DARTMOUTH
Engineer
THAYER SCHOOL OF ENGINEERING | FALL 2024

INNOVATING FOR WOMEN

PROFESSOR BRITT GOODS TH'11 STUDIES SYSTEMS BIOLOGY WITH A FOCUS ON WOMEN'S HEALTH.

A CIVIL APPROACH

"Surveying Mechanics" was one of 12 courses that formed the civil engineering curriculum until it was replaced in 1941 with a focus on electrical and mechanical engineering. Here, a survey party (circa 1883) takes a break.

Photograph courtesy Dartmouth College Library

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Photo by Chris Johnson

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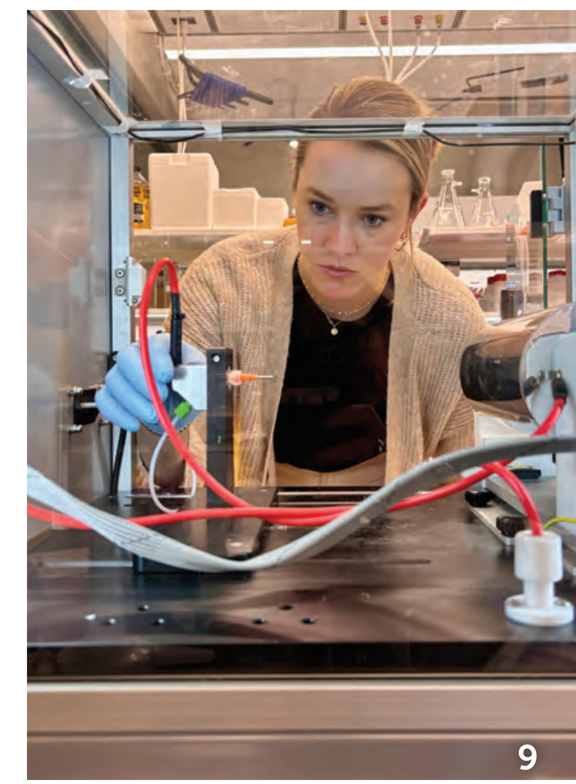

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DEPARTMENTS

COVER: PHOTOGRAPH BY ROB STRONG '04

"As soon as you understand the physics, then there's an opportunity."

—PROFESSOR GEOFFROY HAUTIER

CAMPUS CONVERSATIONS Dean Alexis Abramson talks with Professor Geoffroy Hautier.

Leading Thoughts

"At the Center of Technology"

Dean Alexis Abramson and Professor Geoffroy Hautier discuss how better theories and stronger computers are transforming science.

The Hodgson Family Associate Professor of Engineering uses the power of computers to find new materials—such as high-performance materials for solar absorbers and rare-earth-free magnets to fuel global energy systems (see page 8). We spoke about his multidisciplinary approach to discovery and the future of the field.

What drew you to Dartmouth?

HAUTIER: Dartmouth is in a very unique spot with world-class education and research in a beautiful environment. One thing that I didn't realize when I first visited is the sense of community. I was not even here yet and I was already on two proposals with Jifeng Liu and Ian Baker. That sense of "Let's bring everyone together as much as possible" struck me very quickly. Our community is very interdisciplinary and because there are no walls, it's very easy to interact with others. This applies to students too. I co-advise some students doing experimental work and have a student doing both computational and experimental work who's advised by a colleague who's an experimentalist.

Can you explain your research?

HAUTIER: Materials science is at the center of technology. It has always been the case, from the Bronze Age and the Steel Age, all these materials are changing our lives. But usually, the way these materials have been developed is empirically—you mix chemicals together and see what happens. There is a lot of trial and error, but for a few thousand years we developed a lot of good materials that are important in our everyday life. Now, with the advent of better theories, including quantum mechanics, and stronger, bigger computers, we can predict properties of materials.

Of all the possible combinations, what percentage do we understand?

HAUTIER: For known inorganic compounds—we know the composition, we know the crystal structure—then it is around 100,000 in organic compounds. But there are probably millions and millions more out there. We know they exist, but we have no sense of their electrical, mechanical, thermal properties. That's the ambitious part of my research: There's hundreds of thousands of things that are known—let's compute their properties. I'm involved in the Materials Project, which is putting all this data on a website where people can browse and ask questions.

Can you talk about your methods?

HAUTIER: This is really a crucial moment for the field. When I started 10 years ago, we could run computation, but we couldn't do much machine learning because the data wasn't there. But now we are building a lot of computed data. We can bypass the modeling and use machine learning. We have become really good at predicting properties of materials. But there's still a bottleneck in the way you synthesize materials—that's still a bit of a black art. There are plenty of synthesis paths; some of them are expensive, some are less expensive. In the future, we might reach that level where we are going to have many different materials and maybe we'll pick them not only based on their properties but also on how easy, for instance, they are to be made.

Is that something you can predict?

HAUTIER: My intuition is that it might be a combination of modeling of certain things, diffusion, nucleation events, maybe machine learning. We've been synthesizing materials for a long time now, and there are rules. So, combining this with a machine learning and an AI approach with modeling could bring us to the point we can predict synthesis.

You and Jifeng Liu recently discovered a new material for solar absorbers ...

HAUTIER: This one is very exciting because the impact is huge. Solar power is going to grow, and we need alternatives or materials you could use in combination with silicon as the current solar cell material. We've been taking candidate materials and computing their defects. We are working now on barium cadmium phosphide. The material has a known composition, but nobody had suggested it would be a good solar absorber. But when you do a deep dive and use computation, then you start to see that it has very promising properties.

PHOTOGRAPH BY ROB STRONG '04

THE Great Hall

NEWS FROM AROUND THAYER

DON HAMERMAN

HEALTHCARE

Engineering Better Outcomes

MOSES MATANDA '25 IS FINDING new ways to bridge the gap between technology and medicine. "I wanted to pursue medicine because of the health problems my family faced," Matanda recalls, "but I wanted to do it at a larger scale. So, I asked myself, 'What am I good at?' " He took "Mathematical Concepts in Engineering" during his first term at Dartmouth—and was hooked.

Next, "Design Thinking" informed his belief in a patient-centered approach to healthcare. "I started thinking, 'How can I bring the best of engineering into medicine? How can I use the skills and concepts I've learned in my engineering classes to create better patient outcomes?' "

Through the First-Year Research in Engineering Experience—under the guidance of Professor Solomon Diamond '97 Th'98—Matanda and teammates won the Brieanna S. Weinstein Engineering Design Prize for their work to improve a neonatal continuous positive airway pressure (CPAP) interface. An internship at Columbia University Irving Medical Center confirmed his path: "I shadowed physicians who thought the same way as engineers. They identified specific needs and devised multiple personalized solutions to patients' problems." *—Sydney Wuu '24*

RESEARCH

Study Defines Equitable Approaches

A STUDY LED BY DARTMOUTH Engineering to define and measure equity in flood-risk management could help decision-makers around the world achieve more equitable outcomes from environmental public policy.

"Equity is a difficult goal to meet in managing flood risks because people disagree about what is equitable," says Adam Pollack, postdoctoral research associate and first author on the study published in *Nature Sustainability*. "Our team synthesized how equity has been, and can be, defined and measured in flood-risk research."

Flooding is a common and devastating natural disaster, and both leaders and their constituents struggle to gauge whether risk-management strategies meet diverse expectations about equity. Providing better practices for quantifying equity can make it easier to see if their goals are being met.

"Conclusions about equity often depend on which principles, value judgments, and perspectives the analysts adopt," says senior author Klaus Keller, Dartmouth's Hodgson Distinguished Professor of Engineering.

It's a complex, multidisciplinary problem he tackled by involving risk analysis and engineering, a philosopher from Penn State, and an economist from the Environmental Defense Fund. "We hope the guidance we provide can facilitate agreements about equity, not only for managing flood risks but also for other environmental management settings where equity is important." *—Catha Mayor*

MARK WASHBURN

Mira Murati Th'12 speaks speaks about the future of artificial intelligence at the "AI Everywhere" event.

ARTIFICIAL INTELLIGENCE

Imagining the Future

"We're building on decades and decades of human endeavor."

—MIRA MURATI TH'12
OPENAI CTO

AI IS GETTING SMARTER, SAYS OPENAI CHIEF TECHNOLOGY Officer Mira Murati Th'12. She predicts computers may soon exhibit PhD-level intelligence for specific tasks. And although that may ring alarm bells among some, Murati also expects smarter AI will be more helpful and safer.

Murati, who leads the development of some of OpenAI's most popular tools—including ChatGPT and DALL•E—says more advanced AI is better at keeping within human-constructed guardrails. "It's much easier to direct a smarter system by telling it, 'Okay, just don't do these things,' " she told a crowd of about 200 at an "AI Everywhere" event in the Class of 1982 Engineering and Computer Science Center following Thayer's Investiture on June 8. She was on campus to receive an honorary degree from Dartmouth at Commencement the next day.

The conversation, moderated by Dartmouth Trustee Jeffrey Blackburn '91, focused on both the promise and concerns surrounding AI.

Murati, who earned her BE from Dartmouth as a dual-degree student, said working on self-driving cars at Tesla—a natural follow-on to her efforts building race cars with the Dartmouth Formula Racing team—sparked her interest in AI. She joined OpenAI to dig deeper into the technology and because she liked the company's mission of building safe AI. Murati pointed out that AI is not completely new—it got its start at Dartmouth back in 1956 at a seminal conference on artificial intelligence. "We're building on decades and decades of human endeavor," she says.

As she spearheads the development of technology that will shape the future, Murati stresses its use is a shared responsibility among civil society, government, and content creators. "Perhaps the most significant thing that ChatGPT did was to bring AI into the public consciousness, give people a real intuitive sense for what the technology is capable of—and also of its risks." *—Matt Golec*

Professor Yan Li

IRVING INSTITUTE

Faculty Tackle Climate and Energy Solutions

TWO RESEARCH PROJECTS led by Dartmouth Engineering faculty have been awarded grants from the Arthur L. Irving Institute for Energy and Society. The Faculty Seed Grant Program—which is supporting six projects with nearly $500,000—is driving efforts with a near-term impact on climate and energy challenges faced by society.

For "3D Printing Enhanced Catalysis for Energy Conversion and Production," Professor Yan Li is leveraging Thayer's expertise in material design and additive manufacturing. Catalysts play a crucial role in various industrial processes, including petrochemical refining, chemical synthesis, wastewater treatment, and CO2 capture and removal. Li and her team—research associate Abhishek Singh, PhD student Ya Tang Th'28, Andrew Kim '25, Jace Henry '24 Th'24, and colleagues at the Oak Ridge National Lab—are optimizing the architectural design and processing parameters of 3D printed catalysts to achieve a balance between efficient thermal transport and robust mechanical integrity.

