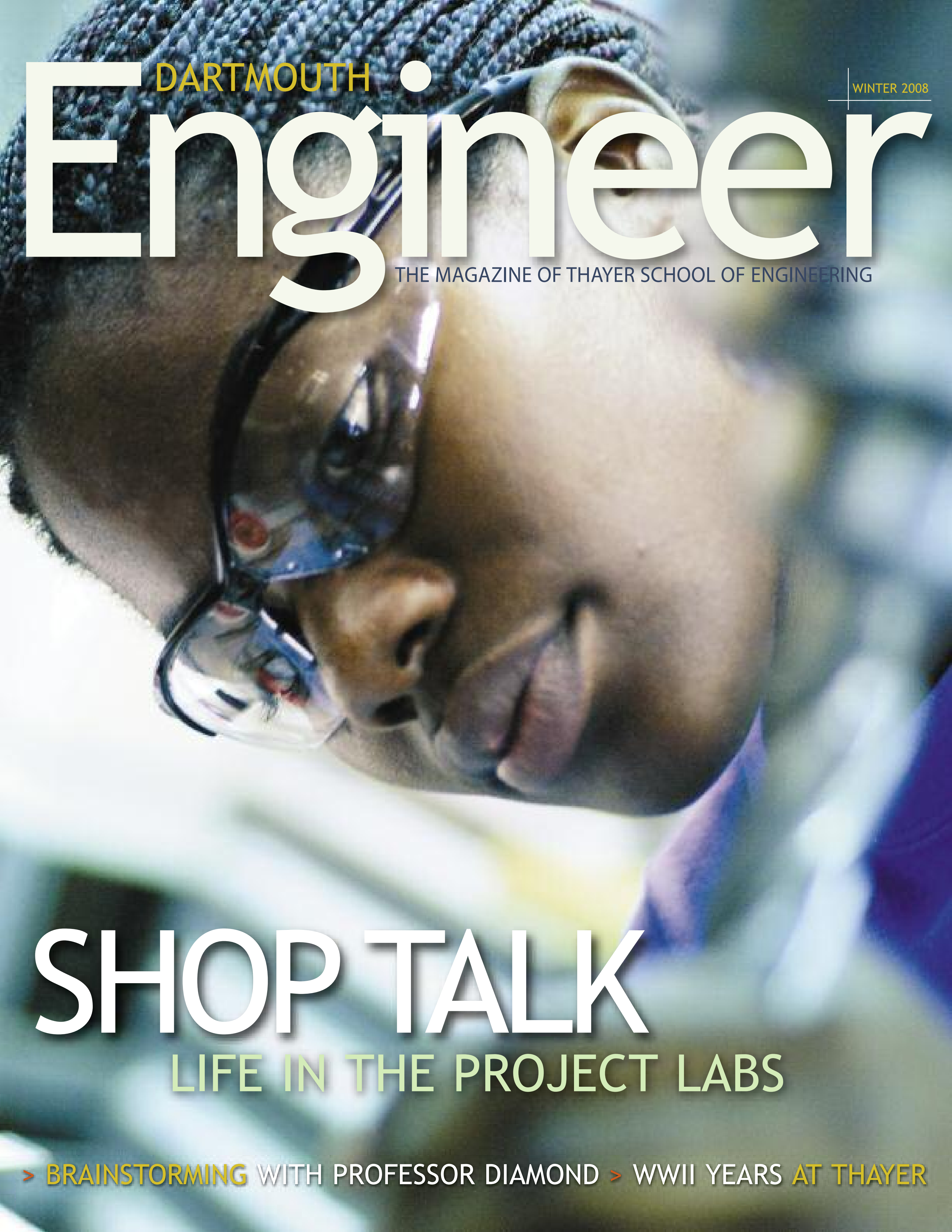

DARTMOUTH

Engineer

WINTER 2008

THE MAGAZINE OF THAYER SCHOOL OF ENGINEERING

SHOP TALK

LIFE IN THE PROJECT LABS

> BRAINSTORMING WITH PROFESSOR DIAMOND > WWII YEARS AT THAYER

Engineering and Politics

BY DEAN JOSEPH J. HELBLE

AS THE POLITICAL SEASON HEATS UP, IT IS CLEARER THAN EVER THAT engineering and public policy—engineering and politics—shouldn't be viewed as separate worlds. Engineering is critical not just for creating technical solutions, but for informing public debate and shaping public policy.

Right now, however, technical talent on Capitol Hill is sparse. Only 4% of Senators and 7% of the members of the House of Representatives have college degrees in science or engineering. Congress regularly debates bills on highly complex, technology-related issues—including energy policy, fuel economy standards, climate change, asbestos use, cybercrime, food safety, spyware, underground mines, and embryonic stem cell research—but few legislators bring technical expertise to their deliberations.

Why does this happen? Unfortunately, students who are drawn to technology often have little interest in politics. And for those who do, their training, which at most institutions remains narrowly focused on solving technical problems, does not show them that engineering or science can be relevant to public policy.

At Dartmouth we are trying to change that. Thayer School and the Public Policy Program at the Rockefeller Center have developed a new modified major: Engineering and Public Policy. Students will study the core of the engineering curriculum as well as the core policymaking curriculum. It is a program for the aspiring public servant who realizes it will be useful to understand technology—and for the engineer who realizes that public policy affects which technologies are funded and chosen for development and adoption.

Energy technology is a case in point.

Speakers at our recent Dartmouth Energy Symposium outlined an array of alternative energy technologies to reduce our national dependence on oil—including solar thermal technology, fuel cells, systems to capture waste heat, cellulosic ethanol processes, compressed air energy storage, and development of improved building materials. Scientists, investors, and venture capitalists alike noted the nation's need for government funding of early-stage research and development of promising technologies, and therein lies much of the challenge. As one speaker pointed out, politicians are more comfortable supporting the general idea of energy independence than assessing the specifics of how to get there.

This is why engineers need to be involved. We need to equip our students with the technological and public policy skills to make substantive contributions to this discussion. All of us with technical backgrounds should do our part to shape the decisions we entrust to Congress. Our collective future depends on it.

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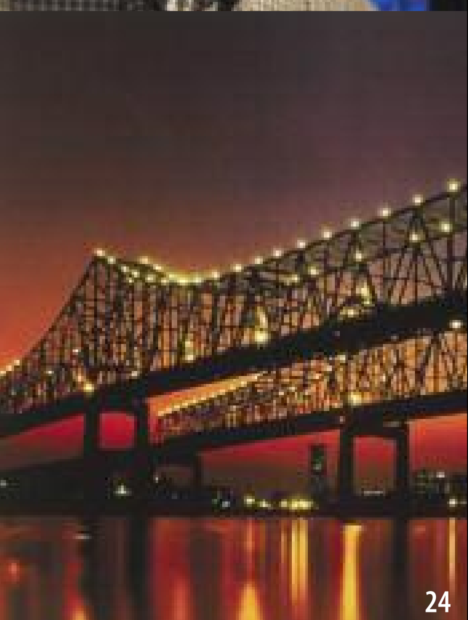
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DEPARTMENTS

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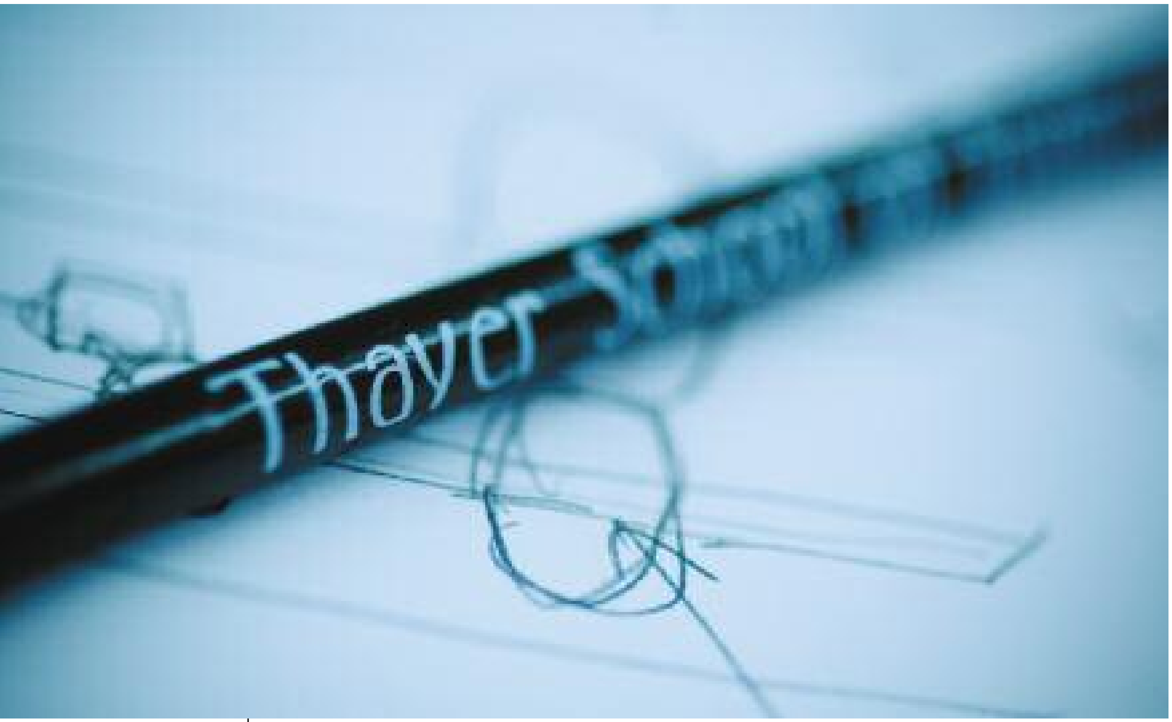
B.E. student Margaret Martei at work in the machine shop.
Photograph by John Sherman

BACK COVER
Students collaborate in Couch Project Design Lab.
Photograph by John Sherman

THE Great Hall

>>NEWS FROM AROUND THAYER SCHOOL



CREATIVE VENTURES
Product design has played a key role in the undergraduate curriculum for years. The new Innovation Program adds entrepreneurship to Ph.D. studies.

JOHN SHERMAN

ACADEMIC INITIATIVES

New Modified Major and Ph.D. Innovation Program

THAYER SCHOOL RECENTLY INITIATED TWO groundbreaking academic programs: an Engineering and Public Policy modified major for undergraduates and an Innovation Program for doctoral students.

Introduced in September, the Engineering and Public Policy modified major is a joint offering of Thayer School and Dartmouth's Rockefeller Center. It combines engineering with areas of knowledge that are essential for policymaking, including economics, electronic journalism, ethics, governance issues, and policy analysis. The modified major is intended both for engineers who want to influence public policy and for students interested in public policy careers who want to boost their effectiveness by gaining a working understanding of technology. Thayer School Dean Joseph Helble, who spent a year in Washington as a science advisor in Senator Joe Lieberman's office, is the advisor for engineering students pursuing the modified major.

Thayer School's new Innovation Program offers Ph.D. candidates the entrepreneurial training they need to turn doctoral-level complex research into innovative applied technologies. It is the first such doctoral program in the nation.

Modifying Thayer's doctoral curriculum—and adding about six months of work to it—the Innovation Program includes courses in new venture creation, finance, accounting, patent law, and organizational behavior, and provides students with the opportunity to complete a three- to six-month internship in a startup or other entrepreneurial enterprise. Thayer School anticipates adding five to six Ph.D. students a year to the Innovation Program, with the first new group beginning in Fall 2008.

The curriculum for the program got underway in September with the inauguration of ENGG 300: New Venture Creation, taught by former Thayer School dean and successful entrepreneur Charles Hutchinson. Modeled in part on Thayer's signature project-centered introductory undergraduate course ENGS 21: Introduction to Engineering, New Venture Creation exposes students to the entire entrepreneurial process, from idea to prototype.

The new program addresses the nation's growing need for people with both technical and entrepreneurial know-how. As pointed out in "Innovate America," a 2004 report presented to the National Innovation Summit by the nonpartisan Council on Competitiveness, the nation's technological and economic leadership depends on investment in the next generation of innovators.

Both the Innovation Program and the Engineering and Public Policy modified major reflect Thayer School's commitment to serving humanity through engineering.

"Society needs more than technical skill from engineering graduates today," says Dean Helble. "We need graduates with the ability to apply those skills to solve society's most pressing problems in critical areas such as energy, communications, the environment, and medicine."

Terry McGuire Th'82: "Thayer School graduates are truly unique individuals. My hope would be for this small corps to continue to make a large contribution to society."

LEADERSHIP

McGuire Chairs Overseers

TERRY MCGUIRE TH'82 BECAME THE NEW chair of Thayer School's Board of Overseers January 2 for a four-year term. He succeeds John W. Ballard II '55 ThTu'56, a member of the board since 1989 and chair since 1998.

"John has done a fantastic job of helping Thayer move forward," says McGuire. "My job is to continue the work he started."

During Ballard's chairmanship, Thayer School built the MacLean Engineering Sciences Center and increased the endowment, the Annual Fund, and funded research. Ballard, founder of Angeli Parvi, a group of industry leaders who aid and fund new Dartmouth entrepreneurial ventures, says, "Thayer is very fortunate to have a person of Terry's breadth, conceptual ability, and knowledge of applied engineering and education."

An overseer since 2000, McGuire is cofounder and managing general partner of Boston-based Polaris Venture Partners. He holds an M.B.A. from Harvard Business School, M.S. from Thayer School, and B.S. in physics and economics from Hobart College. The founder of three companies—Inspire Pharmaceuticals, Advanced Inhalation Research, and MicroCHIPS—he received a 2005 Albert Einstein Award for Outstanding Achievement in the Life Sciences.

In further overseers news, Edward Keible Jr. '65 Th'66, '67 has joined the board for a three-year term. Keible, who holds an M.B.A. from Harvard, is president and CEO of Endwave Corp. (formerly Endgate Corp.), which designs and manufactures radio frequency subsystems that support high-speed data signals in broadband wireless access systems. Previously, as senior vice president at Raychem Corp., he was named Export Executive of the Year by the U.S. Department of Commerce and received the Smithsonian Award for Computer Aided Manufacturing. He holds three patents in the fields of microelectronics and telecommunications.

FACULTY

Thayer Gains Five New Professors

THAYER SCHOOL RECENTLY WELCOMED FIVE NEW assistant professors to the faculty. Here's a quick look at their educational backgrounds and some of their areas of expertise.

