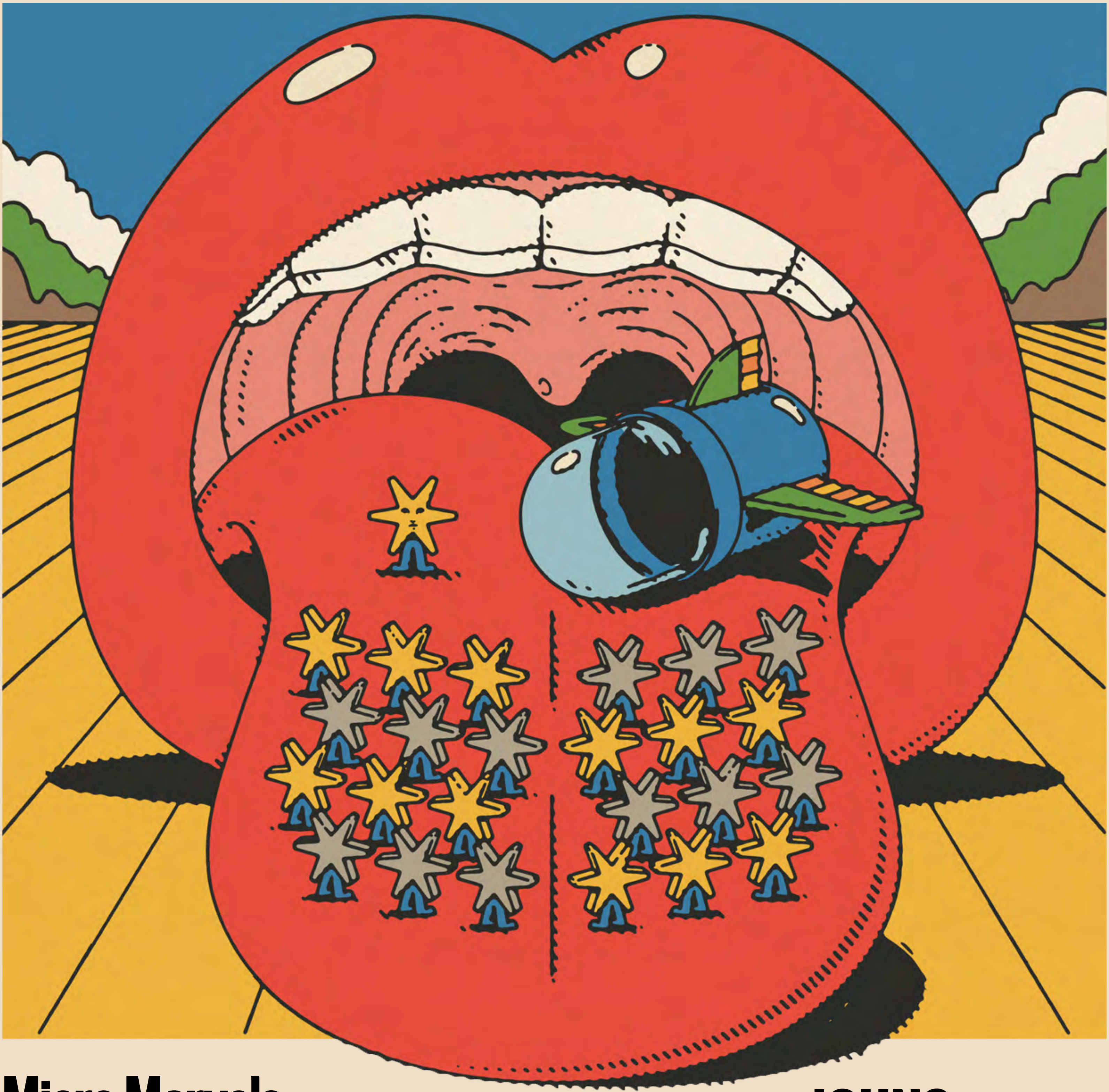
JOHNS HOPKINS WHITING SCHOOL OF ENGINEERING

SPRING 2025



Micro Marvels

Inspired by nature, David Gracias builds micromachines that fold, stick, swim, and sense—all inside the human body.

JOHNS HOPKINS ENGINEERING MAGAZINE

Reimagined, Not Reinvented

A few weeks ago, I listened to a fascinating podcast about research showing that butterflies and moths, even after having undergone metamorphosis, retain memories from when they were caterpillars.

This feels to me like an apt metaphor for introducing you to our entirely redesigned and reimagined *Johns Hopkins Engineering Magazine*. While our new look and content reflects the Whiting School's tremendous growth and evolution over the past decade (the period since the magazine's last redesign), it also reaffirms the enduring core values and qualities that have always and will continue to define us.

With this redesign, we set out to more vividly capture the dynamism and relevance of what we do. You'll find a greater variety of story formats and new recurring columns highlighting ongoing school priorities and initiatives, profiles that celebrate the impact of our alumni, and narratives that underscore our keen focus on solving challenges to come. The look, tone, and feel are a deliberate departure for us, one that we believe better reflects our mission and our role as leaders in transformative engineering research and education.

"With this redesign, we set out to more vividly capture the dynamism and relevance of what we do."

In addition to news covered here, among our many recent milestones include rising to No. 13 overall in *U.S. News & World Report*'s annual ranking of full-time graduate engineering programs and a record-breaking applicant pool for the class of 2029.

We have much to celebrate, and as always, one of our greatest challenges in creating the magazine is fitting the breadth of our accomplishments into just 40 pages!

We hope you enjoy the magazine's new look and approach and that the stories strengthen your pride in being part of the Whiting School community, for it is only with your support that our success is possible.

Thank you for all that you do.

Ed Schlesinger
Benjamin T. Rome Dean

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JOEL KIMMEL

Pedal to the Metal

In early April, against the rocky, muddy backdrop of Pennsylvania's Anthracite Outdoor Adventure Area, members of Johns Hopkins Blue Jay Racing put their engineering and driving skills to the test. They maneuvered the single-seat off-road vehicles they'd spent the year designing and building—an orange-and-blue 21XT and a blue-and-pink 20XT—through a punishing course that included winding trails, rock crawls, and an acceleration track to assess the vehicles' endurance, suspension, speed, and durability—all factors that would determine their success in a series of competitions this spring.

JOHNS HOPKINS ENGINEERING MAGAZINE

SPRING 2025

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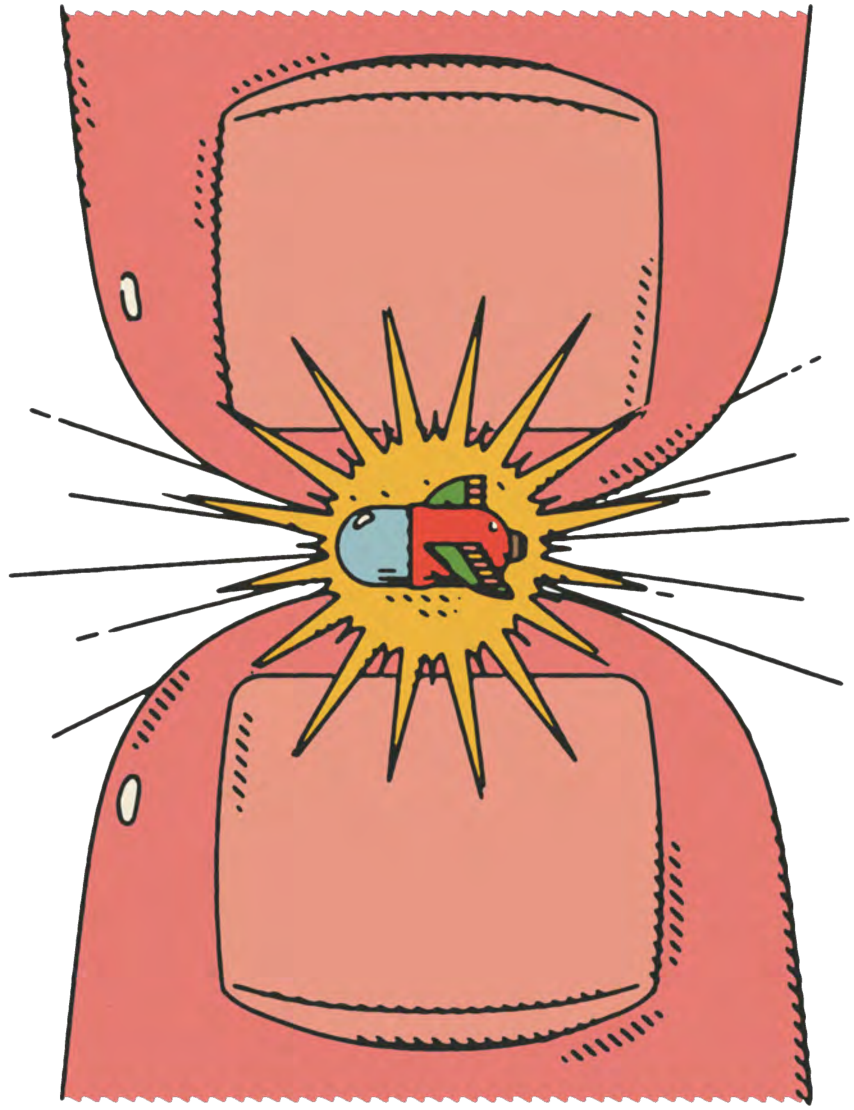

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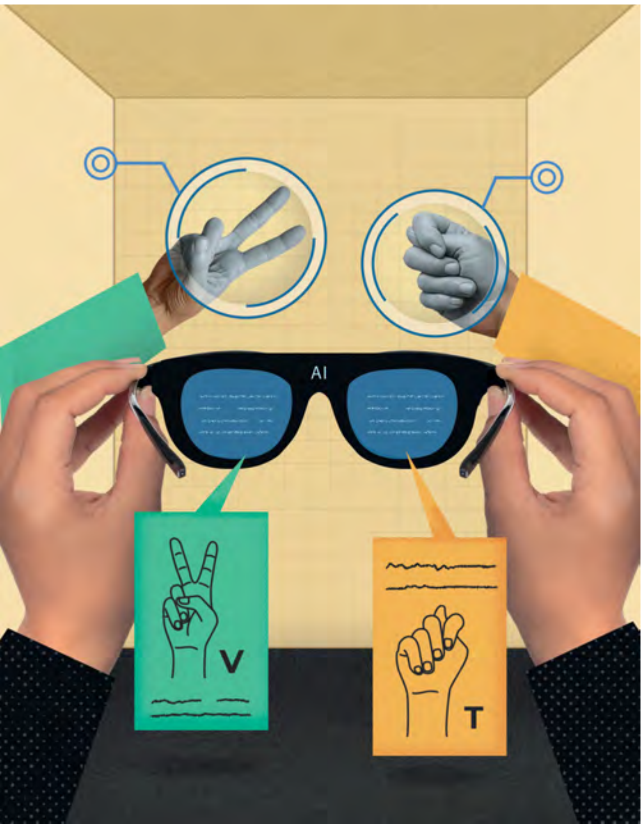

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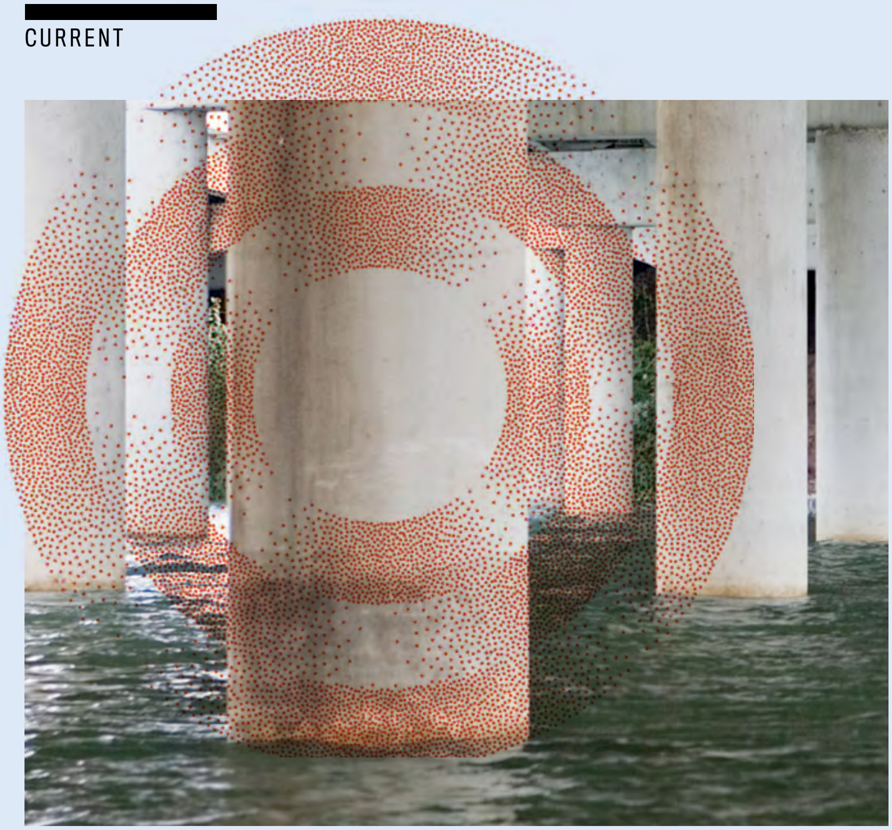


U.S. Bridges at Risk of Ship Collisions

HUEY P. LONG BRIDGE (LA)
collision expected every 17 years

SAN FRANCISCO–OAKLAND BAY BRIDGE (CA)
collision expected every 22 years

CRESCENT CITY CONNECTION (LA)
collision expected every 34 years

BELTWAY 8 BRIDGE (TX)
collision expected every 35 years

When a container ship struck Baltimore's Francis Scott Key Bridge in March of 2024, causing its catastrophic collapse, Associate Professor of Civil and Systems Engineering Michael Shields described the collision as "a wake-up call."