Two Thayer professors—Ian Baker, Sherman Fairchild Professor of Engineering, and Geoffroy Hautier, Hogdson Family Associate Professor of Engineering—will join Earth Sciences Professor Sarah Slotznick in "Searching for New Rare-Earth-Free High-Performance Permanent Magnets." The electrification of global energy systems is an essential component of the clean-energy transition. Yet the necessary high-performance electric motors and generators that power wind turbines and electric vehicles rely on magnets made of rare-earth materials that are costly and environmentally damaging to extract. The team envisions the project could potentially lead to the commercialization of a new low-cost, rare-earth-free permanent magnet within five to 10 years.

PROFESSOR ULF ÖSTERBERG

"What all [my] research had in common was the difficulty in sending electromagnetic waves through media that was both absorbing and scattering. This problem has been part of my research for most of my career."

—ULF ÖSTERBERG, RETIRING AFTER 35 YEARS IN THE CLASSROOM AND LAB

DESIGN THINKING

Breaking Down Complex Challenges

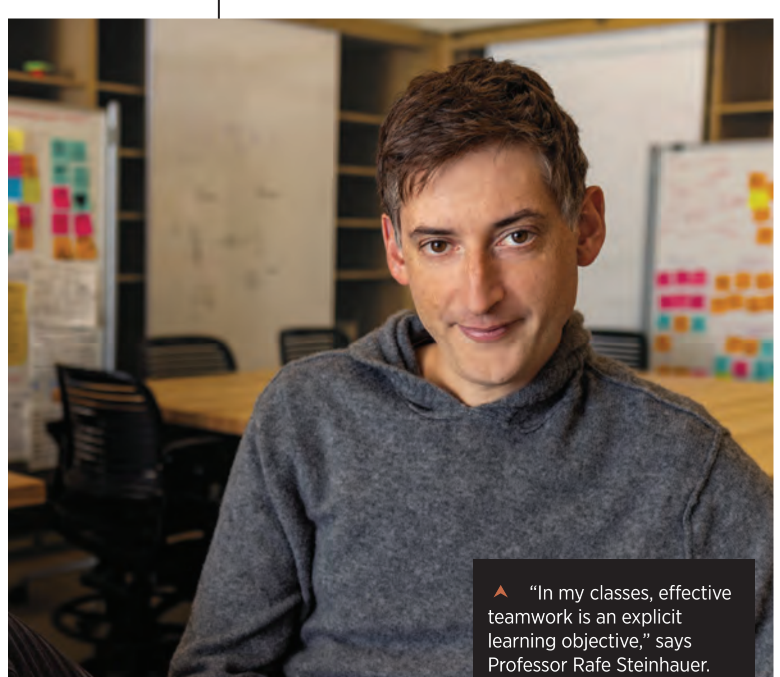
PROFESSOR RAFE STEINHAUER COMBINES HIS expertise in education and engineering to teach design thinking, a methodology that takes a human-centered approach to problem solving.

"Approaching a problem like a designer is an effective way to break down a complex matter." He now trains students to apply that mindset to challenges. "Empathy is an important design skillset," he says. "What tools can we use to understand the perspectives of various stakeholders in a problem?"

It's an approach to teaching drawn from his experience in ninth grade, when he switched from the hands-on learning of a Montessori school to a traditional public high school. "Traditional pedagogy came as a shock: 'Why is the teacher in the front of the classroom?' 'Wait, all I need to do to excel academically is pay attention and remember the material?' " He pursued an MEd to learn the vocabulary and skills to teach higher education informed by that initial upbringing.

His courses include "Range and Radar," which leverages design thinking to navigate some of life's big questions around work, family, and social justice. With support from the Design Initiative at Dartmouth (DIAD), he recently led a team in developing a toolkit—including a card deck with prompts, activity workbook, and video series—for alumni and students working with the Dartmouth Center for Social Impact. Now he's designing a new course at the intersection of design thinking and education that will connect students with stakeholders at local schools to co-design solutions.

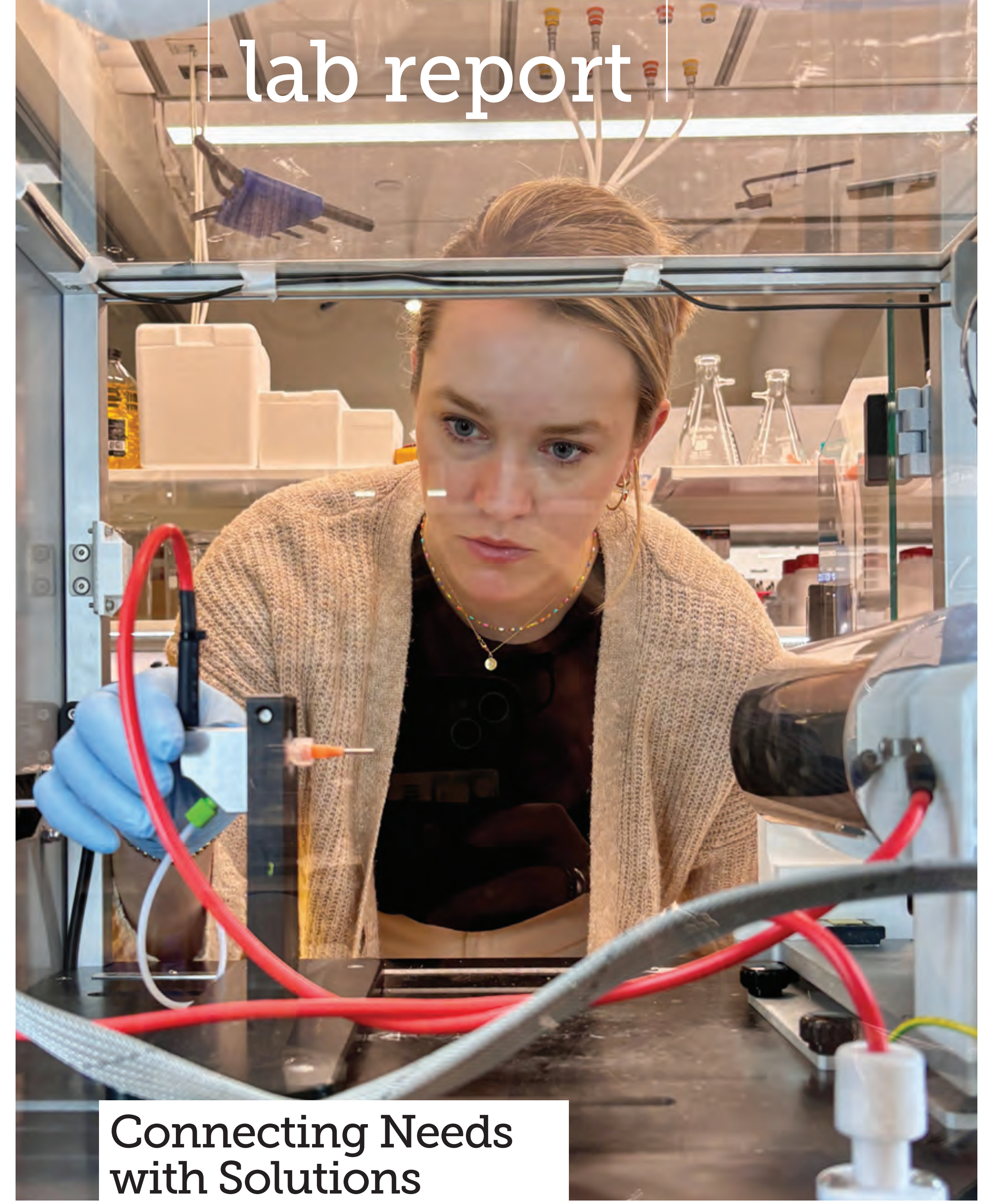
"If you allow yourself to come up with different ideas, some good and some bad," he says, "and then test the best ideas, you can replicate creativity."



"In my classes, effective teamwork is an explicit learning objective," says Professor Rafe Steinhauer.

LEFT: DON HAMERMAN; FAR LEFT: ROB STRONG '04

lab report



CATHA MAYOR

Connecting Needs with Solutions

PHD INNOVATION FELLOW BECCA THOMSON '20 TH'21 works in the Hixon Lab as part of her research in the surgical innovation training program. "I specialize in bridging the gap between clinical needs and cutting-edge technology," she says. "My academic career involves extensive surgeon shadowing and interaction, allowing me to identify critical needs in healthcare and develop innovative medical solutions."

Thomson is also the founder and CEO of NovaGyn, a women's health medical device startup addressing surgical needs in pelvic floor reconstructive surgeries through material biofabrication and tissue engineering. "We're dedicated to pioneering solutions for stress urinary incontinence (SUI)," she says.

SUI is prevalent in more than 25 percent of women, and current surgical mesh can cause tissue erosion and other painful complications. At NovaGyn, Thomson is developing a bioresorbable nanofibrous scaffold that decreases roughness and promotes healthy, autologous fibrous growth to permanently support the urethra for patients experiencing severe SUI.

"I specialize in bridging the gap between clinical needs and cutting-edge technology."

—PHD INNOVATION FELLOW BECCA THOMSON '20 TH'21

COLLABORATIONS

Grants Bridges Disciplines

THE DESIGN INITIATIVE AT Dartmouth (DIAD) is funding three faculty and staff projects to enable interdisciplinary approaches to scholarship and social impact. "I'm delighted to see how faculty and staff from all corners of campus are using design methods to seed and scaffold creative collaboration," says Professor Eugene Korsunskiy, DIAD co-director.

Engineering Professor Xiaoyao Fan and Art History Professor Adedoyin Teriba are joining the study of religious sculptures and modern architecture in West Africa with digital image processing techniques for a course that bridges their disciplines. For the "Storing Images of Divine Nigerian Architecture in a (Digital) Cloud" project, Teriba and a student traveled to Austria and Nigeria this summer to capture aerial images of important religious and architectural sites. Students in Fan's "Digital Image Processing" class will then analyze and enhance the images—while learning some art history from Teriba, who will explain the works' historical and cultural significance.

For the "Prepare to Launch" project, Janice Williams of the First-Generation Office will incorporate "designing your life" programming to provide targeted career support for students. Williams will encourage students to "think like designers—with adaptability and curiosity—so they may build a love for trying things and solving life's wicked problems." With the third project, "Navajo Rug Weaving," Laurie Furch, department administrator for Native American and Indigenous studies, Hood Museum Fellow Jayde Xu, and Film and Media Studies Professor Jacqueline Wernimont brought renowned fifth-generation Navajo weavers to campus in July for a hands-on workshop.

INVESTITURE

"A Beautiful Journey"

Dartmouth Engineering's 2024 Investiture ceremony June 8 at the West End Circle honored graduating BE, MEM, MEng, MS, and PhD students through the presentation of academic hoods, caps, and awards. This year the community celebrated the awarding of a record 351 degrees to its students—including majority female BE and MEM classes. Below are highlights from the keynote address by Mung Chiang, electrical engineer and president of Purdue University.