>> **Mark E. Borsuk** earned his B.S.E. in civil engineering and operations research at Princeton and his M.S. in statistics and decisions sciences and Ph.D. in environmental science and policy at Duke. His research interests include decision theory, integrated systems modeling and management, Bayesian statistics, uncertainty analysis, risk assessment, valuation methods, imprecise probabilities, and sustainability science.

>> **Solomon G. Diamond '97 Th'98** earned his A.B. in engineering at Dartmouth, his B.E. at Thayer School, and his S.M. and Ph.D. in engineering at Harvard. His research interests include biomedical imaging, functional neuroimaging, physiological modeling, heart rate variability, stroke recovery, and Alzheimer's disease. For a discussion of his work, see page 20.

>> **Karl Griswold**, earned his B.S. in chemistry at Southwest Texas State University and his Ph.D. in chemistry at the University of Texas at Austin. His research interests include protein engineering, directed evolution, biotherapeutics, applied biocatalysis, and high throughput screening.

>> **Fridon Shubitidze** earned his M.S. in radio physics and his Ph.D. in physical and mathematical sciences at Tbilisi State University, Tbilisi, Georgia. His research interests include numerical methods in computational electromagnetics, electromagnetic sensing methodologies, detection and discrimination of sub-surface objects, linear and non-linear inverse-scattering, induced geo-electromagnetic fields, micro-strip antennas, photonic band gaps, near field optics, DNA sequencing, and electrostatic discharge.

>> **Douglas W. Van Citters '99 Th'03, '06** earned his A.B. in engineering at Dartmouth, and his M.S. and Ph.D. at Thayer School. His research interests include orthopaedic failure analysis and design, wear of polymers, polymer processing, and biomaterials and surgical device design.

kudos

>> Thayer School made *Business Week*'s list of the 60 best design schools around the world. *Business Week*'s panel of 22 innovation consultants, academics, and executives cited Thayer School's project-centered curriculum, interdisciplinary approach, and Cook Engineering Design Center, which brokers industry-sponsored design projects for advanced engineering students. For the full list of top design schools, see businessweek.com/innovate/dschools/.

>> *New Hampshire Magazine* named Professor Lee Lynd to its 2007 "It" List of "the most interesting, happening, talked about people in the state." Lauding his work to coax ethanol out of cellulosic biomass, the magazine raved, "In a world that's warming up, how cool is that?" For more, see nhmagazine.com.

>> The Big Green Bus completed its third cross-country trek fueled by used vegetable oil. In addition to outfitting the bus with two fuel tanks with a combined capacity of 220 gallons, engineering sciences major Lucas Schulz '08 installed telescoping wind turbines and photovoltaic panels that funnel energy into golf cart batteries to power laptops, phones, fans, a stereo, and a TV. The 11 students on the Big Green Bus spurred public discussions of alternative energy everywhere they went.

RESEARCH FOCUS AREAS

Fall Term Devoted to Energy

CENTERING ON ONE OF ITS THREE MAJOR cross-disciplinary focus areas—energy technologies, engineering in medicine, and complex systems—Thayer School filled fall term with special public lectures on energy challenges and issues.

An intensive one-day Dartmouth Energy Symposium, organized by longtime alternative energy researcher and advocate Professor Lee Lynd, presented energy as a defining challenge of our time. Featuring Lisa Margonelli, author of *Oil on the Brain*; Jason Grumet, Director of the National Commission on Energy Policy; Dan Reicher, Director of Climate Change and Energy Initiatives at Google; and former U.S. Senate Majority Leader Tom Daschle, the symposium addressed environmental, scientific, technological, policy, and business issues surrounding energy. "We're at a crossroads," Margonelli told an audience of some 200 students, faculty, and community members. "The next two generations are going to be devoted to untangling this big knot of energy." But symposium speakers projected optimism for solving the energy crisis. As Margonelli said, "It's a big exciting project with tremendous opportunities."

Thayer School's weekly Jones Seminars furthered the focus on energy, with discussions ranging from closing the carbon loop to hydrogen storage in future zero-emission vehicles. And in a two-day residency sponsored by Thayer's Abbot Technology Leaders Program, Cathy Zoi Th'85, CEO of Al Gore's Alliance for Climate Protection, urged students to join the quest for sustainable solutions to energy-related environmental issues. Zoi outlined the Alliance's can-do approach: "Create hope, not fear. Issue an invitation, not an accusation. Underscore solvability and opportunity. Make friends, not enemies."

Links to Zoi's presentation, energy-themed Jones Seminars, and the Dartmouth Energy Symposium are at engineering.dartmouth.edu/news-events/lecture-series/index.html.

STUDENT PROJECTS

I Want One of Those!

◀ Safer Bike Brake

Learning to use hand-activated brakes on bikes can be tricky and dangerous. Too much pressure to the front wheel brake can send the rider flying over the handlebars. A spring mounted at the connection of the brake cable and the hand lever ensures even pressure for non-spill stops. **Kyle Betts '10, Benjamin Meigs '10, Adam Powers '09**, and **Jeff Spielberg '10** developed the device for ENGS 21: Introduction to Engineering. Their TA was **Laura Weyl Th'09**.

WINDS OF CHANGE
Solutions to the energy crisis formed the core of special lectures during fall term.

“Homeland security concerns have existed ever since humans have, as long as there was a home to protect.”

CLASSROOM

Technologies in Homeland Security


Professor Susan McGrath

ON ONE THURSDAY MORNING IN SEPTEMBER, students piled into MacLean B01 as the ten-o’clock hour approached, filing into their seats, lining up along the walls, and dragging up chairs to attend ENGS 11: Technologies in Homeland Security. “If we’re going to have this many people interested in the class, we’re going to need a larger room,” said Professor Susan McGrath. The following week, the class moved to Spanos Auditorium, capacity 120.

The size of the class underscores how large homeland security looms in today’s American psyche. But as McGrath points out, concerns about defense are nothing new.

“Homeland security concerns have existed ever since humans have, as long as there was a home to protect. It is not something that started with 9/11,” she says. “Various technologies have been developed over the centuries to assist with protecting nations. Homeland security encompasses much more than terrorist events.”

In class, McGrath provided examples of threats to homeland security, including the 1918 influenza epidemic, World War coastal protection initiatives, and Hurricane Katrina. “I want my students to gain an appreciation for the complexity and variety of incidents that are considered ‘homeland security’ events,” says McGrath. She also wants students to understand the need for a wide variety of relevant technologies. “There is not one technology that represents the Holy Grail,” she says. “Homeland security requires incorporation of many technologies that apply to each of the emergency response cycle phases: mitigation, planning, response, and recovery.”

The technological possibilities cover everything from electronics to materials to infrastructure and beyond. “Some obvious historical technologies include firearms and defensive structures, such as castle walls and moats,” she says. “Others include satellite technologies to monitor activities throughout the world, and health measures, such as vaccines to prevent disease from spreading.”

McGrath’s class examines advances in personal protective equipment, physical and cyber security systems, communications and information technologies, intelligence gathering, robotics, and simulation and training technologies. McGrath tells them about new ways to detect chemical, biological, radiological, and nuclear events, including handheld units that emergency responders can use to sample air for radiation and chemicals. “Research is also going on with sensor networks, where you would have sensors distributed throughout major metropolitan areas,” she reports. “With such widespread systems, radiological or chemical events could be detected automatically.”

Since 2001 McGrath has been working with civilian emergency responders and the military to use sensors and wireless networks to monitor the health of troops and responders in the field. Director of the Thayer School-based Emergency Readiness and Response Research Group, McGrath encourages students to contribute their ideas for new technologies.

“There will always be threats: earthquakes, disease, pressure from other countries. There is no such thing as 100-percent protection,” she says. “Homeland security is something everyone should be concerned with, as the effects of our failure to properly address potential events will have an enormous impact on our society. And since homeland security technologies are so varied, just about every engineering discipline has something to offer.”

— Kathryn LoConte

OPPOSITE PAGE: CAD DRAWING COURTESY OF KYLE BETTS ’10, BENJAMIN MEIGS ’10, ADAM POWERS ’09, AND JEFF SPIELBERG ’10. THIS PAGE: DOUGLAS FRASER

kudos

>> Two projects developed by adjunct professor Richard Greenwald and his Simbex company made *Time* Magazine’s list of “Best Inventions of 2007.” The HIT System™ (Head Impact Telemetry System), installed in Riddell athletic helmets, was cited for its ability to measure the location and severity of blows to the head (see page 6). The PowerFoot One™ was hailed as the world’s first powered ankle prosthesis for lower limb amputees. Simbex has partnered with PowerFoot inventor and MIT professor Hugh Herr to commercialize the product. For more, see simbex.com.

>> Thayer students Albert Kang ’06, Terrence Irving ’06, and Ryan Wheeler ’06 joined with volunteers of the Lake Sunapee (N.H.) Protective Association to launch the first buoy in the United States to measure in-lake and surface temperatures every 10 minutes throughout the year. As part of the Global Lakes Environmental Observatory Network, the buoy will gather data along with buoys in lakes in Wisconsin, Taiwan, and New Zealand. The Lake Sunapee data will become part of a database enabling scientists to study trends in freshwater bodies. The students undertook the work as their ENGS 190/290 design project.

>> Dartmouth Formula Racing’s ethanol-85 car won 2nd place in the 2007 Autodesk Inventor Design Communication Award competition sponsored by Formula SAE West. In the overall competition, DFR finished 21st in a field of 61 entrants.

>> Engineering Sciences major Alexander Latham ’09 was awarded Dartmouth’s Francis L. Town Prize for Excellence in Engineering. The annual prize recognizes meritorious and deserving students in science at the end of their sophomore year.

lab reports

POLAR EXPRESS Mary Albert, fifth from right, poses with the Norwegian research team before their Antarctic traverse.

ANTARCTICA'S COLD DATA ON CLIMATE CHANGE

Mary Albert, an adjunct professor at Thayer School and senior research engineer at the U.S. Army's Cold Regions Research and Engineering Lab in Hanover, is the lead U.S. partner on a Norwegian research expedition investigating climate and glaciology in East Antarctica. The project is one of more than 200 encompassed by the International Polar Year (IPY), a research program that began in March 2007 and will continue through March 2009. In late October Albert, chair of the U.S. Committee to the IPY from 2003 to 2005, joined the rest of the team in Queen Maud Land, Antarctica. On November 16 they set off on their traverse of the East Antarctic Plateau.

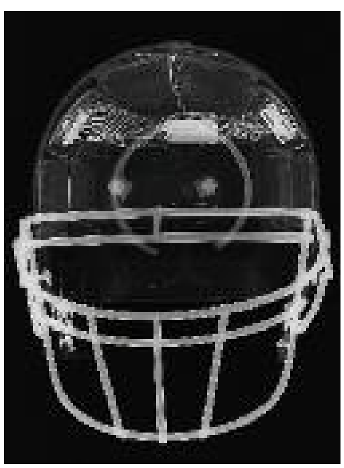
The plateau is part of the vast East Antarctic Ice Sheet. The route for the trek is from Troll Station, a permanent Norwegian research station located halfway between the coast and the plateau, to the United States South Pole Station—a distance of some 1,740 miles. In addition to traveling through previously unsampled areas, the team is revisiting sites investigated in the 1960s. Their objective is to collect ice cores for later analysis and to study the physical and chemical properties of snow and firn (old snow) within shallow snow pits—all to advance our understanding of climate variability within East Antarctica and its role in the global climate system.

To develop historical temperature profiles, the research team will conduct isotopic analysis of the ice and firn cores drilled at different locations on the plateau. Albert is measuring the air permeability, thermal conductivity, density, and microstructures within snow and firn stratigraphy. By comparing these data with those from other expeditions carried out since 1999 under the International Transantarctic Scientific Expedition program (consisting of 21 member countries), the team will be able to map climate history and climate patterns over the past 200-300 years.

At Thayer School Albert acts as thesis advisor to graduate and undergraduate students.

Trek details, including maps, photos, and an expedition diary, are at traverse.npolar.no/.

SMART HELMET DETECTS BRAIN TRAUMA



Simbex LLC, founded by adjunct associate engineering professor Richard Greenwald Th'88 and adjunct professor emeritus Robert Dean, recently expanded its head-impact biomechanics testing arena from the athletic field to the battlefield.

The Head Impact Telemetry (HIT) System™ is a biomechanical feedback system that measures the magnitude and severity of head impacts related to mild traumatic brain injury (mTBI). Sensors installed in the helmet measure and record the linear and rotational acceleration of the head following an impact. The data can be transmitted wirelessly to a laptop computer on the sidelines, which calculates all the key biomechanical elements of impact for later analysis.

The HIT System, incorporated into commercially available Riddell football helmets, has been tested extensively on high school and college football fields. *Time* magazine hailed it as one of the "Best Inventions of 2007" (see page 5).

In April, Simbex, in partnership with researchers from Dartmouth Medical School and the athletics departments of Dartmouth, Brown, and Virginia Tech, was awarded a $3.6 million Bioengineering Research Partnership grant from the National Center for Medical Rehabilitation Research at the National Institutes of Health (N.I.H.).

More recently, the U.S. Army asked Simbex to test the technology for use on the battlefield.

The most common mTBIs in the current U.S. wars in Iraq and Afghanistan are those caused by improvised explosive devices (IEDs). IED shock waves travel at around 1,000 feet per second, almost as fast as the speed of sound. Shrapnel bouncing off a helmet can rattle the brain's soft tissue and cause invisible but permanent damage. Such injuries often go unnoticed until the soldier begins experiencing short-term memory problems or undergoes a change in attitude. The Army has requested technology that can record the biomechanics of head trauma received in combat and provide data for medical staff to quickly analyze the extent of brain injury so that soldiers can get the treatment necessary to return them fit for military or civilian life.

The instrumented combat helmet employs eight accelerometers with high bandwidth so that both high magnitude and high frequency impacts can be recorded. A pressure transducer measures changes caused by shock waves. Should the army decide to implement HIT technology for widescale battlefield use, Simbex will redesign the data collection system to be compatible with existing technologies currently used in army bases, such as hand-held scanners employed by medics in the field.

Simbex also recently received N.I.H. grants for rehabilitation product development, including their fall-risk assessment and fall prevention training system, an in-shoe monitoring system for children with cerebral palsy, and a novel orthopedic implant to improve prosthesis fit and overall comfort and stability for lower-limb amputees.