So he turned to the National Science Foundation and its Rapid Response Research (RAPID) program for funding to investigate the event's implications.

If the Key Bridge, which carried more than 30,000 vehicles across the Patapsco River each day, was so vulnerable, Shields wanted to know what that meant for other U.S. bridges. Shields assembled a team of 13 students and two other faculty members to assess the country's bridges and develop new risk models.

The students analyzed dozens of bridges, wrote data-collection programs, and built a virtual portal to report their findings. Using this information, they calculated collision risk for major bridges and pinpointed which are most vulnerable.

Their findings, released in March, revealed that 19 bridges are at risk of catastrophic collision. Among the most vulnerable are the four bridges highlighted at left.

"There's still a lot of uncertainty in predicting the frequency of ship collisions," Shields says. "But the important point is not whether it will occur every 17 years or every 75 years. It's that it's happening way too often."

— CLAIRE GOUDREAU

NSF Career Honors

The National Science Foundation honored three Hopkins Engineering faculty members with Early CAREER Awards, which recognize early-stage scholars who demonstrate high levels of promise and excellence. Their groundbreaking projects address these critical challenges.

Adam Charles
Assistant professor of biomedical engineering

Problem: How does brain-wide activity spanning multiple regions produce behavior and intelligence?

His project will develop new models to explore brain-wide computational networks to uncover how neural circuits process information flexibly across traditional anatomical boundaries.

Mateo Diaz
Assistant professor of applied mathematics and statistics

Problem: How can we analyze and improve algorithms that tackle massive optimization problems for which traditional methods fail to scale?

His project will develop analytical tools to explain why simple methods often succeed with complex problems while developing new algorithms that avoid computational pitfalls when applied to data science and signal processing.

Susu Xu
Assistant professor of civil and systems engineering

Problem: When natural disasters like earthquakes and hurricanes strike, they cause cascading damage and impacts that are difficult to assess and predict in real-time, making it challenging for emergency responders to know where help is needed most.

Her project will develop new AI-driven software that can quickly process multiple data sources (satellite, ground sensors, crowdsourced data) to map and predict how disaster effects ripple through communities.

Three Hopkins Engineers Win Goldwater Scholarships

Three Whiting School of Engineering undergraduates—Edmund Sumpena, Wu Han (Enoch) Toh, and Lance Xu—are among 441 students nationwide awarded 2025–26 Goldwater Scholarships, one of the most prestigious honors for undergraduates pursuing careers in science, engineering, and mathematics.

Named for U.S. Senator Barry Goldwater, the scholarships support sophomores and juniors who show exceptional promise in research careers. Scholars are selected from a pool of more than 5,000 applicants and receive up to $7,500 toward tuition, fees, books, and living expenses.

Sumpena, a rising senior majoring in computer science and neuroscience, plans to become a physician-scientist researching early neuro-visual markers of brain disease. He has worked on deep learning models for retinal imaging at Hopkins and interned at the Mayo Clinic on an automated pipeline to improve pathology reporting. He is the first author of a manuscript submitted to *Medical Image Analysis*.

Toh, a rising senior studying computer science and molecular and cellular biology, aspires to lead a cross-disciplinary research group developing gene therapies through computational and experimental approaches. He has contributed to lipid nanoparticle research for targeted drug delivery and co-authored papers in *Nature Biomedical Engineering* and *Biomaterials*.

Xu, a rising junior majoring in biomedical engineering, aims to devote his career to investigating the mechanisms behind cancer cell progression to find common biomarkers that can lead to more effective therapies. At the School of Medicine, he has worked on gene TRIM-37 and its role in centrosome regulation and has earned co-author credit on a *Nature Structural and Molecular Biology* article. He is also conducting translational research in the Green Lab on polymeric nanoparticles for gene editing and cancer therapeutics.

The Goldwater Scholarships are one of the most prestigious honors for undergraduates pursuing careers in science, engineering, and mathematics.

INTELLIGENCE

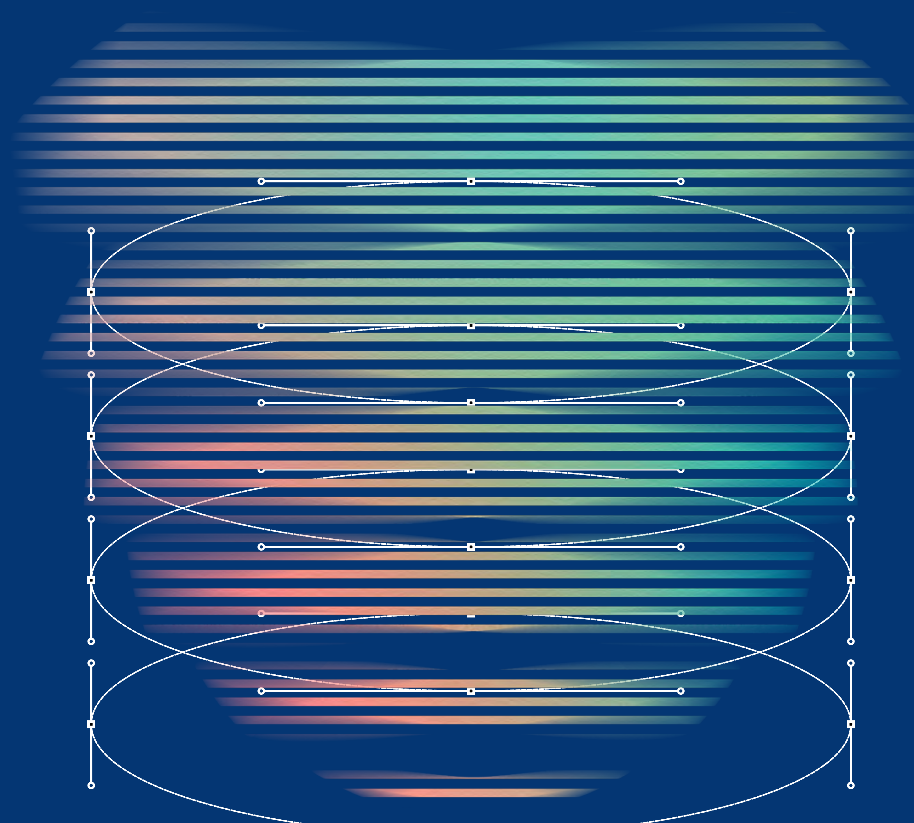
A Boost for AI Research

Thirty new Bloomberg Distinguished Professors (BDPs) are being recruited as part of the university's Data Science and AI Institute, the Whiting School–based hub for data science and artificial intelligence that drives research and teaching at Johns Hopkins.

The Bloomberg Distinguished Professorships program, started by Michael Bloomberg, Engr '64, was created to fuel impactful research that transcends disciplinary boundaries. Every BDP has appointments in multiple Hopkins divisions, and establishing this new cohort in data science and AI will help ensure the impact of the new institute is felt across the university.

The faculty members will weave data science, data-driven research, and AI even more fully into the fabric and future of the university in areas such as medical diagnosis, foundational machine learning, natural intelligence, neuroscience, genomics, cancer research, and the computational social sciences.

"The BDP program has fueled impactful research in areas as diverse as machine learning, health equity, and cancer immunology by harnessing powerful insights that transcend disciplinary boundaries," says Johns Hopkins University President Ron Daniels. "The Data Science and AI Institute and its embedded BDPs will bring this tested approach to cross-disciplinary and cross-divisional collaboration, allowing us to harness the power and potential of AI to open new and powerful avenues of research that drive solutions to daunting societal challenges and aid human flourishing."



IMPACT
FACULTY INNOVATION

ALSO IN THIS SECTION

Micro Marvels

INSPIRED BY NATURE, David Gracias builds micromachines that fold, stick, swim, and sense—all inside the human body.

BY ADAM HADHAZY

ILLUSTRATION BY MIKE HADDAD

Freed from their pill's casing as it dissolves in stomach acid, dozens of star-shaped mini-machines, each the size of a dust mote, sweep into the patient's small intestine. As these devices pass deeper into the jejunum, body heat starts to melt the paraffin wax holding their six arms in place. Like a starfish gripping its prey, the arms snap shut, latching onto the intestinal wall with a vise-like grip. A spring-like mechanism in the machine, constructed of metal and flexible film, now engages, puncturing the tissue and painlessly injecting a drug dose directly into the patient's bloodstream.

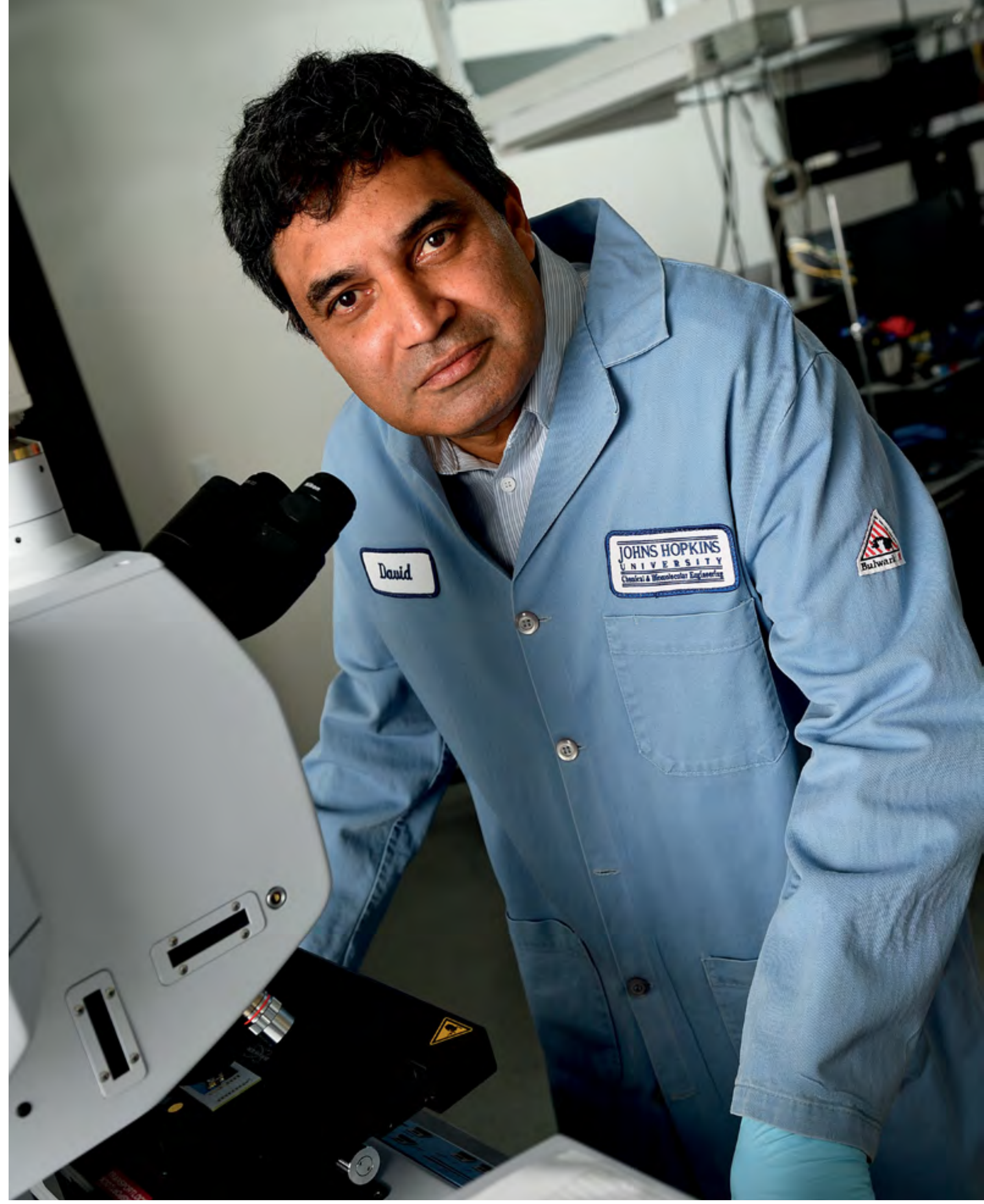
This revolutionary method of drug delivery would avoid the need to inject medication subcutaneously—a standard route for administering drugs that has come to encompass treatment for a wide variety of illnesses, including insulin shots for people with diabetes, immunomodulators for autoimmune conditions, chemotherapy drugs for cancer treatment, and GLP-1 agonists for weight loss.

