DARTMOUTH

Engineer

THE MAGAZINE OF THAYER SCHOOL OF ENGINEERING

FALL 2006

MACLEAN REVEALED

THE NEW ENGINEERING SCIENCES CENTER PLACES CREATIVITY ON DISPLAY.

> WORLD'S SMALLEST UNTETHERED ROBOT > FAVORITE CLASSES

DARTMOUTH ENGINEER
VOLUME 3 / NUMBER 1

Attracting Students to Engineering

BY DEAN JOSEPH HELBLE

EDUCATORS GENERALLY BELIEVE THAT THE SPACE RACE SET IN MOTION by the Soviet launch of the *Sputnik* satellite in 1957 and President Kennedy's 1961 call to land a man on the Moon triggered a surge of interest in technology this country has not seen since. But the data do not support this claim.

According to the Department of Education's National Center for Education Statistics, 38,000 students received degrees in engineering or engineering technology in 1960. This number can be considered a pre-*Sputnik* baseline, since these students had likely already selected their college major by the time the space race began. In 1970 the nation's graduates—who would have been 7 or 8 when *Sputnik* was launched and 11 or 12 when President Kennedy declared his goal—included approximately 45,000 engineers. By 1975, there were 47,000. These numbers indicate some growth in engineering enrollments in the 1960s and early 1970s, but hardly the peak that has become commonly accepted lore. Examined on a per-capita basis, the lack of significant growth is even more striking: 209 engineering degrees per million U.S. citizens in 1960, 217 in 1970, and 218 in 1975.

Engineering enrollments *did* spike in this country, but not until a decade *after* the influence of *Sputnik* should have faded. In 1980, a time of energy shortages and environmental concerns, the U.S. graduated 303 engineers per million citizens. In 1985, the number was up to 403. It is therefore reasonable to ask whether it was *Sputnik* that inspired a surge in engineering interest, or rather the desire to address global issues such as energy, the environment, or health care through biotechnology. The numbers suggest the latter.

So where are we now? A two-decade decline in the per-capita production of engineers has leveled out—but not reversed—in the past few years. In 2004, the nation produced 266 engineers or engineering technologists per million citizens, 30% fewer than in the mid-1980s. During that period the number of degrees in parks, recreation, and leisure studies per capita increased by nearly 300%. The country now graduates a third as many "leisure" majors as engineers. If we believe that technological advances drive our economic and social well-being and that many of our problems require engineering solutions, this is an alarming trend. We need to find a way to convey the relevance of engineering to prospective students—and the enrollment data of the past 40 years tell us how.

Thayer School is facing this challenge by building graduate research focuses, scholarly work, and innovation in a few key areas of broad service to society. One such area, the intersection between Engineering and Medicine, is the target of current and planned faculty hiring, new programs we are building with Dartmouth Medical School, and growing sponsored research activity. Our students, too, are devising new ways of aiding the world—from the innovative Formula Hybrid competition planned for May 2007, to the Big Green Bus, currently in the planning stages for next summer's journey, to "Humanitarian Engineering Leadership Projects Worldwide," a new Thayer School group dedicated to using their engineering skills to help solve basic infrastructure problems in the developing world.

This approach is not another race to the moon. But from the enthusiasm of the students involved in these efforts, I'm convinced it is what is needed to make engineering an attractive option once more.

Editor
Karen Endicott

Assistant Editor
Jennifer Seaton

Design
Wendy McMillan

Contributing Editors
Theresa D'Orsi, Catha Lamm, Lee Michaelides, and Nancy Serrell

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

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

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

engineering.alumni.records@
dartmouth.edu

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

thay6.5m11.06villanti

Contents


32


20


5

10

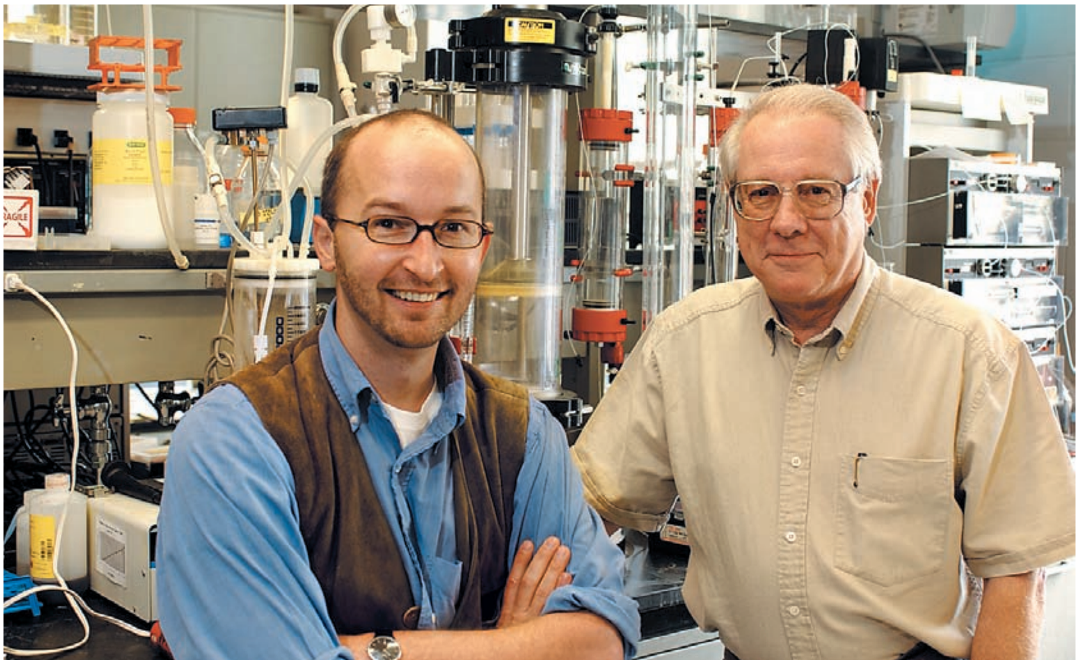
DEPARTMENTS

COVER
MacLean Engineering Sciences Center's main entrance.
Photograph by John Sherman

BACK COVER
MacLean's southern elevation.
Photograph by Douglas Fraser

THE
Great Hall

>>NEWS FROM AROUND THAYER SCHOOL



PARTNERS
Profs Tillman Gerngross, left, and Charles Hutchinson used yeast to raise a thriving company.

JOSEPH MEHLING '69

INNOVATIONS

GlycoFi Bought by Merck

WHEN PROFESSORS TILLMAN GERNGROSS AND Charles Hutchinson co-founded GycoFi Inc. in 2000 they knew they were onto something with huge potential. Six years later they found out what their proprietary technology for turning yeast cells into therapeutic protein factories was worth: $400 million.

That's the price drug manufacturer Merck paid to acquire GlycoFi in June. Citing statistics from the National Venture Capital Association, *The Boston Globe* reported that "the deal was the third-highest price paid for a private biotechnology firm, and the largest on record to be done in cash."

The size of the deal reflects the importance of GlycoFi's scientific breakthroughs. In the September 8 issue of the journal *Science*, researchers from GlycoFi, Thayer School, and Dartmouth Medical School announced that they had achieved the complete humanization of the glycosylation pathway in the yeast *Pichia pastoris*.

"We've successfully completed one of the most complex cellular engineering endeavors undertaken to date," said Gerngross, chief scientific officer of GlycoFi, which is based in Lebanon, N.H.

"Humanizing glycosylation in yeast was a tour de force of genetic engineering, requiring the knockout of four yeast genes and the introduction of over 14 heterologous genes," said Stephen Hamilton, the lead author of the *Science* paper and a senior scientist at GlycoFi.

More than half of all drugs currently in development worldwide depend on the genetic engineering of living cells to produce specific recombinant proteins. Most of these proteins require the attachment of sugar structures, a process known as glycosylation, to attain full biological function. Conventionally, these proteins are produced in mammalian cells. But mammalian cells are prone to contamination by pathogens and are expensive to culture, and glycosylation of mammalian cells is hard to control.

GlycoFi engineered strains of yeast to perform controlled, reliable, specific glycosylation, producing proteins with improved therapeutic capabilities. The technology optimizes drug performance while improving manufacturing efficiency.

Glycoengineering *Pichia pastoris* to produce functional erythropoietin, a protein widely used in treating anemia, was the latest demonstration of GlycoFi's protein engineering prowess. Earlier this year GlycoFi and Dartmouth researchers published a paper in *Nature Biotechnology* detailing the role of glycosylation structures on antibodies.

"By engineering yeast to perform the final and most complex step of human glycosylation, we will be able to conduct far more extensive structure-function investigations on a much wider range of therapeutic protein targets," said Gerngross.

No wonder Merck bought the company. "Our acquisition of GlycoFi's scientific expertise, patent estate, and robust technology platform is a significant step toward enabling Merck to discover, optimize, and develop novel biologic drugs to serve the needs of patients worldwide," said Peter S. Kim, president of Merck Research Laboratories.

For Gerngross, who will continue to guide Glycofi's scientific work, and Hutchinson, who relinquished his CEO duties, the sale to Merck represents the best of both worlds: a profitable end and a promising beginning.

Numerical Analysis:
"It's a lot like dancing class with step one, step two."

FACULTY NEWS

New Professorship Honors Hutchinson

ON SEPTEMBER 29 THAYER SCHOOL unveiled more than the new MacLean Engineering Sciences Center. That same day Dean Joseph Helble surprised Dean Emeritus Charles "Hutch" Hutchinson—and the Thayer School community—by announcing the establishment of the Charles E. Hutchinson '68A Professorship in Innovation. Funded by a gift from John H. Krehbiel Jr., the professorship is intended to "recognize and reward members of the faculty whose teaching is true to the highest standards of Dartmouth's educational mission and whose scholarship has contributed significantly to the advancement of interdisciplinary knowledge."

The professorship is the latest chapter in a long connection between Hutchinson and Krehbiel. When Hutch served as dean of Thayer School from 1984 until 1994, and again from 1997 to 1998, Krehbiel chaired Thayer School's Board of Overseers. The two oversaw a major facilities renovation to Cummings Hall in the late 1980s and helped raised $40 million for the engineering school.

Among other achievements as dean, Hutch founded the Master of Engineering Management program. As dean emeritus and the John H. Krehbiel Sr. Professor for Emerging Technologies, he directed the M.E.M. program and developed and taught courses in electrical engineering, design, Total Quality Management, and emerging technologies. In 2000 he co-founded the biotechnology company GlycoFi with Professor Tillman Gerngross and served as CEO of GlycoFi until it was acquired in spring 2006 by Merck. A man who doesn't know the meaning of retirement, Hutch is in the midst of his latest venture: developing a new Thayer School course in technology, innovation, and entrepreneurship.

JUST ONE QUESTION

What's Your Favorite Thayer School Class?

" 'Solid Mechanics.' The bridge project. Everything we learned during the term was applied to the project. All of the theoretical stuff matched up with the actual testing, which was really cool."

—Paul Salipante '07

Brande

" 'Introduction to Engineering.' You got to actually build and try out something you invented. It was a great beginning class."

—Corbin Churchill '05

Salipante

"I liked 'Modern Control Theory' and 'Introduction to Systems Identification.' It's one of the only areas that's really interesting and satisfying in that there really is an achievable answer that's in your realm of comprehension. It doesn't need to be simplified for you to understand it. And it's very applicable."

—Devin Brande Th'07

Bustamante

" 'Introduction to Engineering.' It was a mixture of everything engineering entails. The project topic was to create something to improve learning. I liked it because the topic was really open."

—Monica Martin de Bustamante '08

Lu

" 'Numerical Analysis.' Professor Shepherd was funny and explained things very well. He made jokes about the steps and he said it's a lot like dancing class, with step one, step two, etc."

—Shanshan Lu, Ph.D. candidate

kudos

>> Professor Erland Schulson, the George Austin Colligan Distinguished Professor of Engineering and director and founder of Thayer School's Ice Research Laboratory, has been named a fellow of the Minerals, Metals & Materials Society, a leading materials science professional society.