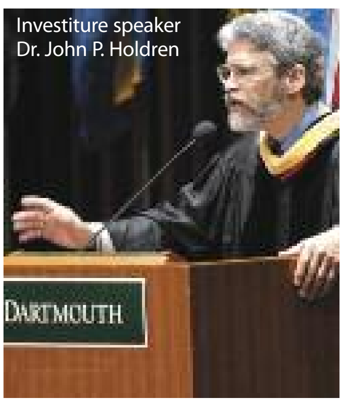
Over the years, a number of B.E. and M.E.M. students have worked with Simbex engineers to improve design and testing of the different systems; some of those students have gone on to become Simbex employees.

For more, visit simbex.com.

—Ellen Frye

investiture

RITE OF PASSAGE
Engineers line up to receive their diplomas at Commencement.



Investiture speaker Dr. John P. Holdren

OPPOSITE PAGE: TOP: NORWEGIAN-U.S. SCIENTIFIC TRAVERSE OF EAST ANTARCTICA; LEFT, COURTESY OF SIMBEX LLC. THIS PAGE: TOP: JOSEPH MEHLING '69; LOWER: DOUGLAS FRASER

THE INVESTITURE CEREMONY honoring degree recipients was held June 9 in Spaulding Auditorium at the Hopkins Center. Dean Joseph Helble presided over the presentation of hoods, caps, and awards to the 123 recipients of Bachelor of Engineering and graduate degrees.

Thayer School's Robert Fletcher Award recognized Dr. John P. Holdren, the Teresa and John Heinz Professor of Environmental Policy at Harvard University and Director of the Woods Hole Research Center, for distinguished achievement and service. In his Investiture speech, Holdren, an expert on global environmental change, sustainable development, and energy technology and policy, outlined economic, environmental, and security issues surrounding energy challenges. Solutions will require advances both in technologies and in public policy, he told graduates.

"Engineers have an important role to play not only in the design and development and deployment of the improved technologies that are needed, but also in the public and political debates that must occur if the needed policies are to materialize. As I tell my own students, the 'numbers' are not everything in public policy—unquantifiable matters of preferences and priorities and politics always enter, too—but forming public policy without an appreciation for the technical facts on the ground is a prescription for failure," Holdren said. "Engineers with the sorts of training you have received at the Thayer School—practical people who understand how technology works and how it is linked to the condition of the economy, the environment, and national and international security—need to be in the thick of the policy debate if we are to get sensible answers. Do not let anybody tell you otherwise."

For Holdren's speech and degree recipient and project lists, see engineering.dartmouth.edu/alumni/investiture/index.html.

CLASS OF 2007

Engineering Graduates

10	Doctor of Philosophy
11	Master of Science
35	Master of Engineering Management
67	Bachelor of Engineering
61	A.B., Engineering Sciences

honors

>> The Dartmouth Society of Engineers Prize for outstanding B.E. project: David Manegold '02 Th'07, Henning Olsson Th'07, and Staffan Skallenas Th'07

>> The Dean's Service Award for outstanding service to Thayer School, Dartmouth, or the broader world: Meredith Lunn '06 Th'07

>> The Charles F. and Ruth D. Goodrich Prize for outstanding achievement: Christina Behrend '07

>> The Caroline Henderson Prize for best M.E.M. project: Doris Ang Th'06 and Ryan Conger '05 Th'07

>> The Thayer School of Engineering Corporate Collaboration Council Engineering Design Prize for best performance in ENGS 190/290: Chris Polashenski '07 Th'07 and Luke Wachter '06 Th'07

>> The Thayer School of Engineering Faculty Award for Academic Excellence in B.E. course work: Erica Wygonik '99 Th'07

>> The Brieanna S. Weinstein Engineering Design Prize for new technologies, systems, or devices addressing physical or developmental disabilities: Kathryn Boucher '09, Alex Latham '09, Brian Mengwasser '09, and James Preston '09

>> The John C. Woodhouse Engineering Design Prize for cost-effective designs of experimental equipment: James Joslin '05 Th'07

>> The John C. Woodhouse Environmental Engineering Prize for outstanding work in environmental study or research: John Ballard '07 Th'07, Parke MacDowell '07, Hillary Price Th'07

>> Excellence in Teaching Award: Simon Shepherd Adv'99

>> Outstanding Service Award for Staff: Ellen Stein '86 and web design team members Catha Lamm, Alison Findon, Ellen Frye, and Karen Endicott

B.E. student Andrew Herchek works on his ENGS 76: Machine Engineering project, a robot capable of gathering and depositing walnuts. "Building things with your hands is a great change of pace from class work," he says. "Machine time is so appealing to engineers. You get to see a project from its birth to its completion."

SHOP TALK

LIFE IN THE PROJECT LABS

BY KATHRYN LOCONTE
PHOTOGRAPHS BY JOHN SHERMAN

The air smells tinny. Machines hum and drone. Students wearing protective goggles weave their way among lathes and drills. Though the sights and sounds may seem familiar, this is no mere machine shop.

For decades Thayer's machine shop has taught students how to manufacture products. Today the shop is one component in a sophisticated suite of project labs where students take ideas from sketch to prototype.

"The historical mission of the shop was to provide a useful skill set for practicing engineers," says machine shop manager and instructor Kevin Baron. "The value of the workshop goes far beyond that these days. Students experience the 'doing' side of an engineering education. Every step in the manufacturing progression exposes them to important engineering considerations across a wide range of disciplines."

"A variety of hands-on experiences is critical to the education of an engineer, and the machine shop provides one side of that," says Professor Chris Levey, Director of Instructional Laboratories.

Keeping pace with industry advances in design and fabrication, Thayer's project labs and machine shop offer an array of modern materials, techniques, and resources—including rapid prototyping, reverse engineering, laser scanning, digitizing, plastic injection molding, thermoforming, and vacuum casting for silicon molds.

"These additions bump up the level and the variety of what we do dramatically," says Professor Laura Ray, who teaches ENGS 76: Machine Engineering and ENGS 146: Computer-Aided Mechanical Engineering Design.

The design and fabrication experience is integral to how Thayer educates engineers. "It gives them a connection between the classroom and the real world," says Ray. "Granted, when they go out into the workforce, they're not going to be machinists, but just to be able to understand how a machinist looks at things is so valuable."

"At every level in the workplace you get this conflict of people who have fantastic ideas but no concept of how that idea can be carried through," says machine shop instructor Leonard Parker. "But the student who leaves Thayer has built something, designed something, and carried it through to completion."

Unlike most other engineering schools, Thayer School makes these resources available to students at all levels, even non-majors. In a case of less is more, Thayer's compact size enables the personal attention that is essential for a hands-on, project-centered curriculum. "You can't run this kind of program in a school that has 5,000 engineers," says Baron.

"Most engineering schools have just a few machines run by technicians," says instructor Pete Fontaine. "Here, the students run most of the machines for themselves, and we teach them how to do what they want to do."

"Our focus is on instruction rather than simply fabricating parts to specification," says Levey. "We engage students in the entire process."

The machine shop experience ensures that education is more than the sum of parts. "We live in a world of such abundance that we forget that we stand on the shoulders of generations of engineers. The most common products—like door hinges, doorknobs, or locks—have had hundreds of years of development. It's hard to make a door that closes right, but you think it's easy because there are doors everywhere," says Baron. "The work of our machine shop is to close the gap between imagination and skill."

PROJECT DESIGN COUCH

Kyle Betts '10, left, and Benjamin Meigs '10 use force gauges on their ENGS 21 project, a safe bicycle brake (see page 4). "The experience—not only the designing, but getting my hands dirty and building something—is rewarding," says Betts. "It solidified my interest in engineering."

IN THE WORLD OF PRODUCT DEVELOPMENT THERE IS ALWAYS A FIRST STEP.

For most students that first step takes place down the hall from the machine shop in the Couch Project Design Lab.

"Students need to toy with their ideas and develop an understanding of how mechanisms work," says Levey. "And that's what the Couch Lab is ideal for."

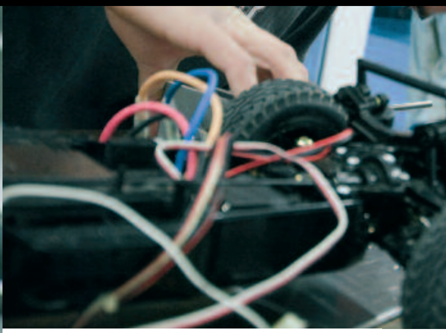
Spacious enough for project teams to spread out their work, Couch acts as a kind of home base for students throughout the iterative product development process. Most importantly, says Baron, "the room is configured with friendly materials—foam core, Popsicle sticks, wood, and paper—so students can cobble together the sort of design mechanism they want to throw their weight behind."

Getting started is trickier than some students expect. They quickly learn that they can't jump from the Couch Lab to the machine shop with half-baked ideas.

"Students have to realize they can't just hold their hands up and say they want something this long and this wide," says Parker, gesticulating with his arms. "They need to translate it for us because we don't know what they have in mind."

"The biggest challenge for some of them is just to be able to write their ideas down on a piece of paper and develop a print," says machine shop instructor Mike Ibey. "They discover that dimensioning and math and the sequencing of events are important. Some of them are dealing with real world considerations for the first time."

LABORATORY



THE ITERATIVE PROCESS

"Product development is not a serial process that moves in lock-step from project room to design studio to machine shop. The process is collaborative, concurrent, interdisciplinary, and iterative," says Kevin Baron. "Students like to work serially, but the best designs result when students are willing to start over and over again."

Dawn Kang '08 builds a prototype of a performance space out of foam core for ENGS 12: Design Thinking. "I like seeing the development of ideas from sketches on paper to working models," she says. "It is extremely gratifying work."

COMPUTER AIDED

B.E. student Margaret Martei prints out technical drawings for her ENGS 76 robot. "This work makes you a critical thinker," she says.

At right: Lindsay Deane '08, in yellow, and J. Watson Sallay '08 dimension their ENGS 76 robot with Pro/ENGINEER. "This work allows us to construct and test all of the pieces that we learn about in class," says Deane.

THE NEXT STEP IN THE PRODUCT DEVELOPMENT PROCESS BRINGS STUDENTS INTO THE CAD LABS,

where they use Pro/ENGINEER, SolidWorks, and other computer-aided design software to create precise drawings of their project components. In this step of the process, young engineers come to an important realization.

"Engineering drawings are really the communication tool for engineers concerning their ideas," says Levey. "If you want to communicate a physical design, you need to be able to draw it."

Traditionally, product designs were limited to what engineers could readily draw, says Levey. "A decade ago, most electronic products, such as computers, were very boxy, defined by shapes easy to represent in a CAD program. The diverse curved shapes of products today provide more functionality and better aesthetics, but also require more sophisticated design tools," he says.

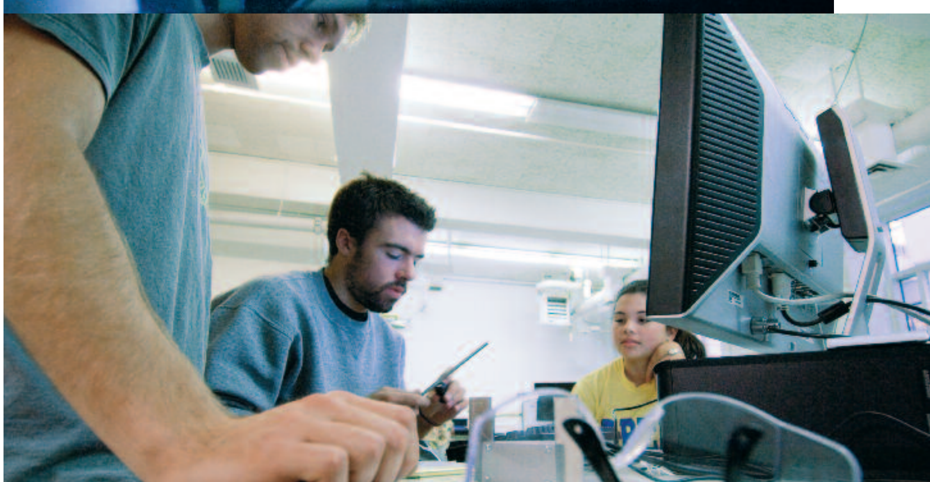
Evolving design tools continue to open new worlds for students. "Students can build things on the rapid prototypers that they could not physically manufacture in real life," says Fontaine. "And the shift in software over the years brings the engineering students more directly in line with what's out there in the real world. People design primarily on computers now. So it pays to know this equipment."

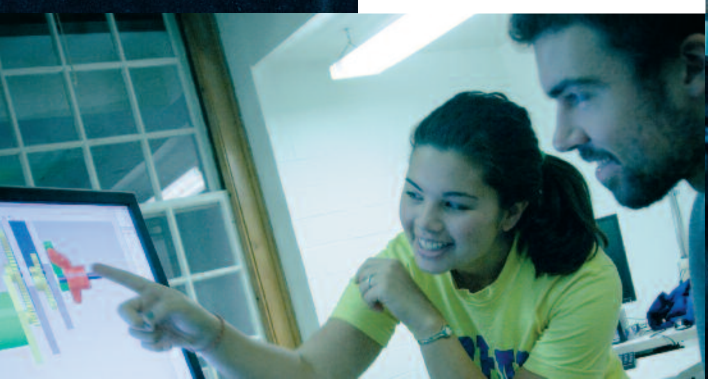
DESIGN LABORATORY

Greg Haines '08, left, and Eric Crawford '08 make Pro/ENGINEER drawings of their ENGS 76 robot. "It's fun to actually make the parts that you envision and design," says Haines. "I think it's really neat how exact everything has to be—even the simple parts that we machined for our robot often required tolerances in the thousandths of an inch."

LAB EXPERIMENTS

"Our curriculum is heavily project oriented, and because projects have a physical reality, you need a way to produce them," says Chris Levey. "Most people think of labs as the sort of traditional chemistry lab, where you have experiments and write-ups, but we see labs in a much broader context. The machine shop is part of our overall lab domain. Projects are basically open-ended lab experiments."





THE MACHINE SHOP

Andrew Herchek uses a lathe on his ENGS 76 robot. Below right: Margaret Martei machines part of her robot on a Bridgeport mill.

