DARTMOUTH
Engineer
THE MAGAZINE OF THAYER SCHOOL OF ENGINEERING
SUMMER 2009

- STUDENT SOLUTIONS
- DOCTOR IN THE CLASS
- ALUMNI IN MEDICINE

ENGINEERING IN MEDICINE

BEHIND EVERY GREAT MEDICAL ADVANCE, THERE'S A GREAT ENGINEER.

DARTMOUTH ENGINEER
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Engineering in Medicine

BY DEAN JOSEPH J. HELBLE

THE DECISION OF THE THAYER SCHOOL FACULTY THREE years ago to develop "Engineering in Medicine" as an area of strategic growth has led to a broad expansion of medical-related activity. Thayer professors have launched new collaborative research programs with Dartmouth-Hitchcock Medical Center and have created courses on a wide range of medical topics, including cellular and molecular biomechanics, protein engineering, and imaging. Half of Thayer School's 47 faculty members—the highest total in our 142-year history—conduct research and/or teach in the Engineering in Medicine area, including 10 tenure- or research-track assistant professors hired since 2006. This targeted faculty growth comes at just the right time, as we are experiencing significant enrollment increases in all of our programs.

Our Engineering in Medicine focus includes tremendous opportunities for our students in the classroom and the lab. Thayer has developed two new programs with Dartmouth Medical School (DMS). One is a five-year M.D./M.S. program to provide medical students with quantitative engineering skills they can carry forward into their careers as clinical practitioners; it complements our research-focused M.D./Ph.D. program that trains medical research scientists. The second is a new undergraduate major in biomedical engineering sciences that provides an opportunity for top students to seek early admission to DMS, enabling them to spend their senior or Bachelor of Engineering year focusing on research rather than on medical school applications. While our alumni records indicate that at least 3 percent of our graduates go on to earn an M.D.—a large percentage for an engineering school—we anticipate that these new programs will lead many more engineering students to careers in medicine, perhaps even surpassing the record set by the class of 1978, in which nearly 15 percent of our A.B. engineering graduates went on to earn the M.D.

Whether or not students pursue the M.D., our Engineering in Medicine focus is preparing them to develop the next generation of medical advances. With the current national focus on health-care reform and increasing interest in quantitative, evidence-based medicine, Thayer students are in an ideal position to help turn difficult problems into much-needed solutions.

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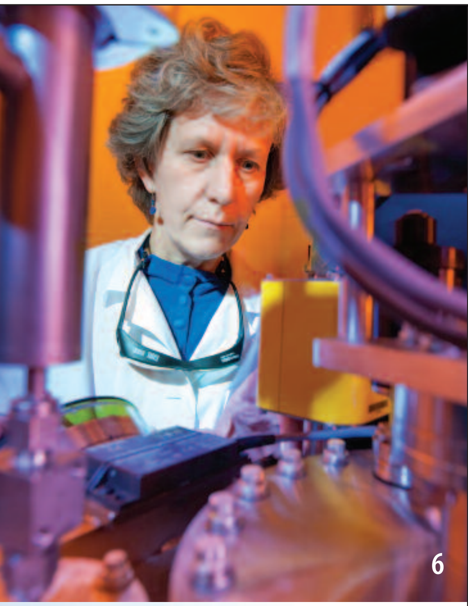
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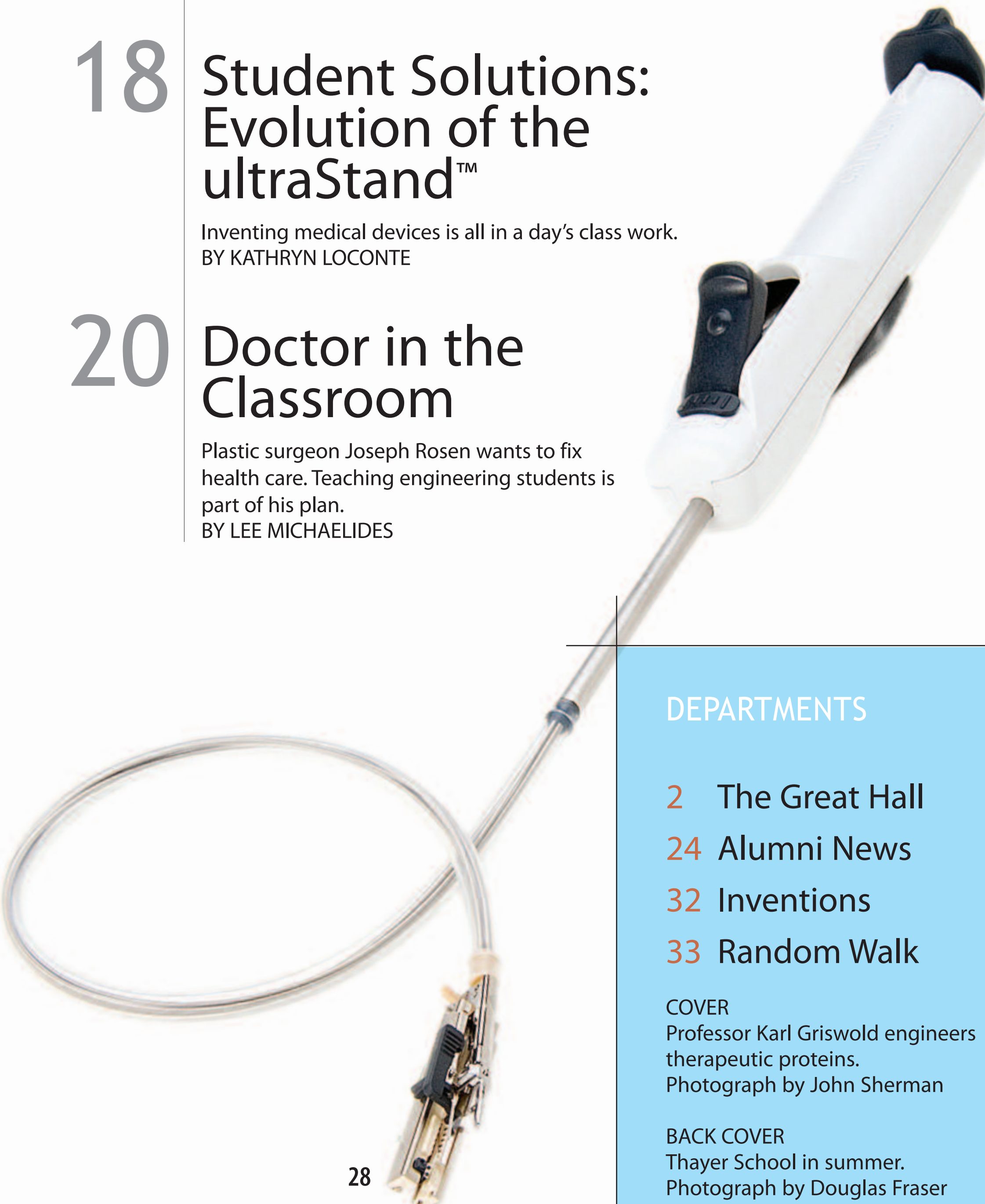
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Professor Karl Griswold engineers therapeutic proteins.
Photograph by John Sherman

BACK COVER
Thayer School in summer.
Photograph by Douglas Fraser

THE Great Hall

>>NEWS FROM AROUND THAYER SCHOOL

FAST TRACK
Dartmouth Formula Hybrid co-captain Mark Criscimagna '07 Th'08, '09 drives in the autocross. This year's car, which featured a mono-shock suspension, independent rear-wheel drive, traction control, telemetry, and custom capacitor monitors, won the IEEE Future of Engineering Award.

STUDENT COMPETITION

Formula Hybrid Speeds Ahead

ANTICIPATION RAN HIGH AT THAYER SCHOOL'S third annual Formula Hybrid International Competition, held May 4–6 at the New Hampshire Motor Speedway in Loudon, N.H. Could two-time champion McGill pull off a three-peat? Could previous underdogs Dartmouth and Embry Riddle catch up? Would Formula SAE World Champion Texas A&M, have the electrical engineering smarts to build a solid first-year hybrid car? Could California Polytechnic State University San Luis Obispo (CalPoly SLO), known to make super-light cars in Formula SAE, leverage that advantage with their hybrid? With 30 student teams competing—twice as many as last year, including teams from Canada, India, Russia, and Taiwan—anything could happen.

The competition began with tech inspections—to ensure that cars were safe to drive—and design and marketing presentations. Judges, including professional engineers from GM, Toyota, A123 Battery, and other companies interested in promoting green engineering, rated the cars side-by-side and tested each team on the execution of design details.

Cars hit the track on a rain-drenched day two. First up: the acceleration event, a 75-meter straight-line sprint, with cars running in two power modes: gas-electric and electric-only. Speeding to first place in both categories, Colorado State posted this year's fastest time of 5.011 seconds (missing the 4.994-second record set by Dartmouth last year by just 17/1000ths of a second). This year Dartmouth placed fourth in gas-electric and second in the electric-only. Texas A&M took second and third, respectively.

Next up: autocross, a one-lap sprint around a twisty course, with each driver allowed two attempts to set the fastest time. Despite a wet track, Texas A&M set a lightning pace, with laps 23 seconds faster than any other car. Dartmouth had expected to excel in autocross, but a heartbreaking spin-out knocked them out of the running.

Day three—also rain-soaked—began with the results announcement of the design finals. Texas A&M edged out Dartmouth for first place. Colorado State placed third.

The endurance event—30 minutes of continuous hard driv-

Formula Hybrid judge Andrew Burston:
"We're seeing even wilder applications of technology. No one knows the answer yet."


Dartmouth's Formula Hybrid team

ing at a car's limit—was the last chance for any team to overtake Texas A&M. Thirteen cars were ready for the event. The run order was determined by finish order from the autocross: Texas A&M, Wisconsin, Drexel, and Embry Riddle were first in line.

Dartmouth was scheduled to start seventh, but a generator failure diverted the team into a race against time. With three hours remaining, 15 students scrambled to tear down the car, rebuild the damaged generator, and put everything back together. As team after team raced the track, Dartmouth closed in on having a functional car. Then heartbreak again: the endurance course shut down 35 minutes early because too few cars were eligible to make the run. Dartmouth never got the chance to race.

Texas A&M, Colorado State, and Drexel topped the endurance event for gas-electric hybrids. CalPoly SLO, Tufts, UC San Diego, and Alabama headed a pack of electric-only vehicles.

The top winners overall: Texas A&M for gas-electric hybrids and Cal Poly SLO for electric-only cars. Colorado State placed second, Drexel third. McGill, which dominated the previous two years, came in fourth. Dartmouth finished seventh, despite having to forego the endurance event.

What contributed to the success of the Texas A&M and Cal Poly SLO cars? Low weight and careful examination of the rules. The Texas hybrid carried a trim 528 pounds due to the rules allowing minimal electrical energy storage and a generous fuel allotment. The car carried enough energy to complete the electric-only acceleration run and was primarily powered by its 250cc combustion engine. Cal Poly's all-electric car was a mere 420 pounds. "Cal Poly SLO took a ruthless approach to reducing weight," says chassis design judge Andrew Burston of Flux Dynamics. The team used superlight scooter wheels and compact battery packs.

Meanwhile, Brigham Young University came up with a whole new approach. Instead of converting mechanical energy to electrical energy like a traditional hybrid, BYU designed a system to store mechanical energy in the form of compressed hydraulic fluid. Displayed this year as an exhibition car, the vehicle may prove to be a game-changer for the competition and the evolution of hybrids.

And inspiring creative thinking is the whole point of Formula Hybrid. "We're seeing even wilder applications of technology. No one knows the answer yet," says Burston. "Some people are playing the game and trying to win. And some people are just trying wild and crazy engineering ideas that might work and might not. Nobody knows. And that's what makes it fascinating."

—Calvin Krishen Th'07

PHOTOGRAPHS BY YONG SU

CURRICULUM

New Degree: M.S./M.D.

ENGINEERING GRADUATES who want to go to medical school but still continue with engineering have a new option: a joint M.S./M.D. program between Thayer and Dartmouth Medical School.

Designed for med students who plan to practice medicine and want to develop greater understanding of medical technologies, the program includes a funded research experience in engineering that involves practical engineering design and analysis and will lead to a research publication.

For several years Thayer and DMS have offered an M.D./Ph.D. degree program that requires approximately six years of study. The M.S./M.D. program will take between four and five years.

Applicants must hold an undergraduate engineering degree and must apply to each school separately. For further information, visit engineering.dartmouth.edu/graduate.

kudos

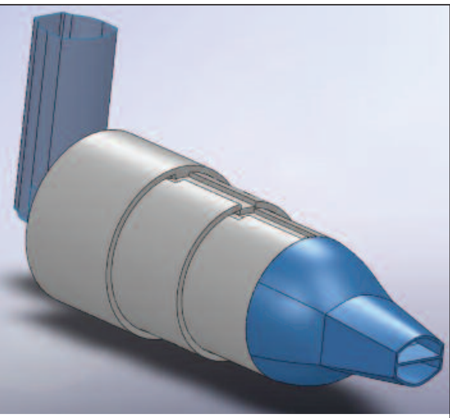
>> Professor Tillman Gerngross, following on the heels of his successful GlycoFi yeast manufacturing system (which he and co-founder Professor Charles Hutchinson sold to Merck in 2006 for $400 million), is driving progress at his latest biotech start-up, Adimab, which re-engineers yeast cells to create antibody factories. "We've created a synthetic human immune system in yeast, and the yeast will do what a normal B cell does, which is create an antibody," says Gerngross. Adimab recently announced major new research collaborations with Merck and Roche.

>> Assistant professor Petia Vlahovska has earned a National Science Foundation Faculty Early Career Development (CAREER) award. Her research aims to mimic the design of biological cells.

>> Professor Ian Baker has been named the Sherman Fairchild Professor in Engineering in recognition of his research, scholarship, teaching, and mentoring. His most recent research is developing iron nanoparticles for cancer treatment.

>> Thayer School has been awarded a grant to support two women as Clare Boothe Luce Graduate Fellows in its new Ph.D. Innovation Program, the nation's first such program addressing the need for engineers with both technical and entrepreneurial expertise.

"Medical imaging is rich with applications of engineering and physics because the instrumentation is technically complex."



STUDENT PROJECTS

I Want One of Those!

Take-a-Breather

WHEN ASTHMA STRIKES, people can regain their breath by using an effective but inconvenient electric nebulizer, a small but inefficient metered dose inhaler (MDI), or an MDI that has a long spacer attached to it to ensure that the medication reaches the lungs. Take-a-Breather improves on the MDI by adding a collapsible spacer and dual-flow mouthpiece. The telescoping spacer keeps the MDI pocket-size. The mouthpiece allows users to breath naturally, like using a nebulizer. **Zakieh Bigio '10, Betsy Dain-Owens '10, Catherine Emil '10, Sarah Feldmann '11,** and **Sarah Rocio '10** developed Take-a-Breather for ENGS 21: Introduction to Engineering. Their teaching assistant was **Ashley Heist '08 Th'09**.