>> Professor Edmond Cooley, Thayer School's chief IT strategist, and Dr. Joseph Rosen, an adjunct associate professor of engineering and a plastic surgeon, were invited to participate in the 2006 Microsoft Research Faculty Summit, "Computing at the Center of Transformation." Rosen spoke about creating a network-centric telemedicine system that will aid health care in Vietnam. Cooley researched emerging technologies.

>> Professor Brian Pogue, director of Thayer School's M.S. and Ph.D. programs, won the 2006 Graduate Faculty Mentoring Award, based on student nominations. In other news, Pogue and Professor Keith Paulsen Th'84, part of a research team testing new imaging techniques to find breast abnormalities, including cancer, recently published their latest findings in the *Proceedings of the National Academy of Sciences.*

>> The College Board Inc. has appointed Professor Elsa Garmire to its commission on Advanced Placement physics.

WEIGHTLESS Lauren Edgar ’07 records data while Abby Davidson ’05 Th’07 exercises in zero-gravity conditions.

STUDENT PROJECTS

I Want One of Those!

Self-Powered Remote

With the Self-Powered Remote, couch potatoes will save more than their own energy. They’ll reduce the need for the 3 billion batteries Americans use in their homes each year. The Self-Powered Remote utilizes a magnet traveling though a conductive coil to generate its own electricity. A 30-second shake is all it takes to produce enough voltage to change channels 70 times. Project team **Fahmi Enam ’08, Lauren Miller ’09, Nandan Shetty ’07,** and **Stephanie Trudeau ’09** won the Phillip R. Jackson Prize for outstanding performance in ENGS 21, “Introduction to Engineering,” last spring. Maxime Guimond ’06 was the team’s teaching assistant.

EXPERIMENTS

Space Workout

THAYER SCHOOL STUDENTS TESTED AN astronaut exercise plan during flights over the Gulf of Mexico last spring. Abigail Davidson ’05 Th’07, Lauren Edgar ’07, Eve Russell ’05, and Jennifer Tonneson ’06 conducted experiments during 30-second intervals of weightlessness as part of NASA’s Reduced Gravity Student Flight Opportunities Program.

The exercises, designed to combat the bone and muscle loss astronauts experience on long missions, utilize elastic bands that take up a lot less space than the bulky exercise machines NASA currently uses.

The students were building on 2004 experiments conducted by Stephanie Feldman ’04, Chelsea Morgan ’04, Lea Kiefer ’04, and Lauren Talbot ’04. That group developed the concept with DHMC physician Jay Buckey, a former astronaut. The exercises, called the Dartmouth Resistance Exercises for Antigravity Muscles (DREAM), proved to be effective in muscle activation during the first round of experiments. Davidson says the second group wanted to expand on the initial demonstration by testing additional exercises, developing visual feedback on muscle activation during the exercises, and improving the electromyogram data analysis.

The team spent 10 days in Houston, where they became flight-certified and then performed tests for two days on a jet that flies parabolic arcs to produce weightless periods.

The students presented their findings at the Aerospace Medical Association Conference in May. “Everyone there thought this was a fantastic idea and wanted to know what our next step was,” says Abigail Davidson. “We are actually hoping that NASA will in some form adopt this exercise regimen for astronauts.”

—*Jennifer Seaton*

THIS PAGE: CHAD HUNT/ *POPULAR MECHANICS*. OPPOSITE PAGE: LEFT, COURTESY OF STEPHANIE TRUDEAU ’09; TOP, COURTESY OF NASA

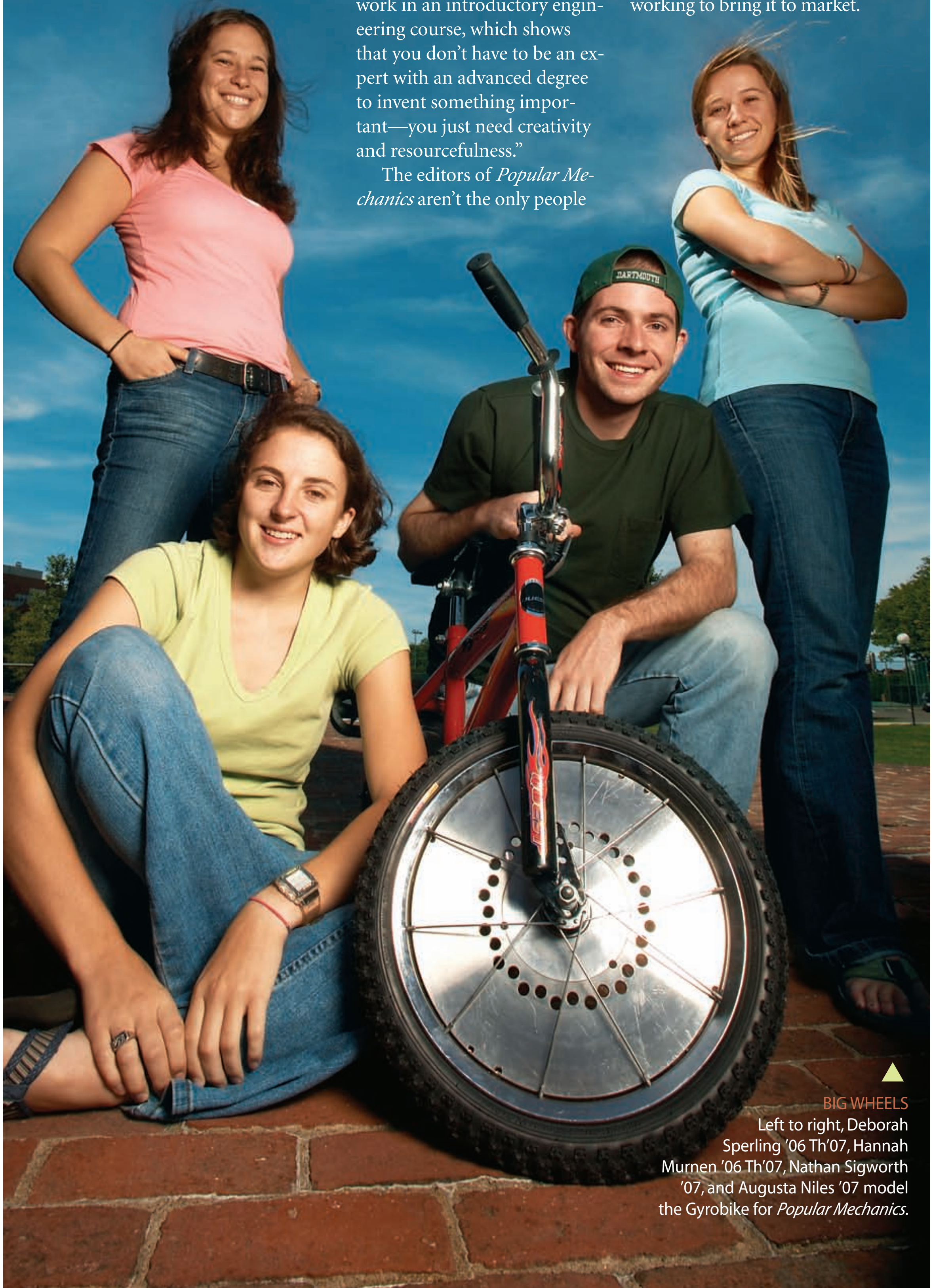
AWARDS

Riding High

HOW FAR CAN A GYROBIKE GO? All the way to *Popular Mechanic* magazine's 2006 Breakthrough Awards. "One of my favorite inventions this year is the Gyrobike, created by a group of Dartmouth students. It's an elegant, simple solution to the eternal problem of learning to ride a bike," writes Jim Meigs, the *Popular Mechanics* contributing editor who oversaw the awards project. "People have been perfecting bikes for over 100 years, and there's been a knowledge of gyroscopes for much longer, but these students were the first to combine them in a device like this. And they did the work in an introductory engineering course, which shows that you don't have to be an expert with an advanced degree to invent something important—you just need creativity and resourcefulness."

The editors of *Popular Mechanics* aren't the only people who like the Gyrobike. Kids who've never ridden a two-wheeler love it because they can hop on and ride it right away.

Gyrobike inventors Hannah Murnen '06 Th'07, Augusta Niles '07, Nathan Sigworth '07, and Deborah Sperling '06 Th'07, who created the bike for their ENGS 21 class in 2004, are working to bring it to market.



BIG WHEELS
Left to right, Deborah Sperling '06 Th'07, Hannah Murnen '06 Th'07, Nathan Sigworth '07, and Augusta Niles '07 model the Gyrobike for *Popular Mechanics*.

kudos

>> Thayer School earned Dartmouth 19th place on *Princeton Review*'s inaugural list of the nation's "Top 20 Graduate Engineering Programs." Some highlights from the Web site (princetonreview.com/grad/research/articles/find/engineering.asp): Enrollment: 1,514; average undergrad GPA: 3.50; and student-faculty ratio: 4:1.

>> In honor of the upcoming International Polar Year (2007-08), the Geographical Society of Philadelphia awarded a $1,000 grant to Rachel Obbard Th'06. Obbard, who earned her Ph.D. in June, specializes in the microstructural properties of ice. She uses scanning electron microcopy and confocal Raman spectroscopy to investigate the location of different chemical compounds in ice. Two of her ice photographs won first- and second-place prizes in the 2006 International Metallographic Contest.

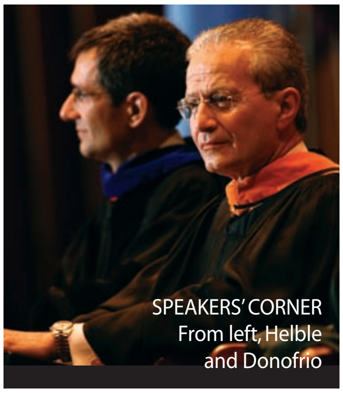
>> During the 2006 International Business Plan Competition at the University of San Francisco, doctoral candidate Ashifi Gogo won the $500 Social Venture Award, which recognized the proposal with the greatest potential to effect positive social change. His presentation was about WOSPRO (that's "wikifarming and open-source processing"), an effort to use virtual reality, social networks, and the internet to link organic farmers in Ghana and elsewhere to global markets. Gogo is chief technical officer of WOSPRO, a joint effort of Thayer School, the London School of Economics, and the Institute of Marketing in Kumasi, Ghana.

>> Christina E. Behrend '07 won a $7,500 Barry M. Goldwater Scholarship for academic merit. She plans to earn an M.D./Ph.D. in neuroscience engineering and conduct research on robotic limb prostheses.

>> Doctoral candidate Colleen Fox received a Graduate Student Community Award for outstanding service to Dartmouth.

“The most important
particular
a broad societal impact

investiture



SPEAKERS’ CORNER From left, Helble and Donofrio

COMMENCEMENT Left to right, Per Wimmercranz, Brenda Zarate ’05, Eleanor Alexander ’04 Th’05, Luis Carrio ’04 Th’05, and Sean Furey ’04 Th’05 received diplomas June 11.

Class of 2006

THAYER SCHOOL’S INVESTITURE, held June 10 at the Hopkins Center’s Spaulding Auditorium, welcomed 114 B.E. and advanced degree recipients into the Dartmouth Society of Engineers. With Dean Joseph Helble presiding, B.E. and M.S. graduates received their academic hoods and Ph.D. graduates their well-earned caps.

Nicholas Donofrio, Executive Vice President for Innovation and Technology at IBM, received the Robert Fletcher Award for service exemplifying the highest ideals of Thayer School. In his Investiture speech, Donofrio told graduates, “The innovation opportunities you will be faced with are far different than the ones I was faced with when I started with IBM. Back then, the necessary and sufficient condition was to be a very good engineer, a very good scientist. Back then, the necessary and sufficient condition was to invent, create and discover….Innovation in the 21st century requires people with deep insight into the issues and challenges faced by business, government, academia, for-profit and not-for-profit institutions, and for society….The most important innovations will be those that transcend any particular business or technology; they will be those that have a broad societal impact and improve the lives of real people.”

