

DARTMOUTH

Engineer

THE MAGAZINE OF THAYER SCHOOL OF ENGINEERING

SPRING | SUMMER 2007



MOVING FORWARD

INITIATIVES FOR MAXIMIZING
THAYER SCHOOL'S IMPACT.

- > OVERSEAS IN HANOVER
- > RECYCLED HIGHWAYS

FIRST LOOK



PIT STOP Abigail Davidson '05 Th'05, an M.E.M. candidate, works on one of two hybrid racecars Thayer School entered in the inaugural Formula Hybrid International Competition. For results, turn to page 2.

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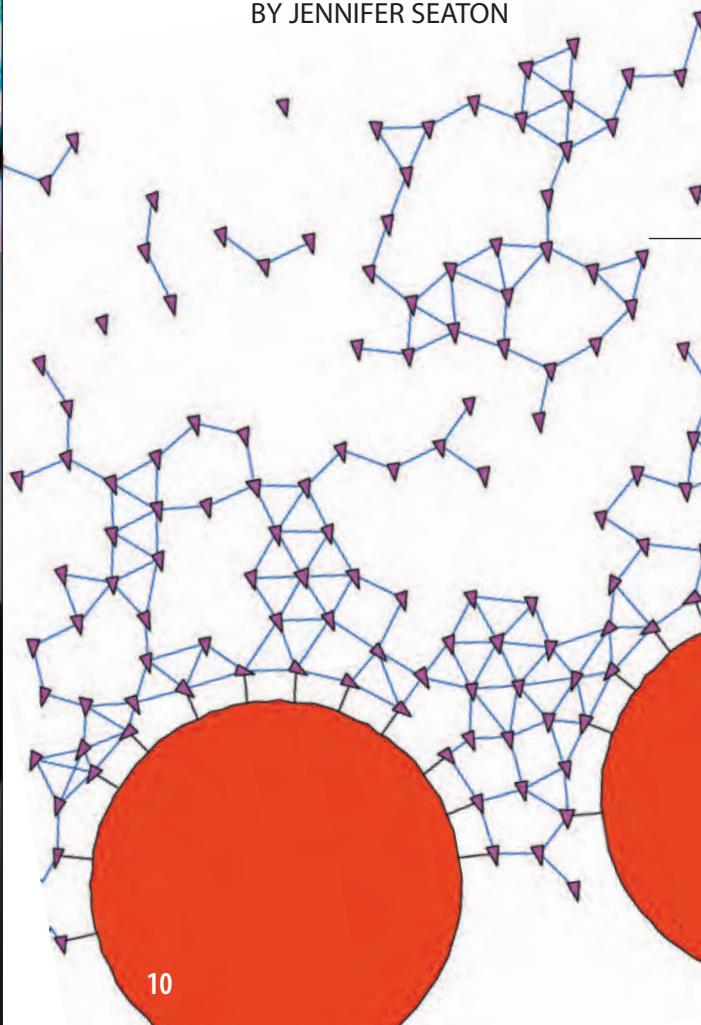
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MacLean Engineering Sciences Center's GlycoFi Atrium.
Photograph by John Sherman

BACK COVER
MacLean's western elevation.
Photograph by John Sherman

THE Great Hall

>>NEWS FROM AROUND THAYER SCHOOL



INNOVATIONS

A Day at the Hybrid Races

THAYER SCHOOL'S NEW FORMULA HYBRID

International Competition raced to inaugural success May 1-3 at the New Hampshire International Speedway in Loudon, N.H.

Student teams from six institutions—Embry-Riddle Aeronautical University, Florida Institute of Technology, Illinois Institute of Technology, McGill, Yale, and Thayer School—competed in acceleration runs, autocross and endurance events, and design and marketing presentations. McGill emerged as the overall winner, with Embry-Riddle coming in second, and Yale third. Thayer School won the design event and placed second in the presentation event.

"Tina," the main car of Thayer School's two entries, gave students a chance to display some quick thinking on the track. When the car suffered

a major electrical failure, the team managed to get it running in time to complete 11 of the 32 required endurance laps. And during those laps Tina showed off some impressive speed—averaging eight seconds a lap faster than the next fastest car.

Challenging students to design, build, and race cars with gas-electric hybrid drivetrains, Formula Hybrid aims at inspiring students to advance hybrid-engine technology, says Formula Hybrid Director and Thayer School Research Engineer Douglas Fraser. "Students are notoriously able to come up with novel solutions. They don't go in with preconceived notions. They sometimes launch off in directions that you think, 'My God,

that won't work,' and, lo and behold, it does."

The competition itself was a novel solution to a problem Thayer School students faced in 2003, when they hoped to enter a hybrid racecar in that year's Formula SAE competition. When changes in Formula SAE competition rules essentially disqualified hybrids, the students paved a road of their own: Formula Hybrid.™ The Society of Automotive Engineers (SAE) and the Institute of Electrical and Electronics Engineers (IEEE) endorsed Formula Hybrid and joined with Thayer School and several other sponsors—including DaimlerChrysler, Toyota, and the U.S. Department of Energy—to underwrite the inaugural competition.

Fuel efficiency and recycling lie at the core of Formula Hybrid. A Formula Hybrid vehicle must use at least 15 percent less gasoline than a comparable "regular" formula racecar operated under the same conditions. And unlike the Formula SAE competition, Formula Hybrid encourages teams to use parts of other racecars rather than build everything from scratch.

Formula Hybrid isn't Thayer's only green automotive innovation. This year, for the second year in a row, Thayer students entered an ethanol-fueled car in the Formula SAE competition, held May 16-20 at the Ford Michigan Proving Grounds in Romeo, Mich.

As for Formula Hybrid, plans are already underway for next year's competition. All of this year's teams have signed up. Not a bad track record.

UP CLOSE

Some 400 middle-schoolers attending the Formula Hybrid competition explored the cars and Dartmouth's vegetable-oil-fueled Big Green Bus.

Explore Thayer's new site: engineering.dartmouth.edu



HONORS

Lee Lynd Wins First Lemelson-MIT Award

HAILED AS AN "ALTERNATIVE FUELS PIONEER," Professor Lee Lynd Th'84 received the first-ever Lemelson-MIT Award for Sustainability for "work that has the potential to improve global quality of life and protect the environment." At a May 3 ceremony in Cambridge, Mass., Lynd received the \$100,000 award for his 25 years of research into alternative fuels, particularly his advances in converting biomass—such as grass, wood, straw, and corn stover—into ethanol for fuel. "Lee's groundbreaking research has driven forward the public policy debate, the business world, and the fundamental science of bioenergy," says Nathanael Greene, a senior policy analyst at the Natural Resources Defense Council and one of Lynd's nominators. "His work has helped frame our basic understanding of the sustainable potential for bioenergy and, especially, biofuels."

The award also recognizes Lynd's vision and determination. "Decades ago, Lee Lynd started doing something about global warming and the rapid depletion of the world's non-renewable energy resources," says Merton Flemings, director of the Lemelson-MIT Program. "He continued to experiment and pursue his ideas even when the conventional wisdom said they couldn't be done."

In addition to his teaching and research, Lynd serves as chief technology officer of Cambridge, Mass.-based Mascoma Corp., which develops ethanol technologies that convert wood-based feedstocks into commercial-scale fuel sources. Mascoma recently received \$30 million in its second round of venture funding.

ONLINE

New Look on the Web

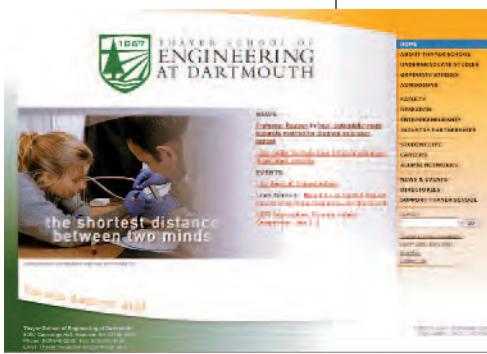
CLICK ON engineering.dartmouth.edu and you'll see the new face of Thayer School. Launched March 22, Thayer's new Web site welcomes visitors with the school's fresh logo, bold photographs, energetic color, and of course, all the crucial information about what makes Thayer School a standout choice for prospective students.

The new site is a major part of Thayer School's profile-building strategy. The site conveys Thayer School's unique strengths and advantages, including its connection to Dartmouth, department-free structure, innovative approaches to education, interdisciplinary agility, ease of collaboration, and extraordinary sense of community.

So spend some time exploring the new site. You'll rediscover what it means to be a Dartmouth engineer—and why that matters in today's world. To let the Web team know what you think, email catha.lamm@dartmouth.edu.

THE BOX
DOES NOT
EXIST

Thayer's new Web site showcases the school's uniqueness.



kudos

>> Professor Daniel Lynch was awarded a Senior Faculty Fellowship at Princeton's Woodrow Wilson School of Public and International Affairs for the 2007-2008 academic year. Working at the intersection of human rights and natural resources, he will analyze issues surrounding the human right to water and the potential for agricultural conflicts between fuel and food production.

>> Professor Elsa Garmire has been named a Jefferson Science Fellow for the 2007-2008 academic year. The State Department program engages the academic science, technology, and engineering communities in U.S. foreign policy in Washington, D.C., and abroad..

>> Lecturer and research scientist David Murr has been awarded an American Association for the Advancement of Science (AAAS) Science & Technology Policy Fellowship to work for the State Department in Washington, D.C., during the next academic year. Murr says that "learning about the policy process is something I want to bring back to the classroom."

>> U.S. News & World Reports rated Thayer School as one of the top 50 engineering schools in its annual list of America's best graduate schools.

>> Professors Tillman Gengross and Charles Hutchinson, co-founders of the therapeutic protein-producing company GlycoFi, have been selected to receive the Entrepreneur of the Year Award from the New Hampshire High Technology Council.

HISTORY

Knowledge with Know-How

1. WHAT WAS THAYER SCHOOL'S FIRST RESEARCH LAB?
2. When was ENGS 21 first taught?
3. Who was the first woman to earn a doctorate at Thayer School?

A new book, *Knowledge with Know-How: Thayer School of Engineering at Dartmouth*, has all the answers and more. Edited by Ellen Frye, senior editor in Thayer School's communications office, and published in February by the University Press of New England, the comprehensive history takes its name from a guiding principle espoused by Myron Tribus, dean from 1961 to 1969: "Knowledge without know-how is sterile."

Featuring 120 archival photos, the history takes up where the 1971 volume *The First Hundred Years of the Thayer School of Engineering at Dartmouth* left off. The new book summarizes the first century and goes on to trace the School leadership and the evolution of the curriculum, degree programs, sponsored research, and corporate partnerships from the 1970s to the present. Along the way it highlights Thayer School's distinctive approach to engineering education, including its appreciation of the liberal

arts, emphasis on systems, conviction that even beginning students can define problems and solve them creatively, and dedication to serving society through engineering.

Knowledge with Know-How can be ordered from University Press of New England by phoning 1-800-421-1561 or online at <http://www.upne.com/1-58465-650-6.html>.

ANSWERS:

1. Professor Millet Morgan's radiophysics lab, opened in 1941, was Thayer's first.
2. ENGS 21 debuted in 1958 to ground students in the theoretical foundation of engineering. In 1961 Professor Robert Dean Jr. revamped it into today's hands-on engineering design course.
3. Diane Knappert Clark Th'77, '78 received the D.E. degree in 1981.



WASTE-BUSTER Cushman-Roisin

CLASSROOM

Industrial Ecology

ON A THURSDAY EVENING IN April, Professor Benoit Cushman-Roisin walked into his ENGS 171: "Industrial Ecology" class in Cummings Room 200 holding a large cardboard box. He opened it and took out a smaller box, then another box, then paper filling, then plastic wrapping, then a tough plastic package that held a tiny electronic item. "All this just to make you believe you're getting something useful," he said as he held it up to the class. "To me, it is just so wasteful."