CLASSROOM

Perspectives on Medical Imaging

PROFESSOR KEITH PAULSEN, THAYER SCHOOL'S Robert A. Pritzker Professor of Biomedical Engineering and a radiology professor at Dartmouth Medical School, arrived in class fresh from the Advanced Imaging Lab at Dartmouth-Hitchcock Medical Center. As he walked into Rett's Room at Thayer School, his ENGS 7: Contemporary and Historical Perspectives on Medical Imaging class was waiting. The 15 students were prepared for the last class of the term. Their task: present position papers on the uses—and potential abuses—of medical imaging.

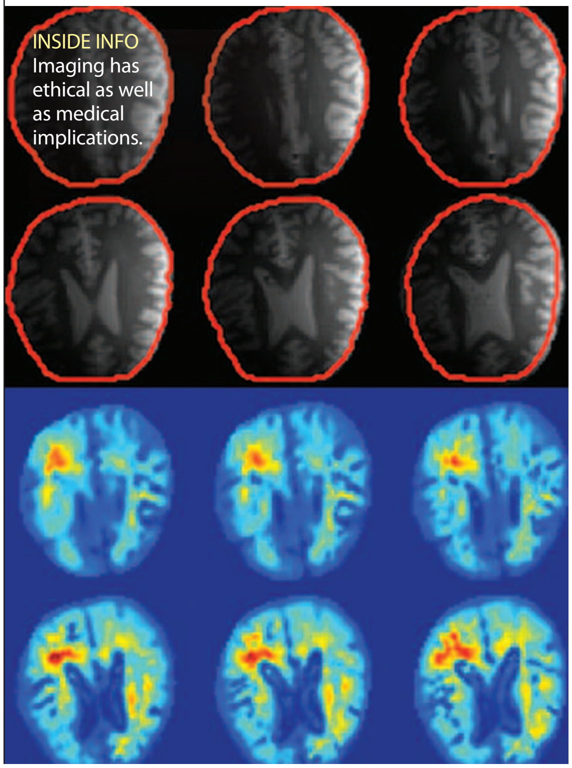
A seminar for first-year students, the course reviews the development of modern radiographic imaging, the basic physical principles behind common approaches to imaging, including computed tomography (CT), ultrasound, and magnetic resonance imaging (MRI), and the pros and cons of each technique. Students consider the broader picture behind bringing imaging into clinical use, such as animal testing, human trials, costs, and the training technicians require. Paulsen, lead investigator on several imaging technology research collaborations between Thayer and Dartmouth-Hitchcock Medical Center (see page 16), also invites students to probe ethical issues surrounding insights that medical images unlock.

So, one by one on this final day of class, students discussed how increasingly sophisticated imaging techniques can lead to earlier diagnoses of breast, lung, and other cancers, and early detection of conditions such as Alzheimer's disease. One student reported on how imaging can be used in assisted reproduction to help with genetic screening of pre-implanted embryos—and then considered moral dilemmas arising from creating a baby to provide bone marrow to another family member. Another student discussed implications arising from the fact that imaging has revealed structural differences between the brains of people with schizophrenia and those without. Some people with structural pre-symptoms go on to develop schizophrenia, but some don't. Should all these people be pretreated anyway? What about unnecessary procedures, costs, and potential stigmatization and discrimination? What about insurance companies using imaging to identify structural differences and then denying coverage?

"The overall goal is to expose students to the field of medical imaging and have them learn the basics, how the systems work, and some of their strengths and weaknesses," says Paulsen.

"Medical imaging in general is rich with applications of engineering and physics because the instrumentation is technically complex," he says. "Many of the body's systems and functions can be modeled, controlled, and investigated using engineering principles and methods. The instrumentation that is used to deliver health care is also very technical and rapidly evolving. As a result, engineering is becoming an increasingly important field of study in both biomedical research and medical delivery at all levels of the health-care system."

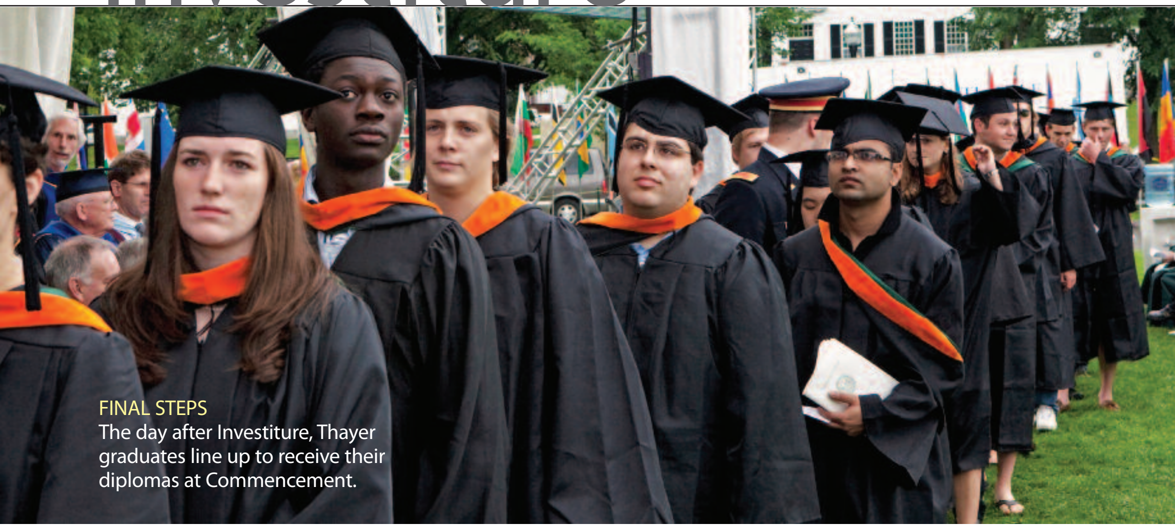
—Kathryn LoConte



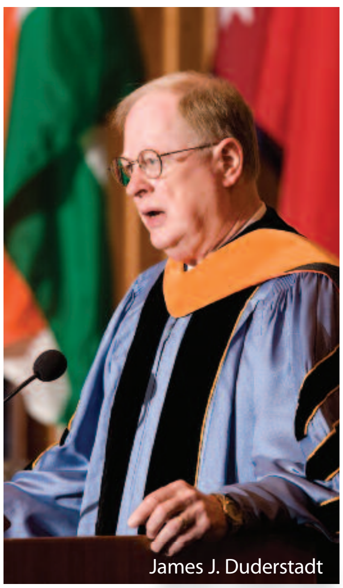
INSIDE INFO
Imaging has ethical as well as medical implications.

kudos

investiture



FINAL STEPS
The day after Investiture, Thayer graduates line up to receive their diplomas at Commencement.



James J. Duderstadt

THE INVESTITURE CEREMONY honoring Thayer School's Class of 2009 was held June 13 in Spaulding Auditorium at the Hopkins Center. Dean Joseph J. Helble presided over the presentation of hoods, caps, and awards to 129 recipients of Bachelor of Engineering and graduate degrees.

The recipient of Thayer School's Robert Fletcher Award for distinguished achievement and service was James J. Duderstadt, President Emeritus and University Professor of Science and Engineering at the University of Michigan. Winner of a National Medal of Technology, he is an expert on nuclear energy, high-powered lasers, information technology, and policy development in energy, education, and science.

"My cloudy crystal ball suggests a future characterized by rapid, unpredictable, and frequently dramatic change, a future of great challenge and responsibility," he told graduates. "You will face challenges of a magnitude that would have been incomprehensible when I graduated—energy sustainability, global climate change, global poverty and health, conflict, and terrorism. But you are also graduating during one of the most intellectually productive times in human history. Knowledge continues to grow exponentially. The more we learn, the more we are capable of learning. Yet it is also this same explosion of knowledge that has made this a time in which permanence and stability become less valued than flexibility and creativity, in which the only certainty will be the presence of continual change; and the capacity to relish, stimulate, and manage change will be one of the most critical abilities of all."

Engineers have an advantage, Duderstadt told the audience: "There is an old saying in engineering that 'the best way to predict the future is to invent it!' You have the ability to go out into that exciting world full of change, challenge, and opportunity and not only shape the future but to actually invent it. Indeed, it is your challenge to make certain that the future is never again what it used to be."

For the full text of Duderstadt's speech, lists of honorees and graduates, video, and photos, visit engineering.dartmouth.edu/alumni/investiture/2009.

CLASS OF 2009
Engineering Graduates

10	Doctor of Philosophy
12	Master of Science
46	Master of Engineering Management
61	Bachelor of Engineering
54	A.B., Engineering Sciences

THIS PAGE: TOP, JOSEPH MEHLING '69; BOTTOM, COURTESY OF KEITH PAULSEN
OPPOSITE PAGE: TOP, COURTESY OF TAKE-A-BREATHER GROUP; BOTTOM, MARK WASHBURN.

>> Ashifi Gogo Th'09 and Shivam Rajdev Tu'09 placed first in the United States and second globally in the 2009 Global Social Venture Competition, earning $10,000 for their business plan for mPedigree Logistics (mpedigree.net). Citing the "huge problem" of counterfeit drugs in developing countries, the World Economic Forum also recognized mPedigree as a Technology Pioneer for 2009, and Forum Nokia awarded mPedigree first place in the emerging markets category of its Calling All Innovators competition. With mPedigree, all drugs distributed in participating countries are labeled with a scratch panel that reveals a unique code, or "pedigree." When a drug is purchased, the patient can text the code to a designated number and receive a response confirming whether the drug is genuine or fake. Piloted successfully in Ghana in January 2008, mPedigree is now working to expand its platform to all 48 sub-Saharan African countries, starting with a trial in Nigeria this summer. Gogo is in Thayer's Ph.D. Innovation Program.

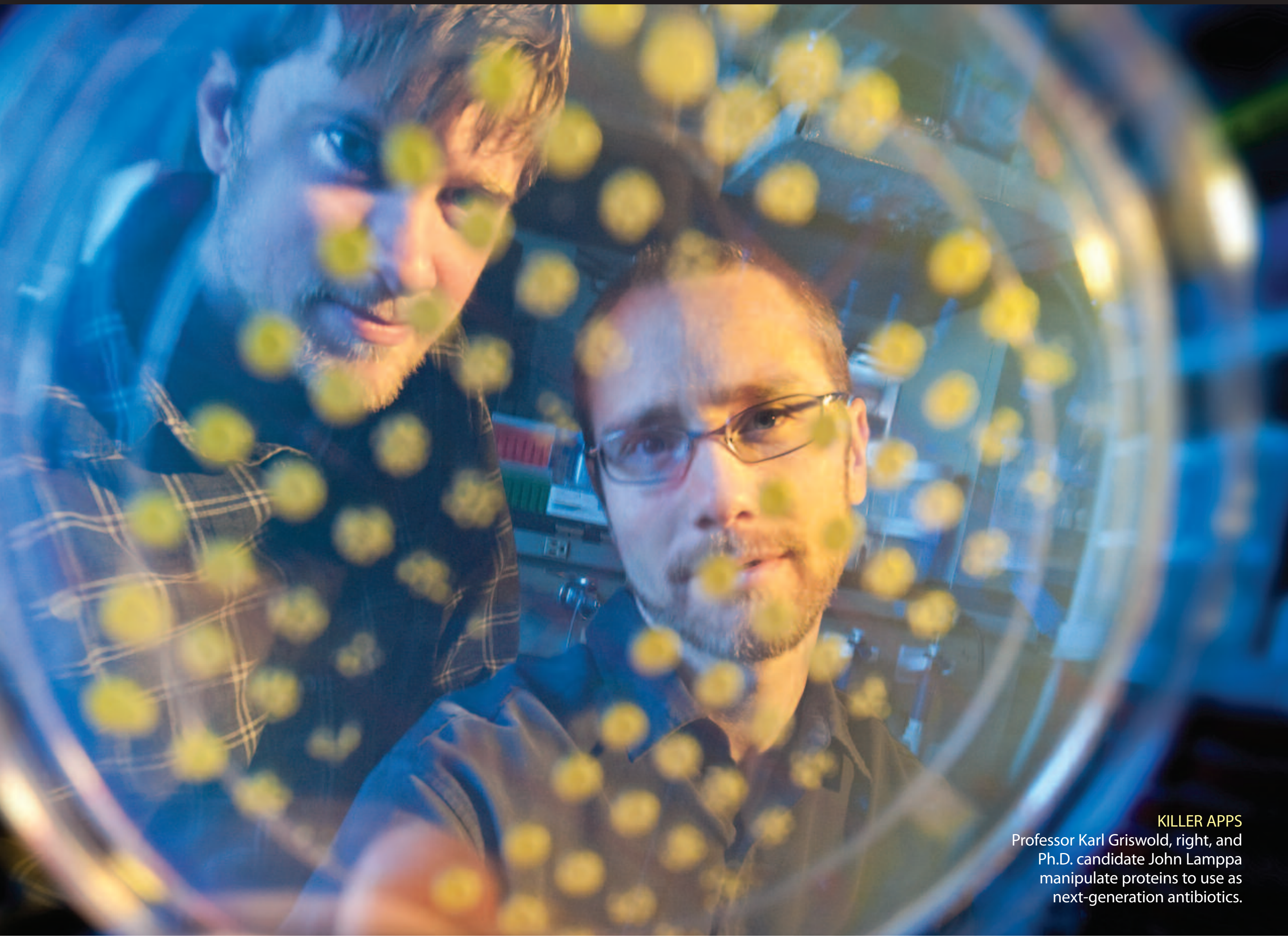
>> Alison Stace-Naughton '11, an engineering major, has been awarded a Barry M. Goldwater Scholarship in recognition of her drug delivery research. Receiving the scholarship "has really confirmed my desire to become a great bioengineer," she says. The foundation awards scholarships to outstanding students who intend to pursue careers in science, mathematics, and engineering.

>> Engineering majors Sarah Rocio '10, Mike Wood '10, and Lucas Schulz '08 are the technical experts for the fifth annual Big Green Bus summer cross-country tour. The 15 crew members of the veggie-oil-powered bus want to raise public awareness of energy conservation and environmental responsibility. Follow the tour at thebiggreenbus.org.

ENGINE IN

BEHIND EVERY GREAT MEDICAL ADVANCE, THERE'S A GREAT ENGINEER.

BY ELIZABETH KELSEY
PHOTOGRAPHS BY JOHN SHERMAN



KILLER APPS
Professor Karl Griswold, right, and Ph.D. candidate John Lamppa manipulate proteins to use as next-generation antibiotics.

ERING MEDICINE

ANYONE WHO GOES TO THE DOCTOR BENEFITS FROM THE WORK OF ENGINEERS. Every medical device represents a collaboration between doctors eager for better ways to treat patients and engineers eager to push technological boundaries. Dartmouth engineers have focused on medical technologies since the 1960s, when Professor John Strohbehn started a biomedical engineering program at Thayer. Collaborating with clinicians at Dartmouth Medical School, Strohbehn directed his inventive skills to a wide range of medical applications, including mathematical models for X-ray tomography, an interactive image processor for clinical use, hyperthermia techniques for destroying cancer cells with heat, and a frameless stereotactic operating microscope for neurosurgeons. His work inspired several graduate students who today are lead researchers at Thayer, including Professor Stuart Trembly Th'82, who developed a microwave thermokeratoplasty technique to correct nearsightedness, and Keith Paulsen Th'86, who heads the engineering side of Dartmouth's comprehensive medical imaging programs (see page 16).