Donofrio pointed out that “innovation happens much faster today, and it diffuses more rapidly into our everyday lives; it is far more open; it spans virtually all disciplines, and it is increasingly global. Innovation rarely arises in the isolated laboratory anymore—it arises in the marketplace, the workplace, the community, the classroom. It flourishes in a collaborative environment.” And he said, “The world is ripe with opportunity for people just like you—people who have benefited from the approach of the Thayer School. People who—because of their exposure to such a unique, forward-thinking program—are almost correct by construction for what lies ahead in the 21st century. You are better equipped than most to chart the new era.”

Donofrio offered some “friendly advice”:

> “Work to make a difference.

> “Take the Hippocratic Oath every morning: ‘Do No Harm.’ If that’s all everyone did every day—just getting the base right—what a great world it would be.

> “Learn to love change. If you simply tolerate it, you will get nowhere.

> “Never let go of who you are, where you came from, what you believe in.

> “Keep your sense of balance.

> “Keep your sense of humor. It is our ultimate sanity check.”

And, challenging graduates to use all their skills to handle inevitable uncertainties, Donofrio said, “As you move deeper into the 21st century, it’s a sure bet that you will be measured less on what you know and more on how you deal with what you don’t know.”

BY THE NUMBERS

Engineering Graduates

8	Doctor of Philosophy
12	Master of Science
37	Master of Engineering Management
57	Bachelor of Engineering
60	A.B., Engineering Sciences

LEFT: MARK WASHBURN; RIGHT: JOSEPH MEHLING ’69 innovations will be those that transcend any business or technology; they will be those that have and improve the lives of real people."

—NICHOLAS DONOFRIO, INVESTITURE SPEAKER

Degree Recipients

BACHELOR OF ENGINEERING

Mathew Ackerman '05
Acoustic Noise Reduction of a Two-Axis Scanner

Afua Amoah
Dartmouth Formula Racing: Driver Controls and Ergonomics

Patrick Cantwell '04
Characterization of Cryolite as an Optical Thin Film

Ka Yan Chan
Integration of Sensors into Household Appliances

Narissa Chang '05
Upper Peninsula Bridge Project 1: Design, Analysis, and Development of a Construction Plan for ATV Bridge

Abigail Davidson '05
Hybrid Racecar, Phase 3: Mechanical Team

Nilanjana Dutt
Automated Remote Cognitive Evaluation

Karl David Geijer
Throttle Body Design and Flowtesting

Jacob Goodman
Hybrid Racecar, Phase 3: Electrical Team

Matthew Guernsey '05
Dartmouth Formula Racing: Engine Systems

Maxime Guimond '06
Dartmouth Formula Racing: Driver Controls and Ergonomics

Joseph Gwin '05
Head Impact Telemetry System™ for Ice Hockey: Monitoring Real Time Impacts

Tia Hansen '05
Feasibility Study of Anaerobic Digestion at McNamara Dairy

Jeffrey Hebert '04
Dartmouth Formula Racing: Front Suspension, Steering, and Braking

Brian Henthorn '04
Ethanol as Fuel for Recreational Boating

Matthew Hodgson
Dartmouth Formula Racing: Data Acquistion and Electronics Development

Benjamin Honig '05
Runway Robot

Joseph Horrell '04
Dartmouth Formula Racing 2004: Front Suspension, Steering, and Braking

Elizabeth Hunneman '05
Dartmouth Formula Racing: Suspension Development

Kathleen Jones
Dartmouth Formula Racing: Vehicle Dynamics

Christopher Kane '05
Dartmouth Formula Racing: Differential, Drivetrain, and Braking Systems Development

Arne Kepp
Hybrid Racecar, Phase 3: Electrical Team

Riad Khan '05
Dartmouth Formula Racing 2005: Rear Suspension Development

Yoosik Kim '06
Anaerobic Digestion at McNamara Dairy

Jonathan Kling '04
Dartmouth Formula Racing 2005: Fluids Team

Jonathan Knight
Variable Dirt Bike Intake

Juliana Lisi '05
Characterization of Cryolite as an Optical Thin Film

William MacPherson
Dartmouth Formula Racing 2005: Vehicle Dynamics Development Abstract

Michael Madson '05
Dartmouth Formula Racing 2005: Vehicle Dynamics Development Abstract

Namrata Mahadevan
Improved Design for Cerebral Aneurysm Clip-Hybrid Design

Richard Martin
Feasibility of Retrofitting Corn Ethanol Plants to Run on Cellulosic Feedstocks

Jaime Mazilu '05
Innovate an Application for Nanomonosphere

Brenda Melius
Water Jet Evaluation and Design for Medical Device Use

Naota Nakayama
Hybrid Racecar, Phase 3: Electrical Team

Alex Nunez '05
Dartmouth Formula Racing: Differential, Drivetrain, and Braking Systems Development

Daniel Olson '04
Solar Domestic Hot Water System Optimization

Charles Pahl III '04
Magnetic Resonance Imaging (MRI) Gauss Meter Design

Joshua Pyke '05
Automated Remote Cognitive Evaluation

Jeremiah Pyle '05
Water Jet Evaluation and Design for Medical Device Use

Sudip Regmi '06
Customized Applications for Personal Digital Assistants

Matthew Richards '05
Feasibility of Retrofitting Corn Ethanol Plants to Run on Cellulosic Feedstocks

Meryl Richards '05
Solar Domestic Hot Water System Optimization

Nelson Rosa '05
Pattern-Following Module for Robotic Applications (DOTCam)

Eben Sargent '05
Variable Dirt Bike Intake

honors

>> The Dartmouth Society of Engineers Prize for outstanding B.E. project: Nelson Rosa Jr. '05

>> The Dean's Service Award for outstanding service to Thayer School, Dartmouth, or the broader world: Douglas W. Van Citters '99 Th'03, '07

>> The Charles F. and Ruth D. Goodrich Prize for outstanding achievement: Richard Scott Darling Th'06

>> The Caroline Henderson Prize for best M.E.M. project: Steven A. Musica Th'06

>> The Thayer School of Engineering Corporate Collaboration Council Engineering Design Prize for best performance in ENGS 190/290: Brian Hendrickson '06, Jonathan Bing Knight '05 Th'06, and Eben Roy Sargent '05 Th'06

>> The Thayer School of Engineering Faculty Award for Academic Excellence in B.E. course work: Yoosik Kim'06 Th'06

>> The Phillip R. Jackson Engineering Sciences Prize for outstanding performance in an introductory course: (Spring 2005) Patrick Biggs '06, Ashley Heist '08, Benjamin Koons '08, and Monica A. Martin de Bustamante '08. (Fall 2005) Catherine Gaito '07, Marc Lajoie '08, Prabhu Perumalsamy '08, Kimberly Rocio '08, and Elisha Tam '07

>> The Brieanna S. Weinstein Engineering Design Prize for new technologies, systems, or devices addressing physical or developmental disabilities: Meredith Ann Lunn '06

>> The John C. Woodhouse Engineering Design Prize for cost-effective designs of experimental equipment: Andrew Thomas Johnston '06

>> The John C. Woodhouse Environmental Engineering Prize for outstanding work in environmental study or research: Richard Lance Martin '05 Th'06

>> Excellence in Teaching Award John Collier '72 Th'77

>> Outstanding Service Award for Staff Michelle Batt '99 Th'00 and Judy Durell

investiture

Nicholas Schaut '05
Dartmouth Formula Racing: Differential Drivetrain and Brake Systems Development
Keith Schuricht '05
Acoustic Noise Reduction of a Two-Axis Scanner
Victor Sibley
Hybrid Race Car, Phase 3: Mechanical Team
Brian Smith '05
Water Jet Evaluation and Design for Medical Device Use
Sarah Smith '05
Dartmouth Formula Racing 2005: Driver Controls, Ergonomics and Safety
Ryan Stehr '05
Design of an Improved Crosslinked Polyethylene
Diana Szczepanski '05
Dartmouth Formula Racing: Vehicle Dynamics
Scott Thoms
Runway Robot
Christiana Toomey '04
Automated Remote Cognitive Evaluation
Tsering Wangdi
Integration of Hall-Effect Sensors into Whirlpool Washer and Dryer
Per Wimmercranz
Throttle Body Design and Flowtesting

Dustin Wong '05
Dartmouth Formula Racing: Differential Drivetrain and Brake Systems Development
Brenda Zarate '05
Dartmouth Formula Racing: Differential, Drivetrain, and Braking Systems Development

MASTER OF ENGINEERING MANAGEMENT

Eleanor Alexander '04 Th'05
Standard Operating Procedures Publication
Luis Carrio '04 Th'05
Vibration Analysis of the Inertial Navigation System in the Next Generation Trident Submarines
Peter Chan
IBM "Speed Team": Automated Design Checking Process
Matthew Clark
Early Assessment of New Assembly Lines
Brian Ferguson '04 Th'05
Double Bushing Link Development for MVS-Dynalink
Philip Frost '04 Th'05
Gateway vs. Enterprise
Sean Furey '04 Th'05
AEF-SAW Integration Analysis
Christopher Graves
Tape Encryption Hardware Evaluation

TRADITION Professor Eric Hansen bestows a hood on Brenda Melius.

Catherine Guajardo '04 Th'05
Data Evaluations for 3-D Computer Model of Aneurysms from CT Scans
Daniel Hassouni '05 Th'05
Sweeper Project: Redesigning the Universal Binding
Jeffrey Hebert '04
Broadacres Ranch River Restoration
Brian Henthorn '04
REACH—Opportunities for AMEC
Matthew Hodgson
Electromotive ECU Testing and Verification
Joseph Horrell '04
Ball-Joint Boot Ring Design Optimization
Seongmog Kim
An Analysis of Corporate Venture Capital in the U.S. Market for a Strategic Consulting Firm
Jonathan Kling '04
Broadacres Ranch River Restoration
Jessica Lawrence Th'05
Environmental Management System
Juliana Lisi '05
Plan for Actively Collecting Landfill Gas
William MacPherson
Feasibility Analysis for Ethanol Financing
Reginald Martin IV '04 Th'05
Membrane BioReactor Pilot Study at Los Angeles County Sanitation District's Whittier Narrows Water Reclamation Plant
Colin Murray '04 Th'05
Patenting and Developing a Water Cooler Caddy
Steven Musica
Communication Earplug Design and Strategy for Sound Innovations, Inc.

Julia Ott '05 Th'05
Information Management for Condé Nast Johansens
Eric Perz
Vail Resorts Confirmation Email Project
Amol Pinge
Effective Strategies for Hedging Mortgage Servicing Rights
Alexander Price '04 Th'05
Thermal Protection System for the Base Heat Shield of a Suborbital Rocket
Peter Rice Th'05
UCSD–Matthew's Apartments Refurbishment
Raymond Ring III '04 Th'04
Expanding the Product Line of an Innovative New Manufacturer of Camp Stoves
Taro Sakazume
Improving Client's Sales Force Effectiveness
Heiya Tessema '04 Th'05
Development of a Peak Flow Management Plan for the New Rochelle Wastewater Treatment

MARK WASHBURN

Plant Nitrogen Removal Improvement Program
Colin Ulen
Universal Transaction Engine
Joseph Victoria Th'05
Performance Metrics for the Panama Canal Authority's Engineering Division
Grant Wagner '04 Th'05
HPX Thermal Analysis
Rebecca Wang '05 Th'05
Replacing a Paper Database with an Organized Computer Database
Xianghui Weng
Heading to 3G
Kristen White '04 Th'05
A Competitive Analysis of Pogostiks™
Courtney Wuistinger '04 Th'05
Designing an HVAC System for a Nieman Marcus Last Call Retail Store