Waste is one of the many topics Cushman-Roisin covers in the course, in which he encourages students to think in terms of everything from product redesign to ecological responsibility.

"I want my students to be able to think broadly about the many ramifications of one's technological activities and to consider the entire life cycle of the product," he says. "They also need to structure their thinking." He instructs his class that they need to be industry-minded and realistic. "We need to design a system that makes what's good for the environment also good for business."

Cushman-Roisin tries to impart the sense of environmental responsibility he clearly feels.

"Engineers are the technology professionals, and technology has caused countless environmental problems," he says. "For some time, environmental engineers have been those called upon to mop up after the other engineers. This is no longer acceptable, and all engineers ought now to incorporate environmental thinking into their practice. Industrial ecology offers a framework to do this."

Cushman-Roisin's students put their studies to use by redesigning real-life products, including home appliances, sneakers, office chairs, disposable plates, and automotive parts. "While most redesigns have revolved around increased energy efficiency and material substitution, some have been radical, going for complete elimination," he says. For example, one student suggested replacing paper lift tickets with a reusable plastic card.

"I want to give my students hope and optimism," Cushman-Roisin says. "There are many green technologies available and, although technological barriers exist here and there, for the most part much can be accomplished when we approach the problem in an organized way, learn the lessons from the pioneers, think creatively to adapt these lessons to our own case, and have the will to go forward."

—Kathryn LoConte

Q & A

Professor Richter on Retirement

HORST RICHTER FIRST CAME TO THAYER SCHOOL from his native Germany as a visiting researcher in 1972, then joined the faculty in 1975. During his 33 years of teaching, he chaired the department, initiated exchange programs with the University of Aachen and Bundeswehr University in Hamburg, Germany, and created one of Thayer School's first courses for non-engineers, "The Technology of Sailing." He retires at the end of spring term.

How does it feel to be retiring?

It's bittersweet. As one would say in German, I have "one smiling and one teary eye." I will have more time to travel with my wife and spend time with the children and grandchildren. But Thayer School is such a wonderful place that it is hard to leave.

Will you still do any engineering?

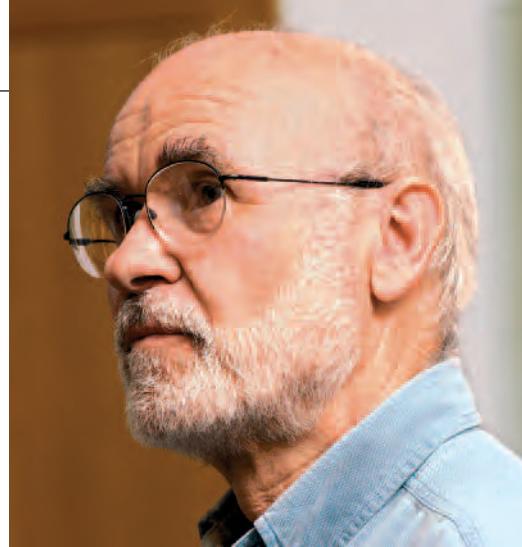
I still want to do a little research. There is still some work to be done in thermal spraying. I think it is great that Thayer School is starting a new initiative on energy (see page 21), and I would like to be involved in some way, maybe only as an observer or have maybe half a foot in the door.

What drove your research interests at Thayer?

The first research I was involved in was nuclear reactors with Graham Wallis. We worked with emergency core cooling systems. I had the largest lab Thayer School ever had—next to the Dartmouth power plant. We had a pressure vessel that we used to test the emergency cooling nozzles of reactors. And we needed a lot of steam from the power plant. We had fun. Later I worked on improving power plant efficiencies. Then I got more interested in computational fluid dynamics. One thing about Thayer School is that you can do the research you want to do. You are not constrained by a sign on the office that says "Energy." If there is research worth doing, you can do it.

How did you get involved in doing computational fluid dynamics for America's Cup yachts?

After the U.S. lost the America's Cup in 1995 I met with a good friend, the pre-eminent American yacht designer Olin Stephens. He had designed



at least five America's Cup boats that all won. He lives in Hanover, so we meet frequently and talk about boats. At the time, we were contemplating why we lost the Cup. He thought that more attention should have been paid to the performance of sails. I mentioned that we could use computational fluid dynamics to evaluate the optimum sail shape. So we approached Young America, one of the new syndicates for the America's Cup 2000. We wrote a proposal, and they provided us with money to study sails. I had two grad students working with me. I learned a lot and it was exciting.

Are you still involved with the America's Cup?

The America's Cup is underway in Valencia, Spain, right now. We did some work for the American boat. As soon as the Cup is over, a new design cycle will start, and I hope to get involved again. On other sailing issues, I am working with the Sailing Yacht Research Foundation to try to improve handicap rules. Big boats sail against small boats. How do you handicap them? The critical issue is the performance of sails under various wind conditions. Further, I would like to publish a paper on computational fluid dynamics for sails in a more scientific sailing journal—and show some good graphics about the air flow around sails.

As you look back on your career, what advice would you give students who are starting theirs?

My students ask me: What should I do? Where should I go? I tell them, get a job where you can have fun because if you don't have fun, you waste your life. It's not the money that makes you happy, it's the fun you have in your work, which will reflect on your whole life, the "pursuit of happiness."

—Ellen Frye

>> Professor Paul Meaney has been appointed associate editor of the Institute of Electrical and Electronics Engineers (IEEE) *Transactions on Biomedical Engineering*.

>> Professor Stephen Taylor has earned a Defense Advanced Research Projects Agency (DARPA) Portfolio Award for his work in the agency's Strategic Technology Office. "Dr. Taylor has created a robust portfolio of programs that represent important new capabilities for the Joint Forces," according to the award. "Under his outstanding leadership as program manager, the programs' successes have convinced several operational partners to commit financial resources and to sign memoranda of agreement to accelerate technology transition."

>> Sound Innovations—a start-up founded by Thayer Professors Robert Collier and Laura Ray and Chris Pearson Tu'03—recently signed a \$1.5 million contract from the Air Force to produce noise-reduction headphones for pilots.

>> Thayer School hosted the first-ever conference on treatments for polytrauma—multiple injuries such as those sustained by many soldiers wounded in Iraq and Afghanistan. Dartmouth-Hitchcock Medical Center plastic surgeon and Thayer adjunct professor Dr. Joseph Rosen organized the December meeting, which brought together leaders in industry, medicine, government, and academia to discuss short-term clinical efforts and long-term research.

>> The Gyrobike appeared in *USA Weekend* magazine's list of The Next Big Things, published in January. Inventors Hannah Murnen '06 Th'07, Augusta Niles '07, Nathan Sigworth '07, and Deborah Sperling '06 Th'07, who created the stable two-wheeler for ENGS 21 in 2004, hope to have the Gyrobike and a Gyro device for existing bikes in stores by Christmas 2007.



SERVICE TO HUMANITY

Extending Engineers Without Borders

THE ORGANIZATION THAT AIMS TO CHANGE THE world one village at a time has undergone its own change. Dartmouth Engineers Without Borders (EWB) has broadened into "Humanitarian Engineering Leadership Projects worldwide" (HELP).

The new organization plans to conduct multiple humanitarian engineering service projects each year, according to its president, Michael Bolger Th'05, an M.E.M. candidate. "Thayer School students realize that they have the knowledge, means, and resources to provide people in need with valuable technical assistance," he says.

J.J. Johnson '06, an M.E.M. candidate who is one of HELP's project managers, explains that "flexibility and independence are the two major advantages of this change—and we still have access to the EWB network."

"We're creating our own model," adds Jeffrey Spielberg '10, the HELP's fundraising coordinator. "We can send our own technical advisors to projects, and we have more freedom."

EWB/HELP is supporting four projects this year. This spring Bolger conducted a feasibility study of energy usage and storage at a micro-hydropower facility in a remote village in Nepal. This summer EWB/HELP members will complete the clean water distribution system installed at Nyamilu, Kenya, in 2005. Another clean water project, led by Spielberg, will get underway in Kipangi, Kenya, this summer, with completion scheduled for 2008. And in a renewable energy project at a health care clinic in Biasata, Rwanda, a team led by Johnson will implement a biogas anaerobic digestion system that will convert human and animal waste to methane fuel for cooking stoves.

—Kathryn LoConte

MOUNTAIN HIGH
Michael Bolger Th'05 traveled to Nepal for HELP.

COMMUNITY SERVICE

Schweitzer Fellows

FOUR STUDENTS SPENT THE year making a local difference as New Hampshire and Vermont Schweitzer Fellows. The Schweitzer Fellowships provide funding for 200 hours of project work addressing the needs of underserved populations.

Kristen Lurie '08 and Rose Mutiso '08 organized, sponsored, and advised a girls' LEGO robot-building team at the Hanover Street School in Lebanon, N.H. Calling themselves the Lebanon Lightning LEGOs, the team's research project won first place in a regional competition. "The girls really became excited about robotics," Lurie says. "I think people were really impressed with the all girls' team."

The girls impressed Lurie and Mutiso, too. "Everyone was able to benefit at their own level,"

says Lurie. "All the 5th graders plan on continuing next year."

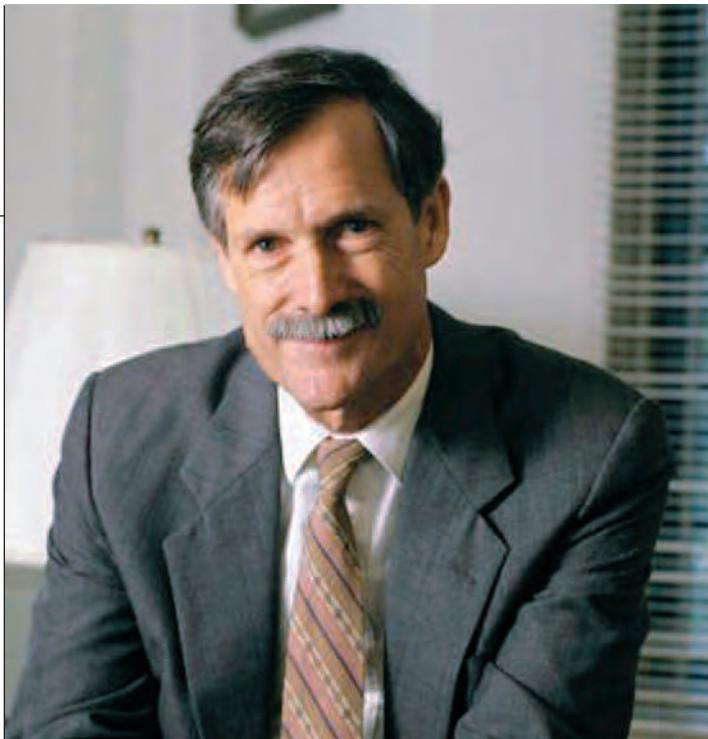
In another project, Schweitzer Fellows Kara Podkaminer and Clara Smith worked with high school seniors in a class on energy and the environment at the Sharon Academy in Vermont. The Fellows developed discussions on hybrid technology, fuels, trucking, public transportation, and public perceptions. "The idea was to have students understand the interconnections between business and environment," says Smith.

Smith and Podkaminer want to build more connections. "I would like to see more students at Thayer going back into high school and/or lower teaching grades to get the wake-up call," says Smith. "These students would like to see what college students are doing, that being a science major isn't all that scary, and that engineers aren't the stereotypical male with a pocket protector and glasses."

—Kathryn LoConte

GIRL POWER Lurie, left, got the Lebanon Lightning LEGOs team going.