"We would have a way to deliver medications without pain," says David Gracias. "Keeping up on your medications and trips to the doctor would become a lot less stressful." The idea of these so-called "theragrippers," or therapeutic grippers, is but one of many to have sprung from the mind of Gracias, a professor of chemical and biomolecular engineering at the Whiting School of Engineering, with a joint appointment in the Department of Oncology at Johns Hopkins Medicine, among other titles.

Gracias is a prolific inventor specializing in miniaturized systems, self-folding materials, and physically intelligent machines that can adapt to dynamic environments, drawing immense inspiration from the living world.

"I think nature is very intelligent. It's the best engineer," says Gracias, who is also an associate researcher at the Institute for NanoBioTechnology.

Over the past 21 years at Johns Hopkins, Gracias has made a name for himself in a richly interdisciplinary space where engineered and living systems meet. The breadth of this research is reflected by his elections as a fellow to international societies running the disciplinary gamut from physics to chemistry, medical and biological engineering, and electrical engineering. Late last year he was named a Fellow of the National Academy of Inventors.



David Gracias, professor of chemical and biomolecular engineering

Much of the work in Gracias' lab focuses on developing engineered living materials that could deliver tremendous advances in health care. Toward this goal, Gracias and colleagues often rely on biofabrication, which weds abiological craftsmanship, such as microchip manufacturing, to biological media such as cells.

Numerous examples of wild-sounding, dynamic devices have been born of the Gracias Lab, including:

- miniaturized biomedical robots, actively powered by microsprings wrought of thin films and "hydrogels" that absorb liquid and swell;
- origami-like, self-folding hydrogels that could help form artificial, transplantable tissues;
- hyper-miniaturized sensors, nicknamed "cell tattoos," that could adhere to individual cells and report on their health as proxies for larger organ systems.

"I like to work on problems that will be important in the future rather than immediate problems which I feel can be tackled by industry," says Gracias.

ENTERING THE BODY WITH SMALL THINGS

One of Gracias' closest collaborators on the medical side at Johns Hopkins is Florin Selaru, a professor in medicine, oncology, and biomedical engineering. Together, Gracias and Selaru are developing theragrippers to perform a variety of tasks. Their concept owes as much to how macroscopic organisms take up residence in our bodies as to flicks like 1987's *Innerspace*, where a miniaturized submersible, piloted by a shrunken Dennis Quaid, maneuvers through Martin Short's innards.

"One of the big ideas in medicine—and this has been around in movies—is, 'Can we enter the body with small things?'" says Gracias. "Clearly if we could, it's a game-changer."

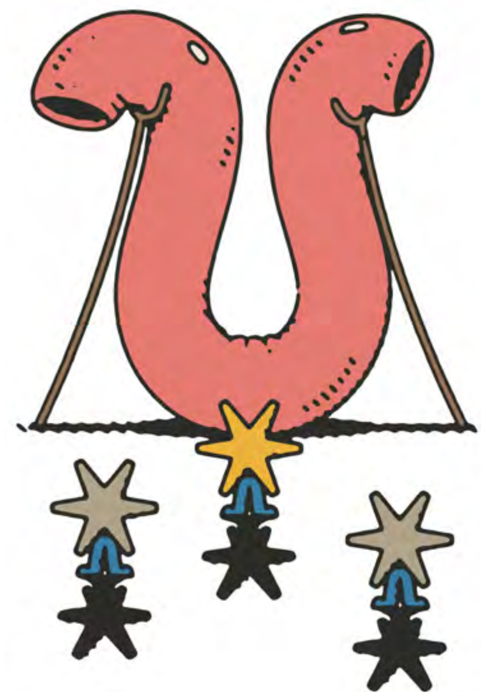
Theragrippers take a cue from the way hookworm parasites attach themselves to intestinal walls. The grippers can be outfitted with chemical sensors to autonomously shapeshift in the presence of certain sugars, amino acids, DNA sequences, enzymes, pH levels, and more to specifically target certain areas of the body.

These theragrippers could also be used for sustained drug delivery. Even with the advent of extended-release drug formulations, pharmacologists still have been limited in how effective they can make oral medications because of the unavoidably propulsive nature of the gastrointestinal tract, where wavelike muscle contractions known as peristalsis constantly move contents along.

"The GI tract is akin to an assembly line; it keeps going on and on," says Selaru, who is also director of the Meyerhoff Inflammatory Bowel Disease Center.

As a result, patients often do not get full doses of even extended-release drugs. "If you wanted to develop a truly sustained release formulation," says Selaru, "then you would have to essentially latch the ingredient on the inside of the GI tract." A pill that turns loose a fleet of theragrippers with pharmacological payloads onboard could do just that.

"I think nature is very intelligent. It's the best engineer."
David Gracias



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1. Dust-speck-sized theragrippers could be used to deliver drugs or conduct biopsies in hard-to-reach places.

2. When exposed to internal body temperatures, the star-shaped device folds and affixes to the intestinal wall.

Gracias and Selaru are conducting preclinical testing of theragrippers fashioned in their labs. In one animal model, mice that received a pain-killing drug via theragrippers had the drug in their bloodstreams for 12 hours, versus just two hours for mice given the drug via the normal oral route, as reported in the journal *Science Advances*.

The little grippers could also be used to conduct canvassing-like biopsies, grabbing tissue samples by the hundreds as they move through the body. In this way, theragrippers could enable robust statistical sampling in a large organ such as the colon, or in hard-to-reach conduits in the body, such as bile ducts, to offer sensitive new disease screening.

By catching cancers and precancerous cell changes early in disease development or progression, clinicians could therapeutically nip the problem in the bud. This strategy potentially could prove more effective at catching malignancies than today's taking of a limited number of chunky tissue specimens, a comparatively crude approach that can readily miss a small and still-easily-treatable bad spot. Other diseases, ranging from infections to metabolic disorders, could likewise be detected during early asymptomatic stages.

"Florin and I have been working on [the] idea of deploying theragrippers and giving an organ a 'score' to get an overall assessment of its health," says Gracias. "You could potentially find cancers or other diseases much earlier this way."

VESSEL VERISIMILITUDE

Another pioneering project from Gracias is the biomimetic artery—a complexly layered and cellularly tiled tube that functions remarkably like real-life vasculature.

Physiologically, blood vessels are wonders of natural engineering. Although presenting as mere tubes, they are actually composed of three concentric layers of cells, all precisely working in concert. Flat endothelial cells line the vessel's interior, backed by smooth muscle cells that contract and relax to enable blood flow, all wrapped in fibrous connective tissue cells. "Blood vessels are very complicated," says Gracias. "They're not just haphazard."

Astoundingly, our bodies contain about 100,000 kilometers (60,000 miles) of blood vessels—enough to wrap around Earth nearly two-and-a-half times. This vast network begins as branches of main arteries and veins, narrowing down into arterioles and venules, then wending further down into copious capillaries. Of the 100 trillion-some cells in our bodies, most are no more than a tenth of a millimeter (four-thousandth of an inch) away from a capillary.

A host of major ailments directly or significantly involve blood vessels, including of course cardiovascular disease, but also hypertension (high blood pressure) and cancer. Working with Lewis Romer, a professor of anesthesiology and critical care medicine at Johns Hopkins Children's Center, Gracias wants to dramatically improve our state of knowledge about vasculature for new insights into disease etiology and treatment.

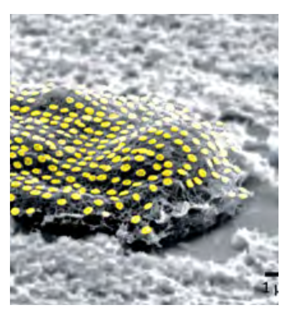
"We're interested in blood vessels because blood vessels are everywhere," says Romer, who is also a professor of cell biology, biomedical engineering, and pediatrics. "The ways in which the walls of those blood vessels are put together have certain themes and certain geometries, and we've been trying to recapitulate those with very high-level biomimicry."

To this end, the two researchers' labs have invented and patented their biomimetic artery and are continuing to hone its abilities.

Scientists have long struggled to engineer such convoluted devices. Gracias uniquely approached the challenge, leaning in part on his background before Johns Hopkins working in the semiconductor industry. As a senior engineer at Intel, Gracias learned how to fabricate novel circuits, and he invented ways for microchips to operate faster.

He brought that experience to his Hopkins lab, where tools and techniques of the microchip trade, such as photolithography—patterning materials using light—rub elbows with 3D printing and advanced imaging technologies. For the biomimetic artery, Gracias, Romer, colleagues, and students have employed such methods to create self-rolling layers of cells and tubular sensors. The upshot is a circular tube with accurately layered and aligned cells.

"They often say, 'Science is magic that works,' and I always tell students that once you learn the basics, you can use that knowledge to build all kinds of things."
David Gracias



These nanoscale dots contain optical elements and electronics that adhere to individual live cells—a breakthrough that could enable remote tracking of cell health and provide early warnings for disease.

The researchers are now putting these biomimetic vessels through their paces by flowing biochemical gels into them containing medicines such as nitrates, which widen blood vessels, and hormones, gauging how the cellular structures respond. "We can better understand dysfunction in the tube and how it occurs by studying these systems," says Gracias.

This approach offers significant advantages, both practical and ethical, over research in animal models or traditional laboratory setups.

"We're able to stay true to many of the genetic and biochemical and anatomic parameters that exist in a person that are very different than they are in an animal or in vitro modeling," says Romer, adding: "This research is a great credit to David's ingenuity and ability to translate abstract ideas into very basic kinds of design parameters for systems production and engineering."

'SCIENCE IS MAGIC THAT WORKS'

Gracias' and Romer's blood vessel mimics could eventually find their way into fully realized, artificially grown masses of cells that work together to function like a bona fide organ. These so-called organoids—another interest area for Gracias—could allow researchers to deeply investigate disease pathologies and drug pharmacokinetics.

As with his various micro-medical bots, the idea of living pseudo-organs might sound far-fetched, but Gracias points out that today's realities were yesterday's big dreams.

"Any great technology, if you saw it 20 years ago, it would've seemed like science fiction, right?" says Gracias. "If you use that same metric and think toward the future, then I think definitely in the next 20 to 30 years, we will go into the body with robots and tiny sensors and it will become very mainstream."

Through his lab's boldly innovative and inventive purview, Gracias is continuing to train and inspire young researchers. He recalls how important mentorship was to his own maturation. "It's a very rewarding part of the job to mentor the next generation," says Gracias. "That's something very important about life—you have to have good mentors."

For Gracias, a critical mentor is George Whitesides, a professor of chemistry and accomplished inventor at Harvard University, where Gracias

served as a postdoctoral researcher. “For the first time, I saw that you can actually use your knowledge to create things, which is very empowering,” Gracias recalls. “They often say, ‘Science is magic that works,’ and I always tell students that once you learn the basics, you can use that knowledge to build all kinds of things.”

One student of Gracias’ who took these words to heart is Anum Glasgow, who graduated in December 2009 as a biomedical engineering major. Now an assistant professor of biochemistry and molecular biophysics at Columbia University Medical Center, her research centers on the ubiquitous and quintessential biological self-folding systems of proteins. Often called the “workhorses of biology,” proteins enable a staggering amount of life’s functions and forms. And proteins do all this thanks to the complex shapes they assume after being initially spit out in cells’ ribosomes as a string of amino acids.

Glasgow recalls her undergraduate work in the Gracias Lab in such matters. “What always fascinated me the most about our projects was this self-folding principle,” she says. “My training there was really foundational to what I do now.”