"IN 1936, *THE DARTMOUTH ALUMNI Magazine*, in memory of [Robert] Fletcher, quoted some of his many students, including this one: 'My pleasantest memories of the Thayer School are linked with your classes in mechanics, not just the subject matter but of the human interest you gave the subject and the enthusiasm you inspired with it.' In recent years, your innovative faculty, staff, and students have further strengthened this human-centered learning and discovery, which has long been part of the institutional DNA, through the cornerstones of systems and design thinking. …

"Engineering is an art of trade-off among multiple objectives. A multi-objective, or vector, optimization is also sometimes scalarized by moving all but one objective into constraints and progressively relaxing such constraints to visualize the trade-off. This leads to the crucial concept of Pareto optimality: Even when you have multiple objectives, there still is the well-defined notion that a certain configuration cannot be made better in one objective without making another objective worse. In work as in life, that's a powerful way to think about competing goals. …

"Engineering is, in some sense, a language for thinking. Like many of you, I had my intellectual curiosity shaped by faculty advisors. [They] taught me not just proofs and experiments but also asking questions and connecting dots so patterns emerge out of fluctuations. They also taught me that much of what's covered in classes and in speeches will soon be forgotten. What is uncovered by yourself lasts longer. In that sense, your lifelong learning is like a beautiful journey without a destination. And it continues on Monday morning, with the enthusiasm that Fletcher's student remembered."

"Engineers solve problems with atoms, bytes, and people."

—MUNG CHIANG
PURDUE UNIVERSITY PRESIDENT
KEYNOTE SPEAKER

INVESTITURE BY THE NUMBERS

118
Bachelor of Arts in Engineering Sciences

101
Bachelor of Engineering

59
Master of Engineering Management

45
Master of Engineering

10
Master of Science

19
Doctor of Philosophy

Kudos

AWARDED SME named Professor **William Scheideler** a 2023 Delcie Durham Outstanding Young Manufacturing Engineer. Scheideler, who also earned the school's Woodhouse Excellence in Teaching Award, researches fabrication of 2D-metal oxides for electronics and energy applications.

QUOTED **Professor John Zhang** is quoted in a *Discover* magazine article about wearable generators that produce electricity. "This study implies that sufficient electrical energy can be converted from the kinetic energy of a pacemaker lead to sustain operations," he said, in reference to a prototype he developed that used a cantilever design to produce electricity from the beating of the human heart.

COATHORED PhD student **Megan Clark Th'21** is first author on a submission named "Best in Physics" at the National American Association of Physicists in Medicine Annual Meeting & Exhibition. "Anesthetic Concentration, Type, and Duration in Murine Model to Play an Essential Role in Tissue Oxygenation and Reproducibility of the Flash Effect" is coauthored by **Arthur Pétusseau Th'23** and **Professors David Gladstone, Brian Pogue, Petr Br⊠ža**, and **Jack Hoopes**.

HIGHLIGHTED **Professor Wei Ouyang**'s recent article in *Neuron*, "An Implantable Device for Wireless Monitoring of Diverse Physio-Behavioral Characteristics in Freely Behaving Small Animals and Interacting Groups," was featured as a "Science Highlight" by the National Institute of Biomedical Imaging and Bioengineering.

INVITED Postdoc **Kasia Warburton** earned a Thomas Hughes Fellowship to attend the 2024 International Congress on Theoretical and Applied Mechanics in Korea, where she will give an invited talk on "Evolving Permeability of Sub- and Supra-Glacial Flow."

TIED **Savannah Decker Th'24** and PhD candidate **Roman Vasyltsiv** tied for first place in the early investigator competition at the New England Chapter of the American Association of Physics in Medicine meeting in Quincy, Mass.

COURTESY ALEAH SOMMERS

RESEARCH

Surges & Floods

"Warming and changes in precipitation patterns are leading to changes in the glaciers, with implications for hazards such as glacial lake outburst floods and glacier surges."

Research scientist **Aleah Sommers** has unpacked her research gear in lots of snowy places: Greenland, Alaska, a glacier in the Himalayas. But for her latest study—a new NASA-backed collaboration with scientists in Pakistan to study the influence of water flowing at the base of glaciers in High Mountain Asia—she and **Professor Colin Meyer** can work from their Hanover lab. Their two-year modeling project aims to improve understanding of subglacial drainage, which can benefit hazard prediction and inform decisions around water resources. "The region provides water for more than 1 billion people," says Sommers. "Warming and changes in precipitation patterns are leading to changes in the glaciers, with implications not only for water resources but also for hazards such as glacial lake outburst floods and glacier surges." The Thayer team will work with the Himalayan University Consortium to disseminate modeling approaches and results to regional institutions.

"I am interested in taking engineering principles and systems-level thinking and applying them to solve problems in women's health."

—PROFFESOR BRITT GOODS TH'11

Innovating for Women

Professor Britt Goods Th'11 applies engineering principles to crucial issues in women's health.

➤ A mother's breast is a wonder of engineering. During nine months of pregnancy, it transforms into an organic factory producing a complex formula of fats, sugars, and protein antibodies that provides a baby exactly what it needs to thrive. "The entire mammary gland essentially grows like a new organ," says Dartmouth Professor Britt Goods Th'11. "At peak lactation, it can make a liter of milk a day."

BY MICHAEL BLANDING • PHOTOGRAPHS BY ROB STRONG '04

That transformation is all the more amazing considering that most cells in the body are in it for themselves, not dedicated to churning out sustenance for another being. "Cells are selfish—they want to cut costs at all corners and maintain their own metabolism," says Goods, an assistant professor of engineering at Thayer School of Engineering at Dartmouth. "It's fascinating we have these mini bio-reactors producing a tremendous amount of material."

Goods has long been fascinated by women's health issues, which historically have been woefully underexamined. Her approach is a practical one, looking to develop new approaches to medicine to keep women healthier and happier. "I am interested in taking engineering principles and systems-level thinking and applying them to solve problems in women's health," Goods says.

Lactation is just one focus. She also looks at contraceptives, working to develop new forms of birth control that do not rely on hormones, which cause side effects in many women. "We are trying to understand what sorts of things drive ovulation, because there is a real gap in the field," Goods explains. In addition, she is examining how female sex hormones such as estrogen and progesterone affect the immune system, looking particularly at macrophages, white blood cells that provide a critical line of defense against microbes and are used in treatment of diseases such as cancer.

"Using single-cell genomics, she has shown for the first time that these hormones have a distinct effect on specific macrophage subsets," says Patricia A. Pioli, associate professor of microbiology and immunology at Dartmouth's Geisel School of Medicine, who has collaborated with Goods on this research. "Her expertise in bioengineering uniquely positions her to use sophisticated technologies to parse the complexity underlying the distinction in immune responses between men and women."

In all of these areas, Goods' philosophy is simple: You can't make improvements in these complex biological systems until you understand them. "As an engineer, it's really hard to think about ways to turn the knobs and change things if you don't have a fully specified system."

Finding Her Path

Goods developed a passion for chemistry and biology in high school; even then, she was focused on making science useful. "I was never satisfied with just knowing the biological answer to something, I wanted to know how it could be used in an applied way," she says. Initially, she was interested in environmental engineering, and as a undergraduate at Colby College applied to Dartmouth's dual-degree engineering program, which allowed her to earned degrees in biochemistry from Colby and in engineering from Thayer. "I was fortunate enough to get into that program, and it set me on my path."

At Dartmouth, she worked with Professor Karl Griswold, who focused on high throughput screens for protein engineering, and shifted her focus from the outside world to the equally complex environment within the human body. After graduation, she went on to earn a PhD at MIT examining diseases of the central nervous system such as multiple sclerosis and brain cancer.

As a postdoc, something happened that completely changed the course of her research—she became a mother. As she observed the many changes happening in her own body, she began digging into literature to better understand them—and ultimately found little to satisfy her. "I wanted to know more about this and did not see it prioritized in the way I had seen other areas," she says. She made a decision to change that. "I was like, I'm a scientist, I could do this—and I did."

Not that it was easy. As a postdoc, Goods remembers going to pitch competitions with a proposal to study endometriosis, a painful disease of the uterus. "I can't tell you the number of times people were like, 'Have you thought about prostate cancer?' " she says. "Meanwhile, there is nothing in this space, and it affects up to one in 10 women."

She persevered, joining MIT's Milk Study to examine the unique components of human milk. That presented its own difficulties, as she dealt with the challenges of obtaining fresh samples from lactating mothers. "As you can imagine, it's not easy to get lactating women to give you some of their breast milk," says Goods, who collected samples wherever she could, picking up coolers from front porches and mailboxes and waiting outside women's offices while they pumped. "There are some pretty unique constraints, and we wanted to be super-flexible for that."

Eventually, her lab built foundational datasets, tracking how breast milk changes through time as the breast itself changes—work she has continued since returning to Thayer as a professor in 2021.

Making Milk "Salad"

Breast milk is an incredibly complex substance that remains little understood by scientists. It contains more than 200 unique sugars, only a handful of which have been reproduced adequately in the lab, along with living cells and immune factors that seem to change in response to signals from the nursing infant. "It's a living fluid that responds to infant needs through this bio-directional communication," Goods says.

In her work, Goods often uses a technique called transcriptomics, which analyzes all of the RNA in a sample to understand how genes are being expressed and what proteins it might produce. "It's a really powerful way to assess what a cell is currently doing," she says. On a bulk level, she compares it to "taking a salad and putting it into a blender." But it can also be done on a single-cell level, which is more like examining each element of the "salad" in turn. "You might have different-colored carrots or lettuce of different shapes and sizes," Goods explains. "You can really specify the system in a way you can't with these bulk measurements."

> **"The 10-year vision is to see if we can actually create on-demand nutrition."**
>
> —PROFFESOR BRITT GOODS TH'11

In her ongoing project on lactation, Goods Lab is working to map specific genes onto the production of the many unique sugars in human breast milk. Among other discoveries, she has found an increase through time in epithelial cells located along the lobules where milk is produced that seem to change to produce different types of sugars. "There's a pretty big diversity of these epithelial cells that make milk, and now we have some thoughts about how they divide and how they may be functionally distinct," she says.

Ultimately, her findings could lead to bioengineering of synthetic formula that more closely mimics the unique qualities of human breast milk. Although she believes natural milk is best for babies, Goods acknowledges there are many reasons why that may not be possible for some women. "Our society is not set up to support breastfeeding securely," she says. "There need to be more options for people that are closer to what people get naturally." By understanding what's happening on a genetic level, she imagines a world in which synthetic milk could be biologically engineered for specific properties. "The 10-year vision is to see if we can actually create on-demand nutrition, using the proportion of different cells to inform the creation of the end product."