THAYER SCHOOL is home to a wide range of medical projects. Some, such as the joint implant work of professors John Collier '72 Th'77, Douglas Van Citters '99 Th'03, '06, and Dr. Michael Mayor, have led to major improvements in medical devices and techniques. Others have resulted in new companies, such as GlycoFi, the protein engineering start-up that professors Tillman Gerngross and Charles Hutchinson sold to Merck in 2006 for $400 million, or Gerngross' latest bioengineering venture, Adimab.

IN THE FOLLOWING, Dartmouth engineers explain some of the many projects they are working on with colleagues at Dartmouth Medical School and Dartmouth-Hitchcock Medical Center to give doctors new tools for better care.

SMALL IS BIG
Professor Ursula Gibson fabricates materials tiny enough to carry drugs directly into tumors.

NANOMEDICINE

Professor Ursula Gibson '76

WHAT IT IS

Nanomedicine is the intersection between nanomaterials and medical research. We're using knowledge of self-assembly of small-scale materials to try to make therapeutic substances that will interact with diseased tissue.

WHY NANOMEDICINE CAN WORK FOR CANCER

Cancer tissues have a vasculature that is not well developed. They essentially have little pores in them that are about 300 nanometers in diameter—a scale at which people have started to gain control over what they can fabricate. The leaky vasculature allows us to preferentially deposit nanoparticles inside a tumor.

MULTI-PRONGED APPROACH

If we can structure materials on a very fine scale, we can give them a plethora of functionalities for targeting cancer. We could incorporate a drug into a polymer structure, add some magnetic nanoparticles that can absorb energy from an externally applied field, and attach an antibody to the outside of the polymer to help it find the cancer or bind preferentially to the cancer for a multiplicative effect.

There's a lot of work now to figure out how to get therapeutic drugs and materials into tumors without having them intercepted by the body's natural defenses, how to optimize entrance into the tumor, and how to activate the drugs and materials once they get there. There are certain conditions that are present in a tumor—the pH is different, the oxygen concentration is different—and people would like to leverage all of those into a system that gives a higher release factor in cancerous regions and a lower release anywhere else.

HOT IRON
Professor Ian Baker is developing iron nanoparticles that be inserted into tumors and heated to destroy them.

MAGNETIC HYPERTHERMIA

Professor Ian Baker

WHAT IT IS

You can heat up nanoparticles by applying an alternating magnetic field. If you introduce the particles into a tumor—either by injecting them or by antibody-tagging them—you can use the heat to kill cancer cells.

OUR APPROACH

Many groups have been working on using iron-oxide particles for magnetic hyperthermia. We're making iron nanoparticles coated with iron oxide. We wanted to use iron because it is more magnetic—and therefore has greater heating abilities—than iron-oxide. But nano-sized iron particles exposed to air quickly form an oxide and produce so much heat that they catch fire. I had the idea of using iron particles for their heating effect and coating them with iron oxide to make them safe and make them visible in magnetic resonance imaging. But I really hadn't much clue how to do it. Fortunately, post-doc Qi Zeng figured it out. More recently another post-doc, Guandong Zhang, managed to tweak the processing so that now our particles range from 8 to 20 nanometers, heat well, have a biocompatible coating, and have good MRI contrast.

GOAL

The ultimate goal is to tag these nanoparticles with tumor-specific antibodies, and put them into the bloodstream to find their way to a tumor and attach to it. Then, using a technique like MRI to ensure the particles are at the tumor, we'll magnetically heat the tumor to destroy it without damaging surrounding tissue.

POWER SOURCE
Professor Kofi Odame streamlines circuits so medical devices can be small, light, and long-lived.

LOW-POWERED ELECTRONICS FOR MEDICAL DEVICES

Professor Kofi Odame

WHY THEY'RE NEEDED

Low-power electronics are crucial for medical devices that need to be portable or implantable.

COCHLEAR IMPLANTS

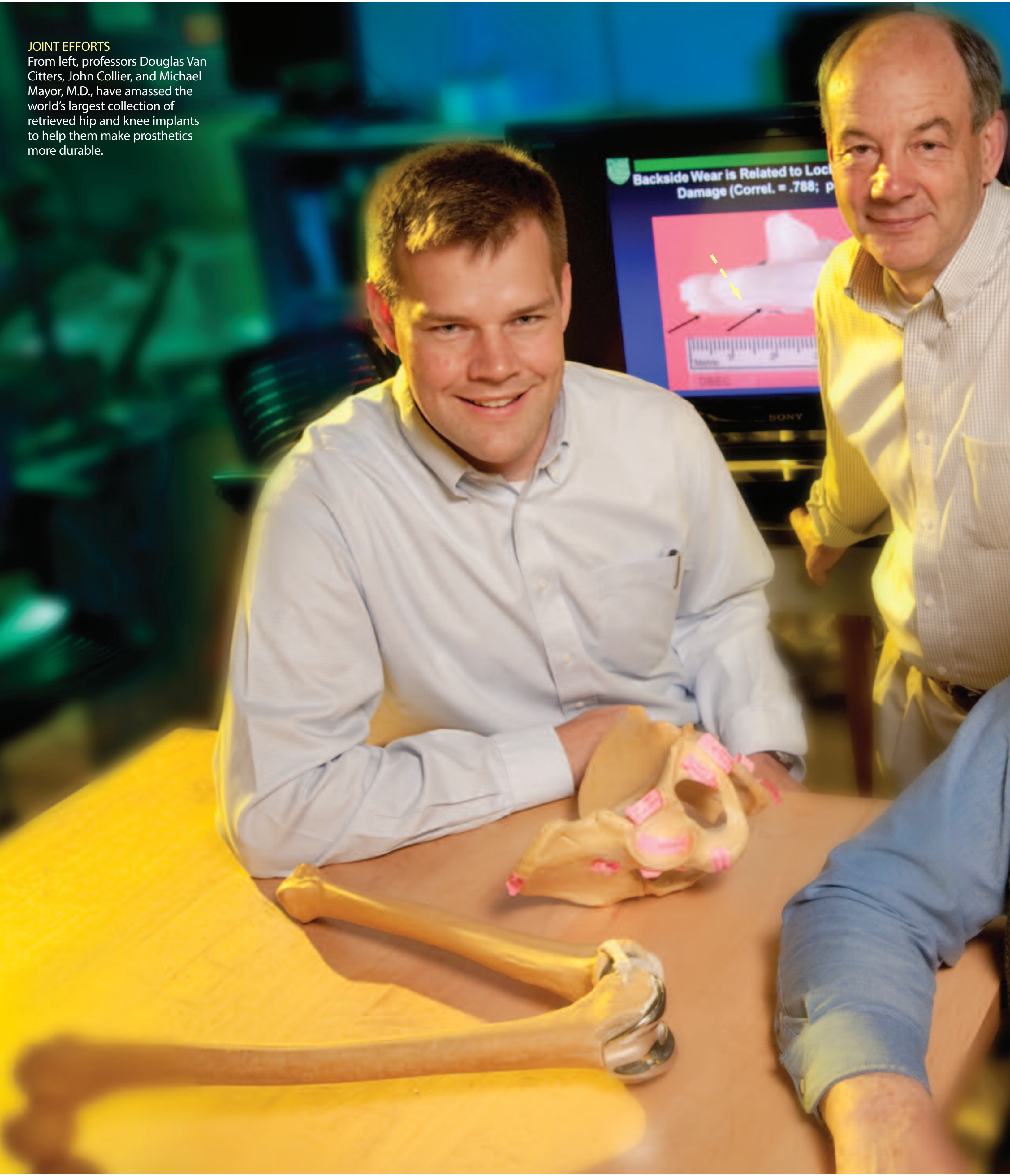
A cochlear implant works by capturing sound, processing it, and—bypassing the inner ear—stimulating the patient's auditory nerve. Currently only a small part of the device is actually implanted. An external part contains a microphone, microprocessor, and batteries, which need to be replaced or recharged every 24 hours or so.

I want to make an implant that will allow users to discriminate between sounds they're interested in hearing—say a conversation—and background noise. I'm currently working on an algorithm and designing an electronic circuit that will imitate a healthy cochlea.

But a fully internal cochlear implant, with all of its parts surgically placed inside the patient's head, will never become a reality unless the implant is made to consume so little power that batteries would only need to be changed once every several years, if at all.

EPILEPSY MONITORING DEVICE

Many people with epilepsy need to be monitored long-term. Monitoring in hospitals is expensive and disruptive. Portable EEG monitors exist, but they're bulky and awkward. My idea is to create a device that is small enough to fit in a hat. The device would be doing wireless transmission of electroencephalogram (EEG) data, which consumes a lot of power. I'm designing circuits that selectively transmit only the important portions of EEG data in a low-power fashion.



JOINT EFFORTS
From left, professors Douglas Van Citters, John Collier, and Michael Mayor, M.D., have amassed the world's largest collection of retrieved hip and knee implants to help them make prosthetics more durable.

ORTHOPEDIC IMPLANTS

Professor John Collier '72 Th'77

MAKING BETTER IMPLANTS

We look at the problems orthopedists and patients have with hip and knee implants and figure out how to solve them.

It used to be that loosening of implants was a big problem. Loosening is no longer a problem [thanks largely to a porous coating Collier developed in the 1980s]. It used to be that a success rate of 70–80 percent at five years was good. Now it's 97–99 percent at ten years. We're looking to push that to 97–99 percent at 20 years or more.

But making better materials for implants is tough. People use implants in a very active environment over many years. We do in-vitro simulations, but when a new material is put in the body, we commonly get surprised. The body environment is complicated—with proteins, enzymes, free radicals, cells, low pH, and a whole lot of other things going on—and implants are submersed in it for a long time. We don't know how to model all those conditions.

IMPLANTS AND OUTCOMES

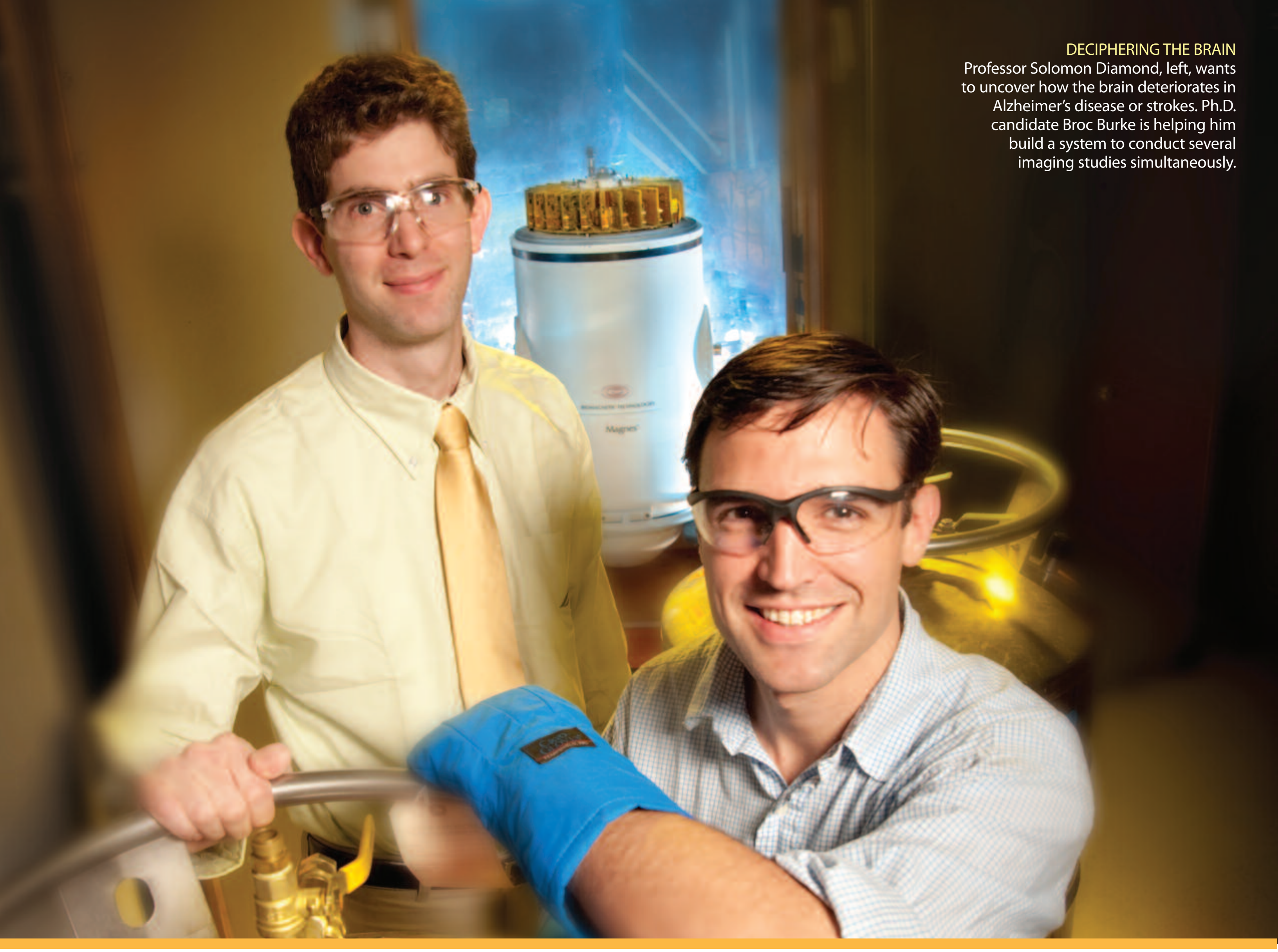
Orthopedic surgeon Michael Mayor thought that if we're putting implants into patients, we ought to examine the devices when they come out. He started our implant retrieval lab. Since the 1970s he has evaluated nearly 10,000 retrieved implants for corrosion and other damage. We compare components that have been in patients to predictions from our tests. There's a constant evolution of tests and evaluation of components.

WHAT'S NEXT

Cross-linked polyethylene components show promise. Polyethylene is a long-chain monomer; you can improve its wear resistance by connecting the chains to one another.

GET AN EXPERIENCED SURGEON

Even with a sophisticated prosthetic device, surgeons can get into difficulty if they haven't done many implant procedures. The device might not be exactly the right size or it might not be tensioned or positioned exactly. Any one of those things is sufficient to cause the device to fail. It's very difficult to make devices robust enough to survive if they're put in the wrong position.



DECIPHERING THE BRAIN
Professor Solomon Diamond, left, wants to uncover how the brain deteriorates in Alzheimer's disease or strokes. Ph.D. candidate Broc Burke is helping him build a system to conduct several imaging studies simultaneously.