IN MEMORIAM

Professor John Strohbehn

JOHN W. STROHBEHN, "FATHER OF BIOENGINEERING" at Thayer School, died in Hanover on February 22 after a long illness.

During 31 years on the Thayer faculty, Strohbehn established his name in radiophysics, then turned his attention to bioengineering, developing extensive collaborations with Dartmouth Medical School and Dartmouth-Hitchcock Medical Center. Honoring his dedication to biomedical engineering, DMS annually awards a medical student the John W. Strohbehn Medal for Excellence in Biomedical Research.

Strohbehn served as provost of Dartmouth from 1987 to 1993 and at Duke University from 1994 to 1999. He was a founding fellow of the American Institute for Medical and Biological Engineering, a fellow of the American Association for the Advancement of Science, the Institute of Electrical and Electronics Engineers, and the Optical Society of America. In 1988 he and DHMC neurosurgeon Dr. David Roberts co-patented a groundbreaking frameless stereotactic operating microscope (see *Inventions*, page 32). In 1991 he received the Eugene Robinson Award for outstanding contributions to hyperthermic oncology. He authored more than 100 papers on electromagnetic wave propagation effects and the engineering aspects of hyperthermia.

He is survived by his wife, Barbara; sister Barbara; children Jo, Kris, and Carolyn; and five grandchildren.

FATHER FIGURE
Strohbehn brought biomedical engineering to Dartmouth.

TRIBUTE

The Ultimate Mentor

I WAS AN UNDERGRADUATE IN engineering at Dartmouth in the early 1970s and found myself in the first of the engineering systems courses taught by Professor John Strohbehn. He was known by the students as one of the sharpest analytical teachers amongst a team that included Professors Millet Morgan, Thomas Laaspere and Bengt Sonnerup in the radiophysics group, Dean Carl Long in structures, and Graham Wallis in two-phase flow. As the class got underway, I found that John was an excellent instructor who was patient and humorous and quick. John made the offer that students who had difficulty with the material could visit him in his office in the radiophysics building. In this way the students who, shall we say, were slower, got to know the professor better; I think I got to know the professor the best, and that benefited me later on. At each meeting John would clarify the points I had missed and always encouraged me. It was clear that he cared about each student and was determined to help us learn.

Later, when I was working on my doctorate in orthopedic biomaterials, John became one of my advisors. At that time the field of biomedical engineering was in its infancy. My timing was lucky in that John was looking outside radiophysics for a field in which he could put his prodigious analytical skills to work and became interested in medical applications.

John's decision to focus on biomedical research brought instant credibility to the field on the Dartmouth campus, and his leadership brought cohesion to the program. Over time John made numerous connections between Thayer and the medical community with projects and contributions in neurosurgery, cardiology, and oncology. He had a tremendous talent for networking, and he put together the ongoing collaboration between Thayer, the Dartmouth Medical School, and the Dartmouth-Hitchcock Medical Center.

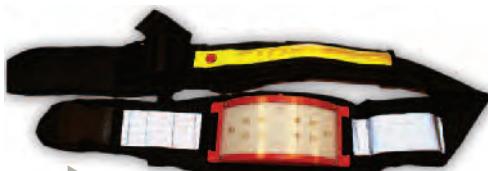
In the early days of the biomedical program, John observed that the biomedical students were woefully ignorant of human physiology. While he had no background in the field, he was determined that we would learn about it together. He organized an intense course combining engineering analysis and physiology and convinced Professor Frances McCann to co-teach it. It was an exciting experience, as there were only a handful of us in class. John was both taking and teaching the course and was only about three pages ahead of us in the book. We all strove to get ahead of him but were never able to do so.

Over the decades John guided many students to reach their goals. For four of us he made such an impact that we followed in his footsteps and took up the challenge of biomedical research. Thayer Professors Keith Paulsen, Stuart Trembley, Alex Hartov, and I were all graduate students of John's and have been influenced for life by his guidance and example.

—Professor John Collier '72 Th'77

STUDENT PROJECTS

I Want One of Those!



Night Runner ➤

An L.E.D.-studded belt acts as both flashlight and reflector for safety in the dark. **Abraham Clayman '07, Daniel Harburg, Sanderson Hull '09, Michal Jablonski '09, and Alex Lippai '09** won the Fall Term 2006 Phillip R. Jackson Award for outstanding performance in ENGS 21: "Introduction to Engineering." The team's teaching assistant was **Deborah Sperling '06 Th'07**.



◀ Nordic Exchange

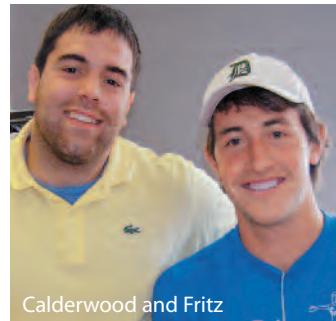
For developing strength in cross-country ski double poling, the Nordic Exchange leaves other trainers in the cold. Dual degree students **Robert Courtney, David Drennan, Chris Klabes, and Christa Miller-Shelley**, and **Alix Toothman '08** earned a Phillip R. Jackson Award honorable mention. **Brian Hendrickson '06** was their teaching assistant. You can see the Nordic Exchange in action on YouTube.



Yang



Teitelbaum



Calderwood and Fritz



Hercheck

JUST ONE QUESTION

Have You Ever Worked on a Project that Failed?

"This project I'm doing right now. It's a digital bowling alley. We can't get it to keep the proper score and we have a day and half before it's due."—**Andrew Hercheck '07**

"In 'Introduction to Engineering' our original project was trying to use solar power to charge the battery in a hybrid car. It was completely impossible. We didn't realize how big the solar panels would need to be—they'd be bigger than the car!"—**Cara Yang '07**

"Our bridge project was terrible. We didn't allow time for the glue to dry."—**Bobby Calderwood '05 and Michael Fritz '07**

"I can think of projects where time ran out before we could get them to do what we wanted them to do. My 'Introduction to Engineering' project was an airbag for inside a motorcycle helmet. We couldn't get it to deploy fast enough. If we had more time and a lot more money we could have made it work."—**Donny Zimmanck '07**

"You might want to ask me tomorrow. ... All the professors always tell you it's the journey, not the top of the mountain."—**Aaron Teitelbaum '07**

lab updates

PROCESS QUERY SYSTEM

Gathering information—from network monitors, surveillance cameras, financial records—is easy. Making sense of large quantities of raw data is not.

The Process Query System (PQS), developed by George Cybenko, Dorothy and Walter Gramm Professor of Engineering, employs two tools to solve this challenge: a software framework for categorizing irregularities within a system and algorithms that can provide detailed explanations of those irregularities.

All computer systems are characterized by distinct states, dynamics, and other properties that can be picked up by sensors. Installed into a particular system, PQS quickly reads such data, detects changes or oddities, and infers intent by separating honest errors from potentially deceptive activities.

Perhaps the most useful PQS application to date is in the area of network security. Currently available monitoring tools produce information in quantities that make analysis a formidable task. “PQS closes the gap between gathering a tremendous amount of valuable data and figuring out what the data mean,” says Professor Cybenko.

Other applications for PQS could include scanning credit reports for identity theft or detecting suspicious activity at an international border.

Cybenko and research associate and lecturer Vincent Berk published a paper on PQS in the January 2007 issue of *IEEE Computer*. The research, a project of Dartmouth’s Institute for Security Technology Studies, is

supported in part by funding from the U.S. Department of Homeland Security, Science and Technology Directorate, and the Department of Defense (DTO, AFRL, and DARPA).

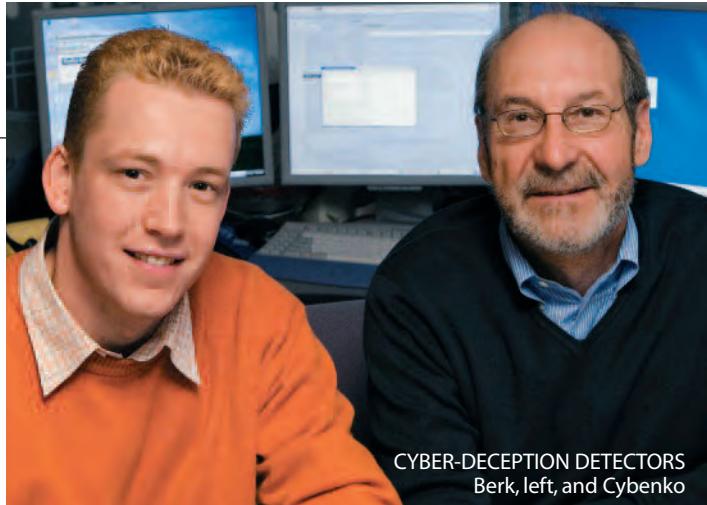
INDUCTOR EFFICIENCY

The efficiency of current power electronics equipment is limited by the typical power loss in high frequency power converters. Doctoral candidate Jennifer Pollock and Professor Charles Sullivan have recently patented a new inductor technology that is likely to become the industry standard for converters used in hybrid vehicles, wind energy systems, photovoltaics, fuel cells, and other applications.

The new technology provides the low DC resistance of a foil-wound inductor without the high AC resistance ordinarily found in such inductors. The result is an inductor that is both smaller and more efficient than inductors currently used in power supplies, inverters, and electric motor controllers. The technology is well suited to newer silicon devices such as Insulated Gate Bipolar Transistor (IGBT) modules, which handle currents in the order of hundreds of amperes with blocking voltages of up to 6000 volts while operating at frequencies over 10 kHz.

Tests in Professor Sullivan’s labs measured the potential energy savings of the new foil-winding technology and found that total winding losses of the new inductor were 17–35% lower than those in conventional solid-wire or litz-wire inductors.

The technology has been



CYBER-DECEPTION DETECTORS
Berk, left, and Cybenko

licensed by West Coast Magnetics in Stockton, Calif. The company forecasts a global market for inductors using this technology that may reach \$2.5 billion by 2015 with the greatest opportunities occurring in the hybrid vehicle market and in power generation for wind and solar power equipment. If the technology is extended into lower power applications such as personal computers, desktop electronic equipment and handheld devices, West Coast Magnetics says that the 2015 global market could exceed \$5 billion.

ADVANCES IN BREAST CANCER DETECTION

By combining two techniques, magnetic resonance imaging (MRI) and near-infrared optics (NIR), researchers led by Professor Keith Paulsen may have devised a new, potentially more accurate method for diagnosing breast cancer. Their pilot study, demonstrating the feasibility of the concept, was published in the April 15 issue of the journal *Optics Letters*, published by the Optical Society of America.

MRI produces information on the shape and composition of breast tissue, while NIR measures its blood volume and oxygen saturation. Thus the MRI provides information on the form and the

NIR on the function. Together the two techniques create high-resolution functional images of tissue, which can then be compared with tissue that is known to be cancerous.

The pilot study involved a 29-year-old woman with a ductal carcinoma, a common breast cancer. Using the information from a contrast MRI procedure—one MRI done before and one after the contrasting agent gadolinium is injected—the research team pinpointed the region for the NIR. Results showed tissue with high hemoglobin level, low oxygen saturation, and high water content—all indicators of cancerous tissue.

A follow-up study will draw on volunteers who have breast abnormalities and have been recommended for biopsy. Using the MRI/NIR technique on the subjects before and after the biopsy, the researchers will be able to compare their results to the biopsy results.

The Thayer researchers, including Paulsen, Professors Brian Pogue and Shudong Jiang, and Adjunct Professors Hamid Dehghani and John Weaver, are collaborating with Dartmouth Medical School researchers and Dartmouth-Hitchcock Medical Center clinicians.