SAFETY, SAFETY, SAFETY

"We have a safety orientation for students where we show them how to handle the machines and all the weird ways they can get hurt," says Leonard Parker. "We want them to have fun but we don't want them to be so relaxed that they get injured. We emphasize safety, safety, safety. We tell them to count their fingers and toes when they come in and make sure they're still there when they leave."

THE LAST PIECE OF THE PUZZLE IS THE OLDEST PIECE: THE MACHINE SHOP.

Students often walk through the shop's doors with big dreams that the instructors and students must work on together to complete. But students quickly find that they can't leave the hard work to the experts.

"When a student comes into the machine shop, the instructors don't just tell the student what to do," says Ray. "They listen and they sometimes turn things back to the student and tell them what they need to think about, rather than fixing it for them. The students really learn."

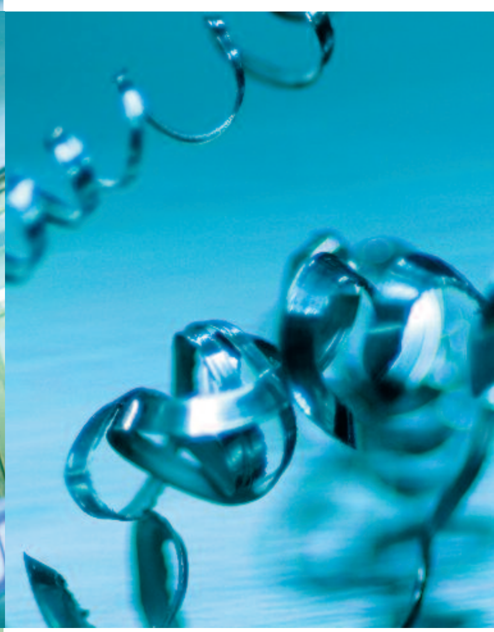
"Our role here is to help them get through their projects. Keep them down to earth a little bit. We try to intercede and say that they gotta think about something a little bit more, maybe change their plans," says Parker. "Sometimes I just stop and look at them and they'll go, 'What's wrong?' And I go, 'Oh nothing.' And they'll stop and go, 'What am I doing wrong?' "

Students also quickly find that project work takes time. "A common experience of students is to discover that it takes longer to make things that they thought," says Baron.

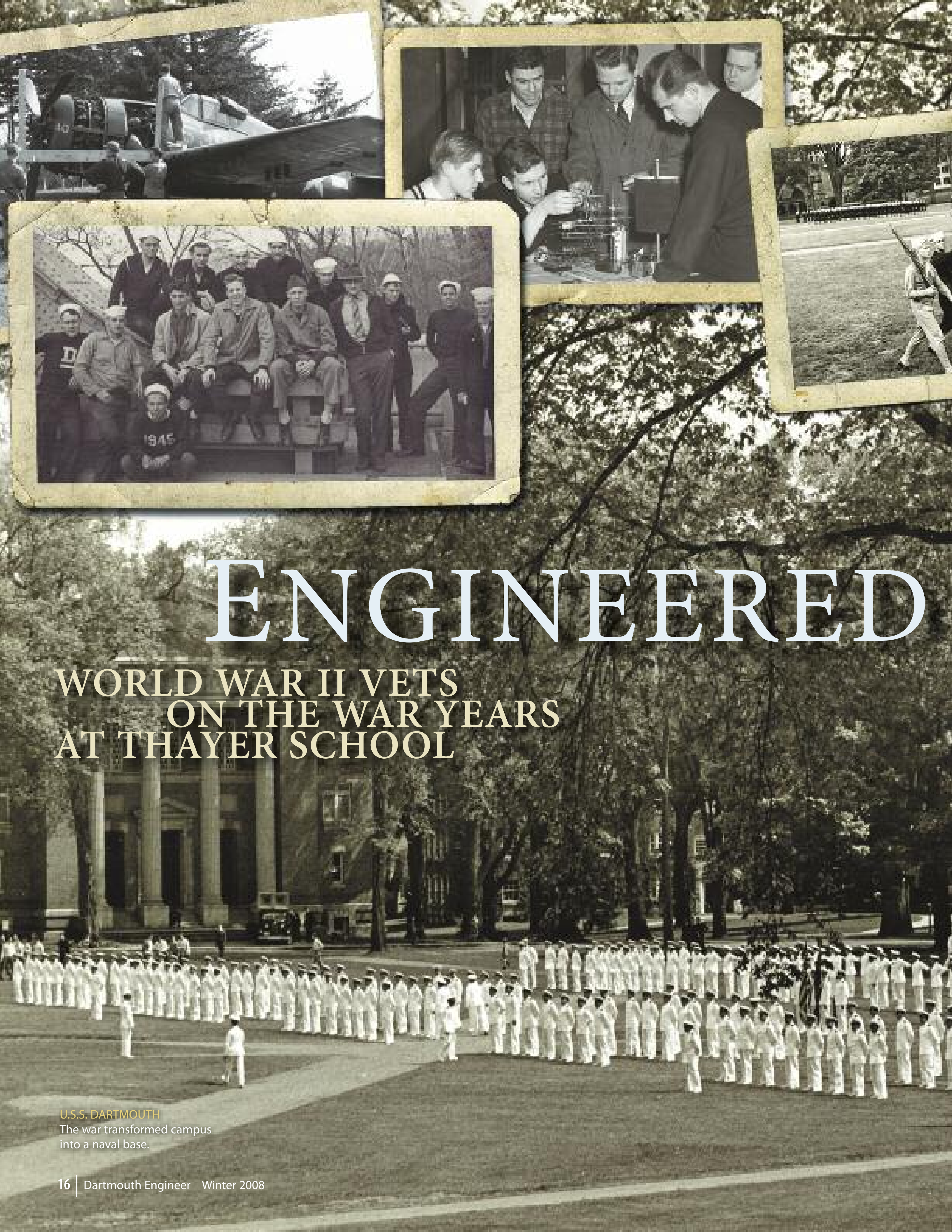
"I spent at least a hundred hours in the machine shop alone and another hundred on CAD," says ENGS 76 student Aaron Gjerde, a B.E. candidate. "Our design required amazing precision. I polished parts by hand because they needed to slide against each other."

But when deadlines loom, students may try to cut educational corners. "That's the dark side of project work," says Baron. "Students sometimes see the technical staff as obstacles to their progress because we're trying to make sure they do things right, and they just want to get their projects done.

"We want to make sure that there is real learning going on and that their process is sound. While doing is important, we need to make sure that it's a knowledgeable doing." □



Dual Degree student Zheng Cao operates a lathe under the guidance of machine shop instructor Leonard Parker. "It's always exciting to manufacture my own design into a real part," says Cao.



ENGINEERED

WORLD WAR II VETS ON THE WAR YEARS AT THAYER SCHOOL

U.S.S. DARTMOUTH
The war transformed campus into a naval base.

The advent of the Second World War ushered in an era unlike any Thayer School had experienced before. As the nation prepared for war, the military began to depend on extensive civilian support. The Dartmouth community confidently answered this call to arms. Thayer professors taught engineering drawing and math to local defense industry workers. Civilian Pilot Training depended on Thayer School for ground classes while conducting flight instruction at nearby White River Junction Airfield.

After Pearl Harbor, professors and students all over the nation joined or were called to military service, and America's standard four-year college experience became a casualty of war. With the draft age lowered to 18, many young men could not enroll in college—much less earn a degree—before entering the military. Adjusting to the consequent shortage of college-educated commissioned officers, the U.S. Navy developed a way to combine college education with military service: the V-12 Navy College Training Program. When Thayer School assured the Navy that it could handle up to 200 men per term in labs, Dartmouth became host to the largest of the Navy's V-12 units. On July 1, 1943 some 2,000 enlisted men and an officer staff came "on board" at the College—including 300 students from Dartmouth and 74 from Thayer School. Dartmouth shifted to three-term, year-round operation. Thayer School added five instructors, accelerated the engineering curriculum, and taught specialized V-12 courses, including naval organization, law, history, and strategy. Run on military time, with reveille at 6 a.m. and taps at 10 p.m., Dartmouth operated like a naval base for the rest of the war.

Eight Thayer School alumni recently described their wartime experiences on campus and in the service.

FOR SERVICE

Bruce Espy '40 Th'41

Our class was the first to occupy Cummings Hall when it was new. The engineering school was serious compared to liberal arts, and I think it was even more so because of the impending war. You could tell it was getting close to wartime; you knew something was going to happen.

Our class was very small; there were eight in it. It was a marvelous period for us. We got individual attention, and the camaraderie was very unusual.

All eight of us went in the Navy in '41. We went down to Boston and the dean went with us and we saw a recruiter there. The Navy wanted engineering graduates. Seven of the guys went to MIT, and they sent me to Caltech. At Caltech, we went to three aircraft factories that were turning out huge airplanes. They gave us 90 days of intensive work, and supposedly we were qualified aeronautical engineers.

I was sent to a naval aircraft factory in Philadelphia, where I tested planes. Being around the planes, I wanted to fly them. I asked for two years of sea duty so I could get flight training. I was assigned to an aircraft carrier. We were supposed to go on the Casablanca invasion, but the ship I was on was declared unseaworthy and was sent back to Norfolk. My two years at sea were spent checking out pilots for carrier landings. I ended up as a fighter pilot. One day we were forming at a field in Boston and I remember flying up to Hanover and circling Baker Library.

Thirty days after the atomic bomb was dropped, I was out of the Navy. I stayed in the reserves and flew on the weekends.

Espy ran his family's ice business in Denver until 1986. He now makes and sells aspen wood vases in Colorado.

BY JENNIFER SEATON

BASIC TRAINING
V-12 courses included naval strategy and map reading.

Charles Weinberg '42 Th'43

In the fall of 1941 I went down to Boston and tried to get into the Navy. They said to finish my degree and then come back. The war hit December 7, and the College accelerated classes. By December of '43, I was gone.

Thayer School was just a tiny building then. There were no vacations. We had classes on Saturday. It was a small group, and we were very close. There were only four or five professors, and they became friends to the students.

I went into the Navy as a 90-day wonder. After seven or eight months of training camp in Williamsburg, Va., I was shipped to the West Coast, then to Australia and New Guinea. In New Guinea, we built officers' clubs and docks and airports. I was doing real civil engineering. The improvisation you have to do when the nearest store is 2,000 miles away teaches you to get a job done without the tools you need.

After the war, Weinberg pursued a career in real estate development. He and his wife, Judith, live in Hartsdale, N.Y.

Dick Livingston '43, Th'44

I signed up for the Navy during my third year at Dartmouth. I had been taking civilian pilot training, flying early in the morning before class. After Pearl Harbor, we were told we had to enter the military to continue training. The Navy gave me a deferment until I graduated.

The coursework was aimed at making mechanical engineers out of us so we could make and repair things the military needed. Thayer School had a large room with drafting tables on the second floor. You could look out over the river, and one day three B-17s came roaring up the river. Those flyovers were to encourage people to sign up.

After graduation, my classmates and I went to Boston and spent three months in a training class on overhauling airplane engines. I then went down to the Norfolk Naval Air Station for more exposure to naval engines. That December I got married, and six weeks later I was off to the Pacific. As a mechanical engineer, I was assigned to a repair facility, replacing fighter engines on Guadalcanal. I was not in any danger, but you had the sense that a lot of people that you knew were in harm's way.

Livingston later worked for Dupont. He and his wife, Shirley, live in Seaford, Del.

Dan Fuller '46 Th'46

I was a freshman in 1942. I was only 17 but wanted to enlist. Everybody was going into the military. I wanted to go into the PT boats. I left Streeter Hall at 39 below zero and went down to Boston to join the Navy.

Coming from a seaside town in Mystic, Conn., I was interested in the water, and the Navy appealed to me. I was appointed to the V-12 program and stayed at Dartmouth. My entrance to the Navy meant I moved from Streeter Hall to Lord Hall—that was my big move into the service.

I was probably the most unprepared person to ever enter Thayer School. I didn't have physics or chemistry, and I realized I was in over my head. I ended up spending four or five months at Notre Dame training as a midshipman and then I went to sea. I was only 19 when I got my commission. I was a deck officer and a gunnery officer on a big Navy troop ship. I'm listed as a Thayer '46, but in '46 I was still at sea. I was devoted entirely to the Navy then.

After the war, I wanted to get back to Dartmouth, so I did in '46. I was 21 and a junior and decided to study liberal arts. When the Korean War broke out in 1950, I was put on active duty and was assigned to the Electric Boat Company in Groton, Conn., assisting the planner for the *U.S.S. Nautilus*. The man there said, "Anybody who's been to Thayer School, I can use."

Fuller and his late wife, Katherine, ran a dry goods store for 27 years in Mystic, Conn.

Bob Roberts '45 Th'45

I entered Dartmouth in the fall of 1941 with the goal of graduating from the Tuck-Thayer program. When the war broke out that year, I applied to the Navy V-12 program and was assigned to Thayer. There were about 15 of us in the program, and we continued together until

we were graduated in December of 1944.

We all lived together in Lord Hall, the closest dormitory to Thayer. We had uniforms and drill. An enlisted sergeant was in charge of us. We would eat together and study.

We were really closely involved with the faculty; that was the best thing. On weekends we were always invited out to their houses for barbecues. We were on a first-name basis with them, and they were very nice to us, I think because they had some sense of wanting to contribute to the war effort. My favorite was John Minnich. He was a structural engineer, a great teacher, and a very smart guy. He really taught you and was proud of it.

On weekends we were allowed off campus. There weren't many cars around, but we'd wear our uniforms and thumb a ride to small towns around Hanover. Each town had a USO with a bunch of records and a bunch of girls who would come down and dance. The towns loved to put on a party for the V-12 boys.

All the Navy people in our class went together to officers training in Rhode Island and then to the Pacific. Most of us went to Guam. My best friend and I were together there for over a year. We'd see our buddies wherever we went.

My first assignment was at a ready-mix plant, where we made concrete and delivered it to buildings that were being built. Then I went to an asphalt plant where they were building airport runways. I also built a Pepsi Cola plant on Guam, with Japanese prisoners as the crew.

Roberts worked at the C.F. Haglin & Sons contracting firm, buying it in 1962. He and his wife, Eleanor, live in Edina, Minn., and Naples, Fla.