MULTI-MODAL BRAIN IMAGING

Professor Solomon Diamond '97 Th'98

IMAGING ALZHEIMER'S DISEASE

My graduate students and I want to understand how neurodegenerative diseases like Alzheimer's work, so we're developing brain imaging tools and technologies to dynamically measure neurovascular coupling—the relationship between evoked neural activity and subsequent changes in cerebral blood oxygen, volume, and flow.

We're building a special brain imaging lab at Thayer that will allow us to run three different noninvasive neuroimaging techniques simultaneously. One technique is electroencephelography (EEG), which measures electrical potentials on the scalp that arise from ionic currents in the brain's neurons; the second is magnetoencephelography (MEG), which measures the magnetic field around the head that also comes from neural currents; the third is near-infrared spectroscopy (NIRS), which uses near-infrared light to rapidly measure brain blood volume and oxygen dynamics.

FASTER THAN FMRI

Our instruments will allow us to explore neurovascular relationships with more precise timing and better specificity to neural currents than can be done with an MRI. With functional MRI, you get an image stack of the whole brain about every two seconds, and you can see how the stack evolves over time due to the cerebral blood dynamics. You can tell what part of the brain was active when the subject saw a certain stimulus or performed a particular task. But you wouldn't know the moment-to-moment waveform of blood dynamics, and you wouldn't have any concurrent measure of the neural currents. We will be able to measure cerebral blood and neural dynamics in our lab.

CLINICAL WORK

Once all the instruments are functioning, we'll start studying the neurovascular coupling relationships in healthy normal controls. With that data as a foundation, we can then begin the pilot clinical work, measuring people who are at risk for developing Alzheimer's or who are in the early stages of it. The background work could take five years, but I envision early clinical work at the pilot level starting in two to four years.

PROTEIN ENGINEERING

Professor Karl Griswold

NATURAL MACHINES

I think of proteins as the nanoscale machines that enable life. Knowing how well proteins work in their natural context, engineers and scientists have envisioned ways in which we can use these molecules to enable practical applications. However, when you yank proteins out of their natural context, they frequently lose some or all of their desirable qualities. This is where protein engineering comes into play. We take natural protein sequences as a starting point and redesign them to meet our own performance criteria.

CYSTIC FIBROSIS ANTIBIOTICS

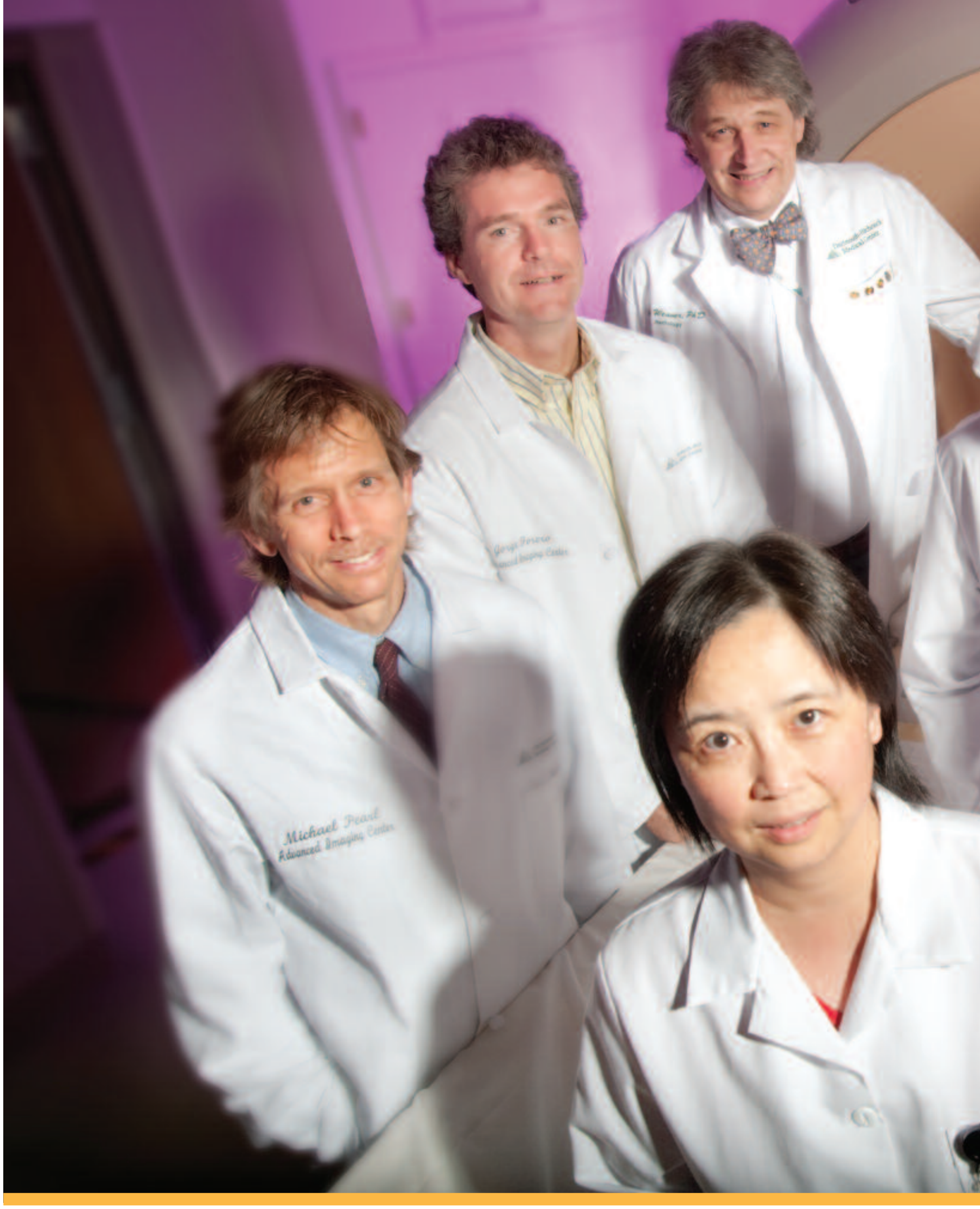
Seeing proteins as next-generation antibiotics, I wanted to develop enzymes to treat bacterial infections. That led me to work on cystic fibrosis.

Most CF patients die from complications associated with *Pseudomonas aeruginosa* bacterial infection of the lungs. In many infections, bacteria adhere to a surface—such as the lining of the lung, a catheter, or an orthopedic implant—and cover themselves with biofilm, a blanket of proteins, nucleic acids, carbohydrates, and other components. By growing inside this complex matrix, bacteria gain protection from the human immune system and antibacterial drugs. This is what makes *Pseudomonas* in the lungs of CF patients so insidious. Once contracted, the bacteria generally cannot be eradicated.

We're looking for enzymes that will break through *Pseudomonas'* biofilm armor. We're identifying natural enzymes that have infection-fighting potential, outlining their limitations, and then developing improved versions in the lab.

ANTIBODY HUNTER Professor Karl Griswold wants to find proteins capable of curing deadly lung infections for people with cystic fibrosis.

BREAST CANCER IMAGING



Alternatives to Mammography

Mammography isn't perfect. That's why Thayer School engineers and Dartmouth Medical School (DMS) researchers have been working together for a decade on four alternative imaging technologies to detect and help treat breast cancer.

Keith Paulsen Th'84, Thayer School's Robert A. Pritzker Professor of Biomedical Engineering, and Dartmouth Medical School radiology professor Dr. Steven Poplak are the principal investigators. Together they lead a team of some 40 engineers, radiologists, pathologists, computer programmers, data analysts, and other collaborators who are refining the technologies and conducting clinical trials at Dartmouth-Hitchcock Medical Center.

The four technologies—microwave imaging spectroscopy (MIS), electrical impedance spectroscopy (EIS), near-infrared imaging (NIR), and magnetic resonance elasticity (MRE)—differ from mammography in a key way. Mammography detects tissue that looks like a tumor. The other technologies detect tissue that acts like a tumor.

MIS and EIS measure the ability of different regions of the breast to hold or conduct electricity. Part of what defines a tissue as cancerous is how its cells and blood vessels are organized. Normal tissue is quite orderly. Cancer, however, is "just a jumble," says Thayer professor Alex Hartov Th'88, EIS project leader. "A lot of membranes, a lot of vascularity—all these things are associated with different electrical properties."

NIR uses a "unique spectral window," says Thayer professor Brian Pogue, who leads the NIR project. Penetrating deep into tissue, NIR reveals information about hemoglobin and oxygen saturation levels, which can indicate a tumor.

MRE uses an MRI scanner and specialized coils to vibrate breast tissue and measure whether it is elastic or stiff. "Almost all cancer is stiff," says MRE project leader John Weaver, a professor of radiology at DMS and adjunct professor at Thayer.

All four technologies differ from mammography in another way as well: computational complexity. Since mammography utilizes X-rays, which penetrate the body in more or less a straight path, constructing an image from X-ray data is a relatively easy linear problem. But the electromagnetic waves used in MIS, EIS, and NIR and the mechanical waves generated during MRE travel through the breast in complex patterns. Generating images from this data requires complex differential equations.

The mathematical and engineering problems involved in getting these modalities to work are "huge," says Thayer professor Paul Meaney Th'95, head of the MIS project.

Even so, the Thayer-DMS group has developed both the software and the hardware—free-standing machines for MIS, EIS, and NIR, plus specialized equipment that's used inside an MRI scanner for MRE and NIR. And while researchers elsewhere are working on their own versions of the technologies, no program is as comprehensive and well developed as the Dartmouth collaboration.

"We're looking at all four technologies in a common setting," explains Paulsen. "We can look at them together and comparatively and synergistically."

Size is part of the success, says Paulsen. "It's sort of the big company/small company paradigm," he explains. A big company can't adapt itself quickly to something new, he says, "because there's huge infrastructure and huge investment in teams. We're a much more nimble, small enterprise."

—Jennifer Durgin

(Excerpted and adapted from "All Together Now," by Jennifer Durgin, published in Dartmouth Medicine. *For the original article, see dartmed.dartmouth.edu/winter07/html/together.php. Used with permission.)*

SHARED VISION
A few of the Thayer professors who work on imaging gather in the Advanced Imaging Center at Dartmouth-Hitchcock Medical Center. Clockwise from lower left, veterinarian Jack Hoopes (who conducts animal studies for the technologies), Brian Pogue, John Weaver, Ryan Halter, Paul Meaney, Keith Paulsen, and Shudong Jiang (who evaluates the effectiveness of neoadjuvant treatments of metastatic cancer).

BEYOND BREAST CANCER

Thayer researchers explain new applications for their imaging technologies.

IMAGE-GUIDED NEUROSURGERY

Professor Keith Paulsen Th'84

We're developing a fluorescence signature to guide surgeons in removing brain tumors. We've found that high-grade tumors fluoresce, so the fluorescence can be used as a kind of surgical road map. We hope to be able to make low-grade tumors fluoresce, too, so they can be treated before they get worse.

MOLECULAR IMAGING OF GLIOMA BRAIN TUMORS

Professor Brian Pogue

Glioma brain tumors don't always show up in an MRI scan. The most problematic parts of a tumor cannot be seen structurally because they're a microscopic invasion. With better molecular tracers and optical imaging, though, we've been able to detect them. This is very exciting, because we can now demonstrate that we can see something that standard clinical imaging doesn't capture.

Our glioma research has been done on mouse models of human cancer. We use an injectable agent that isn't FDA-approved yet, but would be a good candidate for future clinical use. We need to do phase-one trials with new drugs and imaging systems to make sure they don't harm the patient. The process takes years and depends on funding, competing technologies, and other factors. If all the right factors come together, we can consider doing imaging studies on humans.

IMAGING FOR METASTATIC CANCER

Professor John Weaver

We're using imaging to monitor neoadjuvant therapies to treat metastatic cancers. Rather than immediately removing the primary cancer, the oncologist leaves it in place and attacks it with a mix of chemotherapies. If the chemotherapies shrink the primary tumor, you can assume that they also attack unseen metastases. Obviously, you want to find out really quickly if the chemo cocktail is working. Instead of waiting a month, we want to use imaging to find out in a week.

MICROWAVE IMAGING OF ULTRASOUND HEATING

Professor Paul Meaney Th'95

If you're using heat to destroy a tumor, you want to monitor the temperature during the treatment. It has been challenging to find a noninvasive method. We use a focused ultrasound system to heat the tumors. We've integrated a microwave imaging system into it, allowing us to continuously image the patient while the heating occurs.

EIS FOR PROSTATE CANCER

Professor Ryan Halter Th'06

A big problem with screening for prostate cancer is that the prostate-specific antigen (PSA) test is not specific to just cancer. Benign conditions can also cause PSA levels to rise. Ultrasound-guided biopsy is used to definitively diagnose prostate cancer in men with elevated PSA, but it misses some malignant lesions and doesn't accurately characterize the extent of the disease. We're incorporating electrical impedance spectroscopy (EIS) sensors into standard biopsy needles and ultrasound probes to improve this detection and disease characterization. We're also developing EIS-enhanced probes that surgeons can use during surgery to ensure clear margins.

Elizabeth Kelsey is a contributing editor at *Dartmouth Engineer*.

BY KATHRYN LOCONTE

PHOTOGRAPHS BY DOUGLAS FRASER

EVOLUTION OF THE ULTRASTAND™

STAND AND DELIVER
Left to right, Kristen Lurie '08 Th'08, Aaron Gjerde Th'09, and Eric Winer '08 Th'08 added finishing touches to the ultraStand.

INVENTING MEDICAL DEVICES IS ALL IN A DAY'S CLASS WORK.

Sometimes doctors need a helping hand. In 2005 alums Kathy Hickey Th'03 and Amish Parashar '03 Th'03 began work on a "Biomedical Positioning Stabilizing System" to give them one. "Anesthesiologists were working with ultrasound to guide needle placement under visualization for regional nerve blocking, but found they needed an extra person, or at least an extra hand, to be able to use the ultrasound technology effectively," says Hickey. "We wanted to make a two-person job into a one-person job to allow people to learn and do other jobs instead of standing there and holding an ultrasound probe."

Encouraged by Gregg Fairbrothers of the Dartmouth Entrepreneurial Network, Hickey, Aaron Gjerde Th'09, and Rob van Aalst co-founded Wellan Medical Inc. to turn the idea into a marketable reality. Collaborating with Dartmouth-Hitchcock Medical Center anesthesiologists Brian Sites and Brian Spence '95 Th'96, Wellan Medical sponsored two more teams of Thayer ENGS 190/290: Project Design students to add other features and refinements to the device. The result is the ultraStand™, a probe-positioning system that works as a third hand, allowing a single clinician to perform image-guided procedures with ease. Wellan Medical, which is based in Lebanon, N. H., now sells the device throughout North America, Europe, the Middle East, and Asia.

Wellan and Thayer share further connections. Until recently Hickey served as assistant director of Thayer's Cook Engineering Design Center—the clearinghouse for linking 190/290 students with industry-sponsored projects. (Still part of the Wellan team, she's now in the Ph.D. program in biomedical sciences at the University of West Virginia.) And Gjerde is at Thayer for an M.E.M. degree, for which he has worked on—what else?—the ultraStand.