Contraceptives and Cancer

Goods uses similar techniques of single-cell transcriptomics in her work on non-hormonal contraception to understand what is happening inside the ovaries when they produce eggs. She also uses a more advanced technique called spatial transcriptomics, which allows a researcher to better examine where specific components exist in space. To continue the salad analogy, it's like looking where individual vegetables are in the mix, "like how all the carrots fall to the bottom," Goods says.

These techniques allow her lab to examine the full process behind production of eggs in the ovaries an implantation in the uterus. "About 40 percent of women who start with hormonal birth control stop in the first year because of the significant side effects," she says. The goal is to find a place where a gene could be switched on or off to interrupt the process, thus preventing pregnancy without those side effects. "The dream is to be able to see a target that I discovered in my lab ultimately translated into the clinic for family planning purposes" in the form of a pill or other therapeutic, says Goods, who is pursuing the goal along with a group of researchers called the Ovarian Contraceptive Discovery Initiative. "It's a really hard problem from a drug development standpoint, but it looks like we'll get there. So that's exciting."

Her last line of research involves the immune system, which some evidence shows differs in men and women as a result of interactions between blood cells and female sex hormones. As with other issues in women's health, these interactions have been poorly studied in the past. "It makes it really hard to engineer strategies for these cells, because you are going to alter their behaviors based on local signals from these sex hormones," Goods says.

Her work includes taking human blood cells called monocytes and using a "special sauce" to turn them into macrophages, the white blood cells that attack and eat harmful microbes in the blood. They also play a critical role in attacking cancer tumors, and some cancer therapies involve engineering special macrophages carrying anti-cancer drugs to augment that process. Goods is hoping to determine how to best engineer such cells to take into the account the impact of sex hormones so they can be more effective.

In her work, Goods has come full-circle, working with undergraduates at Thayer, where she took her first engineering classes more than a decade ago. These students serve as study coordinators obtaining samples for a local milk bank for the lactation research. "It's been a lovely way to get them trained in how to do human subjects research," she says. Just as her hands-on research took her in different areas to find her lab's focus on women's health, it is crucial as undergrads figure out their own paths, she says. "It can not only help you learn skills but also help you learn the things you like and don't like," says Goods. "When I think about my own meandering path to where I am now, these opportunities are incredibly important."

In the years since she has started working on bioengineering and women's health, Goods has been happy to see interest in the area increase. She hopes to inspire more scientists to work in the field, where so many discoveries remain to be made. "I have to acknowledge those who have come before me in this field, and worked really hard to make it a priority," she says. "I hope that the trend continues—because there is so much to do here."

MICHAEL BLANDING is a Boston-based journalist whose work has appeared in *Wired*, *Smithsonian, The New York Times, The Nation*, and *The Boston Globe Magazine*.

Energy Immersion

During Spring Break in Appalachia, students did a deep dive into the history of the coal industry and its impacts on the region.

A collaboration between the Dartmouth Sustainability Office and the Irving Institute for Energy and Society, the 10-day Appalachia Energy Immersion trips enabled students to examine the legacy of coal extraction across West Virginia as well as the region's shift to a different future.

"This trip underscored the political and economic barriers to renewable energy adoption in the region, and reiterated to me the interconnectedness of energy, politics, and economics," says engineering sciences major F.T. Chiu '26. "By engaging with community members in West Virginia, I gained insight into the multifaceted impacts of energy systems on people's lives and livelihoods."

During trips to the region in the past two years (after a pause during Covid), students across various disciplines—including engineering sciences, environmental studies, and economics—considered energy systems from a variety of perspectives. They toured Southwestern Energy and the Blackhawk coal mines, visited solar developer Solar Holler, researched environmental impacts to the Morris Creek watershed, and explored new biking and hiking circuits created on former mining sites.

"The people I met expressed a deep pride in their state and a genuine desire to see it thrive," says Chiu, "even though they see it through different lenses shaped by their unique experiences and socioeconomic backgrounds."

Students visit Cathedral Falls on Cane Branch, a tributary of the Kanawha River, a main artery used to transport coal in West Virginia.

PHOTOGRAPHS BY CHRIS JOHNSON

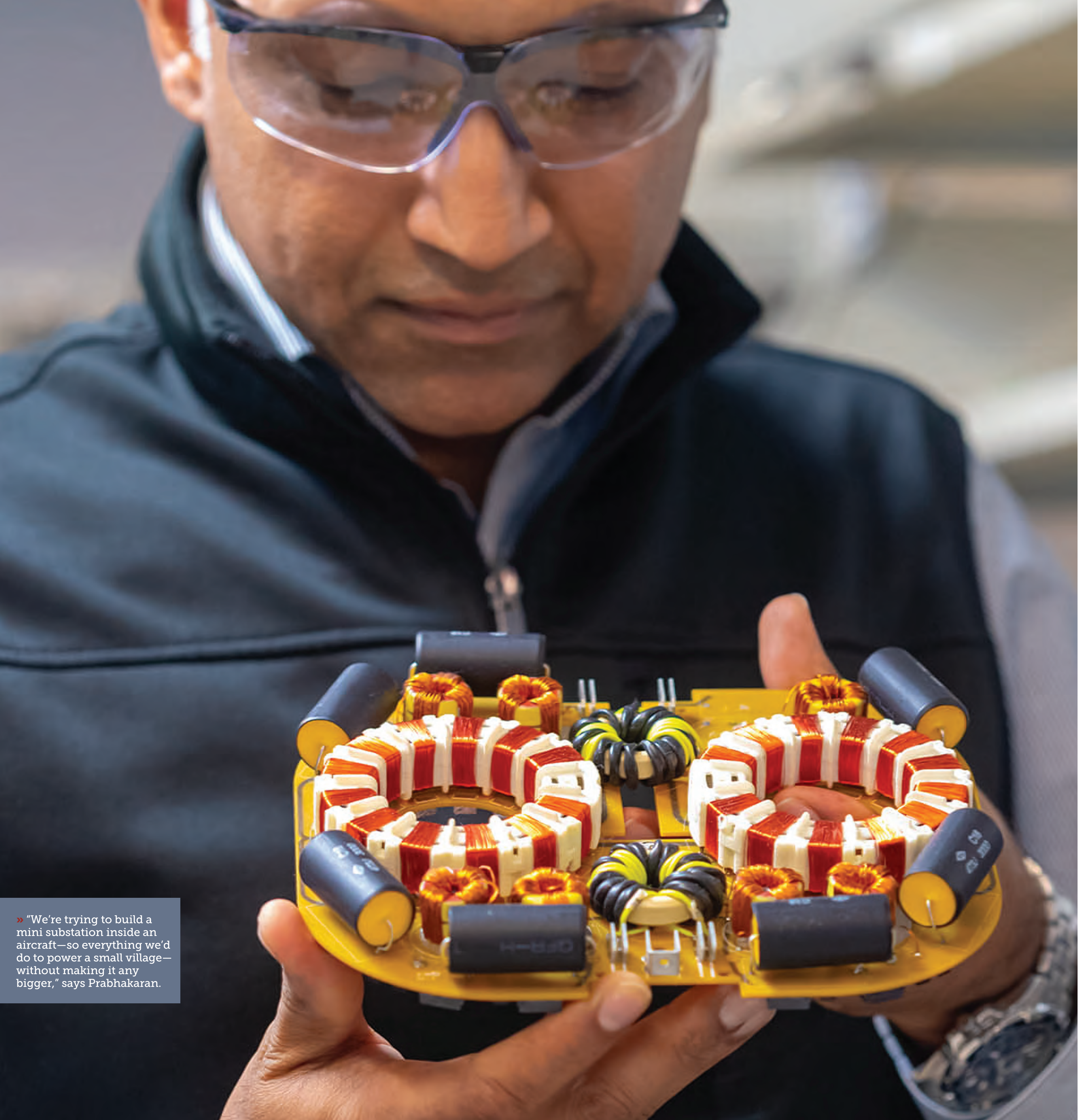
Mike King of the Morris Creek Watershed Association Mike King and WVU Professor Deb Buehler lead students sampling macroinvertebrates in the creek to study watershed health and impacts of acid mine drainage.

Dartmouth Sustainability program coordinator Rachel Kent '21 tries climbing a utility pole.

Joanne Liu '23 (from left), Alex Campbell '26, Ashley Laveriano '24, and Luc Cote '23 Th'24 go creek stomping to sample macroinvertebrates upriver and downriver of an acid mine drainage site.

A coal mining manager explains the process to Constance Legrand '25 and Luc Cote '23 Th'24.

Hamza Najam '26 (from left), Caroline Mahony '25, Victoria Yang '26, Constance Legrand '25, Ashley Laveriano '24, Joanne Liu '23, Alex Campbell '26, Arden Borrup '26, Luc Cote '23 Th'24 pause during a tour of coal mining operations.



» "We're trying to build a mini substation inside an aircraft—so everything we'd do to power a small village—without making it any bigger," says Prabhakaran.

AMPING UP THE SKIES

BY THERESA D'ORSI

Satish Prabhakaran Th'05 and his GE Research team are designing high-tech components for electric air travel.

As technology leader for aviation electric propulsion, Prabhakaran sits at the intersection of aerospace technology and the next generation of products. His latest effort at GE Research in Schenectady, N.Y., involves one of the toughest modern-day engineering challenges: electric air travel. With aviation accounting for about 2.5 percent of global CO_2 emissions, hybrid electric propulsion technologies could do a lot to help bring the number down. But because of limits on space and weight, this crucial electronic componentry needs to be robust, compact, and light. "We're actually aiming for the size of a suitcase," says the electrical engineer. "We've got to take all the things that happen in the lab, and then we've got to go invent the future of so many other things to make these technologies real." Here, he discusses his flight plan.

You've been managing complex teams for the past decade. What makes a good team member? What makes a good leader?

The work that I've been involved with more recently is all about electric propulsion. We're designing our next engines as we seek decarbonization. The aviation industry has a commitment to get to net zero emissions by 2050. To do that, there's got to be a rather big step change in the kind of technologies we introduce. I sit at the confluence of so many engineering disciplines. We have turbomachinery, we have electrical systems. Thermal management is a big one. And then we've got flight controls software. It's such an exciting space. We want engineers to be right in the middle of all these spaces because none of them can succeed on their own. When I think of a good team member, I think of someone who wants to embrace that diversity, who wants to sit in the middle of a lot of engineering disciplines, most of which they may not feel comfortable with but are willing to learn. There's so much going on. That's the first thing I want to see: the sparkle in people's eyes when they participate in these kinds of programs. I am fortunate to be part of team full of such enthusiasts.