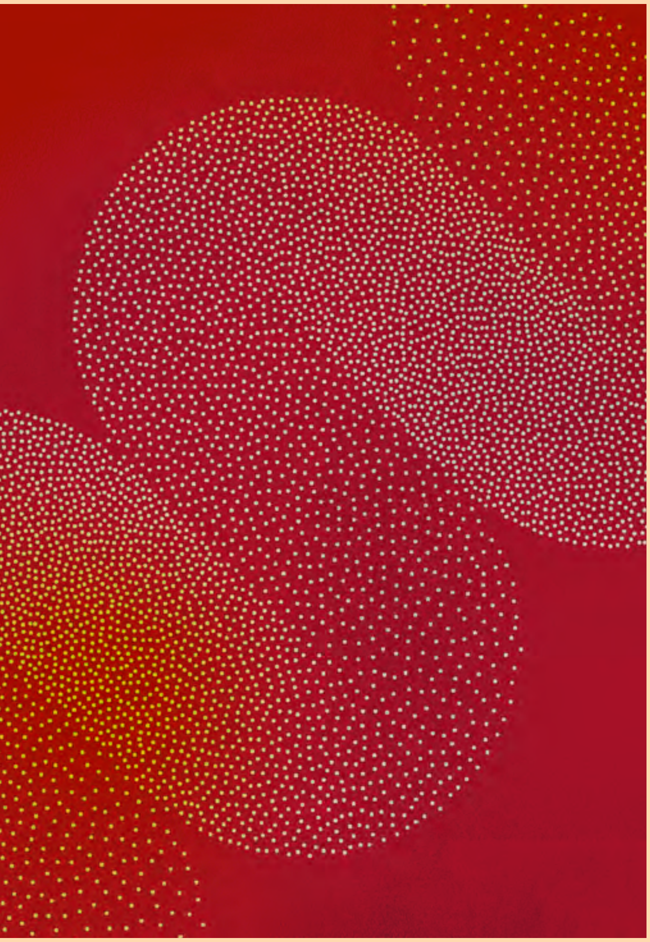
In mentoring students of her own, she is advancing understanding of the principles for protein structure, working toward a goal of rationally designing artificial proteins with desired properties for a slew of applications in medicine and industry. As Gracias did with her and her fellow students, Glasgow is encouraging fresh, innovative approaches.

“The most amazing thing about being an undergraduate researcher in the Gracias Lab is the level of independence that you have in your research,” she says. Glasgow thinks that inventive, independent streak stems from Gracias himself. “He really marches to the beat of his own drum,” Glasgow says.

Indeed, in his research endeavors, Gracias says he continues to find inspiration from solutions honed by the living world, a passion that goes all the way back to his childhood days growing up in India. He remembers marveling over bottled specimens of insects that he and his brother kept preserved in formalin. Even today, he finds himself routinely amazed by trees’ quotidian architectures.

“My son makes fun of me,” says Gracias, “but whenever I’m parked at a traffic light or walking the dog, I admire the trees around us that are often not noticed.” Instilling appreciation for nature’s engineering—honed over millions of years of evolution—is part of Gracias’ vision for the engineers of tomorrow.

“There are all kinds of great ideas, right there outside,” says Gracias. “We humans just have to stop and look.” ■



Gut Check

HOSPITALS PROVIDING DATA
145

3D CT SCANS ANALYZED
45,000+

ANATOMICAL STRUCTURES ANNOTATED
142

PROJECT TIME TO COMPLETION USING AI
< 2 YEARS

PROJECT TIME TO COMPLETION WITHOUT AI
approximately 2 millennia

Johns Hopkins researchers have created the largest, most comprehensive dataset of abdominal organs to date to help radiologists quickly and accurately identify tumors and other diseases.

Previously, creating these datasets required radiologists to manually identify and carefully label individual organs in CT scans, a process requiring thousands of hours of human labor.

By using an AI-based computer vision model, an international team led by Johns Hopkins Bloomberg Distinguished Professor Alan Yuille—and including radiologists and medical trainees—has found a way to increase the scope, scale, and precision of this process without overburdening radiologists.

The team's AbdomenAtlas is an abdominal CT dataset that is 36 times larger than its closest competitor, featuring more than 45,000 3D CT scans of 142 annotated anatomical structures from 145 hospitals worldwide. The project was published in *Medical Image Analysis*.

"Annotating 45,000 CT scans with 6 million anatomical shapes would require an expert radiologist to have started working around 420 BCE—the era of Hippocrates—to complete the task by 2025," says lead author Zongwei Zhou, an assistant research scientist in the Department of Computer Science. "We did it in two years."

The researchers use AI models trained on public datasets of labeled abdominal scans to predict annotations for unlabeled datasets. Then they identify and color-code the most critical sections of the models' predictions for manual review by radiologists. By repeating this process—AI prediction followed by human review—they significantly accelerate the annotation process, achieving a 10-fold speedup for tumors and 500-fold for organs.

The team is continuing to add more scans, organs, and both real and artificial tumors to help train new and existing AI models to identify cancerous growths, diagnose diseases, and even create digital twins of real-life patients before sharing AbdomenAtlas with the public.

— JAIMIE PATTERSON

Improving Cancer Drug Delivery

Cells have a built-in security system that protects them from bacteria and viruses, but a team of scientists has figured out how to pick their locks. Taking advantage of a natural process, they found a way to sneak large molecules inside—potentially improving the delivery of cancer-fighting drugs and antibodies.

"Usually, macromolecules like certain cancers can't enter cells because of their membrane barrier," says team member Kalina Hristova, a professor of materials science and engineering and a core researcher in the Institute for NanoBioTechnology. "We were able to 'hijack' a process called endocytosis, which is how cells naturally let molecules in, by discovering peptides that trigger the cells to make pores that allow macromolecules to come inside."

The team, which included scientists from Tulane University, studied peptides that form tiny openings, or nanopores, in membranes during endocytosis. They found that adding fatty acid chains to a peptide called pHD 108 increased its ability to make nanopores. The peptides respond to changes in acidity inside small compartments within the cell, causing the formation of pores that let large molecules escape. The researchers used this approach to deliver cancer-fighting enzymes and fluorescent proteins used for imaging. Normally, these molecules would be broken down before reaching their targets. "Without the modified peptides, they'd be ineffective," Hristova says.

Next, researchers plan to test the method with cancer drugs and antibodies. The study was supported by the National Institutes of Health, and the results appeared in *ACS Nano*.

— CONNER ALLEN

A Matter of Life and Death

With heart attacks, every second counts. Immediate medical intervention is critical to improving patient outcomes, so any delay in diagnosis can mean the difference between life and death.

But even in a hospital setting, confirming a heart attack diagnosis requires multiple steps, including electrocardiograms and blood tests for cardiac markers. This process can take up to an hour and often needs to be repeated, potentially delaying life-saving treatment.

The wait may soon be over.

Johns Hopkins mechanical engineers Peng Zheng, a research scientist, and Professor Ishan Barman

> **"We're talking about speed, we're talking about accuracy, and we're talking of the ability to perform measurements outside of a hospital."**
> Ishan Barman

have invented a standalone blood test that provides results in five to seven minutes and is more accurate and more affordable than current methods, the researchers say. Their results appeared in *Advanced Science*.

"We're talking about speed, we're talking about accuracy, and we're talking of the ability to perform measurements outside of a hospital," Barman says.

The team used biophotonics to detect biomarkers in the blood that indicate bodily responses to various conditions, including the earliest signs that someone is having a heart attack.

The core of their invention is a tiny chip with a nanostructured surface for blood testing. The chip's "metasurface" enhances electric and magnetic signals during Raman spectroscopy analysis, making heart attack biomarkers visible in seconds, even in ultra-low concentrations. The tool is sensitive enough to flag heart attack indicators that might be missed entirely by current tests or only detected at much later stages.

Though developed primarily for speedy diagnostics in clinical settings, the test could be modified for use by first responders in the field or even for use at home, and adapted to detect cancer and infectious diseases, the researchers say.

— JILL ROSEN

HOW IT WORKS

Keeping Skin Youthful

As we age, collagen vanishes and skin loses its shield, leaving it as fragile as old paper and slow to heal. A team led by chemical and biomolecular engineer Efie Kokkoli has combined two common medications in a hydrogel—a water-based material that can hold and release substances—that could restore skin's youthful resilience.

The team successfully engineered a hydrogel that remains liquid at room temperature but solidifies at body temperature, enabling a controlled release of the medications. Their results appear in *Biomacromolecules*.

— LISA ERCOLANO

HERE'S HOW IT WORKS

1. It packs a punch with two powerful ingredients.

The hydrogel works as a "smart" delivery system, carrying two key ingredients: metformin (encased in tiny fat particles called liposomes) and valsartan (in free form). Metformin is commonly used to treat diabetes and has the power to influence aging-related processes at the cellular level. Valsartan, used to treat blood pressure, enhances collagen production. The hydrogel gradually releases these onto the skin.

2. It targets aging cells.

As skin cells age, they enter senescence, meaning that they not only stop dividing but also produce harmful cell-level signals that contribute to aging and inflammation. Metformin works by waking up senescent cells and helping them regain some of their ability to divide and recover from damage.

3. It stimulates the production of collagen.

Collagen keeps skin firm, smooth, and elastic, but as we age, we produce less of this important protein, making skin wrinkle and sag. To combat this, the hydrogel's valsartan boosts collagen levels—and the more valsartan used, the bigger that boost. Even better, combining it with metformin further strengthened its impact, resulting in a 2.5-fold increase in collagen production over untreated senescent cells.

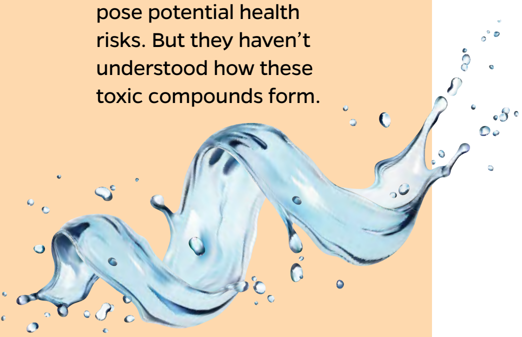
4. It's slow good.

The hydrogel's ability to deliver the two-medication combo slowly is one of its biggest assets. Unlike traditional creams that wash away or wear off, the gel dispenses 28%–35% of its medication during the first 24 hours and the rest gradually, ensuring steady delivery with no need to reapply. Six days into treatment, for example, senescent cells were producing the same amount of collagen as healthy, actively growing cells—proof that the treatment could help improve tissue repair over time.

IMPACT

On the Track to Safer Drinking Water

Scientists have known for decades that chlorination of drinking water creates unwanted disinfection by-products (DPBs), which pose potential health risks. But they haven't understood how these toxic compounds form.



Environmental Health and Engineering's Carsten Prasse contributed to a study that revealed how the process happens, knowledge that is key to improving drinking water safety.

To crack the puzzle, Prasse and a team of researchers labeled molecules containing a rare form of carbon called carbon-13 to track how phenols change into DBPs during chlorination. They identified four main chemical pathways that break down the ring-shaped phenol molecules into potentially harmful compounds, three of which involve the carbon atoms from the phenol's ring structure. The fourth involves a carbon atom from a group attached to the ring.

Understanding these reaction pathways helps pinpoint which starting materials lead to these toxic chemicals in drinking water so that water treatment facilities can adjust their processes to reduce the levels of dangerous compounds, notes the team, which published its results in *Nature Water*.

— DANIELLE UNDERFERTH

TWO-PHASE SOLUTION

Waste Not, Want Not

Michael Betenbaugh
Professor of chemical and biomolecular engineering

Yayuan Liu
Assistant professor of chemical and biomolecular engineering

Impactful engineering solutions are often ones that solve multiple problems at once, such as addressing industry needs while also eliminating waste.

A team of Hopkins engineers affiliated with the Ralph O'Connor Sustainable Energy Institute (ROSEI) has accomplished this with a new method for converting organic waste into medium-chain carboxylic acids (MCCAs)—crucial ingredients in industrial lubricants, bioplastics, food additives, and personal care products.

Their two-phase technique offers an alternative to current MCCA production methods that pose major economic challenges, focusing on innovative approaches rather than traditional extraction processes like obtaining MCCAs from palm oil.

"We sorely need alternative methods," says research team member Michael Betenbaugh, a member of the study.

Because their process can rely on organic waste from a variety of sources, it could be implemented in urban or rural environments, using waste from dairy farms, grocery stores, distilleries, and more.

Phase one of the process is overseen by Shilva Shrestha, an assistant professor of environmental health and engineering. It involves the microbial fermentation of organic waste, a process where microorganisms break down organic molecules and extract chemical energy. This technique works by hijacking the cells' natural microbial pathways to make liquids that contain MCCAs.