Hank Parker '46 Th'47

I arrived in Hanover in the fall of '42. Engineering was my direction because of my math and science skills. I joined the Marine Corps reserves, taking my number off the draft, and on July 1, 1943, I started with the V-12 program. Everybody who was in the V-12 was there by choice. It was a lot better than the alternatives.

The campus suddenly had so many more people. Our room had four bunks in it. We went to school 12 months a year and had about a week off between quarters. Besides taking courses, we had to do the military exercises. We got up in the morning and got in formation out in the street. They were trying to make military people out of us. We went from eight Monday morning to noon on Saturday, and I had only two free periods.

I earned all my credits in February '45 and then went to boot camp. We were at Lejeune taking military classes for officers training when the war ended. My group had a choice of immediate release from the military or staying on and getting a commission. I took the commission but returned to Thayer school in 1946 for graduate work. I finished my M.S. in '47 and went to work at the Winston Brothers construction company in Minneapolis.

When the Korean War broke out I was called back to active duty. I reported to Quantico, Virginia for a refresher course. The group I was with was mostly engineers and lawyers. The classes before us went straight from graduation to Korea, but most of us were given teaching assignments. I taught at Quantico for the rest of the war, lecturing on heavy machine guns. Because we were engineers we had the aptitude to do technical teaching.

After Korea, Parker worked on irrigation and tunnel projects, and then taught construction management at Stanford. He and his wife, Pauline, now live in Hanover.

Ben Brewster '47 Th'47

I joined V-12 when I was still in prep school. I was headed to MIT when I joined the Marine Corps in February 1943, but they had the program at Dartmouth, so I was assigned there. It was a good place to be.

The curriculum was civil engineering. We went in and redesigned the Lebanon Airport on paper. It was practical engineering that you could use in the service. You had to fit the naval part in with all of your academic requirements. There was a lot of marching and calisthenics. We trained on the football field and the Green. There was no rifle range and or armed combat bayonet drill—that you were expected to get after you got out.

By the time we graduated, the unpleasantness was over, so I took a commission and was put on active reserve. The military asked me to come back once Korea happened. I was in a unit that built roads and bridges. I was extremely fortunate not to have been in combat.

Brewster worked at the Avon Sole Co. and then the Colonial Brass Co., retiring as president. He and his wife, Anne, live in Plymouth, Mass.

Lawrence Goodman '47 Th'47

I was accepted as a civilian at Yale, but in '44 I went into the V-12 program and was sent to Princeton and then to Dartmouth. We had a choice to be liberal arts or engineering students. I thought it would be good for the Navy and good for me to have skills in engineering.

The campus was really a naval station. On Saturdays we marched and there was a reviewing stand on the side of the Green. We were subject to strict discipline. We got up at 6 a.m. and we marched in formation to breakfast even when it was 10 below zero. Sometimes the chief petty officer would rouse us before breakfast for a run. We ran down around the gym and up the main street of Hanover. After breakfast, quarters were inspected, and you could get a demerit if there was a paper clip adrift.

Morale was very good. We were lectured that we should work hard to become good naval officers because our enemy counterparts overseas were working hard to best us in combat. There was a very strong sense of patriotism.

Part of the V-12 constituency was men sent in from the fleet—men who saw action in the north Atlantic and Pacific. They really brought combat experience. They'd seen ships torpedoed. But people didn't talk about it much. There was a real feeling that we were going into the thick of it, but it wasn't scary. When you're young, you feel that you're bulletproof.

During the war, we couldn't bask in the beauty of learning. It wasn't a good way to get an education. I really became educated after I got out of college. But I don't think I could have gone anywhere else that would have engendered the sense of loyalty, connection, and love of place that Dartmouth gave me.

Goodman developed the Ormond chain of stores and ran them for 50 years. Goodman and his wife, Sachiko, live in Greenwich, Conn. □

Jennifer Seaton is a California-based writer.

WARTIME PHOTOGRAPHS COURTESY OF DARTMOUTH COLLEGE ARCHIVES

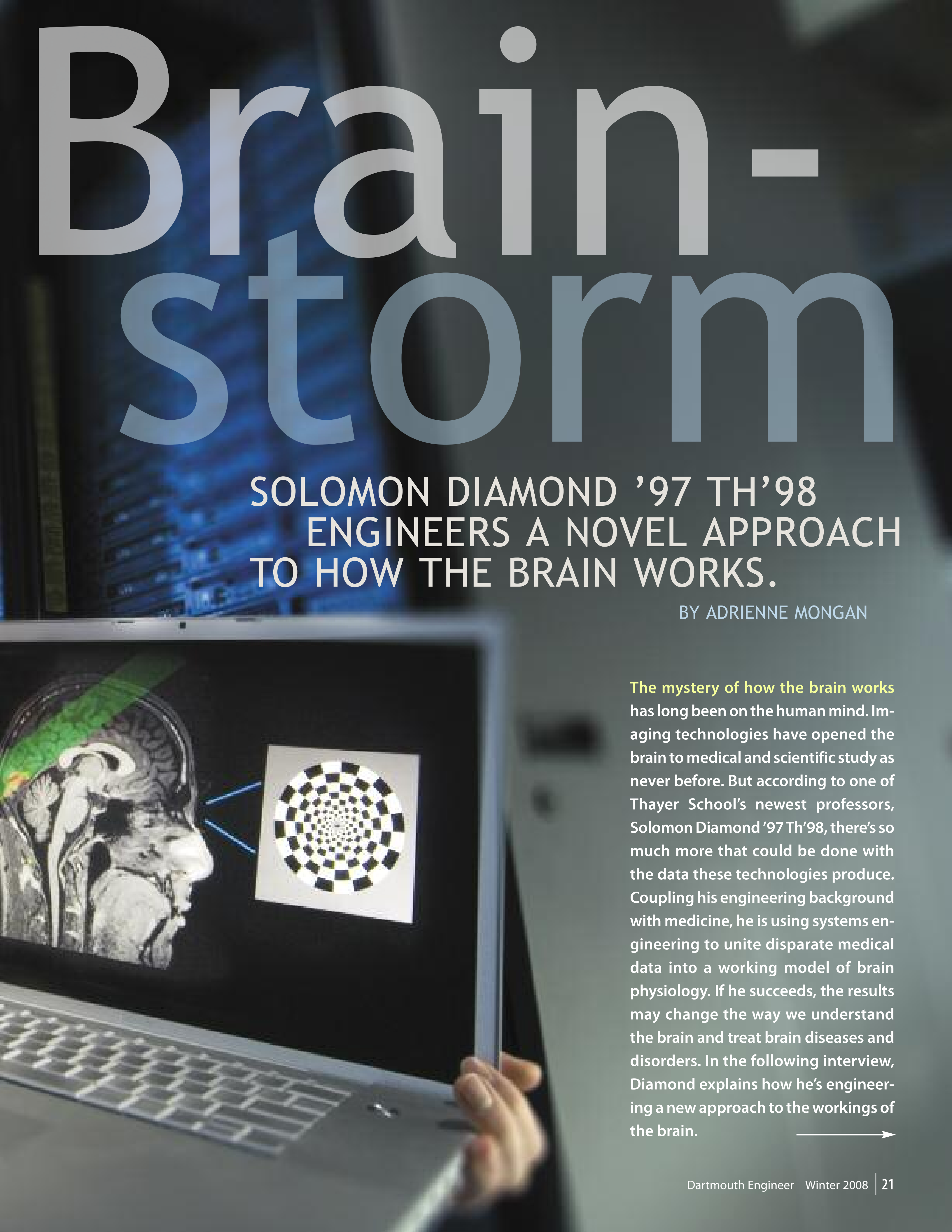
PHOTOGRAPHS BY JOHN SHERMAN

INSIDE INFO
Neuroimaging provides pieces of the brain puzzle Solomon Diamond is trying to solve.

Brain-storm

SOLOMON DIAMOND ’97 TH’98 ENGINEERS A NOVEL APPROACH TO HOW THE BRAIN WORKS.

BY ADRIENNE MONGAN



The mystery of how the brain works has long been on the human mind. Imaging technologies have opened the brain to medical and scientific study as never before. But according to one of Thayer School’s newest professors, Solomon Diamond ’97 Th’98, there’s so much more that could be done with the data these technologies produce. Coupling his engineering background with medicine, he is using systems engineering to unite disparate medical data into a working model of brain physiology. If he succeeds, the results may change the way we understand the brain and treat brain diseases and disorders. In the following interview, Diamond explains how he’s engineering a new approach to the workings of the brain.

How did you become interested in studying human brain function?
My interest started while I was a student at Thayer School working on my B.E. project. I designed the IBEX, an exercising machine for bedridden elderly, and after graduation I continued working on it at Synergy Innovations in Lebanon, N.H. While I was conducting clinical trials, I ended up working with a stroke patient. This experience affected me deeply. I was stirred by the devastating impact of stroke on motor function. Consequently, I studied the biomechanics and neurophysiology of stroke for my doctorate at Harvard's School of Engineering and Applied Sciences. I was particularly interested in investigating the recovery of motor function after stroke and began to focus on the uses of neuroimaging, which measures what is going on in the brain. For my dissertation, I used neuroimaging to examine the effects of hypnosis on motor function and cortical activation in chronic stroke patients.

What are your motivations for modeling brain function?
My three motivations are to improve our understanding of human brain function, advance neuroimaging to improve the diagnosis of neurological diseases, and ultimately customize treatments to each patient's brain physiology.

What are you trying to achieve by developing these models?
I'm working to help transform large-scale descriptive data into concise results that can be applied to understand the way a complex system functions. For example, clinicians who order tests such as magnetic resonance imaging (MRI), electroencephalogram (EEG), and CT scans understand that the information gathered is underutilized because the interpretation is done manually. I'm trying to add a layer of data synthesis to these important tests to predict the interactions of vascular and neuron activity in the brain. The way to achieve this is through predictive modeling of brain physiology.

For those unfamiliar, what is predictive modeling?
Predictive modeling is the process by which a model is created or chosen to predict the future behavior of a system based on its current state. I'm using mathematical models of neurophysiology combined with neuroimaging data to provide a more comprehensive picture of human brain function. Comparing model predictions with measured data provides a way to test assumptions and hypotheses.

For instance, a human physiology book may contain a detailed description of the vessels that supply blood to the visual cortex of the brain. However, these descriptions do not tell you in a quantitative manner how to predict, in this example of the eye, how the blood vessels will respond to a stimulus. In contrast, if you take an engineering book, a description of a physical system will be accompanied by a series of governing equations that predict how the system will respond to a new stimulus. So combining engineering with medicine provides powerful new tools for interpreting medical imaging data.

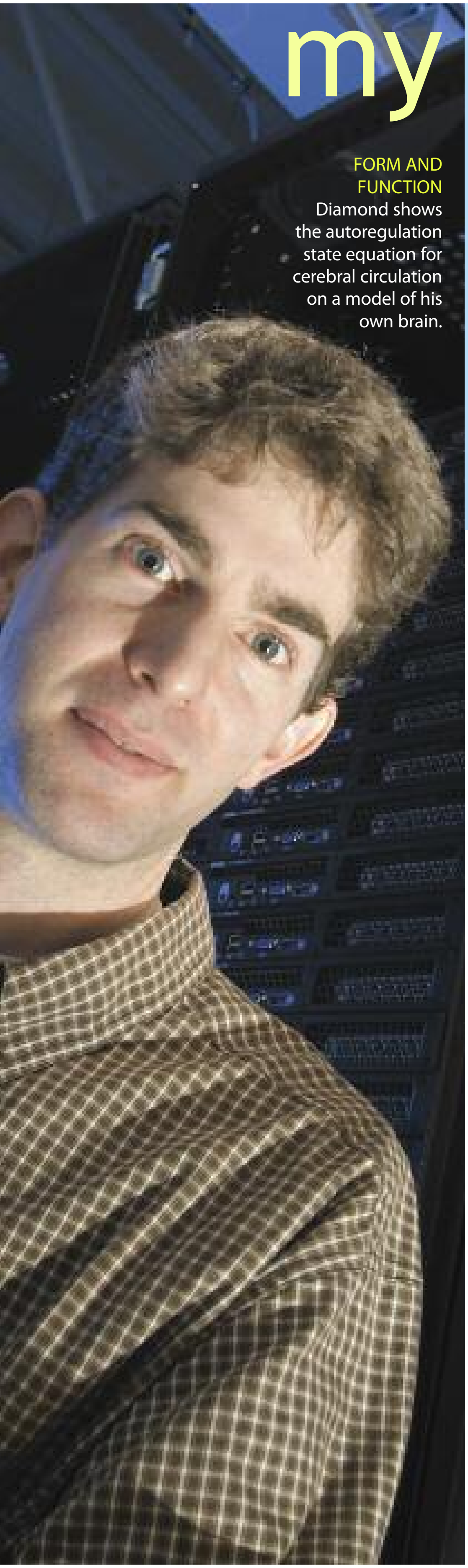
So you're trying to close the gap between the physiology and engineering books?
Yes, essentially that is what I am working to achieve.

What brain functions do you study?
An area of brain physiology that I am particularly interested in is cerebral autoregulation, the ability of the brain to maintain approximately constant blood flow despite changing arterial blood pressure. For example, if you quickly move from a sitting to a standing position, the blood flow to your brain is maintained by a system involving cerebral arteries, which immediately dilate to maintain steady flow to the brain despite the momentary drop in arterial pressure. Failure of this autoregulatory system could result in unconsciousness, brain damage, or death. This system is always in operation, but its function can be damaged by neurodegenerative diseases and external mechanical insults, such as a traumatic brain injury (TBI). Although it remains unproven, failure of cerebral autoregulation resulting from TBI may further impair the recovery process following a mechanical insult. Therefore, greater understanding of cerebral autoregulation might not only enhance our understanding of healthy brain function, but also increase our ability to treat patients with a condition such as TBI.