>>>THE ITERATIONS

2005 Biomedical Positioning Stabilizing System
Kathy Hickey Th'03, Amish Parashar '03 Th'03 developed a device to help anesthesiologists use ultrasound to guide regional nerve-blocking procedures.

2007 The UltraHand
Building on the design of the biomedical positioning stabilizing system, Meredith Lunn '06 Th'07, Deborah Sperling '06 Th'07, and Kazi Ahmed '07 Th'07 implemented a locking articulating arm and an ultrasound cart clamp that allows the arm to sit directly on a cart instead of on a stand. The clamp was brought to market within months of the project's completion and broke ground for other successful medical clamp products.

2008 Ultrasound-Guided Image Optimization System
Kristen Lurie '08 Th'08, Eric Winer '08 Th'08, and Aaron Gjerde Th'09 created a way for the articulating arm to keep the ultrasound probe on target even if the patient moves. The team designed and installed pressure and position sensors at the tip of the arm. When the sensor detects patient movement, a computer-controlled microprocessor adjusts the arm accordingly.

Kathryn LoConte is the assistant editor of *Dartmouth Engineer*.

TO YOUR HEALTH

Students have created numerous new medical devices over the years. Here's a sampling.

NON-RESTRICTING KNEE JOINT

Aaron Goss '03 Th'04, Julie Kowalsky '03, Brian Mason '03 Th'04, '05, and William Shields '03

The group developed a lightweight, adjustable spring-loaded knee-brace for patients with weak quadriceps. "The highlight of the project came when we tested our joint on an elderly woman handicapped by the amputation of one leg while her other leg remained weakened due to old age," says Mason. "She walked with the brace and said it was comfortable and easy to use."

CERVICAL SPINAL RETRACTOR

Alicia Petryk '06 Th'07, Cathy Gaito '07 Th'07, and Narayana Golding '07

The team made a cervical spinal retractor out of polycarbonate, which is compatible with X-ray imaging and can be sterilized by autoclave.

HIP ALIGNMENT JIG

Ryan Stehr '05 Th'06, DMS '10

The caliper assesses the positioning of the femoral head during total hip replacement surgery. "I worked with an orthopedic surgeon, and we conducted a study using 50 patients, 25 of whom had the caliper used during their operation and 25 without," says Stehr. "The data show that femoral length and offset—two measures of leg geometry—are more accurately restored when the device is used during the surgery."

DIAGNOSTIC BREATH COLLECTION DEVICE

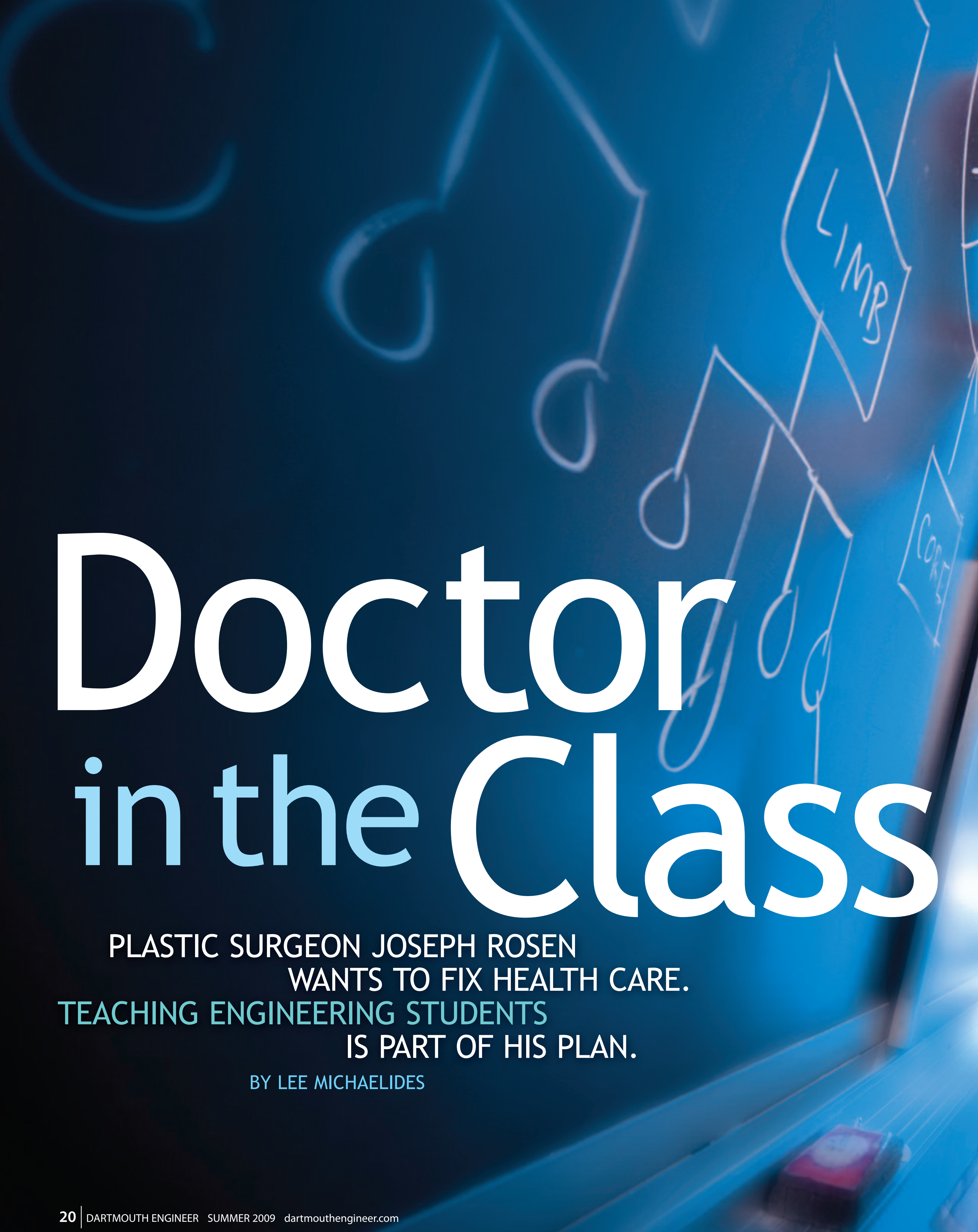
Javier Fernandez '07 Th'08 and Ph.D. candidate Jennifer Tate '08

The team developed a way to detect carbon dioxide in the exhaled breath of patients on oxygen masks while under light anesthesia. "We integrated an adjustable sample collection tube with matching adapter port into normal oxygen masks," says Tate.

STERILIZATION OF INTRAVENOUS FLUID

Renee Cottle '07 Th'09, Steve Reinitz '09 Th'09, and Kathryn Boucher '09 Th'09

The group developed a device that prevents intravenous fluid-borne bacterial infections. It uses ultraviolet light to irradiate and sterilize fluids as they flow through the IV line. "We have filed a patent application for the device and hope to continue working to refine our design during the coming school year," says Boucher.



Doctor in the Class

PLASTIC SURGEON JOSEPH ROSEN WANTS TO FIX HEALTH CARE. TEACHING ENGINEERING STUDENTS IS PART OF HIS PLAN.

BY LEE MICHAELIDES

PHOTOGRAPHS BY JOHN SHERMAN

Dr. Joseph Rosen, Professor of Surgery at Dartmouth Medical School and Adjunct Professor of Engineering at Thayer, likes to say that to see into the future you have to look at the past. To understand where Joe Rosen is heading today let's look back to where he was in 2001.

That was the year Rosen got his 15 minutes of fame in a really big way. A *Harper's* profile had dubbed him "Dr. Daedalus" because he predicted that surgeons in the not-so distant future would be building wings for humans. If Twitter, Facebook, YouTube and blogs existed back then, the story would have gone viral instantly. As it was, the story made the rounds for weeks in old media such as the *Washington Post* and England's *Guardian*. All the coverage caused no small amount of eye rolling, snickers, and condemnation by medical ethicists. A fellow plastic surgeon was quoted as saying Rosen should be "ashamed."

Most people, it seems, missed Rosen's real message: "Plastic surgeons solve problems that don't have solutions."

ROSEN WAS THEN AND STILL IS A PROVOCATIVE thinker who has expanded the boundaries of his surgical specialty and medicine in general by looking at the world around him and asking "why."

Why must a patient travel hundreds of miles to consult a specialist?

Why can't a robot controlled by an off-site doctor do a surgical procedure?

Why can't we reform health care?

These are not just rhetorical questions. Rosen seeks out the people who want and need to move beyond the confines of conventional wisdom: experts in defense, bio-terrorism, global health, disaster relief, high technology, and academic medicine. As a section director of Emerging Technologies Assessment at Dartmouth's Institute of Security Technology Studies, as a member on the Bio-terrorism Working Group of the IEEE-USA Medical Technology Policy Committee, and as a consultant at the Institute of Defense Analysis in Washington, Rosen pulls together people with various pieces of critical technical, medical, and organizational knowledge. Thayer professor Peter Robbie '69, who has worked with Rosen since the early 1970s, describes him as an "instigator and a connector."

Rosen also is a teacher. Despite a full clinical schedule at Dartmouth-Hitchcock Medical Center (DHMC), he has been changing out of his scrubs and heading into Thayer classrooms ever since 1991. These days he co-teaches two courses with Robbie: ENGS 5: Healthcare and Biotechnology in the 21st Century and ENGS 13: Virtual Medicine and Cybercare. Both courses challenge engineering students to think big about what is possible in medicine today—and what might be possible tomorrow.

Rosen brings in his extensive network of experts to talk to students directly about problems and needs on the front lines of health care. Among recent guest lecturers: the director of the Laboratory of Tissue Engineering and Organ Fabrication at Massachusetts General Hospital, the prosthetic programs manager at Defense Advanced Research Projects Agency (DARPA), and the chief technology officer for SimQuest, a firm that's developing training simulators for surgery and combat casualty care. "The goal of the classes is to stimulate student interest and thought by bringing in what is leading in the field—and then getting them hooked," says Robbie.

Rosen sees his teaching at Thayer as a means of reaching students who will be in positions of influence in national health policy in the coming decades. He wants them to come up with the new ways of thinking. As he says on the ENGS 13 home page: *Do you want a new health-care system? Invent one.*

ROSEN HIMSELF IS A MEMBER OF A 10-MEMBER national team that is inventing a distributed network-based health-care system called Cybercare that would take the place of our current hospital-centered system.

"Why do we have hospitals?" asks Rosen while sitting in his office at DHMC. "Hospitals were an outgrowth of the Civil War," he says, answering his own question. "New arms technologies inflicted massive casualties, and assembling medical teams near the battlefield to treat them became a necessity."

The Cybercare team argues that times have changed. "In our model, medical care is delivered locally in neighborhoods and individual homes, using computer technologies like telemedicine, to link patients and primary care providers to tertiary medical providers," the team states in the November 2008 issue of *IEEE Engineering in Medicine and Biology Magazine*. "This decentralization could reduce costs enough to provide all citizens with medical insurance coverage; it would benefit patients and providers; and as a dual use system, it would better protect the country's resources and citizens in an event of biological terror or natural disasters."

Technology is already decentralizing some aspects of health care. For example, some U.S. hospitals now employ doctors in India to read X-rays taken at night rather than waiting until their own radiologists arrive in the morning. Robotic surgery is also gaining a toehold. Two decades ago Rosen and virtual reality expert Jason Lanier pioneered the idea of telesurgery—a doctor in one location operating on a patient somewhere else, perhaps on a battlefield or in a village on the other side of the world. At the time the technology wasn't powerful enough for actual surgery, but the concept itself was proven to be viable. Today doctors are using robotic systems for laparoscopic surgery, and robotics experts predict that in the not-too-distant future, "smart-stretchers" will enable a single person to run two operating rooms, a task that today requires a staff of six.

According to Rosen, Cybercare will reduce hospitalizations because an array of networked

THINKING BIG
Joe Rosen sees plastic surgeons and engineers as sharing a major goal: solving intractable problems.

devices will electronically monitor a patient's condition from home. If Cybercare were in place during a swine flu pandemic, for example, patients could be diagnosed in a local doctor's office, where their entire medical histories are available online, and treated and monitored at home in a portable quarantine unit. In the Cybercare scenario, there would be far fewer hospitals than exist today, and they would only offer specialized services like transplants, oncology, and highly technical electronic scanning.

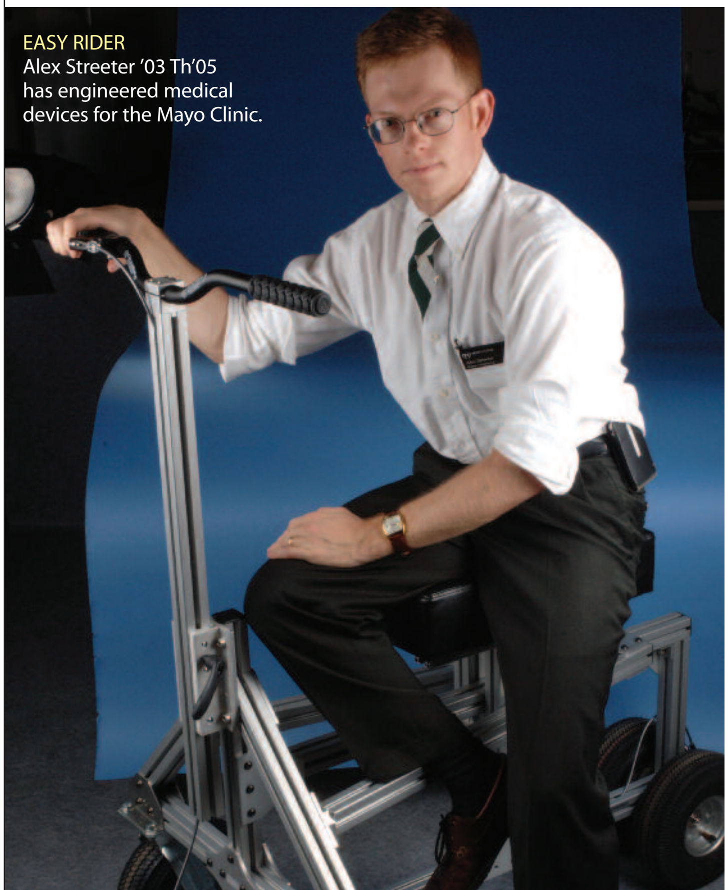
The inertia of the current health-care system, not the lack of technology, will be Cybercare's biggest obstacle. If you think the current debate about public versus private health insurance is loud, imagine the outcry of special interests against a decentralized health-care system that proposes to close hospitals. Rosen and the rest of the Cybercare team recognize that the path to the future won't be easy. That's why they open their IEEE article by looking back and quoting Machiavelli:

There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order.

Lee Michaelides is the managing editor of *Dartmouth Alumni Magazine* and a contributing editor at *Dartmouth Engineer*.

Alumni News

spotlights



EASY RIDER
Alex Streeter '03 Th'05 has engineered medical devices for the Mayo Clinic.