Phase two involves downstream separations, during which leftover liquids are further reduced until only MCCAs remain. While conventional methods for separating liquids in this way are cumbersome and time-consuming, Yayuan Liu, Russell Croft Faculty Scholar, proposes using electrochemical reactors to do the job instead.

"This method is more straightforward, and since it uses electricity, it doesn't create any excess waste," Liu says.

"We believe that our process will be especially valuable in low-resource environments, and we're excited to test it out at a larger scale very soon," says Betenbaugh.

— WICK EISENBERG

MATT TWOMBLY

Thriving Under Pressure

Inspired by human bones' self-adaptive capability to grow stronger through physical stress, a team of Johns Hopkins engineers has developed a material that not only resists degradation over time but also grows stronger and better at absorbing energy with use.

"Traditionally, there's been a fundamental tradeoff between a material's stiffness and its ability to absorb energy," says Bohan Sun, a mechanical engineering PhD student and lead author of the team's paper, published in *Science Advances*.

The team's innovation, called liquid infused porous piezoelectric scaffold (LIPPS), improves two typically opposing material properties: stiffness and energy absorption capacity.

LIPPS was designed with a sponge-like structure containing a liquid mineral solution. It replicates human bones' self-adaptive behavior with one crucial difference: While bones require a liquid environment, like blood, LIPPS functions in dry environments because it contains electrolytes in its porous structure. Under loading, its piezoelectric scaffold generates electrical charges, attracting ions from the electrolyte, forming minerals within its porous structure, and reinforcing the material.

This property reverses conventional materials behavior: Unlike most materials that weaken under repeated physical stress, LIPPS becomes even stronger and tougher with continued use.

"And LIPPS can be integrated with different matrix materials, making it adaptable to various material systems," says study principal investigator Sung Hoon Kang, assistant research professor of mechanical engineering.

LIPPS can also be "programmed" to vary in stiffness levels based on the location and duration of the applied force. And when the force changes or is removed, the material resets and can be reshaped to adapt to a new stress pattern.

The team envisions applications across multiple fields, including soft robotics, vehicles, infrastructure, and medical devices.

— JONATHAN DEUTSCHMAN

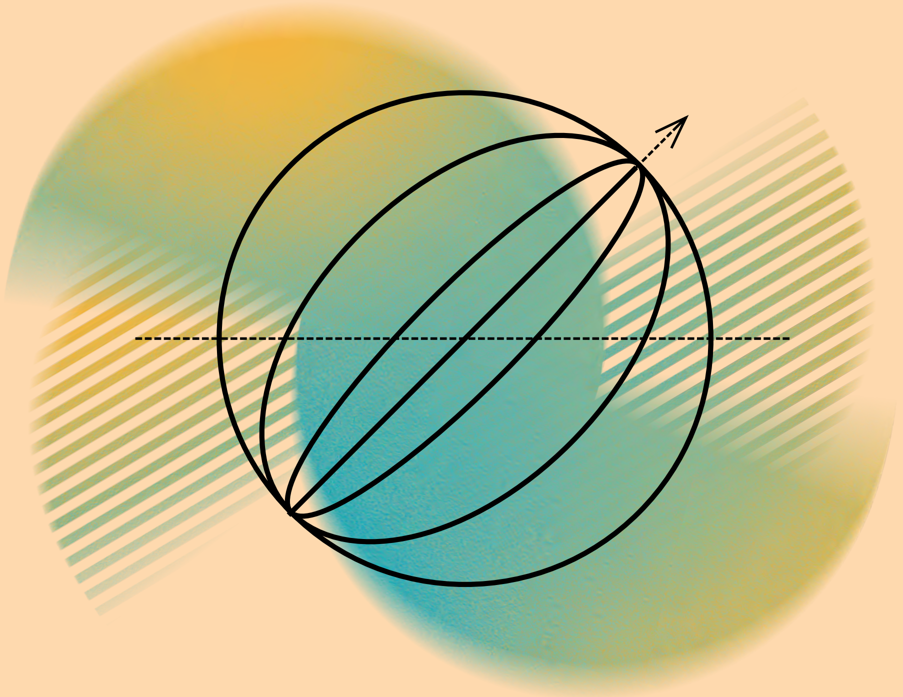
Totally Tubular Science

Nestled deep within the human abdomen, the fallopian tube is a complex and delicate structure—key to fertility, yet difficult to study outside the body. Now, Johns Hopkins engineers have grown one in the lab. The first-of-its-kind model closely mimics the real thing, offering researchers a new tool to study ovarian cancer, gynecological diseases, and fertility challenges with greater accuracy than ever before.

"This powerful and accurate model will let us understand infertility and cancer development better, test new treatments and potentially apply our methods to create models of other organs," said team member Denis Wirtz, Theophilus Halley Smoot Professor of chemical and biomolecular engineering and a core researcher at the Institute for NanoBioTechnology.

This research appeared in *Science Advances*.

— LISA ERCOLANO



Balancing Act

Maintaining balance and coordinating movement is a central challenge for the brain and one that allows us to navigate our daily lives. Much of this happens in the cerebellum region, an area in the back of the brain, where disruptions to this complex process can cause anything from dizzy spells to more serious balance issues like ataxia.

In a study published in *Current Biology*, Johns Hopkins researchers discovered that individual neurons in the cerebellum's nodulus/uvula region combine proprioception (body position) and vestibular (balance) input to help us stay steady and upright relative to gravity even as we move around.

These findings could pave the way for new therapeutics and neuroprosthetics for people with balance and movement disorders, notes senior author Kathleen Cullen, the Raj and Neera Singh Professor of Biomedical Engineering.

"Our work provides new insight into the neural computations that stabilize gaze and maintain balance and posture relative to gravity, processes that are vital for our mobility and independence," says Cullen, who conducted the study with postdoctoral fellows Robyn L. Mildren and Lex J. Gómez.

To better understand the processing performed by the cerebellum, Cullen's team, working with animal models, zeroed in on Purkinje cells, the major output neuron of the cerebellum in primates. In the lab, researchers recorded the cells' activity when exposed to vestibular and proprioceptive stimulation, such as turning the head.

They discovered that Purkinje cells integrate both types of sensory information, returning to ensure accurate postural neural commands are sent to control our muscles whenever the head and/or body moves. Overall, the researchers demonstrated that groups of Purkinje cells "work together" to send more precise signals to other brain regions about the body's overall position and movement relative to Earth's gravity.

The researchers say this discovery provides a clearer picture of why the brain is so good at quickly adjusting to keep bodies balanced and upright in everyday life.

"Unlike earlier studies that focused on one sensory modality and single channel recordings, our approach demonstrates, for the first time, the real-time synergy between two streams of sensory input, and how together they stabilize posture and maintain accurate spatial orientation relative to gravity," says Cullen.

— CATHERINE GRAHAM

CITED

"All it takes is one seed to start a revolution."

Michael Schatz, Bloomberg Distinguished Professor (Computer Science), on a study that discovered genes that control how large tomatoes and eggplants can grow. The findings, published in *Nature*, could enable greater agricultural variety and heartier crops.

"It's like asking a car to stop every time you want to change the song on the radio."

Jochen Mueller (Civil and Systems Engineering) describes the inefficiencies of G-code, the traditional 3D printing control method that forces printers to pause constantly as they process each instruction. Mueller and team developed T-code, which allows for continuous smooth printing—even while mixing materials or changing nozzle shape. Their work is detailed in *Nature Communications*.

"Our work brings us closer to equipping medical robots with the intelligence needed to assist in complex surgical tasks."

Anqi "Angie" Liu (Computer Science) on how she and her team are advancing robotic-assisted surgery with their simulation platform, SurgicAI, a program they developed by training the da Vinci robotic system to suture by breaking the process down into smaller, more manageable skills. Their work was presented at the Thirty-Eighth Annual Conference on Neural Information Processing Systems late last year.

"Our platform can test 96 different electrolyte mixtures in just three hours—a process that would normally take a full day. That's eight times faster."

Dian-Zhao Lin, postdoctoral fellow (Chemical and Biomolecular Engineering), on his team's creation of an automated platform that could speed up the search for better batteries. Their results appeared in *Science Advances*.

Face-to-Face with AI

In a high-stakes poker game, reading subtle facial cues to know when your opponent is bluffing can mean the difference between walking away with the pot or going home empty-handed.

But for AI, decoding such nuanced facial cues remains challenging, whether for identity verification, emotion analysis, or facial recognition.

Enter FaceXBench, a comprehensive system designed by Johns Hopkins engineers to assess and improve how multimodal large language models (MLLMs) interpret and analyze faces.

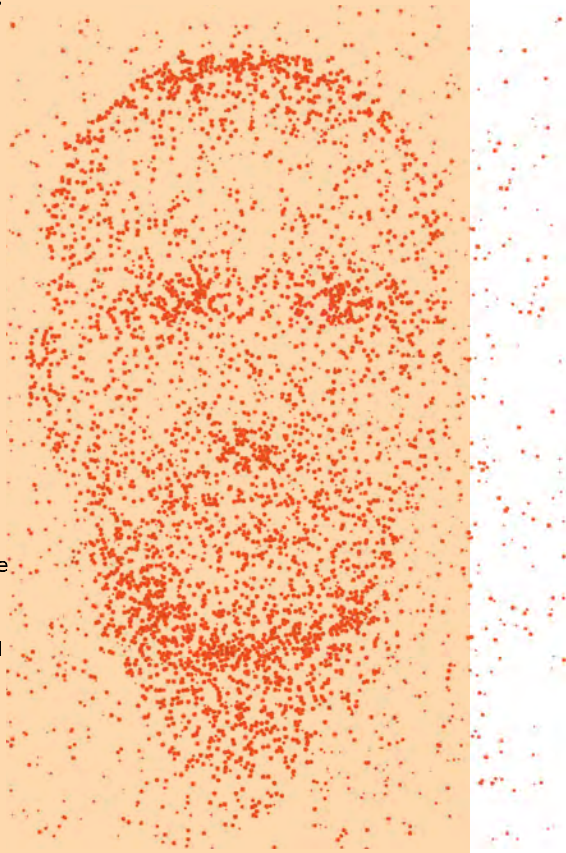
"FaceXBench evaluates MLLMs across 14 tasks in six key areas," says co-author Vishal Patel, an associate professor of electrical and computer engineering.

The system tests fairness across demographics, face recognition capabilities, authentication security, crowd counting, and head position estimation—crucial for accurate face recognition in real-world settings where people may not be positioned in full view of the camera.

It also evaluates how well models detect deepfakes and prevent spoofing—attempts to trick an AI system into using fake videos, images, or masks to impersonate someone.

Initial testing of 26 open-source models and two proprietary ones (GPT-4o and GeminiPro 1.5) revealed significant performance gaps, with even the most advanced AI models having difficulty spotting deepfakes and counting people in crowds. Models also sometimes produced inconsistent results across different demographic groups, indicating variability in performance.

To address these challenges, the team proposes expanding training data, using face-processing APIs, and developing techniques to improve consistency.



"By identifying these weaknesses and offering a structured path for improvement, FaceXBench lays the foundation for advanced, ethically responsible, and highly accurate face-understanding capabilities in MLLMs," says co-author Vibashan VS, a PhD student in electrical and computer engineering. The team's findings were posted on the preprint site arXiv.

— DINO LENCIONI

QUIZ ME

Reducing Epilepsy Misdiagnosis

Diagnosing epilepsy is challenging—there's no single definitive test, and conditions like migraines and panic attacks can mimic its symptoms. Since early diagnosis leads to faster treatment and better outcomes, a more accurate test could improve millions of lives every year.

Biomedical engineer Sri Sarma and her team have developed EpiScalp, a new diagnostic tool that could be a game-changer.

TAKE OUR QUIZ TO LEARN MORE

What percentage of epilepsy tests result in false positives?

A. 15%

B. 30%

C. 65%

Answer: B
False positives occur in about 30% of cases globally, leading to unnecessary treatments, medication side effects, driving restrictions, and reduced quality of life.

While an electroencephalogram (EEG) is the most common way to diagnose epilepsy, interpretation of the test can be subjective and prone to error. Which factors make it challenging to interpret EEG results?

A. EEGs can capture noisy signals, unrelated to epilepsy

B. The number of electrodes used in the EEG can vary

C. A seizure may not occur while the test is being conducted

D. A patient can use mind control to alter the results

Answer: A and C
EpiScalp uses dynamic network models to detect epilepsy markers even in seemingly normal EEGs—leading to faster, more accurate diagnoses.

What significant improvement did the EpiScalp tool bring to the misdiagnosis rate in the study?