—Ellen Frye

Moving Forward

DEAN JOSEPH HELBLE EXPLAINS THREE NEW INITIATIVES FOR MAXIMIZING THAYER SCHOOL'S IMPACT ON THE WORLD.

BY LEE MICHAELIDES

Thayer School is in an enviable position. The completion of MacLean Engineering Sciences Center—Thayer’s new 64,000-square-foot addition of labs, classrooms, and offices—has given the school a rare opportunity to build initiatives that will maximize Thayer School’s ability to improve the world.

Dean Joseph J. Helble recently announced that the school would be leveraging its academic strengths to address three interdisciplinary areas that have broad societal impact: the interface between engineering and medicine; energy technologies; and complex systems.

The impact areas emerged from a year-long faculty effort to identify how Thayer School can make a difference to society. With unanimous faculty support, Thayer is moving forward with new programs, courses, workshops, symposia, and research in all three areas.

The school is also hiring seven professors in two of the areas—engineering in medicine and energy technologies. (Three professors working on complex systems were hired in 2006). Added to the 25 tenured and tenure-track faculty already at Thayer, the new hires will have a tremendous impact on the educational opportunities afforded to students.

For Helble and the Thayer faculty, choosing the right people is crucial. At the large engineering powerhouses, where single departments are often larger than the entire Thayer faculty, the addition of seven people is important, but hardly transformative in the way it will be in Hanover.

“We are the smallest Ph.D.-granting institution in the *U.S. News* top 50 engineering schools,” says Helble. “We have some interest in seeing our graduate student body grow, but it’s all about balance. You want a critical mass of scholarly activity in each area. You want research opportunities to be accessible to undergraduates as well as graduate students; you want to have a sufficient number of faculty to support that program and transfer that knowl-

edge directly by teaching at the undergraduate level.”

Helble sees this strategic expansion as an opportunity to break with Thayer’s past hiring practices. “Historically, we, like many other programs, would fill a faculty opening in the following way: If the faculty member who taught mechanical engineering classes retired, we would look to hire a mechanical engineer to teach those classes. And then we would say, ‘Here is a laboratory; build a research program.’ We wouldn’t look for any cohesion with our other research programs, and there were no efforts to try to structure scholarly activity.”

Arguably that system served Thayer well in the past. A hiring wave back in the 1960s set the stage for the Thayer School of today. For example, the late John Strohbehn, “the father of bioengineering at Thayer” and a longtime professor and associate dean, found ways to encourage engineers to collaborate with Dartmouth’s medical researchers. More recently, the success of GlycoFi—the biotech firm started in Thayer labs by Professors Tillman Gerngross and Charles Hutchinson and bought last year by Merck for \$400 million—demonstrates how productive the Thayer system can be.

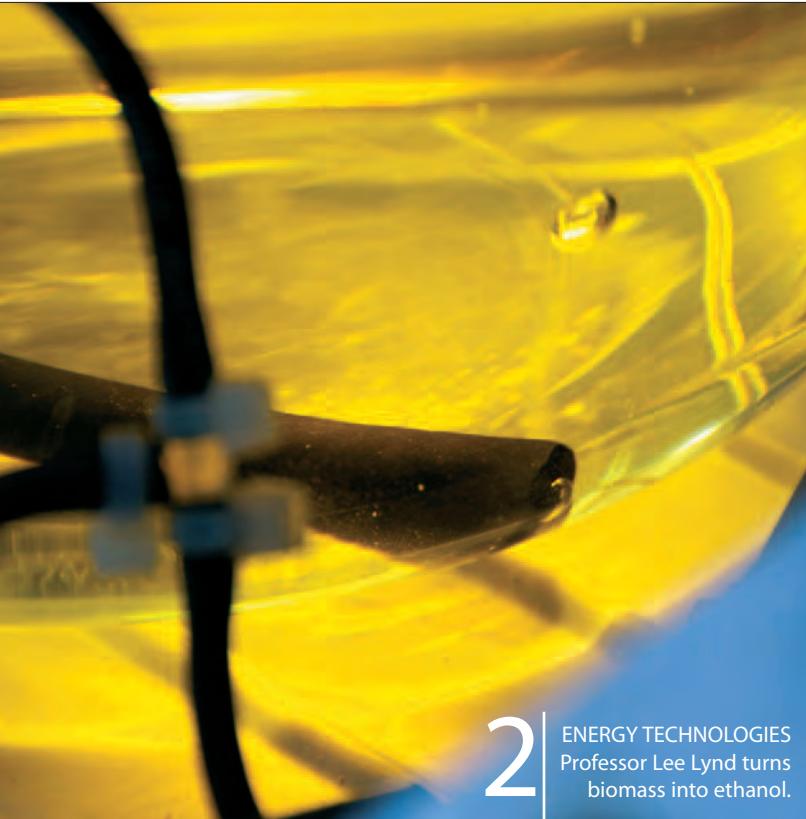
WHAT HELBLE BRINGS TO THE TABLE IS A PLAN THAT MERGES engineering’s historic mission as the problem-solvers of society with Thayer’s research strengths and its openness to collaborations. “We have the luxury of stepping back and asking, ‘What are the world’s problems that require engineers to be working in concert toward solutions?’” says Helble.

“A year and half ago we started taking stock of what we were doing and discovered that 40 percent of our faculty were already interacting with Dartmouth Medical School faculty,” he says. This formed the basis of the first of Thayer School’s new impact areas, the interface between engineering and medicine.



STATE OF THE SCIENCE

SAMPLE RESEARCH IN THAYER'S IMPACT AREAS



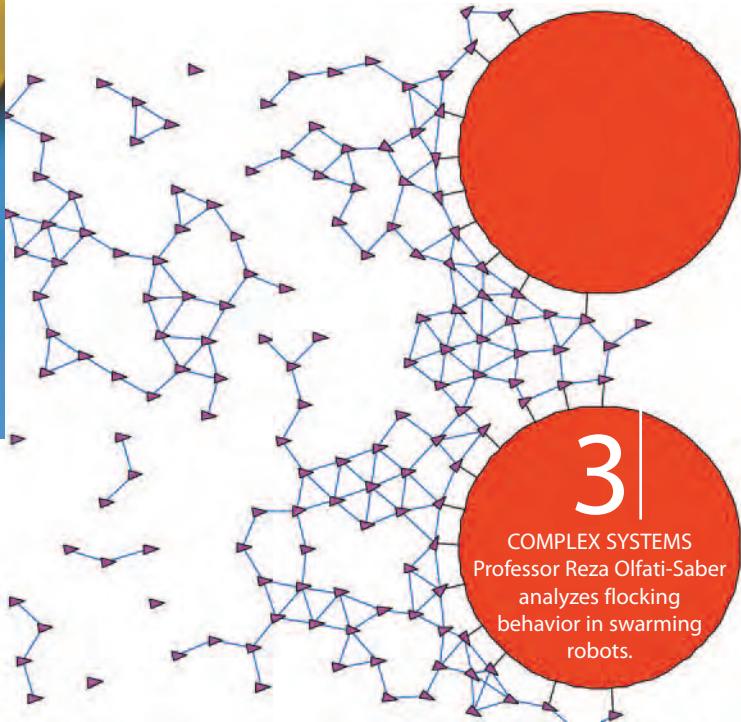
2

ENERGY TECHNOLOGIES
Professor Lee Lynd turns
biomass into ethanol.



1

ENGINEERING IN MEDICINE
A Thayer team created a 3-D
imaging stylus to aid surgery.



3

COMPLEX SYSTEMS
Professor Reza Olfati-Saber
analyzes flocking
behavior in swarming
robots.

Why not simply call it biomedical engineering? Because Helble and the faculty have a vision that is bigger and more ambitious.

"Biomedical engineering is an engineering discipline. It's an existing branch of engineering that focuses largely on biomechanics or signal processing," says Helble. "What we do here incorporates that, but it's broader. It incorporates biomechanics and biomedical imaging. It also incorporates protein engineering. We just hired two new faculty members—Solomon Diamond '97 Th'98, who works in the area of neural imaging, and Karl Griswold, who works in protein engineering. Faculty are already collaborating at Dartmouth with the William H. Neukom 1964 Institute for Computational Science and its director, Professor Richard Granger. Others are developing more extensive research programs with Dartmouth Medical School faculty. This is the kind of initiative that we're building, and we're looking for interactions

with the best faculty at all levels of the curriculum."

"We can't be a world unto ourselves here if we want to make a significant contribution toward solving the world's problems. We have to pull in expertise from around campus and outside the institution," he adds.

Crucial to Thayer's plan is the willing collaboration of Dartmouth Medical School faculty. Helble and his counterpart, medical school Dean Stephen Spielberg, are building new partnerships between faculty from each school. "Our goals include plans to bring engineers into medicine and also take medical students and give them an engineering experience as part of their training," says Helble. "We both believe this will ultimately make better doctors."

Indeed, anyone who has visited a doctor recently knows that medical care involves more sophisticated technologies than ever. "More and

“I’D LIKE TO SEE PEOPLE POINTING TO US AS A SCHOOL THAT IS MAKING A SIGNIFICANT CONTRIBUTION IN THESE IMPORTANT INTERDISCIPLINARY AREAS.”

more of what physicians do is based on pushing the limits of complex diagnostic technology,” say Helble. “Dean Spielberg and I both feel that it would be a good thing if more physicians were trained to understand the fundamental operation and the limitations of their instrumentation. We have an interest in bringing these programs closer together from the curricular level all the way to the research level.”

Training doctors about technology has obvious benefit for the patient. But how much medical training does an engineer need to work with physicians to solve medical problems? “A sound engineering background and a good understanding of basic biology can provide the foundation. Engineers can learn many of the problem-specific details from the scientific literature and from talking to and working with clinicians,” says Helble. “We want those engineering students and engineering faculty to have access to the clinics.”

Helble cites Meredith Lunn’s senior honors thesis project as a perfect example of how engineers and doctors working on the interface can solve a problem. Lunn, an ’06 who will earn her B.E. this year, took an engineering course co-taught by Dr. Joseph Rosen, an adjunct professor and Dartmouth-Hitchcock Medical Center plastic surgeon, and Professor Peter Robbie. Then Robbie and Professor William Lotko introduced her to surgeons at DHMC, who interested her in trying to improve devices for cleft palate surgeries. Working with pediatric craniofacial surgeon Dr. Mitchell Stotland, Lunn succeeded in developing an oral retractor for a palatoplasty procedure performed on 10- to 11-month-old children. The device will undergo testing soon. For her B.E. project, Lunn teamed with classmates Deborah Sperling ’06 and Kazi Ahmed to fit an articulating arm to a portable ultrasound cart; the invention is being used by Dr. Brian Sites and other DHMC anesthesiologists. “It was really amazing to have the opportunity to work so closely with the physicians at DHMC,” says Lunn. “I have probably been over there once every week or two for most of my Thayer experience to work on projects and meet with physicians about research and ideas.”

FEW WOULD ARGUE THAT ENERGY ISN’T ONE OF THE WORLD’S biggest problems—and for its second initiative, energy technologies, Thayer will build on a strong foundation in this area. Two decades ago Professor Lee Lynd began work on cellulose-derived ethanol. Now, with the demand for ethanol skyrocketing, Lynd is in the spotlight for starting a company to commercialize production of ethanol from switchgrass, woodchips, and other inedible biomass—resources that won’t put energy and food production in competition. In April Lynd was honored as the first recipient of the \$100,000 Lemelson-MIT Award for Sustainability (see page 3).

Helble envisions recruiting other energy researchers of Lynd’s stature to expand opportunities for students to explore the wide array of work going on in the field. Helble is optimistic that engineers leaving Thayer

will have the education needed to help solve the world’s energy problems.