As a Mayo Clinic engineer, **Alex Streeter '03 Th'05** tackled doctors' and patients' requests as he did the ENGS 190/290/390 sequence: Define the problem, develop several ideas to address it, then prototype and test one or more solutions until the problem is solved. Streeter was one of more than 50 engineers at Mayo who work on inventions to make doctors' jobs easier and patients' lives better. Some of his designs have included life-sized models of pediatric scoliotic spines for presurgical planning; a physical therapy chair/bench for a set of conjoined twin infants; a "knee-walker" for a 7-foot-8-inch, 600-pound patient with a bad foot; a wheelchair attachment for a mother to use to hold her infant; high-speed videography of breaking bones; and a horizontal mill for grinding out the inside of a femoral head to harvest bone graft material. "Some of our work has a high impact on patient care at the clinic, sometimes for just a single patient. Some of our work seeks to enable the kind of medical and technological research and development that will bring about the next revolution in medicine, and will have a high impact beyond the clinic," he says. Streeter will be bringing that revolutionary approach to DEKA Research as he returns to New Hampshire for his wife's medical residency.

Husband and wife team **Mark '80** and **Paula Ness Speers '80** first combined their R&D and consulting talents 18 years ago to found Health Advances, LLC. They've built their 60-person firm with offices in San Francisco and Boston into the go-to consultants for advice on commercializing new medical technologies, guiding decisions on which applications, diseases, and conditions to target, optimizing pricing, sizing sales forces, and negotiating channels of distribution. With his engineering training, Mark focuses on the medical-technical and diagnostics clients, and is currently developing a medical device to reduce the incidence of ventilator-associated pneumonia. "I find that my familiarity with materials science and manufacturing processes gains me instant credibility with new clients and often leads to brainstorming sessions that create new product ideas," he says. Paula, who served in the Peace Corps as a tuberculosis worker in South Korea after graduating from Dartmouth with a degree in international relations, continues to work in the developing world. She's currently working on a new diagnostic platform to enable infectious disease diagnostics. "Once in a while we work together," says Mark. "We fondly recall one of our first successes: the development of the Acticoat antimicrobial wound dressing. The product has become the best-selling burn dressing in the world and has saved hundreds of patients' lives."

Rick Greenwald Th'88 is turning his wide range of engineering and manufacturing expertise to the problems of personal injury among elite athletes, soldiers, and the elderly. As founder and president of Simbex (simbex.com) in Lebanon, N.H., he is currently working on ActiveStep technology to train people to recover from a fall. With the system—highlighted on "Good Morning America" in a May segment titled "A Smart Way to Fall? New Technology Prevents Tragedy"—a therapist uses a body harness, treadmill, and sensors to analyze patients' movements and retrain their responses to tripping or slipping. The therapy can be life-saving, as one in three adults over 65 fall every year. Such falls annually cause 300,000 hip fractures, one-fifth of which lead to death. "Simbex stands for Simply Better Exercise and is the realization of a dream to solve important large-scale health problems related to personal injury with appropriate cost-effective technology," says Greenwald. It's an approach *Time* magazine recognized in its "Best Inventions of 2007" issue, highlighting the group's Head Impact Telemetry system (a head-impact monitoring system designed to prevent mild traumatic brain injury) and PowerFoot One (a robotic foot and ankle prosthetic).

Plastic surgeon **Jason Altman '97** has spent the last year traveling the world—Ecuador, Peru, China, India, Vietnam, and Zambia—performing plastic and reconstructive surgery on children in need as a Jerome P. Webster Fellow for the global health organization Interplast (interplast.org). "Usually I am traveling with a team of doctors and nurses; however, on occasion I will also go by myself to work with and teach a local surgeon in some more remote areas," says Altman. His surgeries include cleft lip and palate repair, congenital hand deformities, congenital facial deformities, and burn and trauma reconstruction. "Plastic surgery is the practice of human engineering!" he says.

After 10 years as an audiologist—most recently as the director of the Children's Hospital of Philadelphia cochlear implant program—**Kevin Franck '92** is providing clinical strategy to Cochlear Ltd (cochlear.com). "I've been drawn to this field because I grew up with deafness in my family (my sister)," says Franck, who trained as a biomedical engi-

HUMAN ENGINEERING
Plastic surgeon Jason Altman '97 (center) performs corrective surgery on kids all over the world.

neer at Dartmouth. "The cochlear implant is truly amazing. Deaf babies can grow up listening and talking, and adults who lose their hearing can once again communicate with their spouses and colleagues with phones and all that stuff we take for granted." He is now involved in the global marketing of Cochlear's implantable hearing devices, which are used to replace damaged parts of the cochlea. (Hearing aids, on the other hand, attempt to get the damaged parts to work better, and are usually appropriate for those with mild or moderate hearing loss.) Franck says the cost—about $30,000 in the United States, plus the cost of surgery and rehabilitation—is covered by most insurance companies, due to the high cost efficacy.

Dr. Andrew Mannes Th'83 believes that killing the messenger—pain-responsive neurons in the sensory ganglia—can be a practical way to manage intractable pain. Mannes, who works in the department of anesthesia and surgical services for the National Institutes of Health in Bethesda, Md., is testing a new pain-relieving drug called resiniferatoxin, a single-shot dose of analgesic that lasts forever. The experimental drug targets sensory neurons that convey pain to the spinal cord. Interrupting this one specific class of pain-sensing neurons will eliminate the connection and some types of pain, including that seen with advanced cancer. In animal studies—including treating dogs for refractory end-of-life pain and goats for severe arthritis—the drug has shown remarkable improvement or elimination of pain symptoms, he says. The FDA has approved clinical trials, and Mannes and colleagues are now looking for cancer patients who are experiencing severe pain that is unresponsive to conventional therapy. Under this treatment, the patient is placed under general anesthesia for an hour or so while Mannes injects the resiniferatoxin into the cerebrospinal fluid space around the spinal cord, where it eliminates the pain neurons. If the treatment is successful, he says, patients should be able to discontinue their medications, including high doses of morphine or other opioids to control pain. Unlike other pain medications, his treatment appears to have no side effects (such as sedation or hallucinations) and no addictive potential.

Terry McGuire Th'82, co-founder of Boston-based Polaris Venture Partners and chairman of Thayer's Board of Overseers, is the new chair of the National Venture Capital Association (NVCA). "Although the NVCA has long been an advocate for public policies that encourage innovation and economic growth, our work today is as important as ever," he said. "It is critical that the government and the venture capital industry continue working together to support risk-taking and long-term investment so that we as investors can continue to create new jobs and bring breakthrough technologies to market." Prior to forming Polaris Venture Partners, he spent seven years at Burr, Egan, Deleage & Co. investing in early-stage medical and information technology companies. McGuire has co-founded three companies: Inspire Pharmaceuticals, Advanced Inhalation Research Inc. (AIR), and MicroCHIPS.

The sky's the limit for **Jim Zierick '78 TT'80**, who brings 25 years in building technology companies to "cloud storage" platform provider Nirvanix. In his new role as president and CEO of the San Diego-based firm, he's using his business acumen to grow the company's global cluster of storage nodes. He presented the company's strategies during the spring Red Herring Conference, where he accepted a Red Herring 100 Award, given to the top 100 U.S. tech companies based upon their technological innovation, management strength, and market size.

Dartmouth javelin-throw record holder **Sean Furey '04** qualified for the International Association of Athletics Federations World Track & Field Championships held in Berlin in August after placing third at the USA Track & Field Championships in Oregon in June. "This is something that I've been dreaming of and working towards for so many years," says the former engineering major.

Energy-capture expert **Brian S. Hendrickson '06 Th'07** has been named to the advisory board of alternative energy technology developer Octillion Corp. (octillioncorp.com). An engineer with Veryst Engineering, LLC, in Needham, Mass., Hendrickson is credited with various innovations in the capture of wasted energy for generating electricity. The September 2008 issue of *Mechanical Engineering Magazine*, in an article titled "Harvest of Motion," highlighted his development of a small-scale device that uses human motion to generate five-times greater power output (per volume) than conventional energy harvesting systems.

THIS PAGE: COURTESY OF JASON ALTMAN. OPPOSITE PAGE: COURTESY OF ALEX STREETER

OPERATING ROOM
Derek R. Jenkins '02 DMS'06, M.D. (right) performs a posterior spinal fusion. His research focuses in part on clinical outcomes of surgical techniques in orthopedic surgery.

just one question*

Q. What work are you doing in the medical engineering field?

I am the director of systems engineering at Angel Medical Systems (angel-med.com). We are developing an implantable cardiac monitoring and alerting system that is designed to warn cardiac patients of potentially life-threatening heart conditions. After Thayer I then went on to get my M.S.E.E. at the University of Illinois, with a concentration on control theory and a thesis involving microprocessor applications. I then started working at Bell Labs, working on the very first commercial fiber optic transmission system. I started as a circuit designer but quickly found my calling as a systems engineer. My role through 20-plus years and at least three generations of fiber optic transmissions systems was in writing requirements and managing the high-level architecture and design of such systems. I then somewhat serendipitously landed in a newly formed medical device startup company, Angel Medical Systems, where my role has been primarily that of systems engineer. My main responsibility, particularly early on, was taking the fundamental ideas of the founders and specifying all the details for the software developers, so they could write the code for a reliable heart attack detector with high sensitivity (few false negatives) and high selectivity (few false positives). It was very interesting to me that the microcontroller we use as the heart of our implantable device has capabilities similar to the one I used for my B.E. project so many years ago.

—Steve Johnson '75, Th'76

I am working in a field that blends engineering sciences into a form of high-tech drug discovery. My company, Trellis Bioscience, discovers antibodies from human blood that become therapeutics.

—Stote Ellsworth '76

As a partner at Vanguard Ventures, I have invested in medical device companies. One, Asthmatx, produces a device designed to improve the quality of life and reduce asthma attacks in adults with severe asthma without the use of drugs. Results of the Asthma Intervention Research 2 trial demonstrated statistically significant improvements in quality of life measurements and reductions in attacks and emergency room visits in adults with severe asthma who underwent bronchial thermoplasty delivered by the Alair system.

—Tom McConnell '76

I wrote the New Hampshire Mammography Network Registration database in 1996 and rewrote it a few years ago. Also, my firm, Sylvan Advantage, supports video software for medical simulation.

—Richard Akerboom '80 Th'82

I have more than 20 years of experience in the biopharmaceutical industry, including evaluation of emerging technologies and leading technical development focused on business goals, organizational development, and the management of strategic partnerships. I am now CEO of ImmuRx (immurx.com). Previously I was CEO of MIST Inc., a breast cancer imaging company, and before that I led the development of a genomics-based technology platform at Millennium Pharmaceuticals. ImmuRx has just leased space in the Dartmouth Regional Technology Center. We are now trying to use a combination of agonists—molecules that bind to receptors to improve their function—in a metastatic melanoma vaccine that stimulates two receptors of the immune system at once to advance a kind of pincer move on cancer cells. While ImmuRx is working on fighting melanoma, applications could be broad, with potential to target cancer stem cells, bacterial or viral infections, and HIV/AIDS viruses.

—Dave DeLucia '80

I am president and owner of the Atlas Group. We're implementing a health care CIO dashboard and associated information technology [IT] process improvements in order to prepare IT infrastructure for electronic records, advanced diagnostics, etc. Our target market is small to medium organizations.

—Mark Tuttle '80 Th'82

I have done venture capital investing in health care for the last 22 years—most of it at Morgan Stanley Ventures and now at Saints Capital. Twice I have teamed up with **John Pavlidis Th'89** to build medical products companies. John was CEO and I was primary investor and chairman of R2 Technology, which makes products that significantly improve the detection of breast cancer from mammograms. Together we built the company to $50 million in revenue and sold it to Hologic for $225 million. We have teamed up again on a company named Estech, which makes products for minimally invasive cardiac surgery. The company is doing well and will do about $25 million in revenue this year.

—Scott Halsted '81 Th'82

I work within the facilities and real estate division of New York-Presbyterian. My primary focus is capital planning for facilities infrastructure, including campus utility distribution systems, central plants, and building systems and structures. We are in the middle of developing an eight- to 10-year infrastructure capital reinvestment program that could total as much as $600 million. I'm back in the world of facilities engineering, despite my background as an architect and project management consultant. During the past 15 months with the hospital, I have drawn heavily on my problem-solving and engineering training to quickly learn a new scale of equipment and planning.

—Glenn A. Grube '82 Th'83

As a professor of materials science and engineering at Johns Hopkins University, part of my research involves characterizing the mechani-

* Want us to ask you just one question?

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

CLEAR RESULTS
Andrés Dandler '97 Th'98 heads a design team that developed the hand-held acne gadget Claro.

HEART HELP
Left: Steve Johnson '75, Th'76 developed the algorithm for the microcontroller of this heart monitor.

THIS PAGE: LEFT, COURTESY OF STEVE JOHNSON; RIGHT, COURTESY OF ANDRÉS DANDLER. OPPOSITE PAGE: COURTESY OF DEREK R. JENKINS, M.D.

cal properties of biomaterials. While we have focused on human enamel during the last decade, we are expanding our studies to include other biomaterials such as cartilage.

—Tim Weihs '83 Th'85

For the last 15 years I have owned a company, World Medical Equipment (worldmedicalequip.com), that refurbishes operating room equipment such as surgical tables, lights, and sterilizers. We shipped equipment to 42 states last year. I did my B.E. thesis under John Collier, designing instrumentation to put in artificial hips.

—Bob Mighell '85 Th'86

I am on the board of directors of KidsCareEverywhere (kidscareeverywhere.org), which is focused on improving the delivery of pediatric medical care in developing countries. Our current primary project is delivering pediatric emergency medical diagnostic software to developing countries (Vietnam and Cambodia at the present time). We place this advanced software application—which contains a complete set of diagnostic and treatment data and procedures that are all peer reviewed by global experts—in the hands of local clinics in underserved areas. This application of modern technology to understaffed areas significantly improves the quality of care and the knowledge and effectiveness of the local staff. My role involves actively helping with technology distribution models. My day job focuses on clean-tech companies and venture capital.

—Eric Miller Th'85

After 12 years in the medical device industry and eight years in high tech, I have gone into business with a partner to form IMC Services (imcservicesonline.com), providing Internet marketing services to small- and mid-sized scientific instrumentation and medical technology companies.

—Carrie Fraser '86 Th'87

I am currently associate professor and residency program director in the department of emergency medicine at Louisiana State University Health Sciences Center in Shreveport. I am the person responsible for training medical school graduates in three years to be emergency physicians who are able to practice anywhere on their own. I currently have 21 residents (seven per year). I developed our program from scratch in 2003 when I originally came to Shreveport from a faculty position at the Medical College of Wisconsin. The education that I received in analyzing systems while at Thayer has helped me tremendously in understanding physiology, which I use every day while seeing patients in our emergency department. Also, faculty that I met at the Thayer School provided role models for me that I referred to when I became an educator. I particularly remember the teaching styles of Professors Horst Richter and Lee Lynd as being the most inspirational.

—Thomas K. Swoboda '88 Th'88, M.D.