MASTER OF SCIENCE

Patrick Cantwell '04
Optical Coatings for Improved Contrast in Longitudinal Magneto-Optic Kerr Effect (MOKE) Measurements
Magdalena Dale
Single-Layer and Multi-Layer Design Concepts for High-Frequency Winding Design in Transformers and Inductors
Jordan Desroches '03 Th'05
Development and Analysis of the Electronics, Mechanical Portions, and Fluid Flow for a Portable Spirometry System
Anna Fox
Length-Dependent Absorption Measurements in Deionized Water
Hrithik Govardhan Th'04
A Passive Application to Enable Detection of the Topology of Diversified Local-Area Computer Networks
Yanpin Lu
Enzyme-Microbe Synergism in Microbial Cellulose Utilization by *Clostridium thermocellum*
Douglas Madory
New Methods of Spoof Detection in 802.11b Wireless Networking
Timothy Miller '03
Mechanical Actuation of Tissue in MRE and Its Use in Imaging the Shear Modulus of Fat Pads
Amanda Plagge '03 Th'04
Pulse Electro-Thermal Deicing of Wind Turbine Blades
Lincoln Potwin
Feasibility Study of a Time Domain-Based Data Acquisition Scheme for Low Frequency Ultrasound Computed Tomography
Peter Semen '97 Th'97
A Generalized Approach to Soil Strength Prediction with Machine Learning Methods
Bradley Smith
Grain Boundary Sliding in Inclined Columnar-Grained S2 Fresh-Water Ice

DOCTOR OF PHILOSOPHY

Hui Chang
Directional Recrystallization of Nickel
Richard Darling
Data-Based Predictive Control
Andrew Fortt
The Resistance to Sliding Along Coulombic Shear Faults in Columnar S2 Ice
Ryan Halter
Development of a High Multifrequency Electrical Impedance Tomography System for Breast Imaging
Xi Nan
Eddy Current Loss in Windings
Rachel Obbard
Microstructural Determinants In Glacial Ice
Chao Sheng
Dosimetry for 5-Aminolevulinic Acid Induced Protoporphyrin IX Photodynamic Therapy of Barrett's Esophagus
Xiaodong Zhou
Designing Treatment Individualization in Photodynamic Therapy to Compensate for Pharmacokinetic Variability

PHOTOGRAPHS BY JOHN SHERMAN

ENGINEERING

MACLEAN ENGINEERING SCIENCES CENTER PLACES CREATIVITY ON DISPLAY.

BY KAREN ENDICOTT

REVEALED

Two and a half years after its groundbreaking, MacLean Engineering Sciences Center was formally unveiled September 29 to a jubilant Thayer School community. A dedication ceremony held in the new atrium that links MacLean to Cummings Hall signaled the beginning of a new era for engineering education.

MacLean Engineering Sciences Center is far more than a 64,000-square-foot addition. It is the embodiment of Thayer School's integrative approach to engineering. Designed according to the principle that creativity thrives in synergetic surroundings, MacLean's open, flexible spaces provide new venues and means for applying Thayer School's emphasis on hands-on learning, innovative research, and teamwork.

"MacLean's distinctive design—mixing traditional with contemporary features—mirrors our approach to engineering education, in which we blend time-tested principles of engineering with innovation and emerging technologies," Dean Joseph Helble stated at the dedication.

According to Professor William Lotko, chair of the building committee that oversaw Thayer School's expansion, MacLean conveys the process of technology. "To a Dartmouth engineer, technology is the outcome of an intensive process of research, need assessment, brainstorming, conception, feasibility evaluation, modeling, resource procurement, design, experimentation, analysis, prototype development, iteration, iteration, iteration, and then voilá—technology," he explained at the dedication. "When the faculty started expressing the idea to architects Fred Koetter and Susie Kim that there was something visual and inherently interesting about the messy engineering process, they got it immediately. They accepted the challenge to develop a MacLean Center that would give form and substance to the fuzzy idea of 'revealing engineering.' You can see a vivid expression of this idea in the entire wall of the building, inside and out, but especially in the atrium, where it appears that MacLean indeed has been sheared open to reveal the inner workings of engineering."

The result is a building that welcomes people into engineering. For students and faculty, easy observation of works in progress invites new ideas and associations. For visitors to Thayer—from prospective students to non-engineers—MacLean is a window into the ingenuity and creativity of engineering.

Increasing Thayer School's facilities by more than 60 percent, the Engineering Sciences Center, named for lead donors Barry '60 Th'61 and Mary Ann MacLean, provides space for strategic growth in an environment that fosters community and close student-faculty interaction.

Combining soaring beauty with exacting functionality, MacLean Engineering Sciences Center will not merely house the work of Thayer School. For decades to come it will inspire and enable students and faculty to reach new heights of innovation in education and research.

WINDOWS ON ENGINEERING

From almost every angle MacLean provides views of the inventiveness behind innovation.

ARCHITECTURAL ARTISTRY
MacLean configures traditional materials—copper, brick, glass, and granite—in contemporary ways.

CRITICAL PATHS
An overlook spanning the atrium provides direct access from the Great Hall in Cummings to the first floor of MacLean. Well-planned connections ensure that the two buildings function as one.

SHEAR BEAUTY

MacLean was designed to appear as if one side of the building was sheared off to expose the inner workings of engineering. MacLean's white walls form part of that effect. Store-front windows showcase the student project labs that dominate the ground floor. The three-story atrium linking MacLean and Cummings invites the imagination to soar.

CURRICULAR CENTERPIECE

MacLean's ground floor is dedicated to student project labs and the services and staff that support them. A large central project lab can be reconfigured into several smaller spaces for mini-lectures and student presentations. Work benches are on wheels so students can roll their projects into the atrium or to the CAD and fabrication workshops or machine shop in Cummings Hall. The project lab is surrounded by the instrument room, offices for instructional staff, the electronics workshop, and diffractometer, microscopy, high vent, and materials processing labs. A large-frame lab, home to Dartmouth Formula Racing and Formula Hybrid, is a short walk in one direction, while an advanced design studio is down the opposite hallway. A room for student presentations and video-conferences with project sponsors caps off the integrated project lab suite.

SMARTER CLASSROOM

The 70-seat auditorium in MacLean is more than a lecture hall. It is a center for collaborative learning. Its extra-wide tiers and moveable, adjustable chairs allow students to cluster together to work on problems in class. Every student is connected by wireless and Ethernet for maximum communication flexibility. Side-by-side screens and large-screen video capability provide presentation versatility. The lecture bench is equipped with a sink and pressurized air for demonstrations. Professor Christopher Levey, a member of the MacLean planning committee, predicts that the room will inspire further classroom innovation. "It's a chicken and egg thing," he says. "It doesn't happen unless you have the space for it."

COMMUNITY SPACE

A second-floor patio and a light-filled seminar room are among MacLean's distinctive spaces for community gatherings and classes.

HOW SMALL?
When placed on a penny and viewed through a microscope, the microrobot looks like a blue hair on Lincoln's chin.

PHOTOGRAPHS BY JOHN SHERMAN

The World's Smallest (untethered) Robot

PROFESSOR CHRISTOPHER LEVEY EXPLAINS THE BIG LEAPS BEHIND A MICRO DEVICE.

BY ADRIENNE MONGAN

L

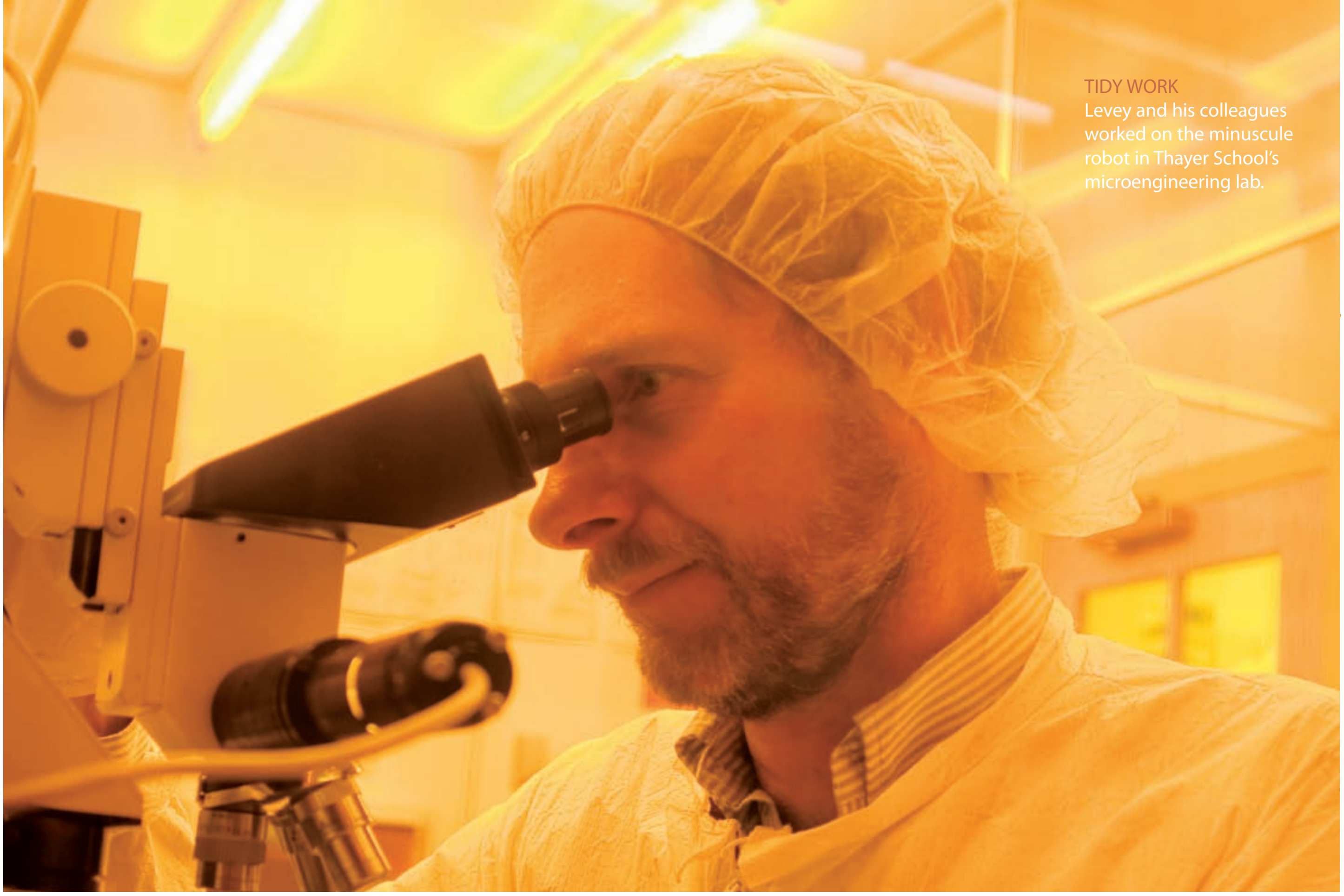
for a tiny innovation: the world's smallest untethered mobile robot. A joint project between Dartmouth computer scientists and Thayer School engineers, the microrobot was created in the microengineering lab in Cummings Hall. We asked microengineering lab director Professor Christopher Levey, co-PI and lead creator of the breakthrough robot's electromechanical design and fabrication, to tell us how he and his colleagues took microrobots to a whole new level.

Just how small is this robot?

The entire robot is under 10 micrometers thick—one-tenth the thickness of a human hair—and consists of a locomotion drive that is 60 micrometers by 120 micrometers and a steering arm that is 8 micrometers by 130 micrometers. When placed on a penny and viewed through a microscope it looks like a hair on Lincoln's chin.

What is the significance of this being an untethered mobile robot?

Whereas earlier mobile devices this size were powered via wires or rails, our robot moves freely on its surface. It is the tiniest robot without tethers that is engaged in its own locomotion and



TIDY WORK
Levey and his colleagues worked on the minuscule robot in Thayer School's microengineering lab.

steering. Power and instructions are broadcast from a grid of electrodes buried under the surface it walks on—there is no direct electrical contact.