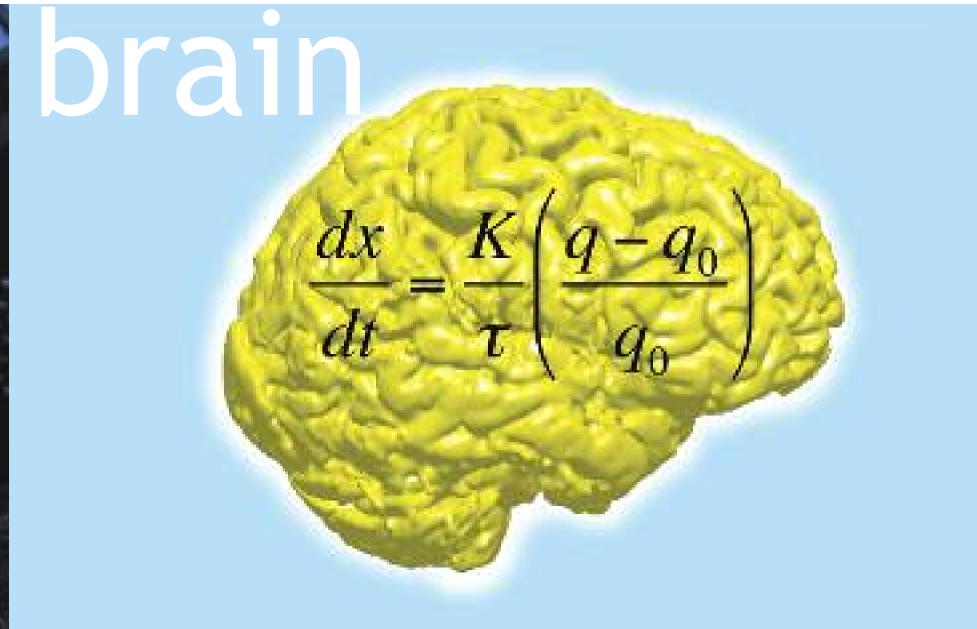
Traumatic brain injury is unfortunately a common condition among service men and women returning from Iraq, affecting approximately 10% of these veterans. TBI can lead to temporary and potentially permanent deficits in cognitive, physical, and psychosocial function. While the body has a remarkable ability for recovery, impairments in cerebral autoregulation after trauma may limit brain recovery.

Cerebral autoregulation has previously been studied by measuring blood flow and blood pressure with techniques such as tran-

my brain



FORM AND FUNCTION Diamond shows the autoregulation state equation for cerebral circulation on a model of his own brain.



BRAIN IMAGE COURTESY OF SOLOMON DIAMOND

scranial doppler ultrasound, which provides a localized measurement of cerebral blood flow.

My hypothesis is that an autoregulatory deficit may vary in different parts of the brain, depending on the vascular circuit and physical properties. Rather than treat localized measurements of cerebral blood flow as unrelated quantities, my models incorporate the major features of the vascular anatomy and relate the physical properties of the vessels to the dynamic autoregulatory response. I plan to use MRI imaging of the vascular structure and blood flow to tune the model to an individual patient. The result is a concise quantitative assessment of that patient's cerebral circulation and physiology. This is how my models could help to interpret neuroimaging data.

An advantage of working with models is the ability to predict the system's response to new situations. In a healthy individual you would expect a robust recovery of blood flow to a sudden drop in blood pressure, and this should bear out in the tuned model prediction without submitting the individual to such a potentially risky test. If a patient's model predicts a poor recovery to a simulated test, then the model will also give clues about where and why there is a problem.

Given the interdisciplinary nature of your research, who are you collaborating with?

I'm working with the psychiatry, neurology, physiology, and radiology departments at Dartmouth Medical School, and the psychological and brain sciences department and Neukom Institute for Computational Science at Dartmouth. We've formed the Dartmouth Brain Imaging Group and meet monthly to apply our individual research to ongoing clinical studies. We look to each other for new insights, and we plan to write research grants together.

Are people elsewhere doing similar work?

The notion of applying an engineering approach to functional neuroimaging is relatively new. Thayer School is uniquely positioned to be a leader in this area because of its inherently interdisciplinary structure.

What challenges have you faced in your research?

A major challenge continues to be capturing the salient features that are needed to understand the data and observations without becoming too complex and rendering the model useless.

What is the timeframe for your work?

The good thing is that my research can be scaled up or down in terms of complexity. I'm predicting that it will take three to five years to create models to understand cerebral autoregulation.

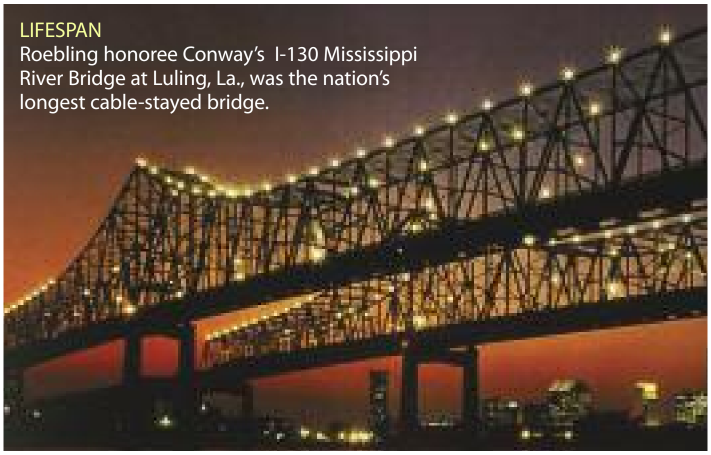
What are the potential clinical applications for your research?

Ultimately, I hope that my research helps in the diagnosis and monitoring of treatment for a variety of brain diseases, especially Alzheimer's, stroke, and traumatic brain injury. Other outcomes include creating individualized treatments and exploring how brain physiology changes during normal aging. □

Vermont-based writer Adrienne Mongan is a frequent contributor to *Dartmouth Engineer.*

Alumni/ae News

spotlights



LIFESPAN
Roebling honoree Conway's I-130 Mississippi River Bridge at Luling, La., was the nation's longest cable-stayed bridge.

William B. Conway '52 Th'54, P.E., received the John A. Roebling Medal for lifetime achievement at the International Bridge Conference in Pittsburgh, Pa., last June. He is the chairman of Modjeski and Masters Inc., a structural engineering firm in St. Louis, Mo., that specializes in bridge engineering for federal, state, and local agencies, railroads, and port authorities. His works include the first Newburgh-Beacon Bridge across the Hudson River, the Brent Spence Bridge over the Ohio River in Cincinnati, the Teddy Roosevelt Bridge over the Potomac, and the Iowa-Illinois Memorial Bridge and seven other bridges across the Mississippi. He recently served as principal-in-charge on the seismic retrofit of the San Mateo-Hayward Bridge in San Francisco and the vessel collision vulnerability study assessment of bridges on the lower Mississippi.

Heinz Kluetmeier '65, whose career as a photojournalist for *Sports Illustrated* spans nearly four decades, was honored in October for outstanding achievement in sports photography with a Lucie Award, an international photography award. Kluetmeier, who was already shooting pictures for the Associated Press at age 15, majored in engineering and worked as an engineer for a steel company until 1969, when he joined Time Inc. as a photographer for *Sports Illustrated* and *Life*. He has since shot more than 100 covers for *SI*, and in 1986 was named the director of photography at the magazine. "Technique and technical stuff is absolutely irrelevant to the picture in terms of what you do as a photographer," he told PDN Legends Online. "I think the most important thing is to have a vision, to have an emotional feeling, to care about what you're photographing, and to have something that's already there in your heart, in your eye." View his images at pdngallery.com/legends/heinz/.

The American Society of Civil Engineers recognized *Philadelphia Inquirer* science reporter **Tom Avril '89** with an Excellence in Journalism Award honorable mention for his article about skyscraper construction, "Water to Tame Wind Atop New Skyscraper: Giant Bathtub in the Sky." His lead was a grabber: "It's a great big bathtub in the sky, but hold the soap. A 300,000-gallon, double-chambered tank of water is going in near the top of the Comcast Center—a creative solution by engineers to keep Philadelphia's tallest building from swaying too much in the wind."

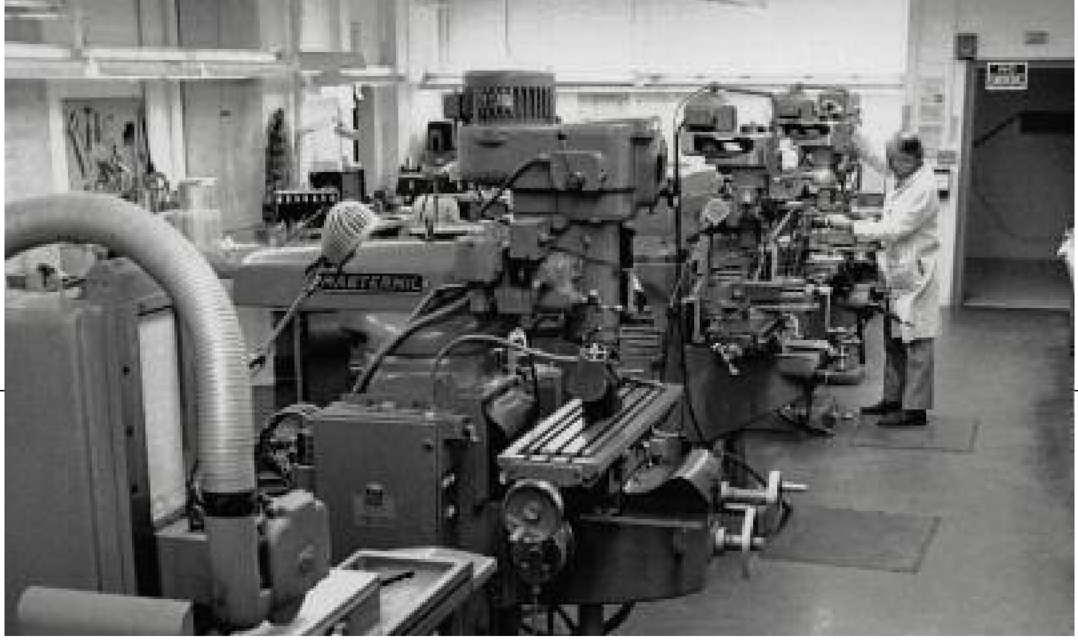
Bert Yankielun Th'92 offers step-by-step instructions on building igloos, spruce traps, bivy bag shelters and drift caves in his new book, *How to Build an Igloo and Other Snow Shelters* (Norton Press). As a doctoral student at Thayer and then a research engineer for the U.S. Army Corps of Engineers Cold Regions Laboratory in Hanover, Yankielun developed ground penetrating radar systems and other geophysical instrumentation. He is now a consulting engineer in private practice.

Charlie Nearburg '72 Th'73, '74 set three new land-speed records at the Bonneville Salt Flats World Finals in October. Driving "The Spirit of Rett," a 35-foot-long streamliner, Nearburg beat two 10-year Southern California Timing Association (SCTA) records with two-way runs averaging 348 mph and 351 mph over a course with five miles for acceleration and two to three miles for shutting down. Three days later he set a Fédération Internationale de l'Automobile (FIA) record with a two-way average run of 359.5 mph over a course with six miles for acceleration and five miles for shutting down. "In the first FIA run I exited the timed mile at 375 mph. It was pretty awesome," he says. "This puts me seventh on the all-time fastest list at Bonneville and makes the 'Spirit of Rett' the fastest gasoline powered car in history."

Owner of Nearburg Producing Company and a member of Thayer School's Board of Overseers, Nearburg has been racing since high school. "I enjoy the engineering of it and the skill," he says.

The "Spirit of Rett" is named after Nearburg's late son, Rett. Watch Nearburg in action at rett.org.

ZOOM, ZOOM
Charlie Nearburg, third from right, pictured with his crew, hit 375 mph at Bonneville Salt Flats.



SHOP FLOOR
Fred Schleipman headed the machine shop in 1977.

THIS PAGE: DARTMOUTH COLLEGE ARCHIVES. OPPOSITE PAGE: TOP, COURTESY OF WILLIAM CONWAY; BOTTOM, COURTESY OF CHARLIE NEARBURG

just one question

Q. What is your enduring memory of the machine shop and project labs?

In the early 1940s Thayer had no machine shop. We three M.E. candidates were charged with building a shaper from raw castings. (A shaper produces a flat surface in metal by repeated, horizontal cutting strokes while advancing the piece a desired amount at right angles to the stroke.) Our professor, Joe Ermenc, arranged with the Lebanon High School to use its machine shop and shop teacher after hours. We drove to Lebanon each Friday, worked until late, and then rolled up in sleeping bags on the gym floor. The shop teacher got us started on various components and then pretty much left us alone. It was back to our sleeping bags in the gym on Saturday night. We completed the machine and installed it in the Thayer basement, one of the first machine shop tools. My companions in this effort were Roger Gaskill '43 Th'44 and Frank Perley '43 Th'44.

—Dick Livingston '43 Th'44

Perhaps most memorable was the water. Yes, water in the lab. Water in pipes and valves and flowing through channels and over weirs. This was the hands-on part of courses in fluid mechanics, water supply, and sanitary engineering. Professor Ed Brown's good nature helped temper the hard study with pleasant hours. I remember faculty members who relished the physical side of our studies, and demonstrated the importance of "feel" in engineering.

—Sam Florman '46 Th'46

Machine shop was a required lab course in which we learned how to work metals on a lathe, a planer, and a milling machine as well as learning how to weld. It was taught by a retired machinist from Springfield, Vt., Larry Goldthwaite, who was a wonderful character and a very good teacher. Part of the final exam was to weld two pieces of steel together and then break it in the testing machine, hoping that it broke in the base metal rather than the weld. The course was great fun and has served me well throughout my dealings with steel bridges, including welding fabrication and the machining of the parts that go into movable bridges.

—Bill Conway '52, Th'54

In the electrical machine lab I turned off the wrong breaker and cut off the field current to a big DC motor that was turning at a good clip. The armature current shot up and burned the commutator bars. Professor Kingsley made me dismantle the motor and trundle the armature over to the machine shop to have the commutator resurfaced. Maybe he called ahead over there, because they made me do the job all by myself: set the armature up on the big lathe, center it properly, set up the tool and the cutting angle, and make tiny shallow cuts until no more burned copper showed. Everybody stood over me and made scathing comments whenever I did the tiniest thing wrong. You can bet that after that I thought twice before I touched a breaker!

—Randy Cooper Th'54

Larry Goldthwaite oversaw the shop with great skill and even greater patience. He showed us how to arc weld two small pieces of steel, drawing a perfect bead with ease and practiced skill. When my turn came I carefully placed my two pieces on the welding bench, pulled down the mask, and set about drawing the best bead I could. Not bad, I thought. Then Larry quietly asked, "How do you plan to get it up from the bench?" Much to the amusement of all hands, I had welded the work firmly to the steel bench.