The last impact area Thayer is focusing on is complex systems. “Complex systems are made out of large numbers of locally interacting units that exhibit cohesive global behavior as a whole, in a similar way to flocks of birds and swarms of ants,” explains Professor Reza Olfati-Saber, one of three professors with complex-systems expertise hired in 2006. “This is true across diverse applications of complex systems in various fields of science and engineering.” Thayer faculty are working on a diverse range of projects in this area, including computer networks, social networks, smart robots, living cells, energy infrastructure, and the near-Earth space environment.

HELBLE HAS SET A SEVEN-YEAR TIMETABLE TO MAKE THESE various initiatives happen. Come 2014, what metric will he use to assess success? Qualifying his answer in the best style of an engineer, Helble notes, “There will always be tinkering as we go along—these are dynamic areas where research will evolve.”

Still, he outlines a few markers. “I’d like to see focused research activity in each of these areas, as represented by graduate students who are coming here specifically to study energy or complex systems or engineering in medicine,” he says. “I would like to see research funding in place to support integrated disciplinary efforts in these areas. I would like to see curricular developments in each of these areas so that those graduate students who are picking the Thayer School as a place to study have these courses as an entryway into the field. I would like to see opportunities for our undergraduates both in scholarship and coursework in these areas. I’m not talking about an energy engineering degree, but an elective or two to help introduce all of our engineering undergraduates to the problems they will face if their careers take them in this direction. And I’d like to see the school recognized in some fashion for its efforts—people pointing to us as a school that is making a significant contribution in these important interdisciplinary areas.”

Ideally, in the future Thayer School will stay small and focused while creating an environment where faculty create knowledge and students can benefit from their teaching, expertise, and professional contacts across the Dartmouth campus. Big money successes, such as GlycoFi, make for great press, but for Helble the real bottom line is always what an engineer and an engineering school are supposed to do.

“I think you could say that Thayer’s expectations for its faculty are higher than at other schools,” he says. “It’s not just bringing in grant money and publishing papers. It’s putting the technology to use—either patenting it or working with people who can patent it, and if it’s not patentable, finding a way to give it to someone else to address the world’s problems.” □

Lee Michaelides is a contributing editor.



PAVING TO RECYCLED

GAS MILEAGE

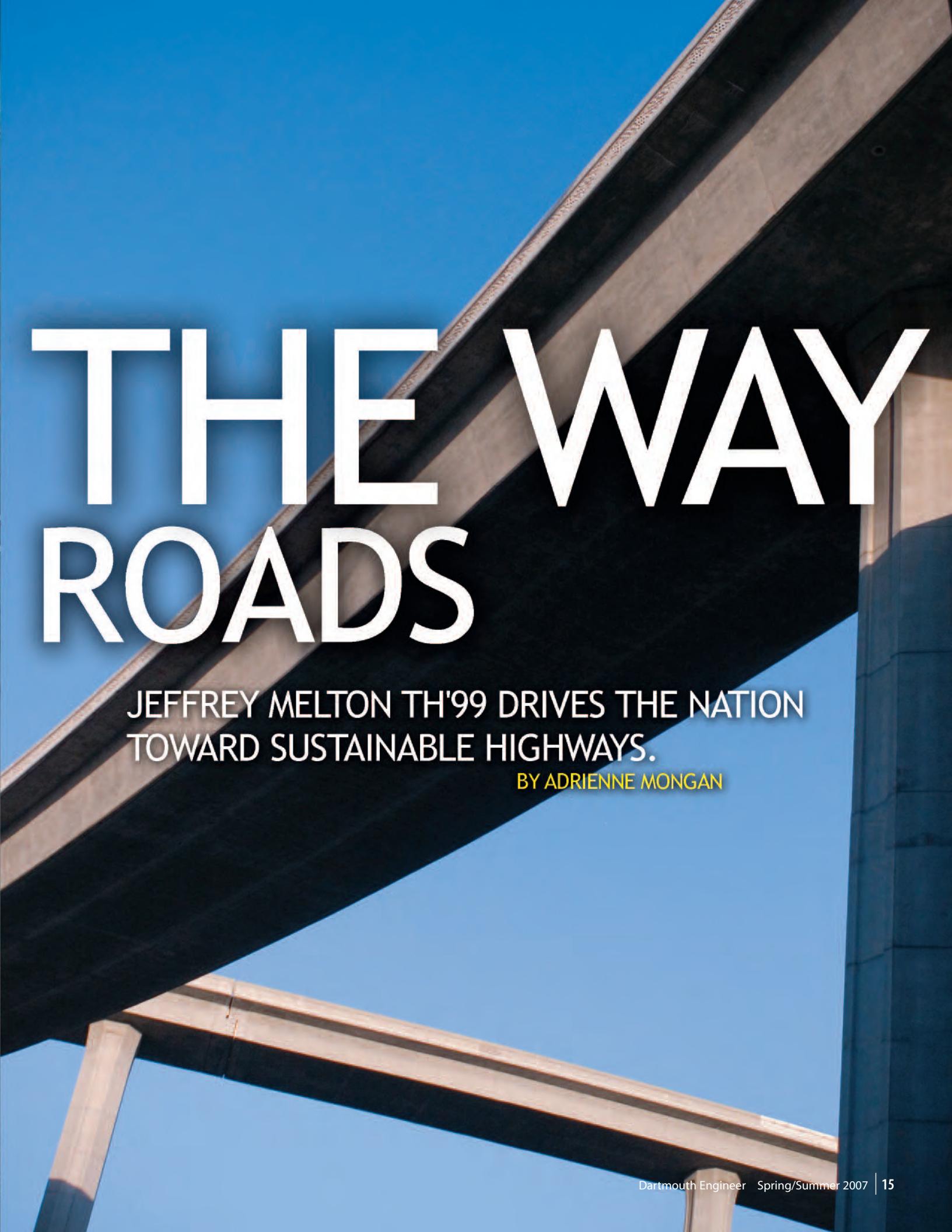
is a concern of millions of Americans who drive along the country's highways. But when Jeffrey Melton Th'99 takes his vehicle out on the road, he's actually thinking about the road.

As director of outreach at the national Recycled Materials Resource Center (RMRC), Melton is on the road a lot to promote sustainable highway engineering, including building roads with materials otherwise destined for landfills.

Established in 1998, at the University of New Hampshire, the federally funded RMRC partners the Federal Highway Administration with UNH to address the difficult task of continuing highway expansion without further depleting vital resources. Working with numerous state departments of transportation (DOTs) and environmental regulatory agencies (ERAs), Melton advocates for big changes in the highway landscape.

We are all familiar with today's main roadway material. Asphalt is everywhere: thousands of miles of roads and highways are paved with it. Most Americans are not aware that asphalt is a byproduct of crude oil—with the same limited road ahead. "In a couple of decades, we'll see a shortage of asphalt," Melton says. "People are

THE WAY ROADS



JEFFREY MELTON TH'99 DRIVES THE NATION
TOWARD SUSTAINABLE HIGHWAYS.

BY ADRIENNE MONGAN



ROAD WARRIOR

"The green highway movement is where green building was 20 years ago," says Jeff Melton, pictured at a test site at the Recycled Materials Resource Center at the University of New Hampshire.

timated 350 to 850 million tons of byproduct and secondary-use materials are generated each year in the United States. These secondary-use materials include tires, asphalt shingles, crushed concrete, reclaimed asphalt pavement, coal combustion products, foundry sands, and slags. Implementing these secondary-use materials in road construction allows engineers to conserve high-quality virgin materials while finding a value application for materials that might otherwise go into a landfill. Given this, the question that engineers using the sustainability application face when working on projects becomes: "Can I take a material that in the past has been viewed as a waste and make it into something of value either as a construction or fill material?" says Melton.

At the RMRC, researchers are challenged on a daily basis to test, evaluate, and develop guidelines and specifications for new and familiar materials for use in the highway environment. The center works through outreach and research projects to, as Melton says, "overcome barriers to the appropriate use of recycled materials in the highway environment." Among the areas studied at the center and an example of recycling in action is the use of recycled concrete. Concrete is one of the most recycled materials used in highways, because of its abundance and high quality as an aggregate source. In fact, estimates indicate that building demolition in the United States generates approximately 123 million tons of waste per year and helps create recycled concrete. After a cleaning process that removes unwanted materials such as brick, steel, and glass, the material is crushed. Once this process is completed, electromagnets remove any residual metal and the remaining recycled product is used as recycled concrete aggregate (RCA).

One of the initiatives of the RMRC is to help promote the use of RCA to state DOTs that are not currently using it. As a part of its action plan, the RMRC is conducting a performance survey of the pavements in high RCA-usage states such as Idaho, Minnesota, and Wyoming as well as obtaining field samples for physical, chemical, and petrographic evaluation. The data obtained will be used to help develop guidelines for the expected performance of pavement made of RCA concrete and will be disseminated to all state DOTs, with the hopes of increasing the use of this plentiful recycled material.

The pay-offs can be substantial in several realms. "By increasing our recycling efforts today, we will undoubtedly reduce any adverse environmental impacts in the future," Melton says. "So in terms of the big picture, the benefits of recycling go beyond the environment and include significant economic ones as well." Researchers at Penn State, for example, credit concrete mixtures—using byproducts such as fly ash, silica fume, ground granulated blast furnace slag, and an alkaline earth mineral mixture—with helping to lengthen lifespans of bridge decks. The added materials reduce the permeability of concrete, deter salt from entering concrete, and increase electrical resistance. By using these byproducts in bridge deck construction, which significantly increases the lifespan of such structures and also helps slow corrosion, researchers in Pennsylvania estimate cost savings could reach more than \$35 million annually.

But there are still roadblocks to using recycled materials for highways.

COMING TO A HIGHWAY NEAR YOU

A wide range of recycled materials are already used in roads in the United States or abroad or are being tested for suitability. Here's a sampling.



ASPHALT ROOFING SHINGLES

Uses: aggregate, asphalt cement modifier, substitute for gravel roads



BLAST FURNACE SLAG

Uses: hot-mix asphalt, Portland cement concrete, granular base, embankments, fills



SCRAP TIRES

Uses: embankments, retaining walls, aggregate substitute, asphalt modifier



COAL BOTTOM ASH/BOILER SLAG

Uses: asphalt concrete aggregate, granular base, stabilized base aggregate, embankment, fills



FOUNDRY SAND

Uses: asphalt concrete, flowable fill aggregate



MINING AND MINERAL PROCESSING WASTES

Uses: asphalt concrete aggregate, granular base, embankments, fill



MUNICIPAL WASTE COMBUSTOR ASH

Uses: aggregate substitute in asphalt paving mixes, fill, embankments



WASTE PLASTICS

Uses: soil stabilizing pins, aggregates



RECLAIMED ASPHALT PAVEMENT

Uses: new pavement



RECLAIMED CONCRETE

Uses: aggregate substitute



SEWAGE SLUDGE ASH

Uses: asphalt paving mixes



WASTE GLASS

Uses: aggregate substitute, road base, fill



STEEL SLAG

Uses: asphalt concrete aggregate, granular base, embankment, fill

To learn more, visit:

<http://www.rmrc.unh.edu>

One of the most significant barriers Melton focuses on is separating legitimate concerns about recyclables from general negativity associated with materials defined as waste. "The potential for leaching dangerous materials is always a concern, both from environmental and human health perspectives" he says. "People in favor of recycling need to have the data to prove that a given material does not pose a risk in a given application." Getting the right information to the right people is key. With communication between all the parties involved, whether between the state DOTs and state EPAs or between one of these agencies and individual community members, the chances of a project getting the green light are much higher. "People want to be involved in the process from the beginning," says Melton. "They do not want to be surprised. Even though they may be very receptive to using recycled materials, they want to understand the project parameters, why this material is being considered, and all the data collected on it."

