at Thayer School from 1942 until 1978. In 1964 he taught the first classes on the history and philosophy of science and technology. He served as atomic energy consultant to the New Hampshire state legislature from 1957 to 1962. As chair of the American Society of Mechanical Engineers' National History and Heritage Committee, he helped establish several dozen national historic engineering landmarks. His wife, Mary, predeceased him by five days. He is survived by three children and two grandchildren.

# inventions


## PLASMA TORCH

>> INVENTOR: PROFESSOR JAMES BROWNING '44

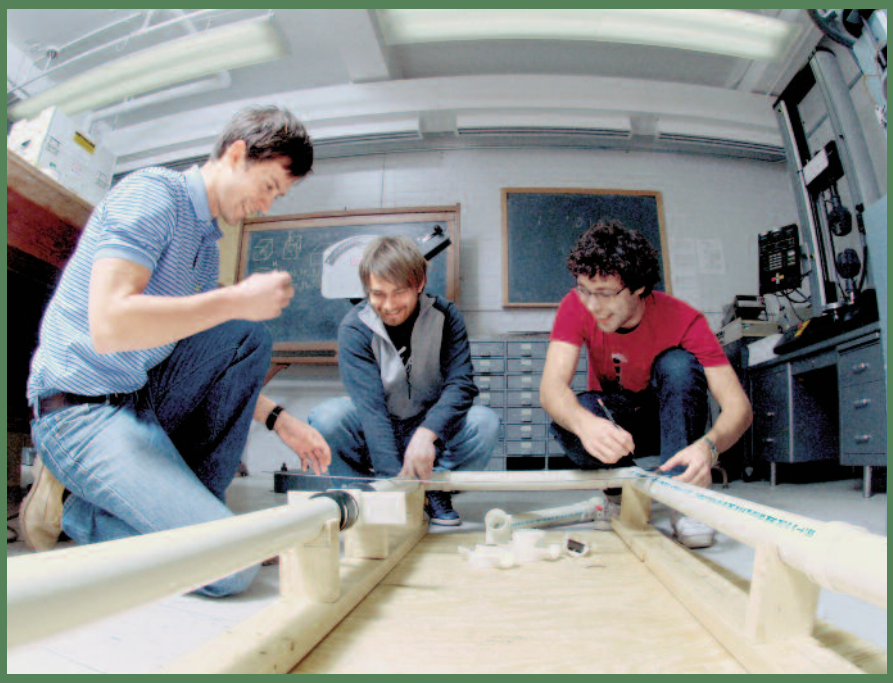
Half a century ago Thayer Professor James Browning '44 was nicknamed Hanover's firebug for his study of flame stability and combustion. In early work on Project Squid, a government-funded study of propulsion, Browning experimented with methyl naphthalene, which smells like gasoline-soaked mothballs. Not only did his lab reek, but news clips from the era reported that as Browning "passed people on the street on his way homeward, he was the subject of many curious glances from people who suddenly realized who was defiling the usually 'pine-scented' atmosphere of Hanover."

Browning will be remembered best not for his smell but for inventions that fired up the Upper Valley economy. In the 1950s he created a plasma torch that produced flames twice as hot as the sun's surface. Passing nitrogen or hydrogen through a high-intensity electric arc, the torch cut metal like butter. Browning and Thayer colleague Merle Thorpe founded Thermal Dynamics Corp. to manufacture the device. Within three years the start-up had sales of $1 million. A decade later, Thayer Professor Robert Dean and Richard Couch '64, Th'65 formed Hypertherm Inc. to produce a water-injection plasma torch that was nine times hotter than the sun. Today that company employs 500 people.

Meanwhile, Browning invented a high-temperature rocket drill called the "Thermoblast." In 1977 he used it to pierce Antarctica's 1,400-foot-thick Ross Ice Shelf so scientists could study the water underneath. Drilling time: nine hours—a cool use of a hot technology.

**—Lee Michaelides**

PHOTOGRAPH COURTESY OF DARTMOUTH COLLEGE ARCHIVES



## RANDOM WALK

B.E. candidates Per Wimmercranz (left) and Karl Geijer (center) and M.E.M. candidate Josh Kjenner (right) work on an apparatus to test designs for an all-terrain vehicle throttle. An ENGS 290 ("Engineering Design") project, their work is sponsored by Moto Tassinari, a company specializing in aftermarket parts for ATVs.

PHOTOGRAPH BY DOUGLAS FRASER

THAYER SCHOOL OF ENGINEERING
DARTMOUTH COLLEGE
8000 CUMMINGS HALL
HANOVER, NH 03755-8000

NON-PROFIT
U.S. POSTAGE
PAID
DARTMOUTH COLLEGE