And a good leader is absolutely a team member foremost, someone who works closely with their teams in problem solving We also need leadership beyond the technology itself. New propulsion systems transcend multiple partners beyond research and development. As a leader, one has to champion these technologies with collaborators such as airframers, regulatory agencies, manufacturing partners. And there's a really high bar on safety, which we respect a lot. How does all this technology come together—not only across GE but across industry, across so many organizations like the Federal Aviation Administration or NASA, so many groups that are involved. Leadership in this space requires patience and strategic processes to advance our technology and manufacturing readiness in collaboration with the broader aerospace network.

What are your favorite aspects of your role—working with your team members, tackling the science, taking a broader view across the landscape and plugging in those other systems?

One of the reasons I've stayed at GE so long is because I get to do all of those things. I've been a technologist. I've led a team advancing electrical technologies for potential product insertions. And now, in my current role, I manage the platform of hybrid electric propulsion technologies at GE Aerospace Research. It's a liaison role. I work closely with our business segments on their technology and product roadmaps; I enjoy the strategic outlook. Back at base, we have several labs working on several demonstrations—the sheer number of tests in play is awesome!

How does your PhD research when you were at Thayer inform what you're doing now?

I was with Charlie Sullivan and his group working on miniaturizing components that went into elements that did power conversion for mobile computing platforms. When I came to GE, I was looking at power conversion at about six orders of magnitude higher, such as for wind turbine or a gas turbine. Daunting! But when you take a step back and look at all of these systems, they want to do something similar: perform more at the same size or get smaller with the same performance. Thematically, it's not very different. Many of the same foundational strategies to miniaturize components apply here no matter what scale of power they process. It is industrial R&D with a whole new layer of product transition. The aspects of bringing research to reality has been well worth it.

I gravitated to aerospace because it's very challenging to introduce new ideas into this industry. This is a business with long cycle of development where you need really safe and robust technologies. We're trying to build a mini substation inside an aircraft—so everything we'd do to power a small village or a small community. That's the kind of power we're trying to put on an airplane without making it any bigger. Weight and volume are the primary driving factors for any technology. As we seek to compress our technologies, we conflict the physics of scaling and require new supply chain strategies, new manufacturing processes. It's not just sandbox stuff that gets to fly the next day. There's an impressive number of steps that every technology has to go through before it eventually flies. There is rich opportunity for breaking new ground on so many fronts.

> **"We're actually inventing a new form of flight. … This is forcing the research community to become more applied so that we understand the realisms of flight."**
>
> —SATISH PRABHAKARAN TH'05

Why can't you just scale up or scale down the current technology?

If you have a problem with, say, an electric car, you can pull over. You can't do that on an airplane. Safety is fundamentally at the foundation of everything that we do. We need robust, redundant, and reliable solutions. It's not just about making it small. Building in the resilience to survive long flight cycles, harsh environments through the lifecycle is critical. Today's technologies, when iterated to meet these demands, drop out of the race soon. At GE Aerospace, we go through a rigorous multi-generational technology maturation campaign to prove out new designs. Often state of art isn't going to get you there. We work on new materials that can scale more favorably than present-day solutions. At one end of the spectrum of our developments, we have technologists focused on fundamental aspects of materials and semiconductors, and at the other end, we are building out demonstrations toward flight. The ability to control the sheer breadth of the design space at GE is something I am proud to be part of.

So you're seeing things that don't even exist till tomorrow …

… And we get to walk that journey back and forth. Historically, as a researcher, I might have been more academic, working on the fundamental stuff and throwing it across the fence and hoping somebody would graduate it to a product. But now, let's keep in mind we're actually inventing a new form of flight. Nobody's done this before. This is forcing the research community to become more applied so that we understand the realisms of flight. It's also forcing the product community to become more technologically savvy. We're all coming at it from different directions, and then we might meet and then go back and invent again at the fundamental places we come from. So, my friends in the business can go back and say, we just have no way of manufacturing these things, but we recognize we've got to find a way. They're busy understanding how to manufacture all the fundamental technologies and at the same time we know we can make them better.

Since this is a totally new thing, are you finding that you're having to do some educating among regulatory agencies?

I'd say it's back and forth. There's a lot for us to learn about how these new propulsion systems are certified and made into a safe product. There's a lot of learning to be had. And it's happening—and collaboration is the best way to do it. We're working closely the FAA in progressing technologies with lower emissions and high efficiencies. We participate in several standards committees to help the broader industry implement new standards. Our work is often reviewed by a rich network of government agencies in order for us to disseminate the value of our advancements and get the feedback on the path to certification of these technologies. We have a healthy dialogue that is consistently iterating towards safe implementations.

Do you have a timeline for some of the flight applications or the craft you're working on?

You might have noticed that there's a lot of activity in the small aircraft space, where there's small payloads, short-range aircraft looking at using energy storage such as batteries or fuel cells. I think those types of systems are probably going to be early adopters. For larger payloads and longer ranges, we have more challenges. These larger systems are higher energy and require higher altitudes. The electrification tech maturation is a longer cycle. At GE, we have the RISE engine that aims to achieve 20-percent lower-fuel consumption than current products. In the next decade, we have an exciting lineup of several demonstrators and proof points to advance our developments toward new products.

Alumni News

FROM AROUND THE WORLD

spotlights

Transitions

Longtime Thayer Board of Advisors member **Samantha Scollard Truex ’92 Th’93 Tu’95** has ended her nine years of service, the last four as board chair. The CEO of Cambridge, Mass.-based Upstream Bio, Truex has served in leadership roles at multiple venture-backed companies, including as CEO of Quench Bio, COO of Synlogic, and CBO for Padlock Therapeutics. Drawing on her BE in biomedical engineering, she was previously vice president of corporate development at Biogen. Replacing her at the board helm is **Todd Cook ’93 Th’94**. He serves as managing partner of Boston’s Bain Capital Double Impact, a fund that invests in companies providing financial returns alongside social and environmental impacts. The engineering sciences-economics double major has spent his career at Bain Capital, and previously worked 20 years as a member of the North American private equity team. Thayer also welcomed four new members to the Board of Advisors: **Amber Bryant Colón ’12 Th’12, Mike Doogue Th’98, Sujan S. Patel ’01,** and **David Swift Th’84**. In other leadership news, **Natasha Herring ’12 Th’13** joined the Dartmouth Alumni Council as Thayer’s alumni representative July 1. Also on July 1, **Will Griffith ’93** joined the 26-member Dartmouth Board of Trustees. The engineering sciences and history double major is a partner at ICONIQ Capital, a global investment firm; founder of its growth-equity platform; and cofounder of IPI, ICONIQ’s digital real estate business, which is dedicated to scaling data centers globally to support the cloud economy.

Natasha Herring ’12 Th’13

The Olympians

Isalys “Ice” Quiñones ’19 Th’20 and engineering sciences major **Billy Bender ’24** are two of the six athletes with Dartmouth connections who headed to Paris to compete in the 2024 Summer Olympics. Heavyweight rower Bender, a two-time first team All-American, and teammate **Oliver Bub ’20** qualified for the Games by winning the men’s pair this spring at the U.S. Olympic and Paralympic Team Trials. They weren’t on the same team at Dartmouth but competed in pairs together in 2022, when the Norwich, Vt., native took the winter term of his junior year off to join the California Rowing Club, where he was paired with Bub. They finished 10th overall. “I feel like I have always been the best athlete when I’m out of my comfort zone,” he tells *The Norwich Times*. “When these guys are better than me and I know I need to step up my game, that’s when I’ve been my best.” When he’s not in the lab or on the river, Bender helps install PV solar trackers as an intern at Solaflect Energy, founded by his father, **Bill Bender ’78**.

Oliver Bub ’20 and Billy Bender ’24

“I remember the depth of understanding I received from my undergraduate classes and look at those as standards.”

—JOE BROWN ’00

Quiñones returned to the basketball court for her second Olympics. Part of the first-ever Puerto Rican women’s Olympic basketball team at the 2020 Tokyo Games, Quiñones was starting center at the 2024 Games, where China stopped the team’s advance. Quiñones also works as an environmental engineer at QNOPY Inc. based in her home state of California. She is reportedly pursuing an offer to play professional basketball in France and plans to juggle the sport as well as her engineering role.

The Professor

Professor Joe Brown ’00 easily transitions from nanoscale technology to big-picture ideas. Before joining the University of Hawaii at Manoa (Honolulu) mechanical engineering

“I’m a big consumer of microgreens.”

—JOHN LAMPPA TH’12

The Innovators

JOHN LAMPPA TH’12 | COFOUNDER, REAL GREEN FOODS

The Norwich, Vt., entrepreneur, scientist, and farmer is bringing the nutritional power of microgreens to the table with a line of refrigerated vegan salad dressings and more products to follow. His six-person team is aiming to deliver to 500 regional outlets within the year, and most recently started stocking shelves in Hannaford supermarkets in Vermont.

What career path led to Real Green?
After I earned my PhD in protein engineering at Thayer, I expected to work in biopharmaceuticals, but a Harvard startup in the food-tech space caught my eye. I joined as a scientist and eventually became the chief technology officer of that company, now known as Foodberry. From there I launched a consulting business focused on food and beverage clients, while in parallel creating Lamppa Farms, which partners with academic and research institutions to pilot and scale novel crops. These experiences ultimately led to the creation of Real Green Foods and bringing fresh, nutritionally rich ingredients, such as microgreens, to everyday food and beverage products.

Why microgreens?
I just love eating them. I love that they’re more nutritionally dense than a lot of lettuce or other leafy greens out there. I thought, “Hey, it’d be great if microgreens were more readily available beyond just the clamshell at the grocery store, in everyday products such as soups, salad dressings, and beverages.” We partnered early with Butterfly Bakery owner Claire Georges to refine, blend, and bottle our dressings. Claire really brought these to life and even had some excellent flavor suggestions, such as the ginger turmeric.

What makes your product line unique?
Real Green’s dressings are the healthiest you can buy. All dressings contain fresh, organic microgreens, which give them a powerful nutritional boost. The microgreens also add flavor and body while keeping fats, sugar, salt, and calories low. Flavors range from my favorite, maple mustard, made with maple syrup from Nott Family Farm in Hartford, Vt., to seriously spicy serrano lime and a new Green Goddess that, like all our dressings, is vegan and free from the eight major food allergens. From here the Real Green brand will continue to launch new products powered by fresh microgreens.

department in 2017, he researched nanoscale device and materials engineering—first when he cofounded a company that provided nanotube textiles used on NASA's *Juno* mission to Jupiter and then while earning an MS and PhD at the University of Colorado Boulder. "In the field of nanosystems, we aim to actively control physical behaviors at sizes from human scale down to the atomic scale," he says. "This means we have widely varying projects but with some common themes of applied mechanics, materials synthesis, instrumentation design, multiscale data acquisition, and data analysis." Real-world projects include designing mechanical attachments for microchips and space systems, fabricating new materials for gas sensors and storage, and developing safety improvements for the commercial fishing industry. He entered the field through the mentorship of Professor Ursula Gibson, who brought him onto a project that became his undergrad honors thesis and first journal publication, "Ordered Arrays of Amphiphilic Gold Nanoparticles in Langmuir Monolayers." As department chair, Brown says, "I try to create such opportunities for as many students as possible." When he gained tenure in 2022, Brown realized he could take on something big that will occupy the next 20 years. "I've started to think about how to make meaningful contributions to technologies for global sustainability and structural materials synthesis," he says. "In order to pursue these directions, I would like to understand more about how electrons move in and out of surfaces."