FIXING A BROKEN LAWNMOWER WAS THE SPARK that ignited Jeff Melton's interest in engineering. "I became fascinated with how things work, why they break, and how to fix them," Melton explains. After graduating from Hamilton College in 1991 with a B.A. in physics and then from UNH in 1994 with a M.S. in ocean engineering, Melton entered Thayer, where he earned a Ph.D. in engineering sciences in 1999. After graduating from Thayer, Melton joined the U.S. Army Corps of Engineers, working as a research hydraulic engineer. While serving as a member of the dredging team, working on sediment management, Melton's interest in contaminated sediment and recycled materials began to develop. In working with the team to determine ways to use the dredge material in a beneficial manner instead of simply disposing of it, Melton recalls, "I began to think, how can we take a mixture of sand and mud, for instance, and do something of high value with it instead of simply using it as a low-value application." He adds that the transition to the RMRC was a natural extension of his interest in the beneficial use of waste materials.

Among his current research projects, Melton is working on the characterization of construction and demolition (C&D) debris found in New Hampshire. "Because we build so much with granite here, we have a lot of it mixed with concrete and brick available. But because we do not know how this material behaves under certain circumstances, we have not used it. So my challenge is to determine how this C&D material behaves in order to promote its use in the highway environment," explains Melton.

Looking forward, he believes that the use of recycled materials will only increase. Among the reasons he cites are higher demand for natural resources from developing nations and population growth, most notably in the United States. "As our population grows so will the infrastructure needed to support it," Melton says. "As a result, available land will become scarce for such things as gravel pits, which hold the aggregate material used in highways, so out of sheer necessity we will have to recycle materials." □

Adrienne Mongan is a freelance writer living in Vermont.

OVER SEAS IN HANOVER



FOR INTERNATIONAL STUDENTS
THAYER SCHOOL IS A FOREIGN ADVENTURE

BY JENNIFER SEATON □ PHOTOGRAPHS BY JOHN SHERMAN

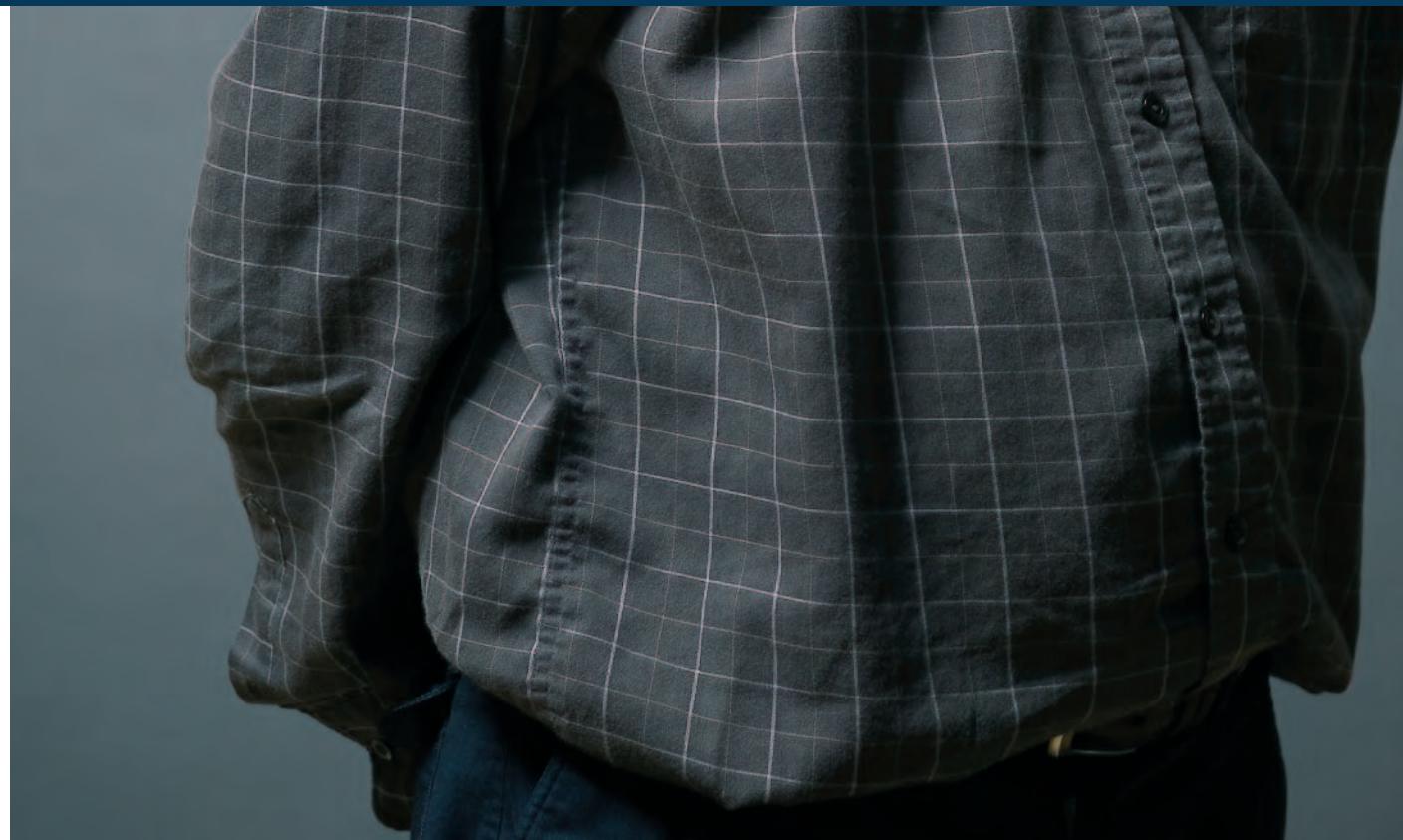


HOMESICKNESS FOR SHAO'S NATIVE CHINA HAS FADED SINCE "I CAN CALL HOME OR WE CAN EVEN SEE EACH OTHER ON THE INTERNET."

XIONGJUN SHAO



“I LIKE THE EFFORT THE SCHOOL IS ALWAYS MAKING TO HAVE
EVERYBODY FEEL WELCOME AND ENCOURAGED TO CREATE.”



S

Students come to Thayer School from all over the world. They bring different cultures, educational backgrounds, and engineering aspirations. Thirty-six percent of all Thayer students—the majority from China, India, and Western Europe—hail from outside the United States. On top of the move to Hanover and the new classes all students have to navigate, many foreign nationals must master a new culture and study in a second language. Once they graduate, some have a more difficult time finding employment than their American peers—in part due to the limited number of visas released by the U.S. Office of Citizenship and Immigration Services. But students are willing to leave the familiarity of their home countries to study at Thayer because, they say, the best educational and job opportunities await them in the United States. Those profiled here give us a glimpse into international students' lives.

ANNARITA GIANI, PH.D. CANDIDATE

For Annarita Giani, home is a seaside town in Italy. Giani had earned a master's degree in math and was working for the Italian government as a researcher when she got to know Thayer Professor George Cybenko. When she decided a Ph.D. in computer engineering would be helpful in her career, Thayer seemed a natural choice.

Arriving in Hanover in 2000 to work with Cybenko on cybersecurity, Giani encountered some unexpected cultural hurdles. She began her first applied math assignment, stopping when felt she had mastered the concept. At the beginning of the next class she was shocked to hear the professor ask for her work. "It was unthinkable to me that in a Ph.D. program we have homework to turn in," she says. The professor gave Giani an extra day to complete the assignment, and she figured out that she was expected to finish all assigned problems.

She had to make other adjustments, too. "The way people interact is very different here," she says. "It's more formal and distant." In Italy Giani wouldn't think twice about dropping in on friends or family unannounced. But in America, "it would be unacceptable to go and visit a friend and knock on the door without informing them before," she says. Other social conventions puzzle her as well. "You invite people for dinner at 8," she says, "and they say 8 is too late."

Giani smiles as she describes the positive aspects of life in America, such as how strangers say "hi" to each other in the halls and how easy it is to obtain a driver's license. Still, she misses home and she tries to make it back to Italy several times a year. Each time she returns to Hanover with coffee grounds to use in her Italian coffeemaker. (Although she has grown to like barbecue and bacon and eggs, she cannot give up Italian coffee.)

Giani's advice to other international students considering U.S. programs: "Do not think of finding here the same life that you had in your home country. Be positive, this country offers many great things," she says. "And if you see something that you do not understand, try not to be too critical."

JESSICA LAWRENCE TH'05, '06

Jessica Lawrence wanted a liberal arts education. In her home country, Jamaica, students specialize in one field from an early age; her strong academic skills landed her on the science track at age 13. Not wanting to limit the scope of her studies, she left Kingston, Jamaica, to study physics at

Vassar College in Poughkeepsie, N.Y. After two years there, Lawrence came to Dartmouth to study engineering under the dual-degree program. "My parents were the main proponents of me and my sister coming to the school in the States," she says about her engineer father and nutritionist mother. "They knew it would open doors for us."

Lawrence immediately encountered differences between life in the United States and Jamaica, where she graduated from an all-girls, Catholic high school. "So many people thought differently here," she says. "In my family and community in Kingston, everyone was Christian, everyone went to church, everyone was black."

Lawrence likes the way Americans seem open to talking about diversity. "What stood out were the different belief systems and different ways of thinking about things, but it didn't have to be antagonistic," she says.

At Thayer, she says, professors made a special effort to reach out to her by including Jamaica in case studies or applying principles discussed in class to specific situations in her home country. She appreciated this, she says, because she aims to help Jamaica address problems of poverty and environmental degradation.

As a student she joined Dartmouth's Gospel Choir, International Club, and a local church. She complemented her engineering courses with acting, religion, and economics—and still marvels at the room in her schedule for non-engineering pursuits. "I think that influences Thayer's style of teaching engineering and its culture," she says.

Missing her family and what she calls the "casual, outspoken friendliness" of people in Jamaica, she returned each winter break and summer. (She spent one summer working on an engineering project in a Jamaican mine.) Looking back though, she wishes she had spent at least one summer in the United States. "I think the experience of being away from your parents and culture and country is invaluable for growing up and claiming your own identity," she says.

Lawrence is now working in business operations at a retail firm in New York City. She plans to return to Jamaica in about five years to work in environmental engineering or business. "For me, work experience in the States is a means to getting experience," she says, "and enhancing the toolset Thayer has given me so I can make a meaningful contribution in Jamaica."

JUAN PABLO FERNANDEZ TH'07, M.S. CANDIDATE

Juan Pablo Fernandez grew up in Colombia, attended college near home, then earned a Ph.D. in physics from the University of Massachusetts, Amherst. When his wife entered a doctoral program at Dartmouth, he decided to augment his physics training with an engineering degree from Thayer. "I originally wanted to study something as far removed from the real world as possible," says Fernandez. "But I've become more pragmatic with age."

Thayer was both welcoming and challenging. "The way in which an engineer thinks is very different. It's been tough," he says.

A bright light was ENGS 149: "Introduction to System Identification," taught by Professor Min Phan. "It was amazing to see Professor Phan derive from scratch a whole practical scheme for the characterization and control of mechanical systems," he says. "The homework consisted mostly of toy problems, but the tools we developed for those could then easily be adapted for serious systems analysis in real-world

conditions—in fact, the final exam was an analysis of real Hubble Space Telescope data.”

In his research, advised by Professor Fridon Shubitidze, Fernandez uses electromagnetic induction sensors to address a disturbing world problem: detecting and identifying buried unexploded ordnance.

Fernandez says he likes the fact that science and technology are important parts of American culture, and he enjoys the congenial atmosphere at Dartmouth.