A. It could reduce misdiagnoses by up to 30%

B. It could reduce misdiagnoses by up to 70%

C. It could eliminate false positives entirely

Answer: B
EpiScalp helped reduce false positives significantly by uncovering epilepsy markers in EEGs that initially appeared normal, improving diagnostic accuracy. The study analyzed data from 198 epilepsy patients from five major medical centers: Some 91% of the patients had epilepsy, while the rest had non-epileptic conditions mimicking epilepsy. When Sarma's team reanalyzed the initial EEGs using EpiScalp, the tool ruled out 96% of those false positives, cutting potential misdiagnoses among these cases from 54% to 17%.

INQUIRING MINDS
STUDENT DISCOVERY

ALSO IN THIS SECTION

Research Meets Reality

AN INDUSTRY-ACADEMIA partnership with Amazon gives doctoral fellows funding to pursue their big ideas in AI research.

LEFT: Sanjeev Khudanpur and Drew Prinster

BY KRISTIN HANSON

PHOTOGRAPHY BY WILL KIRK
ILLUSTRATION BY BEATRIZ ORTIZ

During his senior year as an undergraduate at Yale, Drew Prinster completed a global health certificate program. His capstone project focused on the use of AI tools to predict patient diagnoses and improve health care quality. But as he conducted his research, he noticed that there were virtually no guardrails in place guiding the development of these tools. Unlike with pharmaceuticals and medical equipment, there has been very little government policy or wider consensus on standards to ensure the safety and security of AI deployments in health care.

"My optimism for AI's potential in health care shifted toward prioritizing the question, 'How do we ensure responsible deployments of this technology in the health care field?'" Prinster recalls.

Now a fourth-year PhD student in computer science at Johns Hopkins, Prinster is still addressing questions about the safe use of AI in health care. Those questions are central to his work as a doctoral fellow in the JHU + Amazon Initiative for Interactive AI (AI2AI). The Whiting School program, which launched in 2022, is a novel industry-academia partnership designed to advance technologies in machine learning, computer vision, natural language understanding, and speech processing.

Amazon has a longstanding relationship with the Whiting School, says Sanjeev Khudanpur, director of the AI2AI program and an associate professor of electrical and computer engineering. The company has collaborated with the school's faculty for well more than a decade. Khudanpur himself worked on the speech recognition functionality that eventually went into the Amazon Echo.

"[AI2AI] took those one-off interactions and formalized them into a program where two things happen: They bring us interesting problems for us to work on, and we use our ideas and thinking to solve problems and do research that they can't always pursue," says Khudanpur, who also directs the Center for Language and Speech Processing.

This partnership is especially timely, as securing diverse funding for large-scale academic research programs is increasingly important. Industry investment plays a vital role in developing the ideas that will shape the way we live and work with AI—and the people who will make those discoveries.

Central to the program are the AI2AI doctoral fellowships, which provide a year of funding for Whiting School doctoral students like Prinster. To apply, PhD students write a research statement that summarizes their AI focus area. While successful applications usually correlate with one of Amazon's research interests, the fellow's research remains self-directed. Each fellow is matched with an Amazon liaison, a company scientist who provides feedback and ideas, and they are encouraged to collaborate over the course of the fellowship.

In Prinster's project, conversations with his Amazon liaison helped him consider additional use cases for his research, inspiring him to expand from AI deployment reliability in health care to monitoring large language models (LLMs) to detect potentially dangerous outputs. His original research statement focused on the "uncertainty quantification" component of AI—how the system can flag for an end user (say, a doctor) when the system's predictions are potentially less reliable or trustworthy. After discussions with his Amazon liaison, he's widened his research scope to include notifying a system administrator or regulator when illicit content or threats appear in chatbots.

"If you had an LLM, you may want to review the prompts given to it by users, as well as the output text generated, to detect things like hate speech, misinformation, or certain agreed-

"They bring us interesting problems for us to work on, and we use our ideas and thinking to solve problems and do research that they can't always pursue."
Sanjeev Khudanpur

upon generated text that could be harmful to users, to flag that for an administrator to determine when they need to intervene," Prinster explains. Because of the significant privacy implications of analyzing prompts, review of user input must be conducted in a way that ensures both user privacy and data security. Robust anonymization techniques, clear data handling policies, and even user consent mechanisms could help mitigate these risks.

A WIDER VIEW OF AI RESEARCH

Amazon benefits from the interaction with the students, too. For one, Khudanpur says, collaborating with the AI2AI fellows can help Amazon scientists make valuable and direct connections to research happening in the academic AI community, offering them fresh perspectives that complement their product development work.

Aparna Khare, a principal applied scientist at Amazon, is a three-time AI2AI liaison. She says mentoring younger scientists is fulfilling and intellectually stimulating.

"I like that I'm able to look at something with the fellows from a pure research point of view and to advance the idea without the immediate considerations of product integration," she says.

"Of course, in industry, you want to build products and new technologies that directly address customer needs and solve some of the world's most challenging problems. This drive to create impactful solutions often leads us to explore fundamental questions that can unlock even greater innovations. This type of program is incredibly valuable in ensuring we make progress both in delivering for our customers today and in advancing the foundational knowledge that will shape the future."

> **"I like that I'm able to look at something with the fellows from a pure research point of view and to advance the idea without the immediate considerations of product integration."**
> Aparna Khare

DEVELOPING A MINDSET FOR INDUSTRY

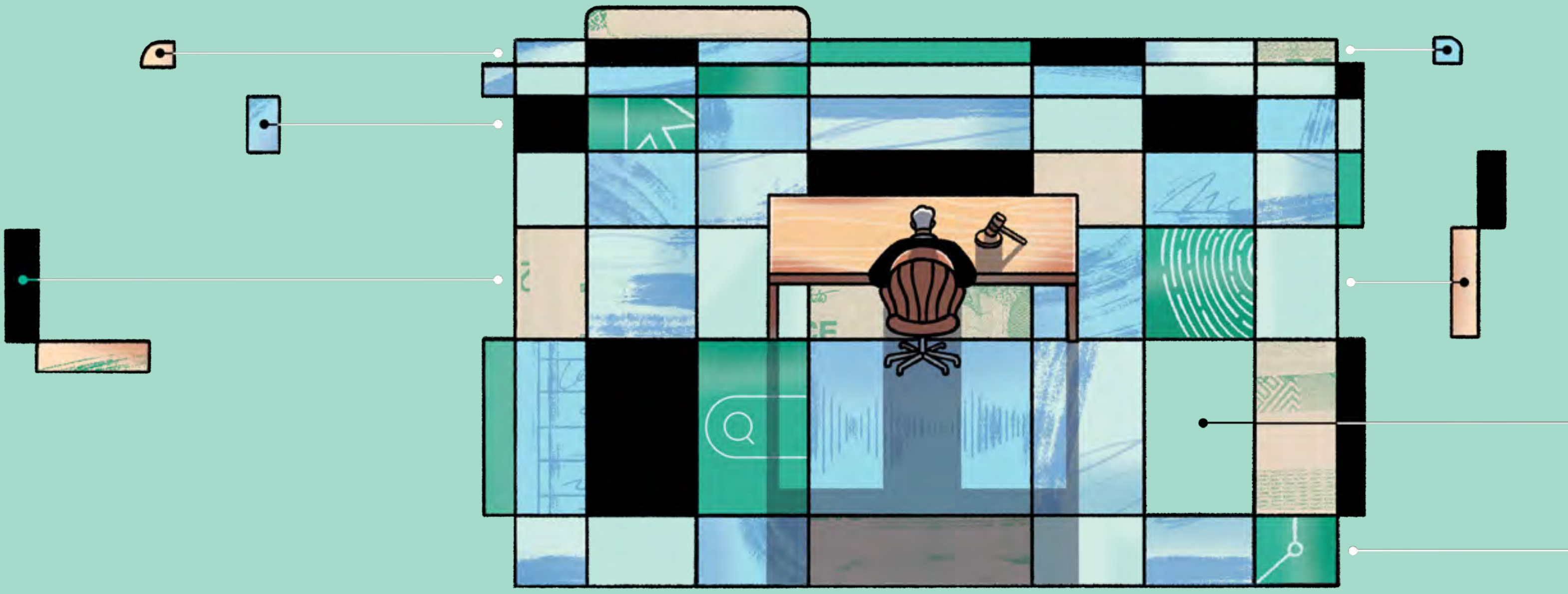
For former AI2AI fellows, the experience has proven a valuable bridge to careers in the commercial sector. Xuan Zhang, Engr '24 (PhD), a 2023-24 AI2AI fellow, transitioned to industry shortly after completing her PhD in computer science. During her fellowship, she worked to reduce the communication gap between the Deaf and hearing worlds by researching sign language recognition and translation tasks. Her aim was to develop a large vision-language model capable of translating signed words into spoken language.

Now she's applying her research to the development of AI-enabled smart glasses. Currently, the translation technology behind such glasses focuses on audio-to-audio translation. But Zhang sees great potential in the technology to extend to sign language. People may one day be able to don their smart glasses, look toward a sign language speaker, and instantly hear an audio translation.

Zhang says that working with her Amazon liaison helped her gain critical insights into data scaling and real-world applications for her research, as well as legal and licensing considerations. "AI2AI helped me learn how to translate between the two worlds of academia and industry," she adds.

As AI2AI nears the end of its third year, Johns Hopkins and Amazon have built a successful model for academia-industry partnerships.

"While the translation of academic ideas into real-world applications is one important outcome, industry's role in investing back into research is equally critical," Khudanpur says. "Advancing knowledge is a shared endeavor, and contributions from all sectors, including industry, are essential for progress."



CHANGE AGENTS

Wiser Counsel for Public Defenders

In the United States, the Sixth Amendment protects the right to legal counsel in criminal prosecutions, but for many Americans, hiring a private defense attorney is financially prohibitive. Nearly 90% of federal defendants rely on public defenders, who juggle overwhelming caseloads, making it difficult to provide each client with adequate time and attention. As a result, many defendants accept plea deals even when better legal strategies exist.

Iris Gupta witnessed the strain on the system during her 2022 summer internship in the juvenile division of the Maryland Office of the Public Defender in Baltimore. There, she saw attorneys receive cases just days before trial, leaving minimal time to interview witnesses, meet clients, and build a strong defense.

With each case came mountains of discovery documents—photos, videos, transcripts, medical records—yet the office relied on manual methods to process them. "They were printing and sorting hundreds of thousands of pages by hand," she recalls. As a computer science and economics major at Johns Hopkins, Gupta realized that AI could be a game-changer for public defenders and their clients.

Now a Whiting School senior with law school aspirations, Gupta is founder and CEO of CounselAI, a digital discovery tool she developed with fellow computer scientist Atharva Barve, the company's chief technology officer. After about a year of working closely with public defenders to refine the platform, they began beta testing.

To navigate the business side, Gupta connected with Xavier Indeglia, Bus '24 (MS), through the Pava Marie LaPere Center for Entrepreneurship in fall 2024. A Hopkins graduate with a master's degree in health care management, Indeglia now serves as chief operating officer, overseeing financial planning, capitalization, and customer outreach.

CounselAI allows attorneys to create AI-powered case folders where they can upload raw discovery materials. Built on Amazon Web Services, the secure platform automatically identifies and organizes documents, summarizes key details, and enables users to pinpoint critical evidence. It transcribes audio, describes images, and extracts text from handwritten notes and scanned PDFs.

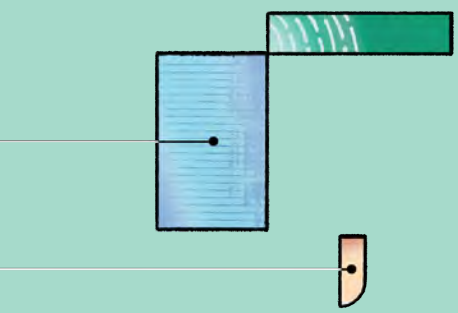
Unlike ChatGPT and other generative AI models, CounselAI employs extractive summarization, meaning it only pulls information from uploaded discovery materials, preventing hallucinations and ensuring data security. A chatbot feature enables users to ask questions of the database in natural language and cites original sources for transparency.

Gupta says that support from Johns Hopkins and the Pava Center has been instrumental in CounselAI's growth. In 2024, the team won the $20,000 Singhal Family Entrepreneurship Award, which funds student-run software ventures. A collaboration between the Department of Computer Science and the Pava Center, the award also includes mentorship and networking opportunities.

"The grant has been extremely helpful to us," says Gupta, noting that the funds helped cover critical production and software development costs, including the ability to pay Barve and a team of three software development interns for their work. "Now that we're beta testing, there's a need to make a lot of rapid iterations," she says. "Being able to afford a team of developers on-deck allows us to respond to feedback within a day or two."