The Captain

Lock and flanker **Nate Brakeley '12 Th'12** retired last winter from Major League Rugby with a 42-12 win over Spain as captain of the U.S. men's team. He had a great run, notching more than 50 matches since starting in 2013 with the New York Athletic Club, which won the Division I Club National Championship in 2015. When the engineering sciences major wasn't in class or the lab, he was leading the Dartmouth men's team to Collegiate Rugby Championship 7s titles in 2011 and 2012. He continued his education at Cambridge University, earning a master's in energy technology while playing for the school's team. He chased achievements in his career—as deployment strategist at software developer Palantir Technologies and now as data analyst at real estate tech firm Compass—and on the pitch. When he was named to the U.S. national team in 2018, he juggled test matches and training sessions during the 2019 Rugby World Cup in Japan with full-time remote work. He anticipates his future will include rugby in some fashion. "I still have strong ties to Dartmouth, and so definitely within the college game in some capacity, maybe more at the high school level," he told FloRugby in December. "I definitely don't want to step completely away from the game. It's given me too much, and I enjoy it too much to just stop cold turkey."

Nate Brakeley '12 Th'12

The Game-Changers

A collaboration between legendary football coach **Buddy Teevens '79** and a team of Thayer School engineers and athletes—including **John Currier '79 Th'81**, football player **Elliot Kastner '13 Th'14 Th'15**, and rugby captain **Quinn Connell '13 Th'14**—has gone far beyond X's and O's. Together they developed the world's first robotic tackling dummy, the Mobile Virtual Player, or MVP, to help reduce unnecessary contacts and injuries suffered during football and other sporting practices. The MVP debuted on Memorial Field in 2015, and the robotic tackling dummies have since been adopted by a majority of NFL teams, plus college and high school programs around the world. Its latest showcase is the Smithsonian National Museum of American History in Washington, DC, where it's part of the new "Change Your Game" exhibition exploring the inventors, athletes, and technologies that have changed how sports are played. "The exhibit tangibly conveys that we all are innovators and hold within the ability to create," says Connell, CEO of the Bradford, Vt.-based MVP Robotics LLC. He shares that DHMC researchers earlier this year published a study in *Orthopaedic Journal of Sports Medicine* that found the use of a mobile tackling dummy in football practice was related to a reduced number of sports-related concussions. "It effectively validated our mission."

Creative Partnership

Kirsten (Stadler) Doogue Th'99 Th'00 and **Mike Doogue Th'98** began their careers together at Allegro MicroSystems in Manchester, N.H., a semiconductor company where Mike is currently senior vice president and chief technology officer. The pair, who met as engineering students in Thayer's Partner School Dual-Degree Program, now live in nearby Bedford with their three children. After graduating from Thayer, Kirsten worked in marketing at Allegro, interfacing between engineers and customers and evaluating the feasibility of certain products. One of the amazing things that Thayer does is create engineers who can communicate," she says. During weekends and evenings, Kirsten practiced hand-embroidery techniques, drawn to the creative and detail-oriented aspects of the art. While earning a diploma in technical hand embroidery from the Royal School of Needlework and taking courses from the Embroiderers' Guild of America, Kirsten explored historic pieces at the Victoria and Albert Museum: "You look at them and start to do a kind of reverse engineering of the piece," says the established embroidery artist. Mike began working at Allegro as a chip designer. He loved how it gave him opportunities to create new product lines and interact with customers. "My job is to understand the problems our customers don't know how to solve yet and then figure out how to bring them solutions in the next two to five years," says Mike, who says he appreciated how Professor William David Stratton made complex electrical engineering topics approachable, digestible, and fun. He's looking out even longer as he develops the company's strategy, which involves mergers and acquisitions and bringing in new technologies. That growth mindset has also enabled connections with his alma mater: Since Mike has been at Allegro, the company has hired more than 10 graduates. "Thayer cultivates independent-thinking, project-based engineers who are able to go out and make a splash in the world."

Kirsten (Stadler) Th'99 Th'00 and Mike Doogue Th'98

Keith Dunleavy '91

The Entrepreneur

Inovalon founder and CEO **Keith Dunleavy '91** was honored in May for "audacious goal of leveraging data and analytics to improve patient outcomes and to improve the economics of our entire health care system," according to **Martin Weinstein '81**. Dunleavy, who earned an AB in biology modified with engineering before earning his MD at Harvard, was inducted into the new Dartmouth Entrepreneurs Hall of Fame. He was "the first one in the office in the morning and the last one to leave the office at night," said Weinstein in introducing his colleague. "He employed creativity, courage, tenacity. Yet none of that defines Keith's superpower. Those magical traits are truly exceptional, but nothing when compared to the desire to make life better for others." Dunleavy founded the Bowie, Md.-based Inovalon, a cloud-based health care software and data analytics company headquartered to empower a data-driven transformation of health care. Inovalon uses cloud-based software platforms for more than 20,000 health plan, hospital, provider system, pharmacy, and life sciences customers across the entire health care ecosystem. Designed to leverage the industry's largest connected primary-source health care dataset, Inovalon's software and analytics are informed by data pertaining to more than 1 million physicians, 640,000 clinical facilities, 372 million patients, and 78 billion medical events.

The Adaptive Architect

Sudden, disruptive changes in business require rapid adaptation, says **Alex Conn '68 Th'69 Th'71**. "Enterprises need to embrace just-in-case thinking and build in flexibility to adapt capabilities for plausible scenarios. They must act rapidly while continuously re-assessing the uncertainty inherent in the context." The managing partner of West Roxbury, Mass.-based SBSA Partners has been developing, practicing, and teaching solution and enterprise architecture at high-tech firms worldwide for almost three decades. Now he and colleague Leo Laverdure share lessons learned in *The Strategic Enterprise Architect's Dilemma: Balancing Fitness for Today's Purpose with Fitness for Tomorrow's Disruptive Context*. Find his blog at blog.sbsapartners.com/blogs.

"There's huge opportunities to do things from a more sustainable perspective."

—JILL LADEGARD '04 TH'05

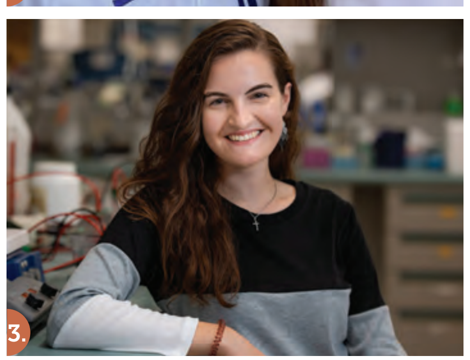
A Global Designer

Phoenix, Ariz.-based **Jill Ladegard '04 Th'05** has worked around the world in fields ranging from environmental engineering to mining, where she is now program director at global design firm Stantec. "I'm designing and planning the engineering to build large mines that will support the future renewable energy transition with raw materials," she says. "I work with teams of engineers to design all the infrastructure you need at a mine site, which is everything you would need for a city: power, water, roads, infrastructure." The multi-tasker most recently turned her problem-solving approach to strengthening connections among alumni as president of the Dartmouth Society of Engineers (DSE). "One of my favorite things about Dartmouth was the opportunity to engage in research and see real-world engineering applications. My vision for DSE is to help build connections between Thayer students and alumni working in industry to increase the number of internship opportunities, connect alumni who need focused solutions with project-based classes, and increase opportunities to network and build professional relationships."

The Fellows

Three of the 13 Dartmouth recipients of 2024 National Science Foundation (NSF) Graduate Research Fellowships are engineering alumni, along with one honorable mention. The mission fo the program is to "ensure the quality, vitality, and diversity of the scientific and engineering workforce of the United States." Alumni include **Amritha Anup Th'23**, a PhD candidate in biomedical engineering; **Mia Giallorenzi '23 Th'24**, bioengineering; **Xiaoran Zhu '19 Th'20**, ecology; and **Alexander Carney Th'23**, PhD candidate in quantum engineering (honorable mention). The awards, which include an annual stipend and access to professional development opportunities, enable fellows to pursue research interests. "The program has a history of funding students who become lifelong leaders," says **F. Jon Kull '88**, dean of the Guarini School of Graduate and Advanced Studies, "contributing significantly to both scientific innovation and teaching."

thayer notes



Gallery

1 Brian Mason '03 Th'04 Th'05, wife Jocelyn '05, and family enjoy reunion in Hanover this summer.

2 Devon Anderson Th'10 and his wife, Abigail, take in a basketball game at Duke, where he completed his fellowship in orthopedic sports medicine.

3 Josephine Kalshoven '19 Th'19 has earned her PhD in biomedical engineering from Brown University.

4 Gregg Cook '69 Th'70 developed a range of submersible and unmanned craft.

1960s

John Lo '63 Th'65 Th'67: I am calculating economic growth (GDP and productivity) to determine rate of growth of population on a long cycle (1,000 to 2,000 years) for the Western Hemisphere and Asia in our artificial general intelligence multiverse era of conversion to nuclear power plants for global escape from carbon emissions as we approach the thousand exajoules mark in energy consumption in year 3000 CE. Thayer was involved in magneto hydrodynamic plasma fusion research and development 63 years ago. Fusion is the goal for civilization to control climate change in the Andropocene era as Earth deals with asteroids' collision paths, with apocalyptic climate consequences such as the one of 65 million years ago, when dinosaurs went extinct. I predict humans will survive by deflecting the meteors' collision trajectory with nuclear warheads–and Thayer will participate in this dark matter-triggered risk cycle every 30 million years.

Mark Tuttle '65 Th'66: I am still doing software development. Instead of writing up my results in the form of a paper (see my work on Google Scholar), I'm going to create a series of videos for posting on YouTube. To my surprise, there's a lot of technical material on YouTube; I hope to add to it.