—Bill Macurdy '55 Th'57

Dan Paradis '61 Th'62 and I were working with schlieren images of burning acetylene and other gases in a small lab, and neglected the use of oxygen and the addition of CO_2 to the atmosphere caused by burning gases. When we walked out, I passed out. Thus, the dean ordered the creation and adoption of a safety code. (We all contribute to the history of the place in one way or another.)

—Jerry Greenfield '61 Th'62 Tu'65

Larry Goldthwaite was in charge when I took the course required to be able to have access in the shop. I still have the gear assembly on my desk that we made using each of the machines. It includes a 16-toothed gear, an 8-spline sleeve, an axle threaded on one end and with a larger opposite end, and an internally threaded base. My second memory relates to using a chuck on a tool or drill. Larry taught us the necessity of tightening such devices on each of the three openings—and I still do that today.

—Harris McKee '61 Th'63

Larry Goldthwaite was a very precise and meticulous man, and it was easy to get on his wrong side with sloppy work. I learned that his somewhat gruff exterior camouflaged a genuinely warm and kind person. I still have on my desk the paperweight that I made during his shop course—four-part assembly that required learning how to use most of the shop's equipment and a lot of useful techniques, skills that were helpful to me during my career and personal life.

—Andy Urquhart '61 Th'64 Adv'71

In 1962 I bought my first car, a VW bug. It came with a small, lightweight shift knob that didn't measure up to my expectations. Thanks to the help of a machine shop teacher, I turned out a beautiful egg-shaped, custom-made, steel gear shift knob. I drilled and tapped it and cut off the shift lever in my new car and threaded that shaft for the new knob. That knob was a real treasure. It was heavy enough that I could toss it from gear to gear and shifting became a snap!

—John D. Pearse '62

I built a radio from scratch and—the most amazing thing—it worked!

—Sandy Duncan '63

I took the machining extracurricular course in the machine shop. The most valuable lesson for me was to understand the process of metal evolving from a drawing to an actual part. The lesson was the time and effort required to machine a part. When I became an engineer, I remembered that as I awaited the parts I had designed, and I appreciated the effort invested by our technicians. My second lesson was to leave your work area in better order than you found it. Not a bad lesson, even now.

—Dick Couch '64 Th'65

My enduring memory is Frank Dulac. He had such an infectious can-do attitude. He always had time for one more request and never lost his patience with students.

—Neil Drobny Th'64

I loved working in the machine shop (hey, it's part of why I'm an engineer). I had a summer job at Grumman Aircraft on Long Island and got to work in the machine shop, where they built the jigs and tools so that everything they did was one of a kind. It was great that I had the Thayer experience so I understood what they were doing and could learn much more because I was already starting with a strong base.

—Ward H. Hindman '65 Th'68

In 1963, as part of ES-22: Systems, I was staring at an equation on the blackboard and realized that an ideal seismograph would reduce the connection of a mass to the Earth to zero. The previous fall I'd seen some impressive table air-bearings used in demonstrations of Newtonian mechanics in physics lectures—these air-bearings reduced (horizontal) friction to almost zero for hockey puck-like disks. I imagined a one-dimensional air-bearing built using a rectangular tube turned with an angular edge up, with a right-angle "sled" riding on it. I went to the machine shop and the gentleman there told me to get the specs—hole diameters and spacing—from his counterpart in the physics department. I did so and returned worried that I wouldn't know how to run the necessary drilling equipment with sufficient precision. The shop's head honcho expressed doubt that the machine shop could take on the job, given the many holes that would be required and the delicacy of the very small drill bits. I came back the next day to find my completed air-bearing, built from beautifully machined aluminum. I built the rest of the seismograph myself, and it won me a very helpful citation.

—Mark Tuttle '65 Th'66

My experience was that the idea of a perfect shop at Thayer was that every tool was in place and accounted for rather than out and at work on projects. That is, my experience was not all that positive. However, if I worked with Vic Surprenant, the on-site technician, I could get almost anything done because he was there to help students, not to keep the place in perfect order. I would have loved to have him with me here at Plastic Technologies Inc., where our culture is to "make things happen" rather than to keep everything in perfect order.

—Tom Brady '66 Th'68

In 1967 I was responsible for making aluminum snow pickets for our Dartmouth Mountaineering Club expedition to put a new route on Mt. McKinley (Denali). I went to the machine shop, was given a catalog, and ordered some stock T-shaped aluminum. When the order arrived, two days before we were to leave for Fairbanks, we realized that the aluminum was not stiff enough. It was too late to reorder, so we reluctantly cut it to size and drilled the carabiner holes. When we unveiled the pickets on the mountain, our shocked teammates were ready to throw us off the nearest face, but we had no choice and used them. Luckily, we had no wrenching falls; certainly the pickets would not have held. Lesson learned: Next time my life depended on a material or design, I carefully researched before I bought.

—Michel Zaleski '68 Th'69

I brought in a rusted brake drum from my 1967 Volvo to see if I could use one of the machines to resurface it and remove the rust. To my surprise the head of the shop, Fred Schleipman, showed me how to do it! I remember him saying, "You need a carbide-cutting head," which I had never heard of. I felt guilty putting this dirty, rusty wheel on a pristine, expensive lathe, but I was very impressed that he allowed this "extracurricular" activity. The machine shop gave me an appreciation for the work of a machinist and how one could spend a lifetime mastering those skills.

—Jim Wood '71, Th'72

Prior to being allowed to run rampant in the machine shop, you were given a project to complete that required the use of every machine in the shop. I was given a drawing of a four-piece paperweight and given guidance by the staff at each step of the project, focusing on both the machines being used, their capabilities, and the tolerances of the build for each of the steps. Our paperweights were sent off to be chromed so that we would have something "sharp" adorning our desks. For my 34 years with General Electric that paperweight has followed me. It still sits on my desk as a reminder that Thayer taught us not just how to think, but to build.

—Jim Bartlett '72 Th'73

Building the Stirling engine for thermodynamics, we learned a valuable lesson on the cost of tolerances—how much more work it was to the tradesman if someone specified +/- .003 rather than +/- .03. My machine shop experience and relationship with Fred Schleipman paid off later when I was a poor married student and my car window crank (a molded plastic part) broke. Access to the shop and a little design advice from Fred enabled me to machine a metal part that not only solved the problem but looked good, too.

—Mike Sulaver '74 Th'77 Tu'77

I was a volunteer fireman on the Hanover Fire Department, and during summer term I brought an antique fire truck with me to school. The truck, built in 1919, had a very pitted water pump shaft from rusting, and it would constantly tear up the water pump bearings. I worked with Fred in the machine shop and built a new water pump shaft to replace the old one. Problem solved!

—John Bartlett '75 Th'78

I learned the most valuable lesson of my Thayer career in the machine shop: Workers on the shop floor know more than I do! Professor Converse required each member of his thermodynamics class to make a Stirling engine so we would understand, in his words, "how things are made." I emerged with a profound respect for the machinists and their skills. My Stirling engine sits on my desk in front of me as my proudest trophy from my Thayer years.

—Scott Magelssen '75 Th'76

The summer before my Thayer fifth year, I applied for a job in a printed circuit board manufacturing facility in my hometown. When I told them about the machine shop class I had taken, they hired me on the spot! I

MACHINE SHOP
The shop was new in the 1940s.

DARTMOUTH COLLEGE ARCHIVES

also remember the Stirling cycle engine that we built in the machine shop class. It's interesting to see that large-scale versions are being used to generate clean energy.

—Wayne Ballantyne '77 Th'78

I still have my Stirling engine. I don't dare test whether it still runs!

—Pete Leone '78

A few years back I discovered my Stirling engine. It brings back fond memories of my Hanover experiences.

—Tony Jones '79 Th'80

My most vivid memory of my Thayer School days was making a Stirling engine. I had very little experience working with tools of any sort, but I quickly grew to love the pleasures of metal shop. I especially recall the satisfying sensation of shaping and polishing the bronze flywheel. When my little machine was done, I calculated its efficiency, which I recall as being dismal. However, once you cranked the thing up it would really buzz along. Now, 30 years later, it sits on a shelf in the family room. My kids still love to pour in the alcohol and get it going. I think they can't quite believe I made it with my own hands.

—Lisa Saunders '79

I enjoyed treks with the Mountaineering Club—and I liked the idea of a real-world test for my undergrad course's machine shop project. So I contacted the REI company and they agreed to send a variety of free carabiners, which I then tested for tensile strength using a very strong machine shop testing apparatus. It was fun seeing where the carabiners failed (near the gate) and ranking their strengths. Blue ribbon went to "D-shaped" carabiners with locking gates.

—Jim Payne '81

Just the other day my 6-year-old was playing with the Stirling engine I built. I have fond memories of the Thayer machine shop and Roger Howes and Vic Surprenant.

—Terry Wong Th'81 DMS'90

I was never really a designer, but I did need to do some data gathering to support Professor Strohbehn's work on hyperthermia using ultrasound. We needed to test our disc-shaped ultrasound transducer before attempting to use it in studies with cancer patients. That meant constructing a non-interfering Plexiglas "fish tank," which is where the shop came in. As I was rather clueless at building, one of the shop guys directed my work and chipped in as I built the tank. Later I filled the tank with de-ionized water and floated a hunk of raw roast beef a few inches from the transducer. The 3 MHz sound heated the meat, and I got temperature readings at various positions. This allowed us to better understand the heating capabilities of the circular transducer when encountering human flesh. It also led to a memorable roast beef dinner.

—Russell King Th'83

I remember the bridge project. We were given three-foot lengths of aluminum strips and a piece of Plexiglas. We roadtripped along the Connecticut River to look at old truss bridges for design ideas. It was my first chance to cut and bend metal with a Bridgeport machine, which was a blast. I got to keep the bridge, which I still display proudly in my study.

—Doug Kingsley '84 Th'85

In the bridge-building contest, our group made the truss bridge too short. Instead of making the bridge greater than the span required, we made it exactly the width of the span to be bridged. Any weight on the bridge sent it to the bottom. We had to build an adapter on the end of the bridge, which threw off any real ability to predict the bridge deflection due to load. I guess that's why I ended up in software design.

—Steve Morris '84 Th'85

I built a mechanical CPR device in the machine shop. The experience was so positive because of Roger Howes. He was very helpful, and I learned a lot.

—Heidi Russell '84

I always found Roger Howes and his team enthusiastic, willing to help and, most importantly, patient. From the popular truss design competition to my ENGS 21 project, where we designed and built a deep sea cable connector out of a titanium "memory" alloy, to my thesis project on thin film transfer printing, my time spent in the shop was not only productive, it was always fun.

—Eric Schnell '84 Th'85

Vic Surprenant gave me excellent help in making the machine we used to investigate the wear of UHMPE against stainless steel in low-amplitude oscillating motion. It was a tribology project that I did for Professor Francis Kennedy as a part of my M.E. degree. How exciting it was to make a drawing and have it realized in the real physical world! I made some parts of the machine myself, but Vic made most of them. The finished machine was used for a number of years for tribology experiments with the guidance of Professor Kennedy.

—Leo Smidhammar Th'85

I have fond memories of the machine shop with Roger Howes. Our group built a wheelchair that elevated upwards for access to cabinets and shelves. We used those wonderful machines like the Bridgeport. I grew up in Bridgeport, Conn., so using that machine was very special.

—Nancy Shawah Cheung Th'86

I was a grad student working for Professor John Collier, manufacturing titanium alloy implants for rabbits and implanting them. The implants were basically glorified washers with countersinks and fancy coatings, and I needed numerous sizes to fit the various rabbit tibiae. Titanium is not an easy material to work, and I was not very experienced in drafting or design. I kept my list of implant sizes on a piece of paper by "my" lathe. When there was time, the guys in the machine shop would help me out (like little elves in the night) and make a few of these little implants and leave them in my box. One day I found a round wire thing in my box. I could not figure out what the elves were up to! I inquired and found it was the smallest diameter implant I thought I needed. Little did I know that this was an "un-makeable" device. I learned two important lessons that have helped me in my career: be careful that you never ask for something that is "un-makeable", and you need to have made things yourself in order to gain that wisdom.

—Kim Dwyer Th'88

My fondest memory came from the introduction to the machine shop that Roger Howes oversaw. To be allowed to use the machine shop, one had to successfully follow a set of directions for various machines and tools, and until that point in my life I was not handy at all with such things. To this day I keep the device that I had to machine on my desk, and anybody from Dartmouth during the same era who sees it says, "Hey, you're a Thayer graduate, aren't you?!" We all built them—and it gave us an appreciation that people have to be able to build what we engineers

PROJECT COACHES
Vic Surprenant, this page, left, and Roger Howes '72, opposite page, right, mentored countless students.

design. Years later, I became a professor at Vermont Technical College and found that Roger Howes had joined the faculty there, too. He remains a whiz in Vermont Tech's machine shop as he helps his engineering technology students, but I can still tap a thread when need be—all thanks to the Thayer machine shop.

—Scott Sabol '88 Th'88

As a master's candidate and later a research associate under John Collier, I was building all manner of Rube Goldberg devices for testing total joint replacement prostheses. My free access to the machine shop was key, as many of these devices and fixtures started out as rough ideas and only took final shape on the mill or the lathe. Having earned my bachelor's degree outside Dartmouth, I was unfamiliar with the Thayer machine shop and was amazed at not only the level of access that students had but the amount of patient teaching that Roger Howes, Gary Durkee, and Roland Gauthier provided. Later on, as a design engineer and a project manager, I was always cognizant of the fact that whatever I designed or had designed, someone had to build it, so it better be buildable.

—Jim McNamara Th'89

Together with the Swedish student Stefan Palmgren Th'91, I worked on our B.E. project. My task was to design two planar robot arms for a master-slave configuration, while Stefan designed the wrist with a special force and torque sensor. After finishing the drawings, I had to manufacture the complete structure in the machine shop on the lathe and milling machine. Roger Howes helped, so the work was done properly. Back in Germany, it was no problem for me to get credit for the project."