“We are principally a social venture, inspired by the goal of equitable defense.”

Iris Gupta, founder and CEO of CounselAI



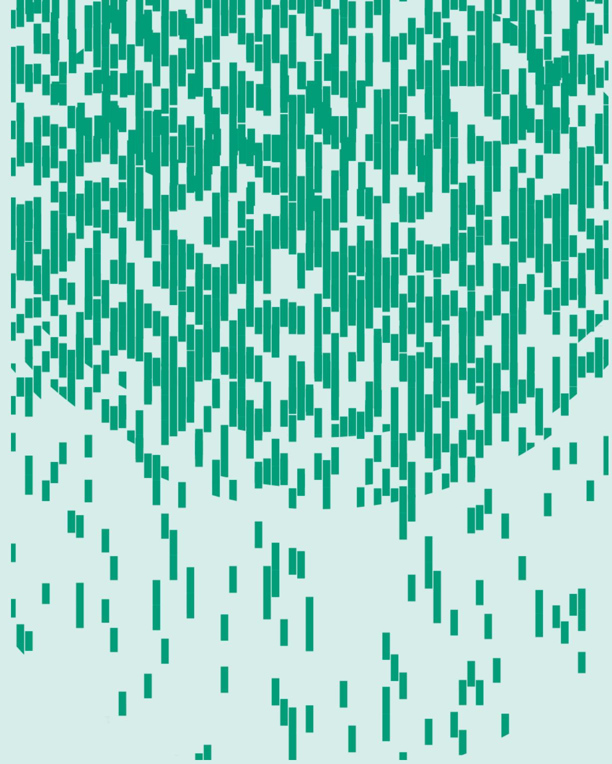
In addition to the Singhal Family award, CounselAI secured $5,000 in funding at the Pava Center’s Fall 2023 Fuel Demo Day, a student venture accelerator competition, as well as $25,000 from Texas Christian University’s Values and Ventures competition.

CounselAI is currently in beta testing with 20 law firms, with the team refining its platform ahead of a planned launch early this summer. The team is prioritizing accessibility for public defenders and small criminal defense firms before scaling to private and corporate firms. “We are principally a social venture, inspired by the goal of equitable defense,” says Gupta.

With a flexible pricing model designed to support attorneys with budget constraints, CounselAI is poised to transform legal representation for those who need it most.

— ERIN D. LEWIS

ROHAN MCDONALD



Speeding the Fight Against Chemical Weapons

To destroy chemical weapons, scientists first need to understand how these hazardous substances break down. Using safer substitutes, Johns Hopkins materials scientists have developed a way to use advanced imaging technology to track the decomposition of surrogate chemicals in real time—a step toward effective protection from these deadly agents.

Their Polygonal Rotating Mirror Infrared Spectrometer, or PRiMIRS, can detect changes in the CWA simulant diisopropyl methyl phosphonate (DIMP) within milliseconds of exposure to combusting metal powders that produce heat. Their findings appear in the *Review of Scientific Instruments*.

“Neutralizing DIMP with metallic powders happens in less than a second, so we needed to develop a system that could measure very quickly,” says team member Preetom “Ruku” Borah, a graduate student. “Our spectrometer captures information more than a thousand times per second.”

Under the guidance of advisor Tim Weihs, professor of materials science and engineering and director of the Materials Science in Extreme Environments University Research Alliance, Borah and colleagues designed PRiMIRS to track molecular changes in infrared light. They do this by reflecting the light off a series of mirrors to capture rapid decomposition in real time. A polygonal rotating mirror moving at 33,000 rotations per minute allows for precise wavelength separation, revealing DIMP’s breakdown.

The fully customizable system can be adapted to study other chemical agents.

— CONNER ALLEN

Sniffing Out Smell Dysfunction

Whether it’s the aroma of the salty ocean or a pie baking in the oven, smells have the power to improve mood, trigger memories, and alert us to potential danger. In fact, our sense of smell is so vital that its loss can be a clue that something has gone wrong in the body.

ScentCare, a new invention from Johns Hopkins biomedical engineering students, could help clinicians detect and treat smell dysfunction earlier. It includes a cylinder case with scented inhaler cartridges and an app to guide users through smell testing and retraining—a simple approach that doesn’t require expensive equipment or fine motor skills.

“There is no device on the market that does both testing and retraining,” says team member Mili Ramani, a biomedical engineering major.

Ramani and classmate Angela Sadlowski started the project in the Department of Biomedical Engineering’s Design Team Health-Tech Project course.

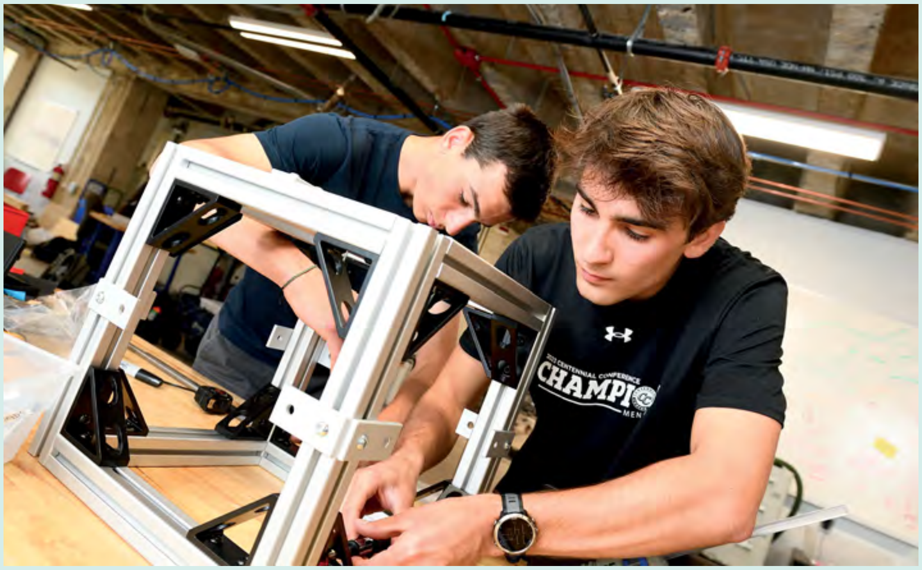
Smell is typically assessed with the scratch-and-sniff University of Pennsylvania Smell Identification Test (UPSIT), but isn’t part of routine health screenings. The inventors say ScentCare could detect early signs of conditions like Alzheimer’s or COVID-19, while its training technique could help patients regain their sense of smell.

ScentCare simplifies smell training: Users sniff inhalers and identify scents like citrus or herbal. The team aims to bring ScentCare into clinics and homes, with testing and patent applications underway.

The students are mentored by Constanza Miranda, an associate teaching professor in biomedical engineering, and Nicholas Rowan, an associate professor of otolaryngology.

The team included Elaine Zhao and Eva Loftus, undergraduates in computer science and mechanical engineering.

— CATHERINE GRAHAM



Grinding It Out

Crushing asteroid rock into dust wasn't the hard part. Figuring out how to do it in zero gravity was.

"The first month of our project, we looked at all of these crushing mechanisms that work on Earth—and basically had to throw them out," says Jonik Surprenant, one of four Johns Hopkins mechanical engineering seniors behind the student design "Asteroid Grinder" project. "They don't work in space."

Surprenant and classmates Jacob Hammond, Grace Nockolds, and Zahari Stoimenov are developing a prototype device that could one day support construction in space for deeper explorations. Their senior design project is backed by Karman+, a young aerospace company focused on mining asteroids for raw materials.

The students' challenge: Build a compact, energy-efficient device designed to work aboard a spacecraft, pulverizing asteroid rocks—known as regolith—into fine, uniform powder. That powder could be transformed into satellite fuel, building materials, or solar panel components—avoiding the high cost and energy-intensive process of hauling raw materials from Earth.

Once the realm of science fiction, asteroid mining is edging closer to reality. NASA and Japan's space agency have already returned samples from asteroids, and commercial missions aren't far behind. Karman+ plans to launch its first mission in 2027 to collect raw materials from asteroids, with later missions aiming to process the regolith onboard the spacecraft itself.

"As a company, we aim to deliver asteroid regolith to supply the space economy," says Jesse Miller, Engr '18, who now works as an engineer at Karman+ and has advised the students throughout the project. "But first, we need to grind it—and that's where this project at Hopkins comes in."

The students' design, which they've nicknamed "Wall-E," is a foot-long cube, a system of spinning blades and mechanical pressure that pushes asteroid rocks through the machine without relying on gravity. Regolith enters through a compact accordion-style "gateway," then feeds into a spinning grinder inspired by an ice shaver. The resulting dust is sieved and stored, ready for future use.

One of the team's most inventive ideas was designing a three-axis rotating frame that simulates the chaos of a microgravity environment. "That was one of the defining moments for me," says Rich Bauernschub, who co-leads the mechanical engineering senior design course. "They had this eureka sort of presentation."

The device isn't meant to fly just yet, but Karman+ expects it to directly inform the version they hope to launch on their future asteroid missions. For the company, it's valuable research bringing them closer to a final design. For the students—who are all busy varsity athletes—it's hands-on, high-stakes engineering work.

"We're not just building a gadget—we're defining a process," says Nockolds. "It's real engineering, with a real client, working on something no one's done before."

Miller says that returning as a mentor has been a full-circle moment. "I remember my own senior design project as the most valuable experience of my time at Hopkins," he says. "It's just awesome to watch this team work."

— KATIE PEARCE

COURSE AUDIT

When the Going Gets Tough

Engineering education is often about the nuts and bolts of how to make things work. But what happens when they don't? In Technical Leadership in Times of Crisis, James Bellingham, Bloomberg Distinguished Professor of exploration robotics, aims to expose Hopkins engineering students to possible crisis management scenarios by exploring historical catastrophes. Having spent most of his career outside academia, Bellingham has seen firsthand how companies handle small and large setbacks, and he brings this expertise to the unique first-year seminar.

KEY TAKEAWAYS

PUTTING 'WHAT-IF?' INTO PRACTICE
Students are presented with a notable real-life occurrence (such as the 1982 Tylenol cyanide poisoning case) and split into three groups—financial, public relations, and executive—to develop crisis management plans, considering ethical practices as well. After the teams make their cases and the executive group decides on a plan of action, Bellingham reveals what actually transpired.

BEING A CONSCIENTIOUS EMPLOYEE
In addition to discussing the financial or technical ramifications of their decisions, students also consider how those decisions affect the intangible element of public goodwill. "For massive companies, their biggest asset is brand trust," Bellingham says. "Should you be driven by the quarterly report, or should you be thinking in the longer term?"

WORDS FROM THE WISE
The students also hear from people with real-world experience: a doctor who managed an Ebola outbreak, a journalist who had to vet information and determine whether it was true or false, and the CEO of a Fortune 500 company. Assigned readings include *Principles* by hedge fund manager Ray Dialo and a guide to avoiding confirmation bias written by an intelligence analyst.

— JONATHAN DEUTSCHMAN

"I chose it because it looked like it had a lot of interesting historical components. Covering Apollo 13 and Chernobyl was very intriguing."

Miles Qvale, materials science and engineering

"Later in their careers, engineers often become engineering managers, so I wanted to hear from a leadership perspective."

Eitan Rosenblatt, mechanical engineering

"What kind of company do you want to work for? What values would you be attracted to?"

Instructor James Bellingham, executive director of the Johns Hopkins Institute for Assured Autonomy

KATHLEEN FU

Plankton Power

Generating electricity from dissolved organic matter.

BY DAVE KIEFABER

Thirty feet below the ocean's surface, a revolution is underway. Ocean sensors—vital for measuring water conditions and tracking changes in the marine environment—are stuck in a high-cost, high-risk cycle of battery replacement. But what if these devices could power themselves using the ocean's own resources?

That's what Ruggero Rossi, assistant professor of environmental health and engineering, is working on: generating electricity from the seawater's microscopic biomass by turning dissolved organic matter, plankton, and algae into energy that could power the sensors while reducing their cost and reliance on traditional energy sources.

"This is a complicated project. Nothing similar has been attempted before," says Rossi, who previously scaled up a device to convert organic waste into electricity, but in accessible wastewater treatment plants, not under 30 feet of seawater.

The upgraded sensor design will consist of three parts: a filter, similar to fish gills, to collect biomass; a fermenter to break it down into organic acids; and a microbial fuel cell to transform those acids into electricity.

Rossi's team is working on the fuel cell reactor, optimizing energy output. The goal is to generate 0.01 kW of energy—enough to charge a cell phone—while maintaining its current weight and size.