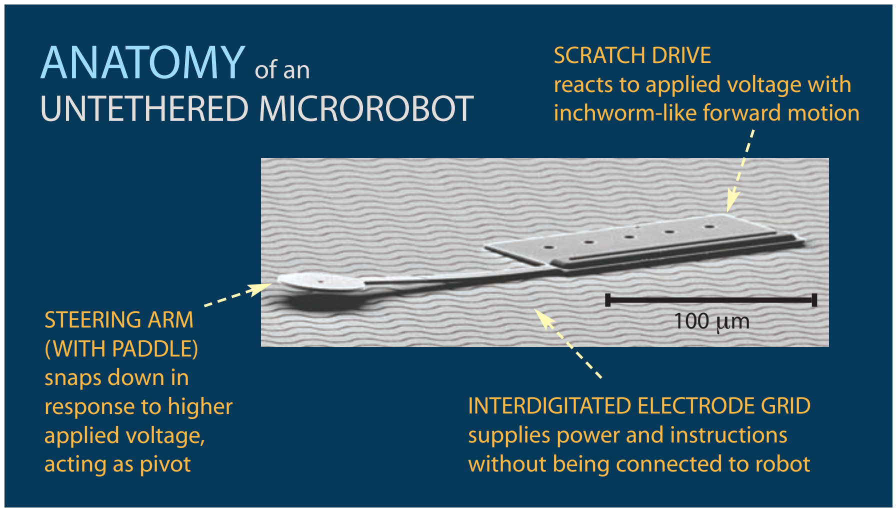
How does the robot move?
The robot contains two independent actuators—the "scratch drive" for forward locomotion and the steering arm for turning. The scratch drive moves like an inchworm, moving forward an average of 10 nanometers each step. We have demonstrated this motion for more than 40 million such steps with no sign of fatigue, covering a distance of about one foot over the course of half an hour. If a person took that many steps, she would travel halfway around the world. The robot turns by snapping down a paddle on the end of its steering arm, then pivoting around it. An operator can control forward motion and turning with a sequence of commands through the wireless transmission that also powers the motion.

How did this idea come to you?
About eight years ago, I was having a discussion with Bruce Donald and Daniela Rus, both computer science professors at Dartmouth at the time (Bruce is now at Duke, and Daniela is at MIT), about their work involving large-scale (brick-sized) self-reconfiguring robots. We started thinking about how to develop similar robot modules but on a much, much smaller scale. Such robots would have several advantages: they would be on the right scale to interact with other very small things and we could make large numbers of them at very low cost by using the microfabrication techniques first developed for the microelectronics industry. The complex interactions of thousands of robots could lead to effects that are qualitatively very different from those of just a few robots, in the same way that the behavior of a computer is much richer than that of a few switches.

What kind of collaboration went into the creation of this robot?
Micromachining research spans a broad range of disciplines, including electrical, mechanical, and chemical engineering, physics, materials science, computer science, and robotics. The success of this microrobot is a reflection of Thayer's non-departmental focus and a strong interdisciplinary collaboration that spanned across Dartmouth. It started with the brainstorming session I had with Bruce Donald and Daniela Rus and grew to include many others, particularly recent computer science doctoral student Craig McGray Adv'05 and current doctoral candidate Igor Paprotny, who did most of the work. Thayer School Professors Ursula Gibson '76 and Francis Kennedy and Ellen Pettigrew '08, an intern with Dartmouth's Women in Science Project, also helped.

What challenges did your team face and how did you overcome them?
Given the minute size of the robot and the delicate environment in which it operates, we faced many challenges. The broadest was how to pack the functionality of locomotion, steering, memory, power delivery, and reception and decoding of control commands into this small a package. We met this challenge by keeping it simple; the entire robot is a single piece of silicon. There are no parts to assemble and no batteries or microprocessors to wire up. Memory is stored in a simple spring-loaded electromechanical switch, the steering arm, which also serves mechanically to make the robot turn.

We also needed to develop a surface environment that would supply power to the robot without using wires, tracks, springs, or other physical connectors. I came up with the idea of using a grid of interdigitated electrodes buried in an insulator to induce a charge polarization in the robot and a resulting vertical force. The scratch-drive mechanism then translates this force into lateral locomotion. After considerable effort by the graduate students in the Thayer microengineering lab fabricating this environment, we found that this scheme works well. It is a "one-wire" system, that is, there is a single signal wire plus one ground wire attached to the environment. All commands are also sent on the signal wire, and distributed



SCANNING ELECTRON MICROSCOPE IMAGE BY CRAIG MCGRAY ADV'05

uniformly over the environmental surface, to be decoded by the robot.

Another challenge was how to address various steering arms and scratch drives individually. Our analysis showed that we could not do this using the standard microfabrication techniques, which allow a designer control of only in-plane shapes; we needed to curl our devices up out of the plane. We took advantage of a previous Thayer microengineering lab invention to do this: Stress Engineered Micro-Structures (SEMS). Engineers working on micromachines typically try to minimize stress gradients in their materials so objects won't curl. In previous work with former Thayer School Professor Al Henning '77 Adv'79 and graduate student Chia-Lun Tsai Th'98, we controlled stress gradients to create usefully curved micromachine parts. The trick is to add a "stressor" layer under tension to the top of the device and to control the extent of the resulting curl through in-plane patterning of the size of the stressor. We now use this SEMS technique to add just the desired curl to our robot steering arms, and hence to allow control of individual arms: Arms curled a long way from the base are thereby programmed to respond only to high signal voltages; arms with little curl will snap down in response to lower voltages.

An obstacle we needed to overcome was that of charging. We found that the scratch drive built up an electrostatic charge, causing it to occasionally stick to the surface. We got around this by alternating positive and negative charges. If the environment charges up positively, a fraction of a second later we switch to a negative waveform to reverse that process. We keep reversing the polarity in order to avoid building up any one charge. The robot responds equally to either polarity.

What is the most significant feat you accomplished in creating this microrobot?
Moving robots this size anywhere we want in two dimensions is a tremendous accomplishment. We managed to free scratch drives from rails and tethers and then added a tiny silicon paddle (coated on the upside with chromium—the SEMS stressor layer) so the robot can turn on command. We can control the paddle's motion separately from the scratch drive; the paddle responds to higher voltage levels. And by varying the size and shape of the paddle, we can create robots that respond to various voltages.

What's the next step for these machines?
Currently we are studying and engineering how these robots can interact. We are studying the waveforms and planning algorithms needed to control complex motion.

We also want to find new ways of making microrobots. One reason that making small robots is so difficult is that we lack an efficient means of assembling small parts. Our robots are made thousands at a time, but as single-piece devices (no assembly is required). It would be advantageous to be able to design future robots constructed from many parts, just the way large robots are. We would like to have our current microrobots eventually work together as assemblers on a microfactory floor; this might allow them to build other, more sophisticated robots out of individual microfabricated parts.

What are the future applications for these microrobots?
We see many opportunities for the microrobots—though there are limits because they only work when sitting on a special buried grid of electrodes. Given that caveat, a likely future application is in cybersecurity. This is an application where Bruce Donald has taken the lead and it has been responsible for much of our funding through the Department of Homeland Security. Here's a security-related scenario: Imagine we are meeting but we don't know each other, so we must verify identity in order to share our secrets. We each bring a vial of microrobots to sprinkle onto a special surface. We then type into a keyboard a coded PIN that makes the robots move properly, which we verify by examining them under a microscope or through shadows cast on a wall. We notice that our robots have started to interact in a way that was not previously told to us, and eventually they produce a shape that we would easily recognize, completing our identity-authentication process. This type of authentication is attractive because it utilizes hard-to-duplicate hardware (the microrobots) as well as a security code (PIN number) and it allows both parties to watch a complex interaction that would be difficult to spoof. By contrast, even the most sophisticated computer-based security-authentication systems typically produce a signal that tells whether the authentication succeeded or failed. This is usually the only signal the user sees; if an intruder intercepts and changes this final signal, the result is compromised, regardless of how robust the authentication was.

Are others taking up this technology yet?
The technology is generating academic and popular interest. We've published two papers in the *Journal of Microelectromechanical Systems*. Craig McGray, who is now with the National Institute of Standards and Technology (NIST), reports that the popular international robot soccer tournament RoboCup—which drew more than 160,000 spectators last year—has proposed forming a new nanogram league in which MEMS microrobots, based explicitly on the technology developed at Dartmouth, will compete in agility drills. A government-industry partnership between NIST and MEMSCAP Inc. is being formed to provide low-cost stress-engineered microrobots to competition participants. The first international competition could take place as early as 2007.

To watch microrobots in action, visit:
engineering.dartmouth.edu/microeng/robot05.html ☐

Adrienne Mongan is a freelance writer based in Vermont.

Alumni/ae News

FEEDBACK LOOP

Life on Earth

I found the interview comments of Dartmouth's sustainability coordinator, Jim Merkel, ["Ecological Footprints"] in the spring issue of Dartmouth Engineer to be at odds with reality. Merkel would have us believe that there is a critical figure of merit, the ecological footprint, that is an overwhelmingly important indicator of man's eco-friendliness. Americans have a footprint of 24 acres, compared to the rest of the world, which has an average footprint of about four acres. He believes we should feel guilty about this calculation, saying that he often has to make the difficult choice between hurting the earth (by flying) and hurting his family (by missing family graduations).

Has Merkel ever flown to one of those countries with a four-acre footprint? If so, he will find some of the worst ecological destruction on earth. Starving people will wipe out a species to eat. People who have no income will slash and burn rainforests or kill elephants for their tusks to earn the few dollars needed to obtain the rudiments of life. It is well known that the advanced countries with enough personal wealth to meet basic needs—with some left over for the environment—do the best with the environment. It's not about footprint. If you want data, go to the EPA Web site. Every important environmental pollutant identified in the 1970s has been driven down dramatically by conscientious efforts funded by our industrial society.

Merkel sees humans as contaminators of the earth, incapable of solving ecological problems. I view humans as intelligent creatures who have proven themselves quite capable of solving the problems required to both enjoy their lives and still leave the earth in good shape. Merkel would categorize me as a large-footprint type because I drive my car solo to Silicon Valley every morning. However, when I get there, I spend my career working on reducing the power consumption of electronics and producing pollution-free power with advanced solar cells. Over the next decade, solar energy will produce much of the clean, pollution-free energy needed to break our dependence on fossil fuels and the countries that control them.

Parents should go to graduations—and enjoy them. Then, our graduates should go forth to solve our problems instead of retreating from them.

T.J. Rodgers '70
President & CEO
Cypress Semiconductor Corp.
San Jose, Calif.

Editor's note: *T.J. Rodgers is a member of Dartmouth's Board of Trustees.*

spotlights

DuPont recently honored **Richard Livingston '43 Th'44** by naming a new consultation room after him at DuPont Singapore. The capstone of Livingston's career with DuPont was an innovative manual he published, which details melt nylon properties responding to chemical and mechanical inputs. The manual was a central reference document for DuPont's mathematical simulations and nylon solid melt processing.

Beginning in 1970, Livingston gathered data for modeling of nylon chemical processes. He presented all of the data with charts, a unique approach that had not been tried before. "This was very early in the computer era," Livingston says. "We were manufacturing nylon at the plant where I worked, and it was hard to cope with the multiple chemical changes. I attempted to categorize all of the changes."