Gregg Cook '69 Th'70: Always interested and involved in the underwater world, in the mid to late 1990s, I was chairman of the board of the Institute of Nautical Archaeology, which was affiliated with Texas A&M. We did extensive work on ancient shipwrecks, much of it in Turkey, where we basically filled the Crusader Castle overlooking the harbor with the material from our excavations. I grew weary of dealing with the academics involved, but did some work with a friend, Brett Phaneuf, in the oceanography department there, and we wanted to bring technology to bear in the undersea world. Brett and I started our own nonprofit to do exactly that. We saw that the Navy was retiring assets used by the U.S. Department of Defense for testing underwater systems, so we built a submersible and secured a contract to use the boat as a test platform for various systems for defense contractors. We then started a for-profit company called Submergence Group, LLC, and did a number of projects for the military. We built a dry diver lock-out submersible that would fit in the shelters that the Navy used on their host submarines, and then the U.S. Special Operations Command awarded us some contracts to build what came to be known as the Dry Combat Submersible (DCS). They are 40 feet long and fit in a sea container for deniability. The batteries are lithium ion and are housed in pods outside the main pressure vehicle. These vehicles are extremely complicated, having a rear compartment for the two-man crew, a center compartment for lock-in and lock-out of divers, and a forward compartment to house an eight-man SEAL team. We worked a great deal on auto heading and depth software, as you have to navigate with an inertial guidance system until you can safely surface to get a GPS fix.

Our software became very robust through the years, and we decided to build an unmanned autonomous boat to duplicate the sailing of the *Mayflower* on its 400th anniversary. We built the *Mayflower* Autonomous Ship in Gdansk, Poland, and set to sea. Our software performed exquisitely, but we had mechanical issues that forced us to return. We fixed them and set out again only to have another electrical issue that had us divert to Horta in the Azores, and then on again, and a severe storm compromised one of IBM's supercomputers and we diverted to Halifax, and then we set out again and made it to Plymouth, Mass. We had a few million images of ships and boats and the complete international collision regulations. During the passage, we generated 17 terabytes of data, which had to be meticulously studied to be sure that every single decision made by the AI software was the safest and correct decision.

This effort was ground-breaking. We have said for years that AI software will be used aboard boats and ships in the future. An autonomous vessel can be built at a fraction of the cost of a crewed—no heads, galleys, lifeboats, crew safety equipment, holding tanks, berths, etc. One hundred percent of the water can be pumped onto the flames, and the boat can be driven into a fire until the plates buckle. No loss of life. I've been told we'll never see an autonomous vessel anywhere near an oil platform; I think in 35 years, you won't see a vessel with a man on it anywhere near an oil platform. It may be that people will still want to reassure themselves before taking the leap and have the bridge system function in an advisory capacity until trust is abundantly evident. There is no question, however, that AI navigation will be our future.

1970s

Mike Chapman '76 Th'77: My wife, Martha, and I recently participated in our 11th Distinguished Gentleman's motorcycle ride in support of suicide prevention and prostate cancer research. This time, we helped organize the ride from the Vintage Racing Stable in Sanbornton, N.H. to Laconia, N.H.

2000s

Brian Mason '03 Th'04 Th'05: I continue to work at Abiomed (a part of Johnson & Johnson's MedTech segment) leading a team to develop a novel device for heart failure. Jocelyn '05 and I continue to live in Lexington, Mass., with our children and puppy Salty. We made it up to reunion a few weeks ago—and loved it.

André Jerenz Th'04: I am a MEM '03-'04 and after graduating had a few different career steps. For the last 10 years, I have been with McKinsey, where I am a partner with McKinsey Technology for three years now, focusing on financial services. One collaboration I am quite proud of is our work with one of the globally leading NGOs that are focusing on financial inclusion for the poorest of the poor. On a family note, I am married and have an 11-year-old daughter and an 11-month-old son.

2010s

Devon Anderson Th'10: I have joined the department of orthopedic surgery at the University of Vermont after a long medical and graduate training. I will serve as a team physician for Middlebury College and the U.S. Ski Team. I have continued engineering research in orthopedics, including sponsoring an ENGS89/90: "Engineering Design Methodology and Project" project last year and collaboration with **Doug Van Citters '99 Th'03 Th'06**, with whom I began my research career. For ENGS89/90, my father and I sponsored a project to do preliminary research and prototype development on a patent that we hold for integrating UV light into surgical lighting systems to provide intra-operative anti-sepsis and reduce surgical site infections. The team did an excellent job performing basic science research to validate the efficacy of the technology, and we greatly enjoyed working with and mentoring the team.

My introduction into engineering and orthopedic research was working over multiple summers and academic terms in the Dartmouth Biomedical Engineering Center with Dr. Van Citters and Dr. **John Collier '72 Th'75 Th'77**. I investigated mechanical properties of articular cartilage and researched the mechanical phenomenon of squeaking ceramic hip implants with **John Currier '79 Th'81**. This research inspired my pursuit of a PhD in biomedical engineering at Oregon Health & Science University in a combined MD/PhD program, during which time I worked on growing articular cartilage tissues in the laboratory from stem cells. At Middlebury, I will be the primary orthopedic surgeon for Middlebury athletics and an orthopedic consultant for the US Ski Team. I grew up an alpine ski racer and am still an avid skier. I became involved in sports coverage and athletic medicine through my medical training with a residency in orthopedic surgery at University of Rochester and a fellowship in sports medicine at Duke University, where I served as a team physician for Duke athletics. While I will be on faculty at the University of Vermont, I will be based in Middlebury at a UVM network hospital, Porter Medical Center.

Max Fagin Th'11: I've moved to the pilot office at Blue Origin, helping to ensure the NASA *Artemis* astronauts will have an easy (and fun) time flying our vehicle when they land it on the moon. I'm learning to fly the vehicle, building the simulators, and assessing the flight controls and displays.

Josephine Kalshoven '19 Th'19: I am excited to announce that I just received my PhD in biomedical engineering from Brown University this past Memorial Day weekend. I am excited now for the next step, as I look for medical device industry jobs in the Boston area. At Dartmouth, I worked in the lab of Prof Doug Van Citters from my sophomore year onward, and I was thankful to have such a great BME research experience under his guidance. He gave me a lot of freedom to make my project my own and investigate—as if I were a new doctoral student—and I loved it! It was also in that lab that I was introduced to the world of orthopedics. For my PhD, I quantified the biomechanics of the thumb carpometacarpal joint, which lies in the wrist at the base of the thumb. It's a joint that is crucial for dictating the power and precision of everyday grasps, but it is also a common site of debilitating osteoarthritis. Unfortunately, all the existing surgical and therapeutic treatments are insufficient to restore proper functionality, in large part because the complex joint has such a unique pattern of motion and biomechanical characteristics. I used a robotic system to move cadaver thumbs, quantifying the multidirectional range of motion and mechanical stiffness of the joints, as well as the contribution of its stabilizing ligaments and the impact of bony degradation during osteoarthritis. It is my hope that this work will enable the development of future interventions for better treatment of the arthritic thumb.

Additionally, it was an honor to learn that I had been selected for both the Outstanding PhD Thesis Award and the Contribution to Community Life Award for the Brown University Institute for Biology, Engineering, and Medicine. While I was highly involved across campus, I believe this award was in large part for my revival of the biomedical engineering graduate leadership board following the pandemic. The organization had all but dissolved, but I organized meetings, recruited members, and established a committee structure and method for rotation of leadership of general body meetings. Faculty and staff turn to our organization as a voice for the students, and I am pleased to say that the structure (and a large, highly engaged membership) continues on even as I have stepped back.

2020s

Julia Bonzanini '21 Th'21: I started a PhD program in bioengineering this past year at the University of Washington, where my research focuses on using computational tools to design de novo proteins against peptide MHC cancer targets.

in memoriam

ARTHUR L. IRVING '72A

— 1930-2024 —

"A Visionary Leader"

Arthur L. Irving '72a, the driving force behind the College's Arthur L. Irving Institute for Energy and Society, passed away on May 13, 2024, in Boston. He was 93.

Born and raised in Saint John, New Brunswick, Canada, Irving developed a love of the environment and entrepreneurship. After graduating from Acadia University, he joined the family business, Irving Oil, later becoming president and chairman in 1972. Throughout his career, Irving demonstrated an enthusiasm and support for business, the environment, education, healthcare, research, and the community.

At Dartmouth, Irving and his wife of 40 years, Sandra '72a, funded scholarships for Canadian students, developed the Sandra L. and Arthur L. Irving Professor of Economics Endowed Chair, and help fund undergraduate students in business studies in partnership with the Tuck School of Business. Dartmouth awarded him an honorary degree in 2010, the same year daughter Sarah received her AB in sociology.

Perhaps his greatest impact on campus came in 2016, when Irving, Sandra, and daughter Sarah '10 Tu'14—along with Irving Oil and the Arthur L. Irving Family Foundation—established the Irving Institute. "Meeting the energy demands of the future is one of the most complex and urgent challenges facing humankind," former President Phil Hanlon '77 said when announcing the institute in 2016. "Arthur L. Irving is a visionary leader on the global energy stage who understands the transformative potential of a Dartmouth education, and Irving Oil has long been an early adapter of technology and processes that improve the environmental performance of their assets and products. The institute will be a testament to Arthur Irving's highest values and aspirations, and a catalyst for the creation of new knowledge and of future energy leaders."

He is survived by Sandra; children Arthur, Emily, Jennifer, Kenneth, and Sarah; eight grandchildren; and one great-granddaughter.

obits

Thomas Upton Chace '47 Th'49 died March 24, 2024, at home in West Jordan, Utah. Chace enlisted in the Navy's V-12 program at Dartmouth, where he also earned his master's in mechanical engineering. Chace joined the workforce with Great Northern Paper Co. in Millinocket, Maine, followed by the Wyman Gordon Co. in Grafton, Mass., where he worked for 32 years. While with Wyman Gordon, he was part of the team that built the SR71 Blackbird. Tom later became the company's liaison between Hercules and Thiokol in Utah. During his last 15 years with Wyman Gordon, he was vice president and general manager of the Rollmet Division. Tom then went to work as CEO of Martin Marietta running its Torrance, Calif., plant. When Tom finally retired, he enjoyed working on his own projects and hobbies. His engineering experience enabled him to build several new family homes. He carved wooden decoys, utilizing his creativity and craftsmanship. He was a member of the Pacific Southwest Decoy Club and won carving competitions with his decoys. Tom is survived by his wife of 51 years, Lenell; children Lonnie, Betsy, Debbie, Tad, and Gina; nine grandchildren; and four great-grandchildren.

Andris Padegs '53 Th'54 of Poughkeepsie, N.Y., passed away May 3, 2024. Born in Riga, Latvia, he emigrated from Latvia to Germany in 1944 on transport ships carrying the retreating German army. Padegs graduated from the Latvian Gymnasium High School and emigrated to the United States. At Dartmouth, he earned his AB and master's in electrical engineering then went on to Carnegie Tech for his PhD in electrical engineering. He joined IBM in 1958 and became deeply immersed in the dynamic environment involved with the advent of mainframe computers. He advanced to senior engineer at IBM's laboratory at Poughkeepsie, where he was responsible for the functional definition of IBM System/360 central processors and channels. Padegs coauthored System/360 Principles of Operation. He participated as a lecturer at the Latvian Technical consortiums and in 1991 was one of the organizers of the First International Engineering Conference. In recognition of his lifelong quest to promote the freedom and culture of Latvia, Padegs was named an Officer of the Order of the Three Stars. He is survived by children Anita J, Gynt, and Sandra; six grandchildren; one great-grandchild; and niece Ilse Padegs Willems '84.