“I think it’s conducive to a lot of hard work,” he says. “There’s a lot of competition. But you feel like you’re part of a team. I like the collaborative impulse you see everywhere. I like the effort the school is always making to have everybody feel welcome and encouraged to create.”

DAVID LUKOFSKY, PH.D CANDIDATE

Before David Lukofsky graduated from Dalhousie University in Halifax, Nova Scotia, in 2005 with a degree in electrical engineering, he applied to Ph.D. programs at three Canadian schools and Dartmouth.

Dartmouth won out. “The fact that there are no departments here was a draw,” says the Montreal native. He was also drawn to the lifestyle. In Canada most students live off campus and have busy lives away from school. At Thayer, Lukofsky’s lab is only a few hundred yards commute.

As an undergraduate he thought of school as one aspect of his life. “In grad school my life is school. I’m here every day of the week, morning until night,” he says. “I’ve noticed everyone is so driven, students are very proactive in their learning.”

Lukofsky is working with Professor Ulf Österberg to examine how water absorbs light. He may pursue a career in academia—on either side of the border.

XIONGJUN SHAO TH’05, PH.D. CANDIDATE

Like many foreign students, Xiongjun Shao and his wife have not been back to their native China since arriving at Thayer in 2001. Their first few years away from family and friends were clouded with homesickness, but those feelings gradually faded. “I can call home or my friends or we can even see each other on the Internet,” Shao says. Getting his fill of authentic Chinese food is another matter; it’s what he now craves most. Homesickness still creeps up during traditional Chinese holidays, when he thinks about the celebrations he is missing back home.

The language barrier was one of Shao’s greatest challenges upon moving to America. Although he studied English as a student in China, working and socializing in English has been difficult. Yet his English and his confidence have improved with time, he says, allowing him to focus on his work, supervised by Professor Lee Lynd, on kinetic modeling and reactor design for converting cellulosic biomass to ethanol.

To help others adjust, Shao founded an International Club at Thayer in 2005. Offering moral support and companionship, the club sponsored movie nights and sightseeing trips. But it disbanded when Shao couldn’t run it any longer. “I have to focus on finishing my thesis work,” he says, “and I couldn’t find someone who could devote to it, although there is need of such a club.”

NILANJANA DUTT TH’06

Nilanjana Dutt talks to her family in India every Sunday morning. They

exchange e-mails during the week, but Dutt looks forward to hearing their voices.

Dutt grew up in New Delhi and moved to the United States five years ago. “I had always enjoyed working with my hands and understanding how things worked,” Dutt says. It was those childhood interests that led her to Thayer after she attended Colby College in Waterville, Maine. “Turned out that the classes at Thayer were a lot of work and long hours,” she says. “But I enjoyed the challenge and welcomed the chance to work on more tangible projects than I had been exposed to at Colby.”

India’s needs influenced her engineering studies. “India is economically booming right now,” Dutt says. “Roads, industries, housing, sanitation, and water projects are major growth areas in the country.” Like many developing countries, India has experienced environmental degradation on the path to economic development. “There is a growing consciousness about the environment in India and the potential for sustainable projects is immense,” she says.

“I took as many environmentally focused classes as I could,” she says. One in particular was ENGS 171: “Industrial Ecology,” in which students look at how sustainability principles are applied. “Professor Cushman-Roisin has many connections and ideas about the field; he helped me as a professor and was an invaluable resource.” She was also inspired by ENGS 44: “Sustainable Design,” in which she learned about architecture and product design.

“It helped to have conversations and talk outside of class,” she says. “For me, I had these interests but I wasn’t sure of the best way to realize my goals and tackle them.”

Cracking social circles on campus was another challenge. “There was no infrastructure for meeting people,” she says. Dutt has found that many non-English-speaking students stick together for comfort at Dartmouth, and the graduate community tends to be divided by background. “For some people it’s harder to reach out to Americans than other internationals,” she says, “even if they’re from the other side of the world.”

Still, Dutt says she is glad she chose to study in the United States, particularly because of differences in the engineering field. Indian students apply directly to engineering colleges for the specialization they want to study. The fixed curriculum does not allow students the freedom to focus their studies on anything other than their chosen field. Though colleges hold annual festivals for music, drama, and fashion, regular athletic and extracurricular activities are not often emphasized. Dutt welcomed the change, joining the mountaineering club and working part-time for a Tuck professor doing research on environmental influences in the business world.

Dutt currently works as an intern with a New York nonprofit. She plans to pursue a Ph.D. and then return to India. “The basic standard of living in India is lower than the United States, and consequently my country’s needs are much more basic,” she says. “This affects the way we prioritize our engineering projects and the materials and processes we use to achieve our goals.” She’ll use her experiences at Thayer to understand how to address these specific problems. “I wouldn’t have discovered my interests in sustainability if I didn’t come to Thayer,” she says. “I wouldn’t be where I am today if I didn’t come to Thayer.” □

Jennifer Seaton is a contributing editor who lives in California.

DAVID LUKOFSKY



IN CANADA MOST STUDENTS LIVE OFF CAMPUS, WITH BUSY LIVES.
AT THAYER THE LAB IS ONLY A FEW HUNDRED YARDS COMMUTE.



Alumni/ae News

+ spotlights



Esquire magazine has named **Yi-Heng Percival Zhang Th'02** to its Best and Brightest 2006 list. Honored for his “crazy idea of the year: ‘sugar cars’”—their phrasing, not ours—Zhang has formulated a chemical process that can turn agricultural waste into cheap ethanol and, according to the magazine, possibly solve the “hydrogen puzzle”—the holy grail of alternative fuel.

The typical process of ethanol production uses corn kernels. Zhang’s approach leaves the kernels for food and instead uses the most abundant agricultural residue in the United States: corn stover (leaves, stalks, and cobs). And, rather than the high-cost, low-yield standard

approach—blowing cells up under high pressures and temperatures to unlock the cellulose within the plant cell walls—Zhang thought to use a solvent. He and Thayer professor **Lee Lynd Th'84** co-patented a recyclable biochemical pretreatment that generates cellulose that is more easily converted to sugar and doesn’t require special facilities.

An assistant professor of biological systems engineering in the College of Agriculture and Life Sciences at Virginia Tech since August 2005, Zhang began his research at Thayer, where he received his Ph.D. and worked as a postdoctoral research associate and research scientist. Zhang is now collaborating with the

National Renewable Energy Laboratory and Oak Ridge National Laboratory, using NREL software to analyze the economic costs of various ethanol production strategies and ORNL facilities to test different enzymes and material performance. “We hope to soon establish the first pilot plant in Virginia based on this new technology with switchgrass,” says Zhang.

But the sweet spot for Zhang is hydrogen. His pretreatment process can cleanly deliver the high energy of the gas while avoiding the pollution, costly storage tanks, and infrastructure of standard technologies. He envisions “sugar cars” fueling up at “sugar stations,” which would allow a driver to pump solid sugar into the car’s tank; a converter would extract hydrogen from the sugar, and a fuel cell would convert the hydrogen to electricity. His recipe for making hydrogen from sugar: start with his ethanol-pretreatment process to release sugar from corn stalks, then add water, using the energy stored in those sugars in combination with a novel enzymatic system to divide the molecules into hydrogen and oxygen. So far he’s had high yields and modest reaction conditions. “We do not store and distribute gaseous hydrogen anymore. We can do it through solid sugars,” Zhang tells *Esquire*. “This new technology could change the whole world energy future completely.”

Good Dirt Radio in April profiled FrontRange Earth Force (www.efden.org), a nonprofit service learning organization led by board president **Kit Ambrose '86 Th'90**. “We work with teachers and nearly

2,000 students in the less-privileged areas of Denver, Colo. We teach teachers how to coordinate wonderful and innovative student-led projects that focus on solving community issues of the students’ choice,” says Ambrose, who works for Microsoft and is also on Thayer’s executive committee. “More than anything, my time at Dartmouth and Thayer helped with the desire to make a contribution and effect change as well as the confidence to participate.”

Hector J. Motroni '66 Th'68 has earned a Dartmouth Alumni Award for his career accomplishments as well as extraordinary service to the College and civic organizations. Currently the senior vice president, chief staff officer, and chief ethics officer at Xerox Corp., where he has worked for the past 35 years, Motroni also chairs the Xerox Political Action Committee. He was recently named the National Hispanic Achiever of the Year by Hispanic Corporate Achievers, *Hispanic Trends* magazine selected him one of the 25 top Hispanic executives, and *Hispanic Engineer & Information Technology* magazine included him on its list of “100 Most Important Hispanics in Business and Technology.” He has served Thayer as its representative on the Alumni Council; as secretary, vice president, and president of the Dartmouth Society of Engineers; and as a member of the boards of the Thayer School Dean’s Fund Executive Committee, the Thayer Campaign Executive Committee, and the Thayer Corporate Advisory Board.

CNNMoney.com recently asked top venture capital investors—including **Amanda Reed '86**—for great startup ideas. Reed is a partner in Palomar Ventures, a northern California-

FLIGHT FRIGHT
The HTL helicopter, pictured during a simulated evacuation in Korea in 1952, was a success. Tom Harriman '42 Th'43 says the XH15 he worked on didn't fly.



based VC fund in which she invests in early-stage technology companies with fellow alum **Randy Lunn '73 Tu'75 Th'75**, a member of the Thayer Board of Overseers. *CNNMoney.com* says: “What she wants now: a Web-based platform to make company spreadsheets—for revenue forecasting and other analytical chores—more easily viewed, updated, and shared by managers. Many small-business execs still rely on e-mailing Excel files around the office to share data forecasts. Software apps like NetSuite import data but not the formulas embedded in spreadsheets. What she'll invest: \$5 million for a team of five engineers to create a prototype in less than two years.”

“Few can claim that they have revolutionized a sport as much as **Judy Geer '75 Th'83**.” So reads the citation marking Geer’s induction last winter into the Choate Rosemary Hall Hall of Fame. The first captain of the Dartmouth women’s rowing team, Geer spent the next decade pursuing honors. She was on both the national and Olympic teams in 1976, captured the national singles championship in 1979 and 1982, and joined the Olympic teams again in 1980 and 1984. But perhaps her greatest contribution to the sport came after she earned her Thayer degree: She developed software that displays motivational graphics and monitors performance for rowing machine company Concept 2. Now on the company’s marketing team, she and husband (and Concept 2 co-founder) Dick Dreissigacker are raising three children, including Hannah '09.

just one question

“I have not failed. I’ve just found 10,000 ways that won’t work.” —Thomas Edison

Q. What was your most instructive failure?

My most egregious failure was the XH15 high-altitude helicopter for the U.S. Air Force, a development spanning about three years in the late 1940s. The Air Force was to provide a new, vertical, supercharged engine, a major modification of an existing un-supercharged airplane engine, as Government Furnished Equipment (GFE). The critical point was that the program was small—only one aircraft and two engines had been ordered. As project engineer, I had no leverage on either the engine manufacturer or the Air Force when the engine would not perform satisfactorily.

On start-up the supercharger driveshaft would snap off, and it took months for the engine people to be convinced that a slip-clutch would fix it. Next, the engine surged with ever-increasing amplitude at about one hertz and the engine guys never did fix this one.

One tarnished silver lining, however, did appear: The supplier of the engine for the little Bell, fabled in M*A*S*H, came up with a substitute engine for flight test development purposes at lower power levels. A favorite test pilot and I had climbed to 15,000 feet

above Niagara Falls when the engine quit, not to be restarted. As we autorotated toward the airport my job was to monitor the temperature of the top bearing of the transmission, which supported the entire weight of the helicopter. To save weight and cost—hugely more important in rotary-wing machines than fixed-wing—I had purposely avoided a separate pressure oil system for the transmission alone, relying on engine oil during powered operation and scooped, splashed, and mist lubrication when the engine was not running. If the top bearing became too hot we would have to bail out before the rotor mast jammed or broke loose. The pilot made a beautiful dead-engine landing in front of our hangar to complete the world record autorotation descent.