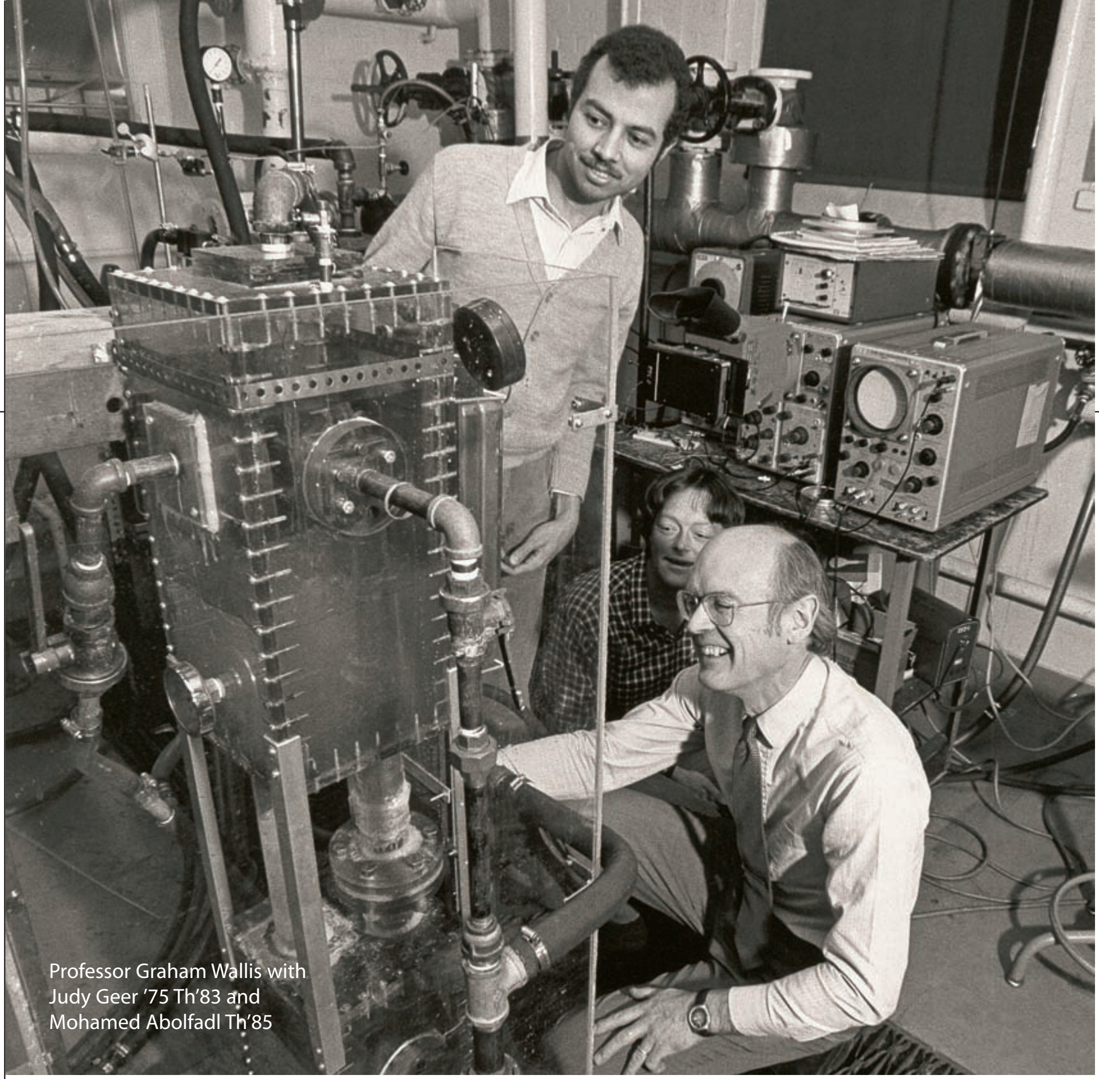
He experimented with applying computer power to the engineering technology for the manufacture of nylon. An early assignment was to work out a simple element of the process to demonstrate it could be modeled on computers. He connected relationships between what happened to nylon under increases in temperature and pressure. "I was shocked to find how little we really knew in terms of specifics, absolute relationships," he says. "It forced me to play around and gather together sources and that went on for several years."

Livingston and his colleagues were allowed to run tests on DuPont's IBM machines at night. "More often than not, they wouldn't work," he says. Livingston assembled all of the information he collected in a manual titled *Polymer Relationships*, which is still in use at DuPont. Livingston says the results that he compiled in *Polymer Relationships* were long-lasting because they were useful in many areas. "What we found turned out to be fundamental truths," he says. "The chemistry is the same even though the equipment is modified. The relationships are not specific to a certain application."

While he says he is flattered by DuPont's recent recognition of his contribution, he has no plans to travel to Singapore to check out the Livingston room in person. He is just as proud that his work is useful more locally. "There are some people who live in Seaford [Delaware] and work at the DuPont plant here," he says. "They tell me they still use the manual."

Livingston, one of three students in the first mechanical engineering class at Thayer School, served with the Navy in the South Pacific during World War II and joined DuPont in 1946. He spent seven years in Buffalo, N.Y., at a DuPont rayon plant and then moved to Seaford, where he worked until his retirement in 1982. He stayed with DuPont as a consultant for another 20 years.

—Jennifer Seaton



Professor Graham Wallis with Judy Geer '75 Th'83 and Mohamed Abolfadl Th'85

Ariel Dowling '05 Th'05 recieved a National Science Foundation grant for three years of graduate study leading to a research-based master's or doctoral degree. Dowling is working on an M.S./Ph.D. in mechanical engineering at Stanford University, focusing on biomechanics with a project on anterior cruciate ligament (ACL) injuries of the knee. She is looking into the mechanism of an ACL injury—as well as how a person's gait changes before and after ACL reconstruction surgery—in an effort to improve the surgical procedure. This year's honorable mentions include Erik M. Dambach '04 Th'05 and Kara K. Podkaminer Th'09.

Benton Routh '86 Th'87 has advanced from his position as chief marketing officer of fuel card provider FleetCor to president of its new division. Routh, a 15-year veteran of the oil and credit card industry, heads FleetSource, which offers products and services customized to independent petroleum marketers. Prior to joining the Atlanta-based FleetCor, Routh was the global manager of the commercial vehicles and card business at Exxon Mobil Fuels Marketing Co.

John McNeill '83, an associate professor of electrical and computer engineering at Worcester Polytechnic Institute, received the Institute of Electrical and Electronics Engineers' outstanding paper award at its International Solid-State Circuits Conference in San Francisco in February. He is the coauthor of "A Split-ADC Architecture for Deterministic Digital Background Calibration of a 16b 1 MS/s ADC."

your favorite classes

We asked you to tell us what engineering classes you enjoyed the most. Here's what you said.

ENGS 15, "Introduction to Product Design"
It focused on preparing business plans for a new product that we designed and built. I thought it had a lot of relevant skills to teach and it had a lot of entrepreneurial spin to it. We had to learn how to be team players, use creativity, and overcome challenges.

—Vicente Ramos '95

ENGS 21, "Introduction to Engineering"
I discovered talents I never knew I had. Developed long-term relationships with faculty—Sid Lees, especially, and John Strohbehn—and fellow students—Dean Spatz, Chris Miller, and Hector Motroni, in particular. Discovered that learning for the purpose of creating is easier, more fun, and more productive than learning to pass a test, get a degree, or learning for the sake of knowledge itself.

—Frank Barber '66

I recall our bus trip to Crotched Mountain School to visit with students with disabilities. Our teams had to come up with a project that would help them. My team selected to construct a typewriter that would produce both Braille and typed letters. We were better designers than technicians, as we were not able to produce a working prototype, although we really tried.

—William Judd '67 Th'68

Learning engineering is a grind, but practicing engineering is fun. Having this course upfront created a vision of what I was really working for through five years at Dartmouth and two at Carnegie Mellon.

—Tom McWhorter '69 Th'70

It taught me the very important lesson that I cannot work with everybody. It wasn't a fun lesson to learn, but it's one of the most important. I think about that class every time I hire someone or come into a work team.

—Kiersten Muenchinger '93

ENGS 21 because of the entrepreneurial/creative/team components.

—Sam Winslow '94

I loved how it covered the whole product development cycle, from identification of a need to prototype

Professor Hans Grethlein

and marketing. It was a great experience so early in the major.

—Elizabeth Davis '99

I didn't want to be a practicing engineer, and this class really helped me apply engineering problem-solving skills to a business settings. The option evaluation, teamwork, market research, data support, and presentation skills I learned gave me a leg up at my first post-graduation job as a management consultant.

—Lindsay (Bowen) Coe '00

I enjoyed the teamwork. I encouraged my non-engineering-major friends to take it and they all loved it, too!

—Sujan Patel '01

The projects required innovation, and students were given the freedom to find problems and solve them in their own way. At such an early part in the curriculum for an engineer, most programs would not allow engineering students the ability to be this creative. I believe this class embodies why Thayer produces phenomenal graduates. This class, as well as ENGS 190/290, prepared me for my career as a project manager for Abbott Diabetes Care. I will be forever grateful for the lessons these classes taught me, as I still use them every day.

—Mara (Bishop) Winn Th'01

My group decided to design a blind-spot detector, which involved selecting and wiring some chips together on a board. We had no idea what we were doing and thought we were doing something pretty advanced. The next year I took ENGS 31 and realized that the whole project would have been pretty easy (with many fewer sleepless nights) if we had only known something about digital electronics.

—Kelly Cameron '04 Th'05

ENGS 22, "Systems I"
We learned how to calculate the heat loss from a bald guy's head in the dead of a Dartmouth winter. Professor Hans Grethlein didn't have much hair.

—Tom McConnell '76

ENGS 22 with Al Henning was the first class that took all of that crazy non-linear math and made it "visible." The class mapped the theoretical formulas to the real world and showed how you could use them to predict a physical problem.

—Alinia Uy Asmundson '96

ENGS 31, "Introduction to Digital Electronics"
I remember the synthesizer that Nik Nesbitt, Caroline Howe, and I built for digital electronics. We went to the music department and recorded several different instruments as they were played. We captured the waveforms and programmed them into digital components. Not only could we play music using the keyboard, but we were able to record, play back, fast forward, and rewind. The look of delight on Professor Hansen's face when we presented the project is one that I will never forget.

—Brad Davis '85 Th'86, '87

In this class you could start out knowing absolutely nothing and end up creating some really interesting tools and toys.

—Krispin Leydon '99 Th'01

ENGS 33, "Solid Mechanics"
I watched Professor Kennedy weigh the bridges before the competition. He ran out of weights, so he used cups of apple cider (which he had on hand for the occasion). Nothing was better than watching Leonard's joy as he pumped up the hydraulic ram to smash our hard work to toothpicks!

—Bob Batt Th'00, '01 Tu'06

ENGS 35, "Biotechnology & Biochemical Engineering"
This class is what jumpstarted me on my current career path.

—Roberto Barbero '01Th'02

ENGS 37, "Environmental Engineering"
As an environmental lawyer for the Ohio attorney general I brought many Clean Water Act enforcement cases against municipalities. It always helped to know a thing or two about design of wastewater treatment plants. I do similar work now with the U.S. Department of Justice.

—Jim Payne '81

ENGS 44, "Sustainable Design"
The class was filled with informal brainstorms, mind-maps, prototyping, and a lot of laughs. I continue to apply what I learned to my career in product design.

—Brian Mason '03 Th'04, '05

ENGS 50, "Distributed Systems and Fields"
Professor Laaspere's class on field theory was very difficult, but it caused me to look at the world in an entirely different way. It was inspiring.

—Bill Kellogg '73

Professor Wallis' fields class pulled together various engineering disciplines into a unifying theme. It also made me really appreciate the beauty of math. Perhaps most important, it was in this class that I learned "there's no partial credit in life" (his reason for giving us none)!

—Bill Rockwood '81

Professor Sonnerup challenged you to think about how different systems use the same underlying mathematics.

—Joyce Nagle Th'90

Professor Kennedy catered the course to the students. I felt like I learned more in his class than I did in any other course at Thayer.

—Patrick Orie '96

ENGS 51 [ENGS 33], "Solid Mechanics"
No question, ENGS 51 with Francis Kennedy.

—J. Tobias Reiley '81

From a standpoint of fun: Professor Kennedy's ENGS 51. From a standpoint of practicality and usable content: ENGS 67, "Digital Electronics."

—William Loginov '85

ENGS 52 [ENGS 26], "Control Theory"
It helped me think through problems more thoroughly and take the human element into account. We read a critique to an article and everyone in the class agreed how bad the original article must have been. We then read a rebuttal to the critique and weren't sure what to think. It is important for people to figure out the truth on their own.

—T. Mark Jones '84 Th'85

ENGS 56 [ENGS 35], "Introduction to Biomedical Engineering"
The instruction was on the engineering principles of current biomedical technologies—hyperthermia treatments for cancer, MRI, respiratory models. It was the best integration of academic and practical instruction.