I work for Boston Scientific in the cardiac rhythm management area (implantable defibrillators, pacemakers, and cardiac resynchronization devices). I am the VP of business strategy, responsible for decisions regarding new product and new technology investments in our portfolio. Medical devices are a highly regulated space. Given the lead time in development, testing, and regulatory review, the quality of these up-front investment decisions are critical. I weigh the potential patient benefit (symptoms, mortality), resulting market size and potential adoption, and overall benefit to the health-care system against several risks (clinical, competitive, etc.) and a finite investment pool. Thayer prepared me well for this role, as success is based on an appreciation and understanding of technical development across multiple disciplines and an understanding of economic modeling, decision analysis, and portfolio management that I began to develop in the Thayer M.E.M. program (and later supplemented with an M.B.A).

—Peter Sommerness '90 Th'91

In 2002, I founded Endless Loop Software (endlessloopsoftware.com) in Gainesville, Florida with my husband Peter Schoaff (Cornell '90). With a B.E. and an M.E.M. from Thayer, I wanted to bring ideas and innovations from academia to the marketplace. Medical and public health-related software projects have been a great opportunity to contribute leadership based on our broad engineering, computer science, and business background. One of our earliest projects involved working with faculty at the University of Florida on a Web-based clinical research platform. That application was eventually licensed to Clinipace (clinipace.com) and is now known as Tempo. From its initial start-up phase, we worked closely with Clinipace, applying our extensive experience in taking ideas from concept to production-scale commercial quality systems. Clinipace is now a successful digital clinical research organization that focuses on improving the management of clinical research in order to save money and time while empowering project stakeholders to make informed, data-driven decisions. Recently Endless Loop Software has begun exploring opportunities to assist international non-profit organizations with the management, evaluation, and assessment of public health initiatives. Increasing innovation and improving efficiency of health care in low-resource areas is our shared goal.

—Christine Baldanzi Schoaff '90 Th'92

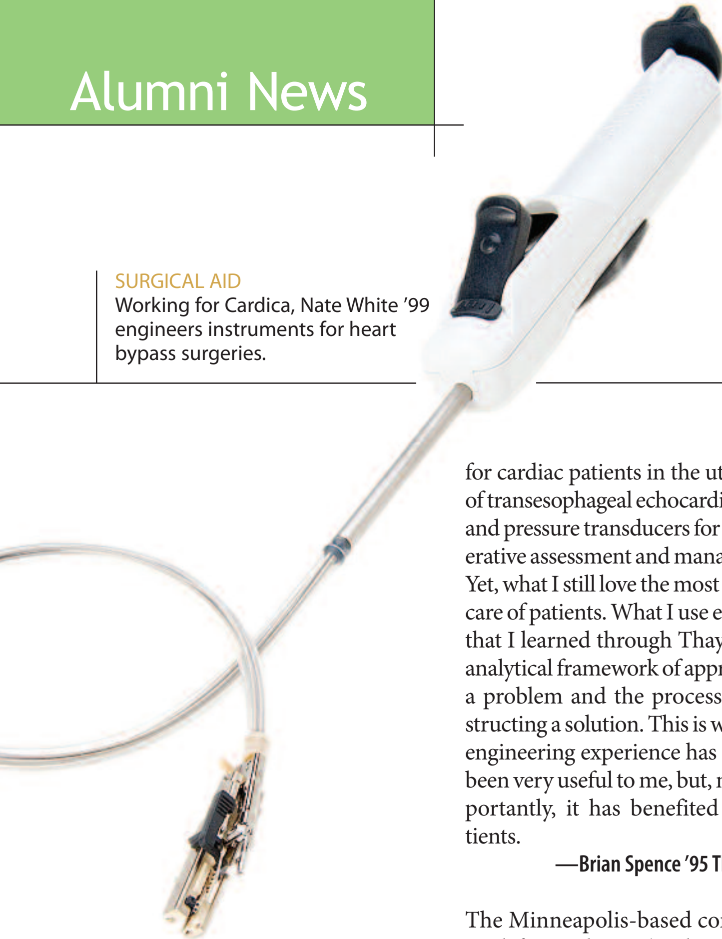
I started a company recently, ODOS (which comes from the Latin abbreviation for "right eye, left eye") Industries Inc., and am working to develop and market electronic medical records for the eye-care industry. I'm also a practicing eye surgeon.

—Kevin Cranmer '92, M.D.

Since founding Acumen in August 2002, we have received FDA clearance on three products, published a number of scientific papers, and established a strategic relationship with Medtronic, one of the largest distributors of medical devices in the world. I am the inventor of the Insight endocardial visualization catheter, and was involved in early-stage IP development and bench-top prototyping. I am the contributing inventor of the Spirit and C315 lead delivery catheters. As founder, president, and CEO of Acumen, I raised $12 million and managed the company from product concept through development, regulatory clearance, and finally product distribution.

—Nick Mourlas '92 Th'93

I have found my way from engineering into public health. After I left Thayer I went down to Boston to work in a biotech firm in toxicology. During the evenings I finished an M.P.H. in epidemiology and biostatistics at Boston University. I left the biotech firm and started a full-time



SURGICAL AID
Working for Cardica, Nate White '99 engineers instruments for heart bypass surgeries.

SMOOTH MOVE
Bill Shields '03 Th'04 is working on improvements to Stryker's Trident Ceramic-on-Ceramic hip system, a titanium-and-ceramic press-fit hip system designed for young, active patients.

doctoral program in occupational epidemiology at the Harvard School of Public Health and graduated with a Sc.D. in 2000. I am now a principal owner of Colden Corp. (colden. com), an environmental health, industrial hygiene, and safety firm. As an occupational epidemiologist I help my clients figure out why people get sick at work. We work in heavy industry and institutional settings such as educational facilities and hospitals, as well as network television and major motion picture sets. I get to see how things are made and produced every day (food, television shows, power, glass, movies, paper, pharmaceuticals). It is the perfect combination of engineering analyses and medicine—I identify the hazards in a process or environment and the methods to mitigate or engineer out the hazard and understand what health effects are possible.

—Shannon R. Magari Th'94

I'm an anesthesiologist at Dartmouth-Hitchcock Medical Center. I have participated in some medical device development and currently am one of four people on a patent for an ultrasound probe holder to facilitate the placement of regional anesthetics. I also use my fluid dynamics training every day when I am caring for cardiac patients in the utilization of transesophageal echocardiography and pressure transducers for intraoperative assessment and management. Yet, what I still love the most is taking care of patients. What I use every day that I learned through Thayer is the analytical framework of approaching a problem and the process of constructing a solution. This is where my engineering experience has not only been very useful to me, but, most importantly, it has benefited my patients.

—Brian Spence '95 Th'96, M.D.

The Minneapolis-based company I work for, Sophrona (sophrona.com), offers online patient communication software to ophthalmology practices nationwide. I handle the strategic and operational management and the development of Sophrona's Sage Portal, a customizable, secure, online communication portal for patients.

—Marc-Francois Bradley '96

After designing consumer telescopes for five years, I became a senior designer at a medical device company. I came to appreciate the high-level design and quality work ethic that goes into designing medical devices. After being employed there for five years, I was inspired to provide more value to my former employer and other clients by forming my own niche design team, Dandler Design (dandlerdesign.com), which specializes in designing medical devices. My background is in mechanical design, and my firm can handle projects from start to finish: concept definition, industrial design (the artistic "vision" for the product), mechanical engineering, management of vendor relationships, and production start-up, both in the United States and abroad. Right now we're involved in developing a hand-held acne gadget, Claro (clrstechnology.com); an ultrasound device; and a complex automated external defibrillator. Each of these is in a different stage of development. I manage about 10 engineers, most of whom work for me remotely. I really enjoy the minimalist infrastructure of running a company from my iPod touch, laptop, and cellphone!

—Andrés Dandler '97 Th'98

I currently work as a program manager at HeartWare Inc. (heartwareinc.com), which makes left ventricular assist devices. My role is to manage all activities required to get the devices from a concept stage through clinical trials, and, ultimately, to commercialization worldwide.

—Heather Harries Th'97

After completing my Ph.D. in biological engineering at MIT and a postdoctoral fellowship in a cardiology lab, I am now an assistant professor and associate biophysicist at Harvard Medical School/Brigham and Women's Hospital, while also teaching a biomechanics class at MIT. My research focuses on studying the effect of mutations that cause muscular dystrophies on the mechanical properties of biological cell (e.g. muscle cells) and how these changes can contribute to the disease. In particular, we are studying how mutations in nuclear envelope proteins, such as lamin, can render cells more sensitive to mechanical stress and affect their mechanotransduction signaling. Insights gained from this work can lead to a better understanding of the molecular mechanism underlying laminopathies, a diverse group of diseases including Emery-Dreifuss muscular dystrophy, Hutchinson-Gilford progeria syndrome, and familial partial lipodystrophy. To achieve these goals, we are developing novel experimental techniques to study nuclear mechanical properties in intact cells and isolated nuclei, investigate the physical coupling between the nucleus and the cytoskeleton, and examine how changes in these properties can affect the cellular response to mechanical stimulation.

—Jan Lammerding Th'97

I am a postdoc at UC Berkeley, using engineering approaches to study HIV biology. I recently accepted a job as assistant professor of biomedical engineering at Yale, where I will establish my own lab to pursue related research on host-virus interactions. Biological systems are characterized by complex networks of chemical and physical processes about which we have incomplete information. Engineering approaches—including quantitative experimental measurements, model-driven analysis, and rational approximations—are particularly well suited to advancing our understanding and control over biological network function. My research applies engineering principles to understand how viruses, particularly HIV, rewire chemical networks that control host cell communication leading to viral pathogenesis. A better understanding of how viruses alter cell communication might allow us to identify novel anti-viral targets and design more effective treatment strategies.

—Kathryn Miller-Jensen '97 Th'98

I am an associate professor in the biomedical engineering department at Vanderbilt University. I do research on the elastic properties of soft tissue in murine systems concerned with breast cancer and tibia fracture healing. I also do work in image-guided surgery of the brain, liver, and kidney, and I work in the imaging field of elastography. I am a co-founder of a company that sells an FDA-approved image-guided liver surgery system—the only one of its kind.

—Michael I. Miga Th'99, Ph.D.

I have been involved with medical device engineering for the last eight years. The company I work for, Cardica (cardica.com), designs and develops products for facilitating open-chest and closed-chest (totally endoscopic) bypass surgery anastomoses. Our products are incredibly cool and complex mechanical systems.

—Nate White '99

I worked for three years at Stryker Orthopaedics. I worked on acetabular implants while in-house and then specialized in prototype instrumentation as a consultant. I have since quit and am in my third year of medical school at the Mayo Clinic. I will probably make it back to engineering someday. **Bill Shields '03 Th'04** still works at Stryker as an engineer, and **Nick LaVigna '00 Th'02** is in the field as a technical sales rep after designing Stryker's hip navigation system from the engineering standpoint.

—Brian Graner '01 Th'02

I work at Myriad Genetics as a process engineer. Patients with a family history of breast or colon cancer consult with the doctors about genetic factors that can contribute to their risk of contracting those types of cancer. Their blood is drawn and sent to us. We analyze the blood for mutations in specific genes that are known to have a profound impact on a patient's likelihood of getting cancer. To handle the large volume of samples, we employ robotics and automation in an assembly line to assemble the reactions. As a process engineer, I ensure that our assembly line is running efficiently.

—Ben Miller '01 Th'03

I'm a project coordinator at Anshen + Allen, an architectural firm in Boston that designs healthcare, academic, and research buildings. One of our showcase projects is the Green Patient Room, a healing environment that uses green materials and technologies, connects the indoors with the outdoors, and deinstitutionalizes the healthcare environment. I helped create 3-D models and a life-sized mock-up of the room that travels to different cities and trade shows to demonstrate what's possible. Within the Green Patient Room, there is a menu of solutions and options that hospitals can customize to their particular settings. At Dartmouth, I majored in engineering and studio art. While working at Anshen + Allen, I have become LEED certified and I am currently in the process of becoming a certified architect.

—Patrick McCarthy '04

I work in a field combining engineering and medicine. I am about to start my third post-graduate year of study in orthopedic surgery at Lenox Hill Hospital in Manhattan. With a degree in engineering sciences and biology from the College and an M.D. from Dartmouth Medical School, I feel well prepared for a career as an orthopedic surgeon. My research interests focus on the biologic response to wear particle debris from total joint replacements, and clinical outcomes of surgical techniques in orthopedic surgery.

—Derek R. Jenkins '02 DMS'06, M.D.

I develop vaccines as an associate director of product development at Emergent Biosolutions in Maryland.

—Katya Kovalskaia Th'02

I am a software engineer, specializing in hardware interfaces, for Medtronic Navigation in Colorado, engineering software for surgical navigation systems. The systems are used by surgeons in the operating room to help navigate instruments through the body. It's kind of like GPS for brain surgery! My last project was to modify our system so it can be used in conjunction with surgical microscopes.

—Erin Morse '02 Th'03

Christina Skourou Th'06

ENGINEER AT WORK

The Life of a Medical Physicist

If you're lucky, you'll go through your whole life without encountering a medical physicist. If you're a cancer patient, you might come across one but not realize it. Few people know that medical physicists play a crucial part in the design and accurate delivery of radiation therapy.

One procedure I handle is the intravenous delivery of glass microspheres containing Ytrium-90, used to treat liver cancer. The microspheres are infused into the liver via a catheter inserted into the femoral artery through a small incision in the leg and guided to the hepatic artery by fluoroscopy. I spend mornings in the "hot lab," where the exact dose for the patient is calculated and measured. In the operating room, I set up the delivery device and, with the assistance of a physician, ensure delivery of the total dose. I use a Geiger-Müller device or scintillator to monitor the delivery of radiation and survey areas and personnel that may have come into contact with the radioelements. Afterward I collect all contaminated material and return it to the hot lab for proper disposal.

I also manage the delivery of high-energy photons or electrons for external beam therapy. About 100 patients are treated daily at DHMC on one of four linear accelerators. One procedure that uses these accelerators is stereotactic radiosurgery (SRS), in which high doses of radiation are precisely deposited in the brain via carefully oriented external beams. SRS is given to eradicate brain tumors. Working with a radiation oncologist and neurosurgeon, the medical physicist is responsible for localizing the target, designing the plan to treat the lesion and miss normal structures, and delivering the treatment. The day of treatment, a light aluminum alloy frame is fixed to the patient's skull with plastic pins. This frame is visible in the imaging equipment and is used to give an exact set of coordinates for the target. Aided by specialized software, the physicist uses the image set and advanced algorithms to plan delivery of the desired dose to the patient's lesion by manipulating beam orientation, intensity, and size. A long series of tests and dry runs ensures that the radiation will be produced and delivered as planned. When the patient is finally brought in for the procedure, all the checks are repeated with the patient in position. Only then is radiation delivered.

Whether or not patients are aware of us, we medical physicists are there: checking, verifying, double-checking, measuring, adjusting, and improving every step of the treatment—and proud to be engineers.

—Christina Skourou Th'06
Department of Radiation Oncology
Dartmouth-Hitchcock Medical Center

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MAP QUEST
Erin Morse '02 Th'03 is engineering software for surgical navigation systems, such as this one (which can also be seen in the sick bay of the new Star Trek movie).