—Harald Schoenenborn Th'91

For three years I worked for Roger Howes in the machine shop as a T.A. From Roger I learned two vital and related things: How to make myself heard and how to stand up for myself. Roger has a keen eye for group dynamics. Many times I saw him pull a quieter student apart from a group and give him or her a talk—telling us usually that our ideas couldn't be any worse than those of the louder members of the group, so we must get in there and fight for them. Usually he was right. Roger also trusted me to help students learn the machinery and new techniques. Once he and Roland Gauthier asked me to shut down the shop for lunchtime. All the students stopped working as asked except one, who informed me: "I don't have to listen to you. You're just another student." So I spun around and hit the emergency stop button on the wall, cutting power to all machinery in the room. When he tried to turn the mill on and it wouldn't start, he turned to me and demanded that I turn the power back on. I told him, "I'm sorry, I can't; I'm just another student." This has helped me anytime I've been dismissed as "just another X"—you are never quite that powerless. Roger lured me away from a lucrative job at the dining hall with the promise of lower pay and a peanut-butter-and-jelly sandwich once a week. Best deal I ever made.

—Becca Voelker '92 Th'94

Roger Howes and Gary Durkee were great—patient with a novice like me and always good with a joke. I had never done anything in a machine shop. They never made me feel afraid to go for it, even though I was scared to death I'd break something.

—Darrin Clement Th'93

One of the proudest entries on my resume is of my experience in the machine shop. Machining metal taught me a ton about planning ahead and doing everything deliberately. Parts were either exactly right or they were junk.

—Zander Lichstein '95, Th'97

Roger Howes ran the shop with pragmatic rules: "If you're about to do something stupid, ask first." "If you bust something, than fess up." "Clean up before closing time." With all the high-minded intellectualism around campus, I could have compartmentalized these rules to the shop floor, but there was something in Roger's manner of teaching that led me to extrapolate instead. After all, what good is an education in mind-bending concepts and theories unless we learn to acknowledge the limits of our understanding, take responsibility for our actions, and respect other people's time?

—Sol Diamond '97 Th'98

My senior thesis project was to design and build a better body for the Formula race car. I loved the countless hours I spent in the basement of Thayer. I'd happily come back and do it all over again.

—Erik Weeman '97

The machine shop opened at 7:30 a.m., an ungodly hour for college students. It didn't take long to learn that I would have Roger Howes, Leonard Parker, and Pete Fontaine almost all to myself if I kept coming in then. I picked a thesis that would let me spend as much time in the shop as I could and dragged out its completion just to keep working in the shop another term.

—Gus Moore '99 Th'01

I was fortunate to work closely with Pete Fontaine in the CNC shop and learn many of the aspects of product design and producibility from him. Working with the cantankerous old Bridgeport CNC, I saw firsthand how small tweaks to designs could significantly improve producibility of a system. Knowing the essentials of machining and smart-part design have enabled me to excel in the aerospace industry, where the vast majority of parts are CNC-machined. It always strikes me how students from other universities have no experience with product design and manufacture, and how much they struggle to understand that engineering is not just calculation of solutions to book problems, it is the ability to make an elegant solution to a real-world problem. Part of that elegance is in the ease of manufacture, a skill Thayer School and its machine shop effectively instill in all their graduates.

—Brian Paris Nealon '01 Th'02

I used the machine shop to create a sculpture for studio art. Kevin Baron was instrumental in ordering materials, as well as setting up the CNC lathe to create a mechanical joint that allowed my sculpture to rotate in the wind. Execution of this sculpture would not have been possible without the machine shop and the enthusiasm and guidance from Kevin for a non-engineering-related project.

—Mat Ackerman '05

Although I did not use the machines, the staff helped me make some parts of the bioreactor for my experiment. I found the staff very nice, helpful, and professional. I wish I had been an undergraduate there and spent more time on the machines with them.

—Yanpin Lu Th'05

The machine shop is the heart of the Thayer—the place where build happens! I believe that working in teams and getting your hands dirty are the most important parts of an engineering education.

—Brian Mason Th'05

I worked under Kevin Baron programming and running the milling machines. One day when Kevin was out, I ran out of work and asked Leonard Parker what to do. He handed me a bright orange mallet and told me to sit behind the new thermodynamics students building their Stirling engines and "threaten" them. Although a bit harsh, we always made sure that anyone new in the lab was watched. The machine shop was one of the most caring areas, even if no one in there would admit it.

—Tasha Sakaguchi Th'05

It's funny how attached I grew to a small, crowded, windowless project design lab after spending a ridiculous amount of time in it. We solved problems, ate meals, fretted that we were going to fail the class because we didn't have our project working a week before our final presentation, and traded high-fives when we managed to get it working.

—Josh Kjenner Th'06

I was intimidated by the machines until Leonard Parker and Mike Ibey began helping me out, making sure I was using the machines correctly. They made the experience way better with their humor and anecdotes of past machine shop "incidents." I always looked forward to my part of the day spent there.

—Erik B. Marquez '06 Th'07

I dropped into the machine shop for practical experience on anything mechanical. As a graduate student driving an old car, I found their mechanical advice invaluable in keeping my 1991 car running through five winters. They had so much knowledge and enthusiasm to share.

—Glenn Nofsinger Th'06

Some of the early Advanced Transit Dynamics' TrailerTail prototypes were made in the machine shop as part of an ENGS 190/290 design project. Jeff Grossman '06 Th'07 was on the Thayer team (and now works for ATD), led by CEO Andrew Smith Tu'07. Also helping was Chuck Horrell '00 Th'01 (also now with ATD).

—Errik Anderson '00 Th'07

I came to Thayer with a B.S. in mechanical engineering from Worcester Polytechnic Institute. This gave me a somewhat unique perspective on the nature of the Thayer machine shop and its role as a learning tool. At my undergraduate institution, the multiple machine shops and casting facilities were guarded from the average student, much as they are at other institutions. In contrast, at Thayer the hands-on spaces are truly integral to the education. My presence there was natural; I didn't need a "reason" or some kind of lab hall pass to use the facilities. I spent some time in the machine shop and project lab working with James Joslin '05, the mechanical design wizard of our research group. He was very comfortable working in these spaces and was treated as a peer by the machine shop guys. I know that developed from countless hours learning by doing, and I know his experience was not unique because you could walk by the machine shop on a busy day and see every station occupied by a student. My enduring memory of the Thayer machine shop is that the people responsible for the space recognized that it is there for the benefit of the students. And in order to maximize that benefit and really differentiate a Thayer education from any other engineering education, they tried very hard to make project space seem like an open environment, a natural place for a student to be.

—Devin Brande Th'07

DARTMOUTH COLLEGE ARCHIVES

thayer notes

not available online

Thayer Notes not available online

OBITUARIES

Albert W. Doolittle Jr. '36 Th'37 died October 7, 2007 at his home in Derry, N.H. After graduating, he worked for the American Bridge Company for a year, then for Jackson and Moreland/United Engineers and Constructors, which later became part of Raytheon. He retired in 1979

MAJOR WORK
The late Henry C. Beck Jr. '38 Th'39 oversaw construction of the Cotton Bowl.

COURTESY OF THE BECK GROUP

and devoted much of his energy to community and conservation projects in Derry. The town honored him as a "Living Treasure" in 2005, and the Conservation Commission, on which he served since 1976, recently named a 95-acre conservation area in East Derry after him. Similarly devoted to Dartmouth and Thayer School, he was a longtime volunteer for admissions and the Dartmouth College Fund, and he served on the Thayer School Annual Fund Executive Committee since 1989. He contributed to the Dartmouth College Fund every year since graduation and to the Thayer School Annual Fund every year since its founding in 1976. In 2001 Thayer School named him a Sylvanus Thayer Fellow for outstanding service to the school, and the Annual Fund Executive Committee established the Albert W. Doolittle Jr. Giving Society to recognize all donors who have contributed to the Thayer School Annual Fund for five consecutive years or every year since their graduation. He is survived by his wife, Edith, sons Paul, David '64, and Robert, and five grandchildren.

Henry C. Beck Jr. '38 Th'39, who oversaw such projects as the Cotton Bowl and NorthPark Center as president of the Dallas, Tex. construction firm now called The Beck Group, died October 15, 2007 in Dallas. He joined his father's business in 1939, prior to a stint with the Navy SeaBees in 1941. He returned to Dallas in 1946 and continued to work for the company, where he was named president in 1948 and became chairman in 1973. Under his leadership the company built Reunion Tower, Hotel Crescent Court and the Hyatt Regency. Other local Beck Group projects include the Texas Motor Speedway, Victory Plaza at Victory Park, and Fountain Place in Dallas. He served as a member of the Thayer School Board of Overseers (1966 to 1973) and was a recipient of the Sylvanus Thayer Fellow Award in 1979. He is survived by his wife, Nell, children, grandchildren, nieces, and nephews.

Clement F. Burnap '39 Th'40, a tireless supporter of his class and Thayer School, died February 3, 2007, a few weeks after the death of his wife and lifetime companion, Elaine. He served for many years as class head agent and volunteer for the Thayer School Annual Fund and endowed a fellowship in his wife's name, the Elaine Schofield Burnap Fellowship, as well as the Clement F. Burnap Project Development and Management Endowment Fund. After earning his Dartmouth and Thayer degrees, he received a master's in naval architecture and an M.B.A. from MIT. He began working in the shipbuilding industry prior to the start of WWII and then joined the U.S. Navy, involved in the repair of warships damaged in the Pacific theater. After the war he was engaged in a number of large industrial construction projects, retiring in 1987 from Kaiser Engineers. Clem is survived by brother Wilder, numerous nephews and nieces, and other family members.

A. James O'Mara '42 Th'43, co-founder and chief executive of the civil engineering firm Greenhorne and O'Mara Inc., died of pneumonia November 7, 2007, at Riderwood Village in Silver Spring, Md. He worked as a civil engineer in New York, New Jersey, and Maryland before starting his firm in the Washington, D.C., area in 1950. The firm, which specialized in surveying, land planning and engineering design, became one of the top-ranked engineering firms in the country and developed strong transportation and structural engineering, water and wastewater, water resources, and environmental engineering expertise. It also provided consulting services to the Army Corps of Engineers and the Federal Emergency Management Agency. He was chairman of a business and community task force formed in 1983 to draft a Prince George's County, Md., strategic plan. Survivors include his wife of 63 years, Lois; sons Thomas, Michael, Marc, Dennis, and Brian; six grandchildren; and a great-granddaughter.

Warren Tuttle Loomis '62 Th'65 of Norwich, Vt., died of esophageal cancer on November 2, 2007. A keen entrepreneur, inspired tinkerer, and clever prankster, Warren infused many lives with warmth and vigor. He earned his B.A. from Dartmouth, where his fellow hockey players knew him as "Zog," and his M.S. from Thayer. Inspired by his mentor George Colligan, he earned a Ph.D in metallurgy from the University of Michigan in 1969. He then entered the nascent field of computers and in 1970 founded computer software company Logic Associates, which he led until his retirement in 2001. In retirement Warren took up his lifelong passion for invention and boating by founding ForwardFace! LLC, which designs and produces forward-facing rowing boats (see page 32). Warren is survived by his wife, Alix Manny; children Aaron, Jason, and Molly; step-children John and Sam; mother Natalie; and sisters Barbara, Betsy, and Natalie.

Joan Queneau, wife of Thayer Professor Emeritus Paul E. Queneau, died September 8, 2007, at Kendal in Hanover. In 1990 the couple endowed the Paul and Joan Queneau Professorship in Environmental Engineering Design. She also showed her commitment to environmental conservation by establishing the Joan Hodges Queneau Palladium Medal, given by the National Audubon Society and the American Association of Engineering Societies and emphasizing the importance of mutual understanding between conservationists and engineers. She was active in numerous community organizations, including Tamarack Twig, Girl Scouts of America, and the Junior League; she formed a Junior Audubon Society in Rochester, N.Y., and was president of its parent-teacher association; and devoted her services to the Church of Christ at Dartmouth. In addition to her husband, she is survived by son Paul, daughter Josephine, six grandchildren, five great-grandchildren, and several nieces.

FEEDBACK LOOP

Thank you for the question on failure in the Spring/Summer 2007 issue. The question stayed in my mind all this time.

I haven't had great failures so far. My husband's business is thriving, thanks to his own talent and hard work, but also to my constant support and help. My three children are well-adjusted. My parents can count on me for care. So far I haven't found a problem that I couldn't solve.

Then suddenly I saw it: an enormous problem that had kept me from moving forward while I raised my family. I had become so good at solving my employees' and family members' problems that I forgot about my own dreams and passions.

My youngest is seven, so I can now concentrate on what makes me happy: I will be looking for a way to go back into engineering without abandoning my family. I know it can be done. It is just that I have so far found 10,000 ways how not to do it.

—Doris Martìnez Th'91

inventions

Loomis rowed the Connecticut River his own way.

JENNIFER HOUCK/VALLEY NEWS

FORWARD-FACING ROWBOAT

>> INVENTOR:
WARREN LOOMIS '62 TH'65

No doubt about it: Warren Loomis '62 Th'65 was a forwarding-looking guy. In the early 1960s, when there were exactly two computers at Dartmouth, he took a keen interest in the new technology. After his first employer, the pioneering Time Share Corp., downsized him out of a job, he formed his own software company, Logic Associates. The two-man outfit soon became a Loomis-only enterprise as the company struggled to find its niche. But Loomis persevered, and a quarter century later the Upper Valley-based firm had 120 employees and sales of $17 million. He sold the company in 2000, and turned his engineering skills to recreation.

Loomis had taken up rowing, and he thought rowers should see where they were going, not where they'd already been. He designed a rowboat that combines the motion of a rowing machine with a rear-mounted propeller. Then he and his sons, Aaron and Jason, founded the Faceforward! company to manufacture and sell the novel craft. Next he developed a set of real-time performance tools to measure speed, power, and efficiency in small boats.

By the time Loomis died last November, neither of his rowing innovations matched the financial success of his software start-up. But they illustrate what son Jason says was a favorite saying of the late inventor: "The guy with the most tries wins."

—Lee Michaelides

RANDOM WALK

Last fall Thayer School became the temporary home of a 1923 Milburn Model 27L Light Electric car. On loan for two years from the Chicago Museum of Science and Industry, the car is a reminder that good ideas never grow old. Light and crankless—and therefore easy to operate—the car was revolutionary for its time. And as an electric car, originally powered by 40 Edison-type wet cell batteries, it remains a model of gasoline-free ingenuity. Thayer Overseer Barry MacLean '60 Th'61, who arranged for the car to be on display in MacLean Engineering Sciences Center, says he hopes the vehicle will be a "stimulus for thinking about alternative energies in the years ahead."

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