—Kevin Franck '92

Professor Collier gave an overview of various aspects of biomedical engineering. The most memorable moments were getting a brain MRI scan for each student and inspecting failed artificial hip and knee joints. I also liked "Physiological Control System Modeling" with Professor Daubenspeck. We only had three students in the class, and we had extreme flexibility to choose our own models. Profes-

Professor George Taylor

sor Daubenspeck was enthusiastic and fostered creative thinking.
—Jan Lammerding Th'97

ENGS 61 [ENGS 25], " Thermodynamics"
My first thermodynamics class almost took me out! Professor Ermenc knew his subject cold but had a distracting speech habit: putting in the filler word "here" every 30 seconds or so. Once in awhile he'd cross you up with a "there." With my thermo skills and his teaching, I was grateful he gave me a D in the course. The next semester I earned one of my best A's from him in heat transfer. Come to think of it, his "here" rate was lower in heat transfer.
—David Porter '59 Th'60

Thermo with Professor Richter. My only regret was that I did not take his courses earlier. He was, by far, the best professor I had at Thayer.
—Logan Bullitt '94

I liked thermo with Prof. Richter, although that was one of the hardest. I also liked building the Sterling engine in the shop. I spent three summers in the machine shop.
—Mike MacAvoy '93 Th'94, M.D.

It's a tie between thermodynamics with Professor Richter and organizational design with Professor Joyce. I use what I learned in those classes every day.
—Sean Casten Th'98

ENGS 62, "Fluid Dynamics"
My grades at Thayer were not strong and I semi-elected to forgo the fifth year and go directly to Navy flight training. After six years in squadrons I was sent to the postgraduate school in Monterey, Calif., where I and other entering classmates took an engineering record exam. I scored in the low 90s, and my fellow classmates, who had attended other major engineering schools, scored mostly in the 50s and 60s. The people giving the test suspected foul play, and I was called in to chat about the test. While my grades did not reflect it, I really did learn and retain a lot, which enabled me to enter the most difficult program (physics) and do quite well.
—Jim Vohr '57

Professor Graham Wallis derived the problems for the final exam from the *The Tempest* by Shakespeare. Each problem was preceded by a passage of *The Tempest*. Then the problem was restated with specific assumptions and values (i.e., wind velocity, mass of the angel Ariel, shape of the angel's wings, etc.). Professor Wallis ideally matched hard engineering science with a masterpiece of literature.
—William Weston '72 Tu'74

ENGS 63, "Science of Materials"
I had a huge "aha moment" when I finally understood the 3-D structure of steel, and hence understood why steel is so much stronger than plain iron. At Thayer School I learned to think in a logical and structured way that has served me well.
—Jack Oswald '84

With its blend of physics and engineering the course directed me toward my life's work.
—Ken Jones '85 Th'87

ENGS 64 [ENGS 32], "Introduction to Linear and Digital Circuits"
The professor was very good and had a wonderful sense of humor—and also took us on a hiking trip in the White Mountains.
—Bart Lombardi '52 Th'54

My best Thayer courses were taught by George Taylor. In this course we learned the fundamentals of each part of a circuit, why it existed, and what function it performed. The final exam was fun. It was open book, and we had to explain what was happening as the current flowed through the entire circuit. Professor Taylor was good at explaining the fundamentals and always challenged us to excel. He was was very approachable, understanding, and helpful.
—Charlie Schneider '57 Th'58 Tu'58

Professor Stratton seemed to enjoy his subject and made the class enjoy it, and, consequently, I think we all learned more than we might have otherwise. Professor Stratton always had time for us if we needed help. He genuinely enjoyed teaching, and it came across to the students.
—Steve Askey '76 Th'77

Without a doubt, Professor Stratton's electronics class.
—Venkatesh Nagar Th'90

Professor Stratton's classes.
—Joshua McCurdy '99

No one loved his subject matter and the students more than Professor Stratton. You didn't get the full Thayer experience without getting the Professor Stratton lecture on gassing up your car the day before Thanksgiving.
—Joshua Payne '96 Th'97

ENGS 73, "Materials Processing and Selection"
We did a project where we learned to weld and study the property changes from welding on various metals. In our group presentation on our finding we learned the value of teamwork and learned to appreciate the contribution of different individuals
—David Prince '79 Th'81 Tu'81

ENGS 76, "Machine Engineering"
The class where we had a large box of parts and had to build a robot for a competition combined practicality, theory, and amusement into one package. Incidentally, I happened to win that particular competition.
—James Rourke '95

We spent endless hours teaching ourselves Pro/Engineer and working in the machine shop to get our "robo-hockey" player just right.
—Gus Moore '99 Th'01

Professor Kennedy's ENGS 76 was a great hands-on experience.
—Ron June '02

Tons of work but rewarding. The combination of interesting subject material and a fantastic project made it worth it. We worked extremely hard but produced a great project.
—Ariel Dowling '05 Th'05

Learning about the mechanical systems that surround us every day, then building a project incorporating all aspects of classroom learning into a friendly competition requiring dirty hands and innovative thinking. Throw in a superb professor, Kennedy, and there you have it.
—Dale Apgar '04 Th'05

ENGS 100 & 101, "Structural Theory and Design I and II"
Structures with Professor Minnich: very practical, always interesting. A class I built a career on.
—Victor Macomber '46 Th'52

While studying for the open book final exam I realized there was only one configuration of end-supported

Professor John Collier, right

beams we hadn't already had as a problem or class example. Preparing for the exam, I carried out that analysis. It turned out that the problem on the final was the one that I had prepared; I had only to change x to -x and copy my work. That problem definitely helped my grade.

—Harris McKee '61 Th'63

ENGS 105, "Computational Methods for Partial Differential Equations"
Professor Lynch's numeric methods required extensive programming and dealing with a plethora of math equations every week. I spent a whole evening just finding a bug in the program. It was fun, though, when the final result was shown in the beautiful graph. Professor Lynch made complex things simple to understand.

—Ming Qi Th'01

ENGS 116, "Computer Architecture"
Professor Linda Wilson's class explored the hardware/software system dividing line. Usually computer scientists operate on the software side and hardware engineers on the hardware side; Professor Wilson asked us to consider both to improve our understanding of computer architectures and design skills.

—John Carey Th'01

ENGS 141, "Heat, Mass and Momentum Transfer"
Three courses leap to mind: Graham Wallis' "Heat, Mass and Momentum Transfer," for learning how to solve PDE's with such geometries as the rolled roast and spherical turkey problems; Hans Grethlein's "Experimental Design"—or how to get the most bang out of the least buck when gathering data; and "Engineering Economics," a concise course on the time value of money in project decision-making.

—Richard Gregor Th'71

Each week Dr. Graham Wallis gave us impossible problems and encouraged us to work together to figure them out. He stimulated numerous conferences and discussions in the old "barn." To show no ill will, he invited us to his house in Norwich for swimming and picnicking. His wife was kind enough to teach me how to make bread. Besides my very average career as an engineer and surgeon, this skill has distinguished me over the years. I also enjoyed Prof Ed "Brownie" Brown's "Water Resources" [ENGG 110]. We designed Quabbin Reservoir and conduits to reach Boston, complete with pumping stations, etc. It made me feel like a real engineer!

—Peter Areson '72 Th'73, M.D.

ENGS 160, "Biotechnology and Biochemical Engineering"
Professor Gerngross gave each student oral interview tests.

—Brian Graner '01 Th'02

ENGG 171/ENGG 181, "Marketing"
Engineering economics changed my entire future as I changed from a focus on surveying and construction to a focus on the financial aspects of business. I retired as the treasurer of New England Telephone Co.

—John Cogswell '55 Th'56

Marketing with the late Professor Caroline Henderson put a different perspective on problem solving—how to look at, identify, and solve non-technical problems.

—Shailesh Chandra Th'91

ENGM 176, "Total Quality Management"
Our project allowed us to visit a company and solve a problem that they had. It was a fantastic experience.

—Heather (Bartholf) Harries Th'97

ENGG 181, "Legal and Ethical Analysis"
I used George Taylor's engineering law for a whole career. That and his engineering economics (I proofed all the problems in his text before it was published) were the two most useful courses.

—Tom Jester '63 Th'64

George A. Taylor taught contract law and a return on capital investment course utilizing discounted cash flow rate of return analyses. George was straightforward and emphasized only a few basic precepts in each course. In the opening lecture he would write on one blackboard the half dozen things he wanted us to retain after taking the course. I still remember his cardinal points, and use them. My classmates referred to him as "The GAT"—a play on his direct straight-shooter style and his initials.

—Bob Woolman '57 Th'58

ENGM 183, "Operations Management"
Group activities in Professor Hall's class made it fun, interesting, and memorable. I've used material from that class in several work projects. I've also utilized information from "Issues in Engineering Management," specifically the content on TQM.

—Ashly Downey Th'03

Case study discussions were a welcome relief from the usual engineering lecture class, and Joe Hall did a fabulous job relating the material to actual business situations and his real-world experiences. Games and simulations were a great part of the class and made for a friendly competitive atmosphere among classmates.

—Kristian Lau '04

ENGG 191, "Physical Metallurgy"
Metallurgy—with a great teacher, Ed Brown. I used the basics of my Thayer courses for the rest of my career.

—Alan Wright '51 Th'52

ENGS 197/198 [ENGS 190/290], "Project Initiation and Completion"
In my fifth-year project with George Whitehead we fabricated a silicon alloy junction diode with materials we obtained from some generous companies. It was a great learning experience that helped prepare me for graduate school.

—Ralph "Dick" Spencer '61 Th'62

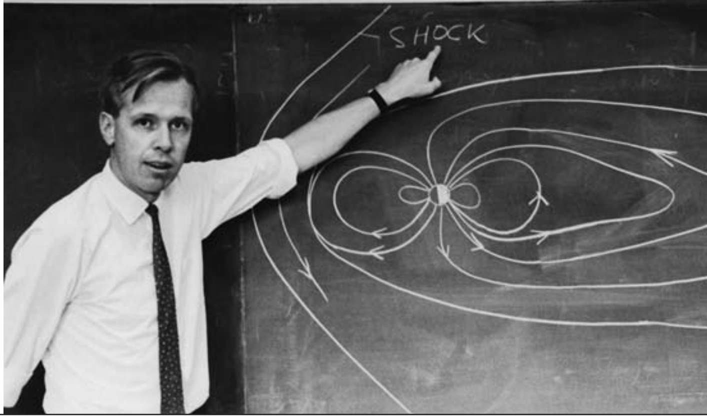
ENGG 296 [ENGG 390], "Master of Engineering Project"
My choice: the M.E.M. project class.

—John Merhige '94 Th'95

More Faves
I really enjoyed surveying—it was as precise as we were skillful.

—Richard Livingston '43 Th'44

My favorite Thayer class during the 1946-47 year was Professor Ed Brown on "Strength of Materials" There was excellent give and take—we didn't just sit there taking notes. And we learned. As we approached finals we decided that memorizing the numerous formulae overtaxed our delicate brains. We petitioned him, forcefully, to allow us to use a helpful compendium of just about any formula we had encountered during the year. He reluctantly agreed, on condition that he prepare the list. Expectantly, we came to the exam. Sure enough, he had a stack of (folded) formula lists as well as the exam itself. We were pleased with our success. When we opened the list, it said only: F=ma. Professor Brown had won (as usual), and we had learned an important lesson: Stop moaning and get on with the work.



Professor Bengt Sonnerup

—*Tom Streeter '44 Th'48 Tu'48*

My favorite course was a tutorial with Jim Browning. I had become interested in jet engine design through one of his thermodynamics course, and I came to him with a question along the lines of, "Why don't they do such and such?" His reply began, "Well because," and ended with, "Gee, I'm not sure. I'll tutor you in a one-hour credit course and you can either figure out why it doesn't work or why it is a sound idea." We determined that the idea really would work, although the metallurgical demands due to certain heat differentials were pretty severe. The experience led to Jim Browning hiring me during my final year as a Tuck-Thayer to work on the development of his plasma jet torch, the precursor to Thermal Dynamics.