Peter C. Buhler '55 Th'56 of Weston, Mass., died February 27, 2024. He received an ROTC scholarship through the Navy to attend Dartmouth. There, he was active in Bones Gate/Delta Tau Delta, Casque & Gauntlet, Green Key, the Interdormitory Council, and the Undergraduate Council; rowed crew; and earned a master's in civil engineering. Buhler's active-duty commitment to the Navy began in Alaska with the Civil Engineer Corps. After his honorable discharge as a commissioned officer, he began his professional career as an engineer at Bechtel Corp., managing the construction of client industrial plants before joining McKinsey & Co as a management consultant. He later joined Continental Investment Corp., where he established two new investment management firms before becoming a vice president at Fidelity Investments; while there, he helped shift the company's mutual fund distribution strategy to direct marketing through advertising and the mail. He eventually fulfilled his dream to work for himself, maintaining his own wealth management and retirement planning consultancy for the 25 years preceding his retirement. He is survived by his wife of 67 years, Elizabeth; children Brenda '84 and Peter Jr.; two grandchildren; two grandchildren. Dartmouth relatives include his father, Carll '30, brother-in-law Charles Solm '58, and niece Stephanie McCusker '88.

Edgar D. Kauffman '60 Th'61 of Baldwin, Md., died May 21, 2024. At Dartmouth, he was active in Navy ROTC and Phi Kappa Psi and earned his AB in engineering sciences and a master's in mechanical engineering with honors. He then served in the Navy as an engineer for almost five years before a successful career as an engineer working for Bell Telephone Labs, Whitman Requardt and Associates, and Rummel Klepper and Kahl. In 1968, he moved his young family to Brooke's Cross Farm in Baldwin to help his mother and stepfather run the dairy farm. He eventually became a full-time farmer, milking more than 100 cows, returning to engineering at Texas Instruments and as a professor of mechanical engineering at the University of Maryland. He spent some time in Prudhoe Bay, Alaska, in 1981 and 1982 working on the computer system that regulated the oil pipeline. Edgar fell in love with sailing in high school, and pursued it for much of his life, taking his wife Sally and young children out on the Chesapeake Bay for a week at a time. When he sold his sailboat to buy a new farm tractor, he took up flying and was licensed to fly a small plane. He is survived by children Virginia, Goss, Stephen, and Marion; seven grandchildren, and five great-grandchildren.

Robert H. Lichtenwalter '65 Th'66 died May 5, 2024, in Waterville, Maine, due to complications from Parkinson's disease. At Dartmouth College, where he was a member of the 1962 Ivy League championship football team, he joined the Kappa Sigma and earned his AB and master's in mechanical engineering degree. After graduation, he drove across the country to start his career with Boeing on the Supersonic Transport project. While working at Boeing, he attended night school at the University of Washington, earning a master's in mechanical engineering in 1970. He was proud of having worked on the design of the Boeing 747 during his 15 years in the aircraft business. He then switched directions and took a job in the forest products industry with Weyerhaeuser, where he designed equipment, acquired two patents, and managed many mill projects. He traveled across the country to troubleshoot paper mills for Weyerhauser until leaving to establish his own consulting company, retiring in 2004. He is survived by his wife of 57 years, Karen; children Robert and Brneda; and two grandchildren.

Neil P. Cannon '82 Th'85 passed away on April 2, 2024, in Longmont, Colo. He came to Dartmouth from the Lawrenceville School and earned his AB and MS in engineering sciences. On campus, he was active in the French language study abroad, student workshops, and the Mountaineering Club. He had a rich career working for a number of lighting and technology companies, where he held leadership roles. Cannon made his home in Colorado for more than 30 years and for the last five split his time between Colorado and Randolph, Vt., where he was the CEO of LEDdynamics. A passionate skier and one of the top U.S. rock climbers in the 1980s, Cannon made several first ascents of some of the hardest rock climbs in the United States and, at 17, in the summer before he started college, climbed El Capitan in Yosemite twice. Cannon had an encyclopedic knowledge of many things, including business, the environment, and especially cars, a lifelong obsession and love he shared with his son, Max. Cannon is survived by Max and his former wife, Regina Figge '84.

Christopher Simmons Hull '83, PhD, passed away February 23, 2024, at his home in Richmond, Va. At Dartmouth, he earned his AB in engineering sciences and chemistry, participated in a language study abroad program in Germany, and was active in Heorot/Chi Phi. He went on to earn his BS in civil engineering and MS in environmental engineering at the University of Massachusetts, Amherst, then his PhD in environmental engineering from the University of North Carolina, Chapel Hill. He taught environmental engineering at North Carolina State University and served as a senior research engineer with water treatment firm Infilco Degremont before joining consulting firm CH2M as a project manager and then client services manager. In 1983 he "caught the paddling bug," beginning a lifelong passion for whitewater kayaking. In his 20s, Chris trained and competed nationally in slalom kayaking. Hull served as president of the James River Outdoor Coalition, leading park improvement projects and river cleanups. He is survived by his wife, Karina; children Clarissa, Denise, Noah, and Isaac; and grandson Neil.

in memoriam

WILLIAM E. SCOLLARD '47 TH'48

— 1926-2024 —

A Lifetime of Contributions

William E. Scollard '47 Th'48, longtime Thayer board member and adjunct professor and Ford executive, died April 7, 2024, at his home in Bonita Springs, Fla. He was 97.

He came to Dartmouth in 1944 and began V-5 training with the Navy and then studied as an engineer and naval pilot. After his service, he returned to campus to join Sigma Nu and graduate Phi Beta Kappa with a BS in engineering sciences and a master's in electrical engineering. In 1950, Scollard earned an MBA at Harvard married Mary-Hope Minton, and was recruited by Ford Motor Co.

He moved up to general manager of the Ford engine and foundry division in Dearborn, Mich., in the 1970s and was VP of manufacturing and component engineering of its North American automotive operations in 1984, when he was named to Thayer's board. Scollard retired from Ford in 1991 as executive VP of North American manufacturing operations and a board officer.

A member of the Society of Automotive Engineers and the Society of Manufacturing Engineers, Scollard shared his vast experience with students as an adjunct professor teaching "Total Quality Management" for several years. He credited his youngest daughter, Samantha "Sam" Scollard Truex '92 Th'93 Tu'95, with drawing him back to Hanover to teach. He earned the Sylvanus Thayer Fellow Award, named after the school's founder, for his generosity to Thayer and commitment to engineering education. He also served the College as class head agent for the Alumni Fund. The School again recognized his contributions to the engineering community—including almost 20 years on the Board of Advisors—with its highest honor, the Robert Fletcher Award, in 2001.

Scollard was predeceased by Mary-Hope and sons Peter, Bill, and Jack. He is survived by his second wife, Kuniko; children Christina, James, Joanne, John, Patricia, Roberta, William, and Sam (and her husband, Edward "Tad" Truex '91 Th'93); 14 grandchildren, including Edward '22; and 16 great-grandchildren. Daughter Sam has followed in her father's footsteps at Thayer and just ended her nine years of service on the Board of Advisors, the last four as chair.

Collaborations

Girola-Guzman and Chin at work.

DON HAMERMAN

"Research here is extremely accessible."

—IRODA ABDULAZIZOVA '26

Hands-on Experience

Professor Peter Chin, lead investigator of the Learning, Intelligence + Signal Processing (LISP) Lab, welcomes first-year students as paid interns researching the neuroscientific basis of intelligence. Iroda Abdulazizova '26 connected through the Women in Science Project (WISP), which matches students and STEM opportunities. Kimberly Girola-Guzman '26 learned about the lab via the First-Year Research in Engineering Experience (FYREE), which provides early hands-on experience and mentoring. It's a win-win: "Kim and Iroda have been writing programs in various coding languages and helping me run machine learning experiments," says Chin. Abdulazizova studied hyperbolic space and differential geometry—"I never realized that there's so much math in daily life," she says—while Girola-Guzman sharpened her communication skills: "Professor Chin has shown me the value of being able to distill our research into accessible and concise presentations." Says Chin: "It's my job to help my students become independent thinkers, researchers, and scientists in their own right."

IN THE NEWS

"It May be Possible to Power Implantable Generators with Our Bodies"

Discover

Professor John Zhang tells *Discover* magazine that wearable generators could produce sufficient electrical energy from the body's kinetic energy "at low frequencies to sustain operations" of pacemakers and other implantable devices.

"NYC is Requiring Landlords to Green Their Buildings"

Fast Company

Dean Alexis Abramson writes in *Fast Company* that the success of New York City's new law will depend on how landlords, renters, and communities engage and talk about "the real financial pressures holding back the energy transition."

"At Least 35 of America's Billionaires are PhDs"

Fortune

A *Fortune* magazine column encouraging PhDs to pursue careers outside academia touts Dartmouth's PhD Innovation Program, the nation's first program of its kind, for providing "entrepreneurial training to turn research discoveries into market solutions."

"Gas-Free Racecars Hitting the New Hampshire Motor Speedway"

The Boston Globe

Formula Hybrid+Electric Director Mike Chapman '76 Th'77 and Dartmouth Formula Racing Captain Joe McInnis '24 are featured in a *Boston Globe* article about this year's competition, where most teams competed with electric-only vehicles.

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Dartmouth Engineering has partnered with Universidad de Ingeniería & Tecnología in Lima, Peru, to establish its first international degree program! Dean Alexis Abramson and UTEC General Director Javier Bustamante Romero signed the agreement that allows students to earn a BE from UTEC and spend their fifth year in the master of engineering (MEng) program at @dartmouthcollege.

Intro to Engineering Student Project: Rescue Pole

Dartmouth students designed and built a hiking/ski pole that can convert to a traction splint, ankle splint, crutch, and flare launcher.

@thayerschool

Photos from Dartmouth's Green City Program in Germany! In this foreign study program, students combine engineering coursework focused on "green" and sustainable engineering with German language and cultural immersion in an environment where sustainability is a lived practice.

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User-Friendly Fortress

In addition to leading 16 students in his two-term capstone ENGS 15: "Senior Design Challenge," Professor Eugene Korsunskiy put his engineering skills to use building this treehouse. The graduating students—who spent the two-term course using human-centered design methods to work on projects with local community organizations—assessed his work during their end-of-term celebration in June.

Front Cover
separate file