There were two lessons: The first, as any learned aviation person knew, is never build a new aircraft around an engine that doesn’t exist yet (Boeing and GE violate this, but at their peril); the second is how wise it was to fight to get the word “satisfactory” written into the contract in front of “GFE engine.”

—Tom Harriman '42 Th'43

The following was a big lesson learned in my very first engineering class. In ENGS 21, the fall of my sophomore year, the class was assigned a project that had to do with sports and recreation. After many hours of brainstorming, our group came up with the idea of creating a “Goal Line Sensor” with the intent of using it in football but with the concept easily applicable to other sports with goals. The idea was to have some sort of sensor signal when the ball broke the plane of the goal line because the refs’ views are often obstructed by the jumble of players on the field. Anyhow, in our proposal presentation, our idea took a severe beating at the hand of several professors. We were told our project was not feasible, and that there were too many potential problems to make this project worth pursuing. We listened to our professors and selected a new project. A few years later one of the other members from that group was reading a magazine and found an article explaining that the very product we had proposed in ENGS 21 had, indeed, been invented and brought to market. I am not telling this story because I am bitter, and I certainly

don't hold anything against the professors, who I believe had our best interests in mind. The lesson to be learned is that nothing is impossible. If you have an idea that you truly believe in, go with it. So what if my teachers told me it was a bad idea; that was their challenge—and should have been my motivation.

As for what I am doing now: After taking the summer off to travel I moved down to the Washington, D.C., area. I work for a company called DC Energy, trading in the energy markets. The work I do is highly quantitative and is extremely challenging, but my co-workers are brilliant and it's a great working environment. Outside of work, I have kept up all my sports, though skiing is not nearly as easy to do when you aren't in New Hampshire!

—Daniel S. Hassouni '05, Th'05

I left Dartmouth with a Ph.D. in 1977 and have stayed at the Cold Regions Lab in Hanover, where I then had a part-time job. I did my thesis on radiowave propagation in the Earth, and still work on it, having published 51 papers to date in refereed journals, mostly on subsurface radar. I'm most proud of my papers, my five NSF grants, and 10 trips to Antarctica, during each of which a discovery always happened. I've had no large disasters but many small ones, most of which centered around hiring the wrong people. The lesson learned is to never take on someone who has no vested interest, either in a career or research.

—Steve Arcone Th'77

My most instructive failure was that I applied to medical school during my senior year at Dartmouth and did not get accepted. Instead, I accepted a job offer from a campus in-

terview with GE in technical marketing. I believe that engineering has been a better career path for me than medicine would have been, or perhaps I just learned to appreciate what I have! I have enjoyed part-time engineering careers with NASA, MIT, and GE that have been rewarding and flexible, allowing me to spend quality time with my husband and four children. Presently, I work for GE Aviation in Lynn, Mass.

—Ellen (Sullivan) Sen '77

I have not failed, I have just found 10,000 potential investors who said "no."

I think there are many starving engineers (or starving artists in a scientific way) who are finding that their science and methods are good but have a tough time convincing markets due to timing, lack of vision, or trends in finance (there is very little venture capital out there right now, for example).

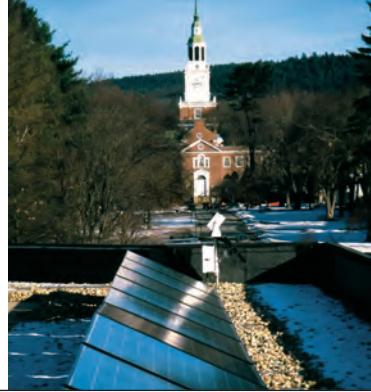
Delivering a good product or service is so much more than engineering alone, and Thayer might want to acknowledge that we as alumni could have a clearinghouse.

—Toby Reiley '81

I worked with Exxon Enterprises Inc. solar thermal systems division in the late 1970s. We had a lot of innovative people, but trying to build a new business in an infant industry with a new product was too much of a stretch. Also, you can be way too early on the technology curve, and that will doom one as well. It is very important to look at the key assumptions and then see how likely they are to occur—if the most critical ones are the least likely ones, then look elsewhere. —Bob Garman Th'70

thayer notes

thayer notes not available online



SOLAR FLAIR

In one of his early PV projects, Edward Kern '67 Th'68 and his company, Ascension Technology, worked with Professors Al Converse and Doug Bolger to install panels on top of Tuck's Murdough Center.

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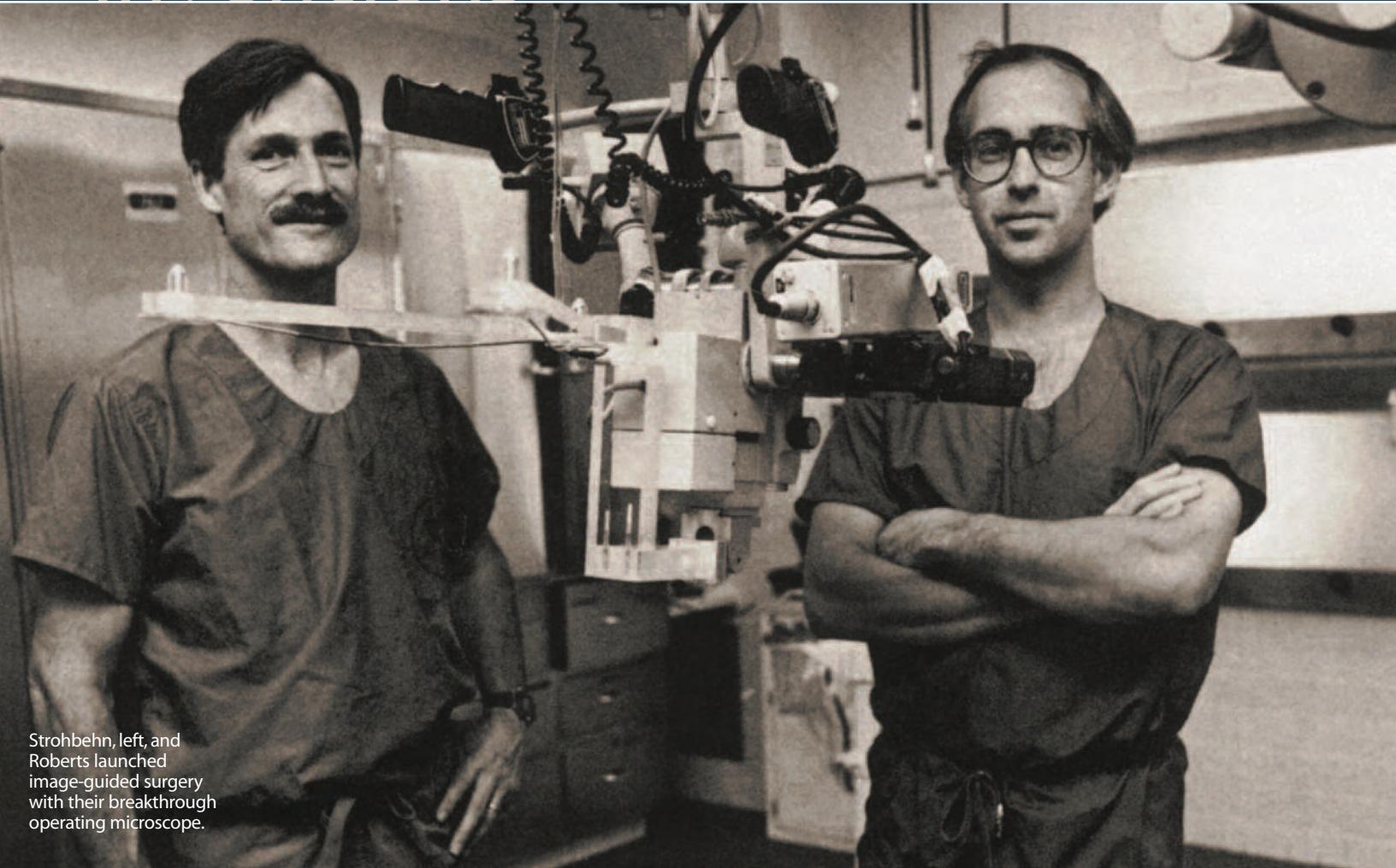
thayer notes not available online

OBITUARIES

J. Alan Groves '75 Th'76, who established and led the Hebrew Institute at Westminster Theological Seminary in Glenside, Pa., since 1986, died February 5 after a year-long battle with cancer. The seminary re-named the institute the J. Alan Groves Center for Advanced Biblical Research two months before his death. He earned his B.A. and B.E. from Dartmouth and an M.A.R. (1981) and Th.M. (1983) from Westminster Theological Seminary, where he then spent his career. He is survived by his wife of 28 years, Elizabeth; children Rebeckah, Eowyn, Alden, and Alasdair and his wife, Lauren; his parents; and siblings Warren, Jill, and Bryan.

Ashley Muller '90 Th'91 died November 18, 2006, after being struck by a car while walking near his home in Cape Town, South Africa. He is survived by his wife, Sarah (Lewis) '89, his parents, brother, many relatives, colleagues, and friends. He graduated from secondary school in Cape Town and then earned a B.S. and a B.E. from Dartmouth. As a college student, he was committed to persuading Dartmouth to divest its endowment holdings in apartheid South Africa. He worked in civil and environmental engineering for 10 years before returning home in 2001 to pursue post-graduate studies at the University of Cape Town. He was passionate about researching and implementing ways to improve public health through the provision of clean, potable water. His wife, Sarah, writes, "Ashley was known to family, friends and colleagues as a critical thinker, brilliant scientist, an eternal optimist, a teacher and as a thoughtful, giving friend."

inventions



Strohbehn, left, and Roberts launched image-guided surgery with their breakthrough operating microscope.

FRAMELESS STEREOTACTIC OPERATING MICROSCOPE

>> INVENTORS:

PROFESSOR JOHN STROHBEHN AND DR. DAVID ROBERTS DMS'75

Ever since early humans drilled holes into patients' heads in paleolithic neurosurgery, doctors have longed for a way to navigate the brain and pinpoint lesions. In the 1970s computerized tomography (CT) produced amazing two-dimensional images of the brain, but the only way to use the

scans as navigational guides during surgery was via a cumbersome metal frame that ringed the patient's head, got in the surgeon's way, and (ouch!) had to be screwed directly into the skull.

In the early 1980s Dartmouth-Hitchcock Medical Center neurosurgeon David Roberts DMS '75

asked Thayer Professor John Strohbehn to create a better solution: an instrument that could map CT data onto the visual field of a microscope to produce a precise three-dimensional (a.k.a. stereotactic) view of the brain. Working together in Strohbehn's lab at 7 a.m.—before Roberts' clinical hours and Strohbehn's classes—they created an operating microscope that was stereotactic, frameless, and precise. They tested their prototype in the operating room in 1983 and

patented the invention three years later.

The frameless stereotactic operating microscope was a hit. Not only was it more comfortable for the patient, it was the beginning of image-guided surgery.

Today every neurosurgical operating room in the world is equipped with an updated version of Strohbehn and Roberts' invention. You don't have to be a brain surgeon to know that brain surgery would now be unthinkable without it.



RANDOM WALK

Nija Joshi, an M.E.M. candidate, volunteers at Thayer Gear, a new student-run shop that opened for business April 30. Located in the former reception area of Cummings Hall, Thayer Gear specializes in tee shirts, glasses, tote bags and other accessories sporting Thayer School's new logo. Proceeds go to Thayer Council, which supports student groups and activities. You can order your Thayer gear by e-mailing thayergear@dartmouth.edu.



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