—*Em Houck '56 Th'58 Tu'58*

At the time our Thayer class was marching through Cummings Hall there was not yet a discipline known as "computer science." But, on the heels of an exceptional course on numerical analysis with Professor Tom Kurtz of Dartmouth's math department, I decided to pursue a career in that high-tech field just unfolding. The two mandatory summer courses between our undergraduate senior year and the following graduate year at Thayer were just what I needed to cement that career proposition into place. One course dealt with digital computers and the other with analog computers, and the syllabuses for the two were coordinated—we could solve some of the same problems in two different ways. Professor Carl Long taught the digital course, and it was absolutely fabulous. I enjoyed it so much that it was one of the few courses I aced. Professor Long was a gifted teacher and a kind and patient man. He opened up the new world of digital computers and made it exceptionally attractive. Forty years of working happily in the computer industry followed for me, I was indeed very fortunate to have had Carl's introduction.

—*Peter Robohm '60 Th'61*

In George Taylor's methods engineering course there were no right or wrong answers. The only requirement was to think "outside the box."

—*Neil Drobny '62,Th'64*

Professor Taylor's methods engineering was a favorite class.

—*Rick Van Mell '63 Th'64*

In Myron Tribus' thermoeconomics class we learned about the value of doing a complete input/output analysis of all the transfers of material and energy across the boundaries of a system and then tying these flows to the economics of each flow. It made such complete logical sense that it has impacted much of my view of situations during the rest of my life! Things are more complex than they appear on the surface. For example, hybrid cars seem to be more economical for society than gasoline-powered cars are, but the impact of the efforts needed to make the batteries and then to dispose of them may, in fact, be more of an environmental/economic burden than the gasoline-powered car is. The class was small and the focus was on practical applications of the theory. A truly life-changing experience.

—*Steve Brenner Th'64*

After 40 years, I no longer remember course names and numbers. However, it is clear that one course taught by Bob Dean to the fifth-year students was a watershed for me. Professor Dean totally shaped my career with his energy, creativity, and enthusiasm. He taught us that creativity (the sort that results in patented inventions) can be learned. He was inspiring at a very personal level. Each evening before bed he dictated notes detailing the issues that he had to deal with. That helped to make his subconscious work on the issues all night. His energy seemed boundless. I would hand in a paper late in the day and find it on my desk in the morning marked up in excruciating detail in red pen. The course itself was nearly irrelevant. The contact that it created between us and Professor Dean was life-altering.

—*Robert Prescott '64 Th'67*

I took only a single Thayer course after having received a double major in physics and chemistry from the College. However, I found that course so interesting that I changed my major from physics to electrical engineering at Stanford and got my Ph.D. in electrical engineering in 1975. So, even though I run a Silicon Valley chip company, my engineering career began with only a single course at Thayer.

—*T.J. Rodgers '70*

Professor Kennedy's metallurgy class was great—working with steel samples, a furnace, and a tub of water. I also loved Horst Richter's thermo class—he kept telling us how the "wapor was doing za verk." Thermo definitely had the most interesting problem sets. I loved the bridge-building class. My group's bridge, which I still have, won for least deflection but got dead last for predicted deflection. I guess my team was good with a milling machine but not so good with a calculator. I took a class called "Corrosion" [ENGG 190] and Professor Frost managed to make rust interesting. Fluid dynamics had to be the highlight, if only because I finally understood applied calculus.

—*Doug Kingsley '84 Th'85*

Complex variables was the hardest course I ever took, dealing with things that I now only remember by name like Riemann sheets and Cauchy's theorem. It was my favorite because of the professor, Bengt Sonnerup, who I remember fondly.

—*Doug Rand Th'85*

Millet Morgan's antenna course was my favorite. There were two of us taking it. Millet, who was already retired at the time, was a lot of fun to listen to. He took us on a field trip to his property, where he had an ionospheric probe. He showed us his private antenna system, which allowed him to listen to a classical music station that broadcast from Montreal. The Morgans very graciously served us lunch on the occasion.

—*Alex Hartov Th'88*

I loved so many courses! Loved product design with Professor Robbie, loved working in the machine shop for thermo, machine design, intro and the project courses. Loved the camaraderie of bridge building for solid mechanics and robot building for machine design. But maybe in the end I keep coming back to manufacturing processes as the most memorable. All the field trips, seeing all the different manufacturing plants—I think about it each time I drive from the Baxter R&D building I work in to meet with some of the engineers over in the Baxter manufacturing plant down the road.

50th Reunion

Left to right, Frank Strong '55 TT'57, Lester Reid '56 TT'57, William Beard '56 Th'57, Phil Coyle '56 Th'57, Bill King '56 TT'57, and Emerson Houck '56 TT'58

thayer notes

not available online

DOUGLAS FRASER

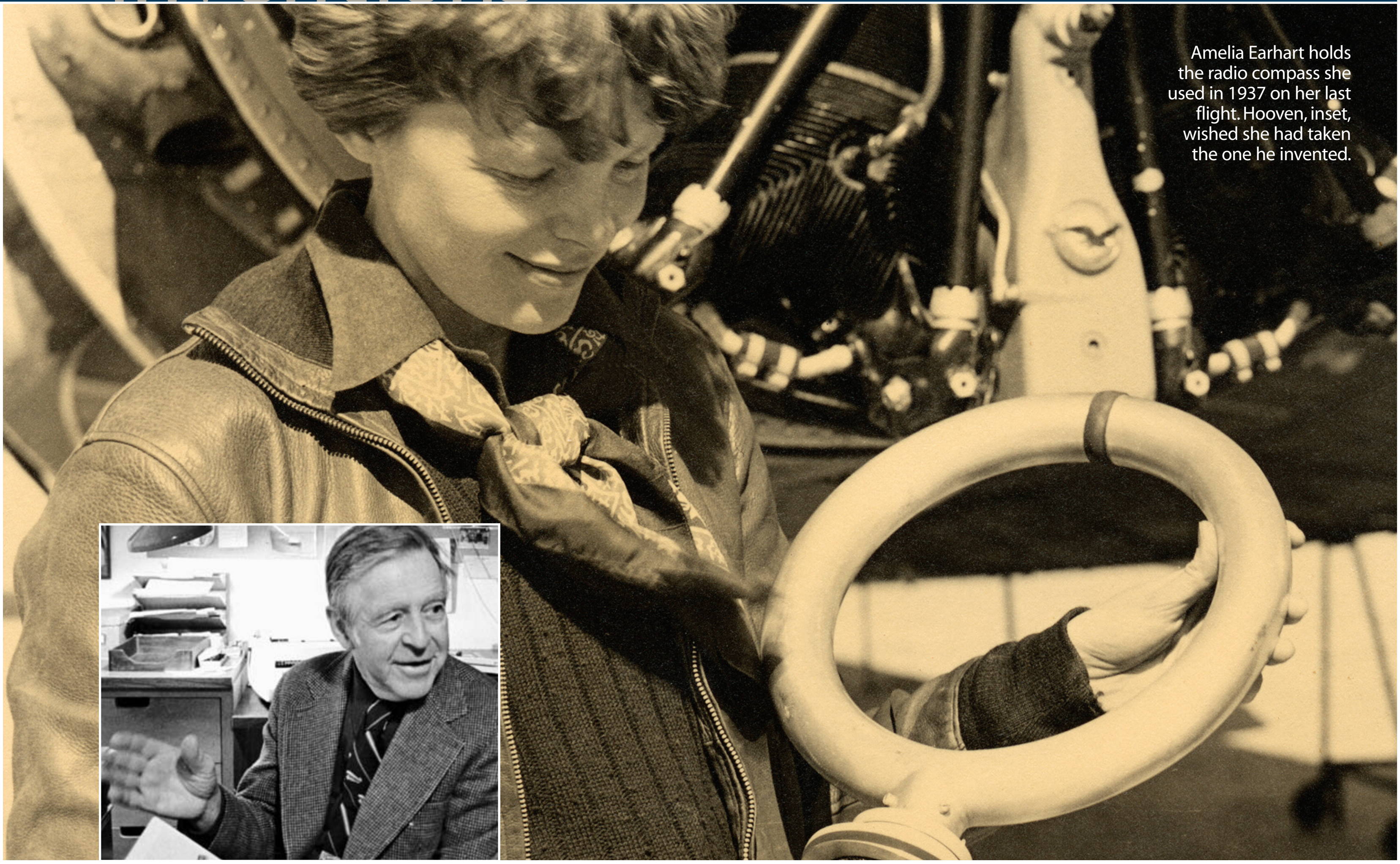
55th Reunion
Left to right, '51 Th'52 classmates John Woods, Don Snell Ed Golden, Henry Parker '46 Th'47 (back for his 60th reunion), Merle Thorpe, and Art Worden

OBITUARIES

Jane Brechlin Olesin Th'76, '78, the first woman to complete the B.E. at Thayer School (in 1976) and one of the first women to complete the M.E. (in 1978) died April 17 in Vernon, N.J., in an automobile accident that also claimed the life of her husband, Steve. She was 53. A graduate of Mount Holyoke College, she held an M.B.A. from Simmons College. She worked as an engineer for Yale University, Westinghouse, the former New England Telephone Co., and Digital Equipment Corp. before retiring several years ago. She was a member of the Acton, Mass., Congregational Church, Acton Council on Aging, and Acton Garden Club. She is survived by her mother, Ella Brechlin, and her sister and brother-in-law, Nancy and Stephen Hoverman.

Bartlett Frost Miller Th'83 died as the result of a workplace accident October 23 in Lebanon, N.H. A graduate of Williams College, he spent several years in Alaska before entering Thayer School and completing his B.E. degree. He worked for Peter Kiewit Sons in Alaska and other locations until 1998, when he founded Interstate Aircraft Co. in Lebanon to redesign and relaunch the Arctic Tern, an aircraft suited for the rigors of bush flying. He had nearly completed his vision for the Arctic Tern at the time of his death. He is survived by his wife, Karen Spencer Miller, and sons Forrest and Graham, of Norwich, and two sisters.

inventions



Amelia Earhart holds the radio compass she used in 1937 on her last flight. Hooven, inset, wished she had taken the one he invented.

HOOVEN RADIO COMPASS

>> INVENTOR:
PROFESSOR FRED HOOVEN '25A

In a memorial tribute to Professor Fred Hooven '25A, former Thayer School Dean Myron Tribus described Hooven as a classical engineer who "viewed the world's problems in terms of their potential solutions." Hooven spent his career solving many problems for science, commerce and fun.

Born in 1905, Hooven grew up in Dayton, Ohio, not far from the Wright brothers. At 5 he befriended Orville. At 15 he sought his advice on building planes. Years later, Hooven used the Wrights' wind tunnel data to design a paper airplane that beat 10,000 other entries in the "duration aloft" category of *Scientific American*'s Great American Paper Airplane Contest.

Hooven, an MIT grad, invented many devices for airplanes, including a radio compass that is still in use. He designed a short-wave radar system for bombers during World War II and invented ignition and landing systems for other planes. Turning to other fields, he developed brake shoes used in all GM vehicles for 25 years and a front-wheel drive system installed in several GM models. He even invented the first successful heart-lung machine. By the time he died in 1985, he held 38 patents in avionics, automotive technology, and medical technology.

Hooven became a legend, however, not because of who used his inventions, but because of someone who didn't.

"Before Miss Earhart took off on her Round-the-World flight she removed from her plane a modern radio compass that had been installed and replaced it with an older, lighter-weight model of much less capability. I am the engineer who had invented and developed the radio compass that was removed, and I discussed its features with Miss Earhart before the installation was made," wrote Hooven in a scholarly paper published in 1982 about Amelia Earhart's final flight. To the end he believed that had she used his radio compass she would have found Howland Island—and a safe landing.

—Lee Michaelides

EARHART PHOTOGRAPH COURTESY OF PURDUE UNIVERSITY LIBRARIES, ARCHIVES AND SPECIAL COLLECTIONS; OPPOSITE PAGE: DOUGLAS FRASER

RANDOM WALK

Thayer School held its annual engineering and technology career fair in a new space this fall: the atrium between MacLean Engineering Sciences Center and Cummings Hall. The event, which attracted 39 companies, was a working reunion: 41 Thayer School graduates came back as recruiters.

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

NON-PROFIT
U.S. POSTAGE
PAID
DARTMOUTH COLLEGE