For the past three-plus years I have worked on many different medical devices through conception, design, and production—including transcutaneous skin vaccinations, a drug delivery device for weekly in-home injection, and a non-invasive temperature measurement device.

—Brian Mason '03 Th'04, '05

I work as a manufacturing engineer for Pall Corp., which manufactures a wide range of filters and filtration systems, including water filters, air filters, and biopharmaceutical filters. All kinds of vaccines and drugs are made using our products. I currently support production of our blood filter media. In addition to daily troubleshooting on the shop floor, I focus on continuous improvement projects, using lean and six sigma tools. (I was certified by Dartmouth Six Sigma.) We have used the lean concept of visual factory, in particular, to facilitate flow and increase productivity and throughput.

—Julie Matteini '03 Th'05

I work as a product development engineer for Stryker Orthopaedics. I design and develop new implants and instruments for total hip replacement surgeries. I spend most of my time working with orthopedic surgeons to develop new products and with our manufacturing engineers to figure out how to make them. Once we have a validated manufacturing process, I develop and perform tests that ensure the product's function and strength. This testing is then submitted to the FDA or other regulatory agencies to obtain product approval. Working with orthopedic surgeons has been one of the most enjoyable aspects of my job, due to the highly collaborative environment. I have had the pleasure of collaborating with some of the country's most innovative surgeons, which has resulted in some very exciting and beneficial products. There is nothing more rewarding than watching a surgeon I have worked with for a number of years use a new product we invented to help a patient.

—Bill Shields '03 Th'04

I'm working on my Ph.D. in chemical engineering at Stanford. We try to produce proteins at high yield using an in-vitro system. We work with proteins that are difficult to produce in living cells due to improper folding, cell toxicity, etc. I have been working on lymphoma vaccines and novel cancer diagnostics. I have been trying to optimize our in-vitro (or cell-free) system to maximize yields of certain protein targets. The real-world applications are in patient-specific cancer vaccines (specifically for B-cell lymphoma) and for stem cells. For stem cells, the proteins we have tried to produce could help reprogram fibroblast cells (skin cells) into stem cells, which could circumvent the need to destroy an embryo in order to generate stem cells. The biggest challenges have been learning to develop my own projects and experiments without having specific protocols or mentors to follow. As with most things, critical thinking and persistence have probably helped the most.

—John Welsh '04 Th'05

I'm working on my Ph.D. in biomedical engineering with a focus on tissue engineering. My thesis is on uncovering some key players in embryonic development and applying that knowledge to create steroid-producing tissue through several means: by directed differentiation of embryonic stem cells and induced pluripotent stem (iPS) cells, reprogramming of ES and iPS cells, and transdifferentiation of terminally differentiated cells. The goal of the project is to set the foundation for a cell-based therapy for individuals with steroid insufficiency resulting from either congenital defects or cancer. The research I did at Thayer really set a strong foundation of problem-solving skills, applying unique approaches, and examining a problem from a variety of angles. I hope to use my Ph.D. as a foundation for a career in academics.

—Jaime Mazilu '05 Th'06

I am the information security manager for Dartmouth-Hitchcock Medical Center. My responsibility is to make sure the organization is compliant with the HIPAA security rule by building an information security program that attempts to identify all of the IT security risks to the organization and recommend and oversee the implementation of measures to mitigate those risks. Information security is a complex and rapidly changing field; hospitals are highly regulated complex organizations. When you combine the two domains, it can quickly be overwhelming. To someone outside the field, you may not be aware just how many automated processes are handling much of the work inside a hospital. For example, when you visit your doctor and get your blood drawn, the sample is placed into a machine that performs millions of tests and automatically routes the results back

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into your electronic medical record. Tracking available beds, dispensing medications, generating laboratory results, and conducting radiology exams are just some of the myriad processes that are automated within a hospital. Protecting those computer systems requires full-time staff who are dedicated to the effort. The trend toward greater inter-operability and communication between hospitals will greatly aid the provision of health care but can also introduce vulnerabilities. If properly mitigated, the risk is worth the reward.

—Doug Madory Th'06

I am a management consultant with L.E.K. Consulting, and I recently worked on a growth strategy for a leading medical devices company, outlining strategies for becoming a global leader in its blood collection systems division.

—Mayank Agrawal Th'08

I am doing my Ph.D. in biomedical engineering at the Johns Hopkins School of Medicine, though I am still a rotation student and haven't started thesis work yet. As part of a class project and in conjunction with one of the research groups in the B.M.E. department, we just finished a prototype automated therapeutic hypothermia machine for use in animal experiments. The lab is studying how therapeutic hypothermia can be applied to the treatment of cardiac arrest. At Thayer I worked primarily on projects involving robotics and electronics. I became interested in biomedical engineering largely because I was thinking about the future; the main fields robotics is used in are military, industry, consumer products, and medicine. I chose to go into medical robotics since this seemed like a noble cause and an area with a huge potential for expansion.

—Kevin Olds '07 Th'08

COURTESY OF ERIN MORSE

thayer notes

1950s

Em Houck '56 TT'58: I chair an accounting firm in St. Louis, and I am working on my second book. My first book, *Go Huskies! Beat Felix the Cat!*, was a collection of stories of why some of our high schools selected the mascots they did for their teams. Schools in all 50 states were covered, emphasizing unique names, such as Appleknockers and Corn Jerkers. The second book concentrates on Indiana alone, again using mascot choice to group schools together, but examining the history of 800 or so schools that have been closed as well as the 400-plus still open. This book is titled *Hoosiers All*, since no matter what name we choose for our teams, at the end of the day everyone in Indiana is a Hoosier. It will be published in August by Hawthorne Publishing.

1960s

Gib Myers '64: I'm involved in growing a bison herd and acquiring land for a wildlife reserve in eastern Montana as the chair of the American Prairie Foundation (americanprairie.org).

1980s

Xiaolong "Dennis" Cai Th'88: After leaving Hanover in 1992, Emma and I worked for Texaco in Houston until August 2001. Then, with our two daughters, we moved to Dhahran, Saudi Arabia, when I took an assignment with Saudi Aramco, the largest oil company in the world. We have enjoyed the expats' lifestyle and many adventurous traveling opportunities to various parts of the world. Our older daughter recently returned to the United States for boarding school at Deerfield Academy, with the younger one following in two years. We look forward to meeting with classmates and friends anywhere in the world (dennis_cai@yahoo.com).

Joyce Mechling Nagle Th'89: I have been a research engineer at U.S. Army Cold Regions Research and Engineering Laboratory since 1989. I work in the area of decision analysis and stability operations.

1990s

Durward K. Sobek II '91: You may be interested to know that a book I co-authored was published this year. It's titled *Understanding A3 Thinking* and is published by Productivity Press (productivitypress.com).

April Whitescarver '96: I'm a new lawyer now! I passed the bar in Virginia in February.

Heather Bartholf Harries Th'97: I am thrilled to introduce Ryan Tobias Harries, born May 17. He weighed 9 pounds, 5 ounces, and was 20.5 inches long. He joins me and my husband, David, and big sister Calista.

Johan Tegin Th'99: I was a project manager and design engineer at telecom company ADC's Swedish laser business, which shut down. I've since been in the Ph.D. program at Sweden's Royal Institute of Technology in cooperation with Orebro University. I successfully defended my thesis, "Tactile Grasping for Domestic Service Robots: Simulations, Experiments, and Hand Design," in June. The faculty opponent was Rudiger Dillman from the University of Karlsruhe. I will stay at KTH Machine Design as a research assistant to continue research with robotic grasping and autonomous manipulation in domestic environments.

DARTMOUTH SOCIETY OF ENGINEERS

HELP BUILD THE DSE

The Dartmouth Society of Engineers was founded more than a hundred years ago by Thayer alumni interested in supporting the school. The organization has evolved over the years to meet the needs of the time. Once again, we are realigning ourselves to carry out the DSE's principal objectives:

- Supporting the students, faculty, and administration of Thayer.
- Building a community of Dartmouth alumni interested in engineering and innovation.
- Providing a channel for communication between Thayer and alumni around the globe.

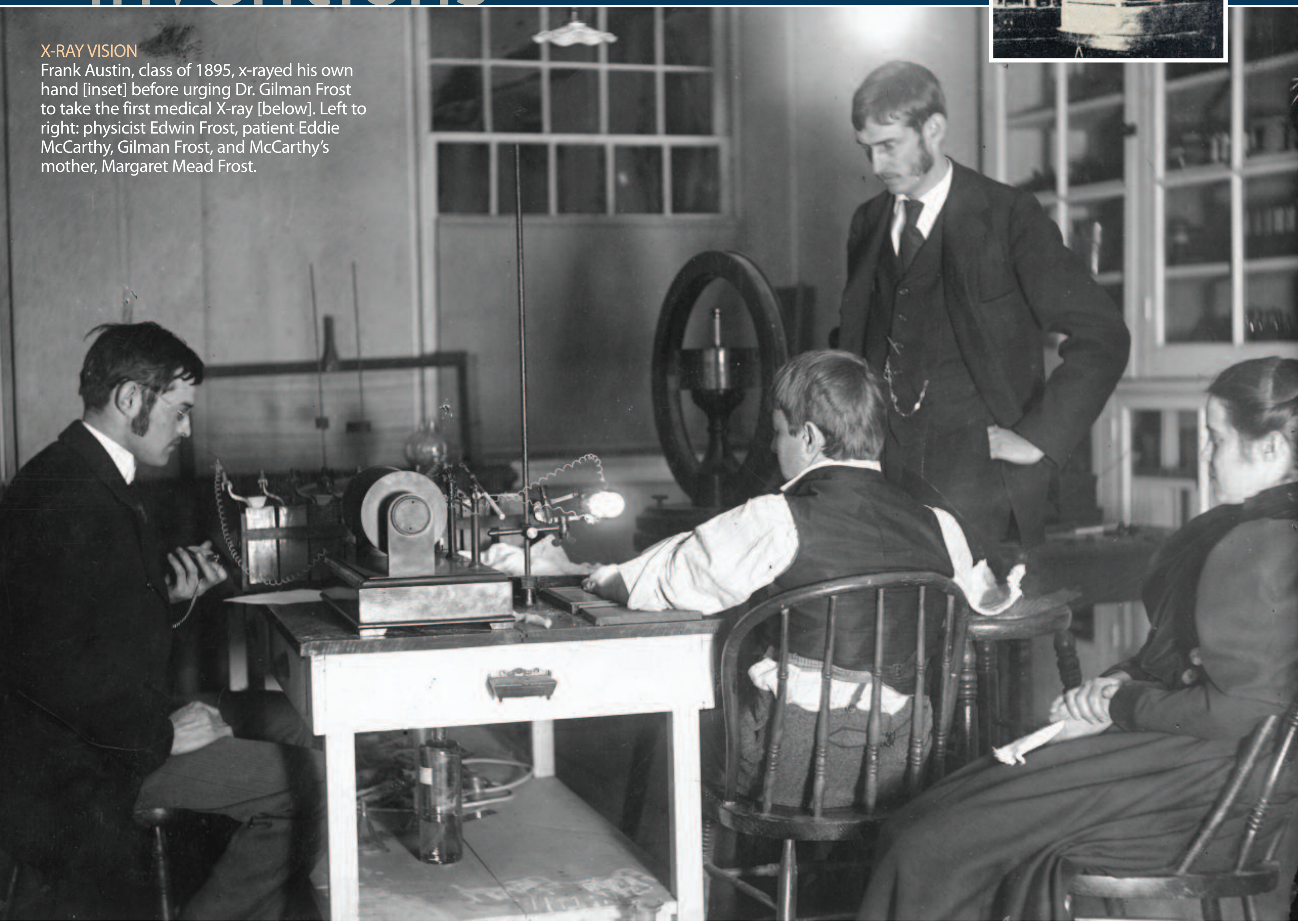
With guidance and support from the Thayer alumni relations office, we are creating a new, federated structure for alumni programming. It combines centralized support and coordination by an executive committee with the flexibility and responsiveness that only local organizations can provide. Local chapters in several metropolitan areas will develop and run pertinent events for the alumni in their region.

This new structure can only succeed with the support of enthusiastic, dedicated alumni at the local level. Alumni have already come forward to lead chapters in Boston, San Francisco, and Washington, D.C. If you'd like to help them or start a chapter in your area, please contact me at DSEalumnichapter@dartmouth.edu.

Thanks for your support. The DSE Executive Committee and I look forward to serving you.

—Steve Hallowell '01 Th'02 Tu'10
President, DSE

inventions



X-RAY VISION
Frank Austin, class of 1895, x-rayed his own hand [inset] before urging Dr. Gilman Frost to take the first medical X-ray [below]. Left to right: physicist Edwin Frost, patient Eddie McCarthy, Gilman Frost, and McCarthy's mother, Margaret Mead Frost.

DIAGNOSTIC X-RAYS

>> CO-INVENTOR:
PROFESSOR FRANK AUSTIN

The medical X-ray, like many inventions, is the result of different people working simultaneously on the same idea. Weeks after German scientist Wilhelm Roentgen announced in late 1895 the discovery of a "mysterious light" emitted from Crookes tubes, scientists and engineers from all over the world began experiments. One such person was Frank Austin, class of 1895, a physics assistant at Dartmouth and later a professor at Thayer. Using equipment he built, Austin made a number of X-ray photographs, including one of his own hand in late January of 1896. On February 3, 1896, at Austin's suggestion, Hanover physician Dr. Gilman Frost and his brother, physics professor Edwin Frost, took a diagnostic X-ray of local schoolboy Eddie McCarthy's broken wrist.

Until recently, Dartmouth had undisputed bragging rites for the first medical X-ray. Then Yale claimed that one of its physicists made an X-ray image on January 27, 1896.

"If Yale's physicist, Arthur Wright, preempted the Dartmouth group," writes Dr. Peter Spiegel '58 DMS'59, a Dartmouth radiologist who has done extensive research on the history of the X-ray, "it remains unreported and unsubstantiated, at least in the scientific literature. The Dartmouth group went one step further. The taking of the first clinical X-ray in America was captured by photographer Henry H. Barrett and so remains the first scientific experiment recorded by photographic means."

—Lee Michaelides

HENRY H. BARRETT; DARTMOUTH COLLEGE ARCHIVES.
INSET: NEW HAMPSHIRE PROFILES MAGAZINE

RANDOM WALK

Students tried their hand at surgery in a mock operating room in a Thayer classroom for the final sessions of ENGS 165: Biomaterials. "The students are taken through the process of repairing a shattered proximal humerus and a broken radius using Locking Compression Plates. The surgery is led by an engineer from industry, and the instruments, plates, and hardware are the same sets that are used by surgeons in the operating room," says Professor Douglas Van Citters '99 Th'03, '06 (back row, right). "Students learn about design principles, bone healing principles, and human factors—how do you put such a small screw in or drill a straight hole?" The approach makes an impression. "Although we all managed to implant the plates on the bones properly, we would make terrible surgeons," says Monica Martin de Bustamante '08 Th'09 (second row, second from right). "If there had been any soft tissue around, we would have destroyed it!"

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