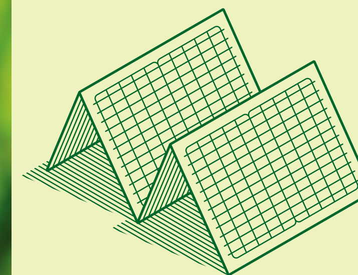
Precise placement is key for effective testing, Rossi says. Too deep, and the cell lacks oxygen; too shallow, and it lacks biomass. The first prototype will be deployed off the coast of Lewes, Delaware.

While the proposed cell design has no precedent in any project of this scale, Rossi is optimistic about the cell's potential. "If we can optimize this process, the possibilities are as vast as the ocean itself," he says.

Researchers from James Madison University, Harvard, the University of Maryland, the University of Delaware, and private industry are partners in the two-year effort with support from the Defense Advanced Research Projects Agency.

“If we can optimize this process, the possibilities are as vast as the ocean itself.”

Ruggero Rossi



0.01 kW

The Hopkins team aims to optimize energy output of each fuel cell reactor, generating 0.01 kW—the equivalent of what a handheld solar panel generates in direct sunlight.

1 million

A liter of ordinary seawater contains up to 1 million phytoplankton cells, along with algae and dissolved organic matter. Together, they are part of the oceans’ 700 billion tons of dissolved organic carbon—a rich potential source of mostly untapped biological energy.

LINE ART: CHRIS PHILPOT

HOT STUFF

SAFIR STRUCTURES

By better understanding heat transfer, Thomas Gernay is making structures **SAFIR**.

BY POORNIMA APTE
ILLUSTRATION BY SEAN & EVE


FIRE

On June 11, 2023, a tanker truck carrying gasoline caught fire on I-95 near Philadelphia. The incident caused the highway's northbound lanes to collapse and significantly damaged the southbound section. Four years earlier, in Auckland, New Zealand, a fire damaged part of a new convention center under construction but the government was able to salvage many of the steel roofs.

Insights gained from SAFIR, a computer program that models the behavior of engineering structures subjected to fire, played a crucial role in responses to both events. Co-developed by Thomas Gernay, Johns Hopkins associate professor of civil and systems engineering, SAFIR has been used for everything from postmortem analysis of disasters like the Philadelphia bridge and New Zealand convention center fires to the design of the roof of the Paris 2024 Olympics Aquatic Centre.

SAFIR—the name is a compression of "safety" and "fire"—is a software program that analyzes structures' behavior when they are on fire. It allows structural fire engineers to evaluate heat transfer that determines how the structure's temperature will increase in the case of fire and to study the mechanics at play.

With more than 300 global users in academia and industry, the product has a devoted following in its niche. SAFIR Day, an online event that Gernay hosts each fall, welcomes about 100 attendees from all over the world who share use cases for the software and learn best practices.

"As structural engineers, we have the responsibility to design safe and resilient built environments. In doing so, we need to think about extreme events that could destroy these structures, and fire is one of these hazards that we cannot fully control," says Gernay. A go-to expert for media outlets in the aftermath of devastating fires, such as the one that damaged the Notre Dame Cathedral of Paris in 2019, Gernay says his goal with SAFIR is to help structural engineers design buildings that can withstand fire—or at least not spread it.

The software relies on the use of finite element analysis, which dices a structure into discrete linked elements and then models the behavior of each in reaction to its environment. Splitting a structure into discrete parts allows for more precision and the study of non-uniform forces as opposed to treating the entirety as a "lumped mass" solution. "If you don't discretize, the models become very coarse and may not lead to precise solutions," says Spencer Quiel, associate chair and associate professor of structural engineering at Lehigh University.

Thomas Gernay, Johns Hopkins associate professor of civil and systems engineering

Quiel used SAFIR to analyze the I-95 collapse for the Pennsylvania Department of Transportation (DOT). He zeroed in on evaluating the highway's girders' response to the fire, with SAFIR delivering a model that correctly predicted the damage to the north and southbound lanes. The DOT can now use the model to predict the behavior of the state's other highways under fire stress.

"As structural engineers, we have the responsibility to design safe and resilient built environments."

Thomas Gernay

THE ORIGINS OF SAFIR

Gernay's passion for structural fire engineering research began during his student days at Liège University in Belgium, where he received his doctorate. His advisor, Professor Jean-Marc Franssen, began building SAFIR in the 1990s.

For his doctoral thesis, Gernay wanted to develop a model to simulate how concrete behaves when it is exposed to fire. Even though concrete doesn't burn, it loses strength and deforms at elevated temperatures. By the time Gernay completed his PhD in 2012, he had added significantly to SAFIR's code.

SAFIR has gathered momentum since, with both Gernay and Franssen adding to its strengths. Among the newer capabilities: pre- and post-processors that enable users to bypass extensive coding; the addition of interfaces with more types of fire models; and various material models, including timber and novel types of steels.

Creating a numerical model using SAFIR and validating it through laboratory fire testing enables engineers to ensure that the software accurately represents elevated temperature structural behavior. Once validated, the numerical model can be used to evaluate fire resistance for a specific structure under various conditions.

This approach has been particularly valuable for the BRE Group, says Octavian Lalu, principal fire engineer at the UK-based structural engineering research facility. The team uses SAFIR to assess the fire resistance of historic buildings and evaluate their compliance with modern building codes. Since in-situ testing is complex and expensive, scenario-based numerical modeling of fire effects with SAFIR provides a practical, cost-effective alternative. Using SAFIR, the BRE Group has evaluated the safety of several historic landmarks in the UK—including Admiralty Arch, Manchester Town Hall, and the Natural History Museum, among many others—to determine whether existing fire resistance meets regulation or whether remedial solutions (additional protection) may be needed.

Another advantage of SAFIR is that it facilitates getting buy-in from multiple parties like investors, government officials, and contractors, which is key for industry projects, says Jeremy Chang, technical director at Holmes Aus & NZ, a structural and fire engineering firm headquartered in New Zealand.

"The greater the number of user-defined variables, the more parameters you have to negotiate and the longer the discussions take," Chang says. Because SAFIR has key data—like material strength and deformation and more—built-in, those validated parameters need not be reverified, shortening project approval times. Chang turned to SAFIR in the wake of the convention center fire in New Zealand, ultimately finding most of the structure's remaining steel members were salvageable.

In addition to using SAFIR for conducting postmortem analysis after fires, both industry players like Holmes Aus & NZ and academia use the software to provide fire safety recommendations for structures. For example, engineer Kevin Mueller at global structural engineering firm Thornton Tomasetti used the software to predict the behavior of an airport frontage road in response to a potential tanker truck fuel fire. A service corridor snaked through the lower level of the road, so the project's goal was to ensure the front-end road structure would survive a fire.

Such assessments are necessary because "understanding risk is the first step in mitigating it and if we don't understand risk, we won't know where to put resources," Quiel says.

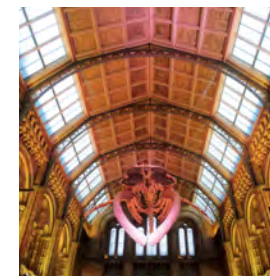
THE FUTURE WITH SAFIR

Gernay also notes that evolving trends in structure design and materials could introduce unexpected fire risks. The growing popularity of mass timber (in some cases wood is considered a renewable resource) or the use of lithium-ion batteries in data centers, for example, might change the way fire could develop in buildings. New modular constructions have connections that could be weak points for fire.

Negar Elhami-Khorasani, associate professor in the Department of Civil, Structural and Environmental Engineering at the University at Buffalo, has been researching wildfires, including those that ravaged LA in January 2025. She says SAFIR could be used for the evaluation of urban structures affected by such disasters. The results could inform the design of buildings and structures more resistant to fires. It is an interesting use case for SAFIR because most structural fire modeling assumes the fire originates from within, not outside the structure.

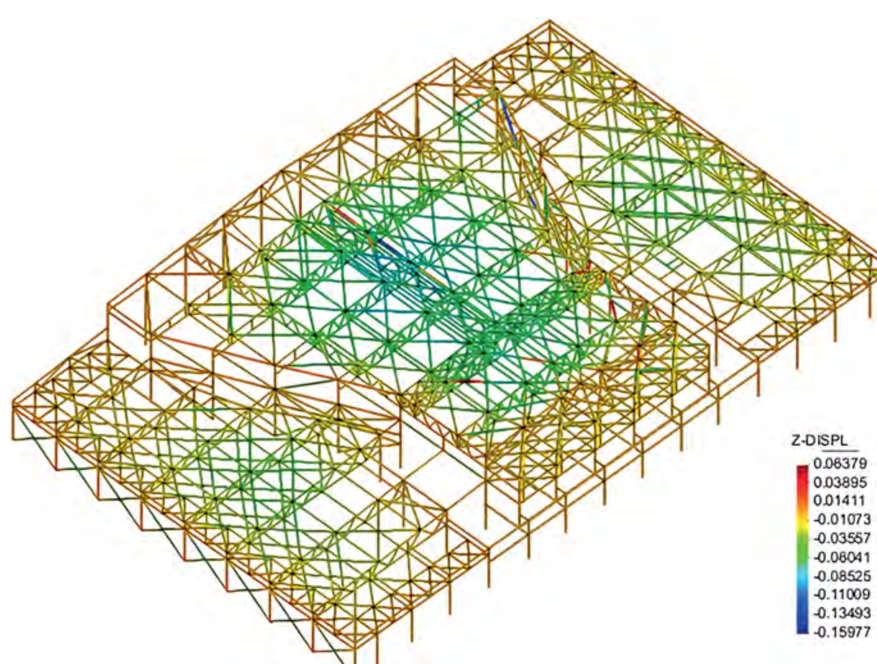
"As we see [an] evolution in the built environment, we can use SAFIR to design these facilities to make them safe," Gernay says.

The key, he adds, is that SAFIR enables performance-based design, which focuses on a building's performance outcomes rather than simply on construction provisions without attention to system behavior. "Performance-based design is really how structural engineers can bring value and enable innovation to support changes in the built environment," Gernay says. "SAFIR is a key tool to enable that."



Using SAFIR, the BRE Group has evaluated the safety of several historic landmarks in the UK—including Admiralty Arch (TOP) and the Natural History Museum (ABOVE).

BELOW: A SAFIR-generated model used for postmortem analysis of the New Zealand International Convention Centre.



Putting Tumors on Ice

Cryotherapy brings human-quality care to humankind's best friends.

BY HEATHER LOWE

Bailey Surtees, Engr '17, and Clarisse Hu, Engr '17, '19 (MSE), met as biomedical engineering undergraduates and have been working together ever since, founding an award-winning company whose origins go back to their student days.

Kubanda Cryotherapy offers the first minimally invasive treatment for lumps, bumps, and tumors in pets. By adapting cryotherapy, which has been used in human medicine for more than 60 years, their team is bringing human-quality care to humankind's best friends.

The duo's novel CryoNeedle system uses focused, extreme cold to quickly and easily treat tumors, avoiding the need for invasive surgery. After eight years of postgrad research and development, including clinical trials at The Johns Hopkins Hospital, Kubanda is now offering its treatments to veterinary clinics everywhere—enabling legions of families to help their beloved pets skip the scalpel.

Surtees serves as Kubanda's CEO and Hu as CTO. The pair attribute their success to complementary skill sets and an unlikely set of shared experiences.

"There's just an ease between the two of us," says Hu. "We have all these weird connections. I was raised in Shenzhen, China, and Bailey grew up in Oklahoma. It turns out her great-grandmother was raised in China."

"And we were both interested in bioengineering from a young age," adds Surtees. "When I was 12, I had reconstructive work done because I'm deaf in my left ear, which sparked a fascination with the intersection of engineering and biology. Meanwhile, Clarisse grew up with a mom who's an ENT surgeon, which spurred her to spend many years doing research on ear implants."

> "We love that we're able to use our expertise in cryotherapy to expand access to care while developing a sustainable business model to help pets and people everywhere."
> Bailey Surtees

The technology behind Kubanda was originally developed for people, not pets. The idea was born in 2015 as a Department of Biomedical Engineering Design Team project, where Johns Hopkins Medicine clinicians present large-scale biomedical engineering problems for students to take on. In this case, the nine-member team, working with faculty advisor Nicholas Durr, co-director of the undergraduate design team program, and clinician and then-Director of Breast Imaging Susan Harvey.

The team's initial idea was to work toward better diagnoses, but after visiting South Africa to study the issues firsthand, they came to realize a bigger problem was access to treatment after diagnosis. Women living in rural areas often can't make the long journey to a city to receive surgery, chemotherapy, and radiation. The question became: how to increase their survival rate?

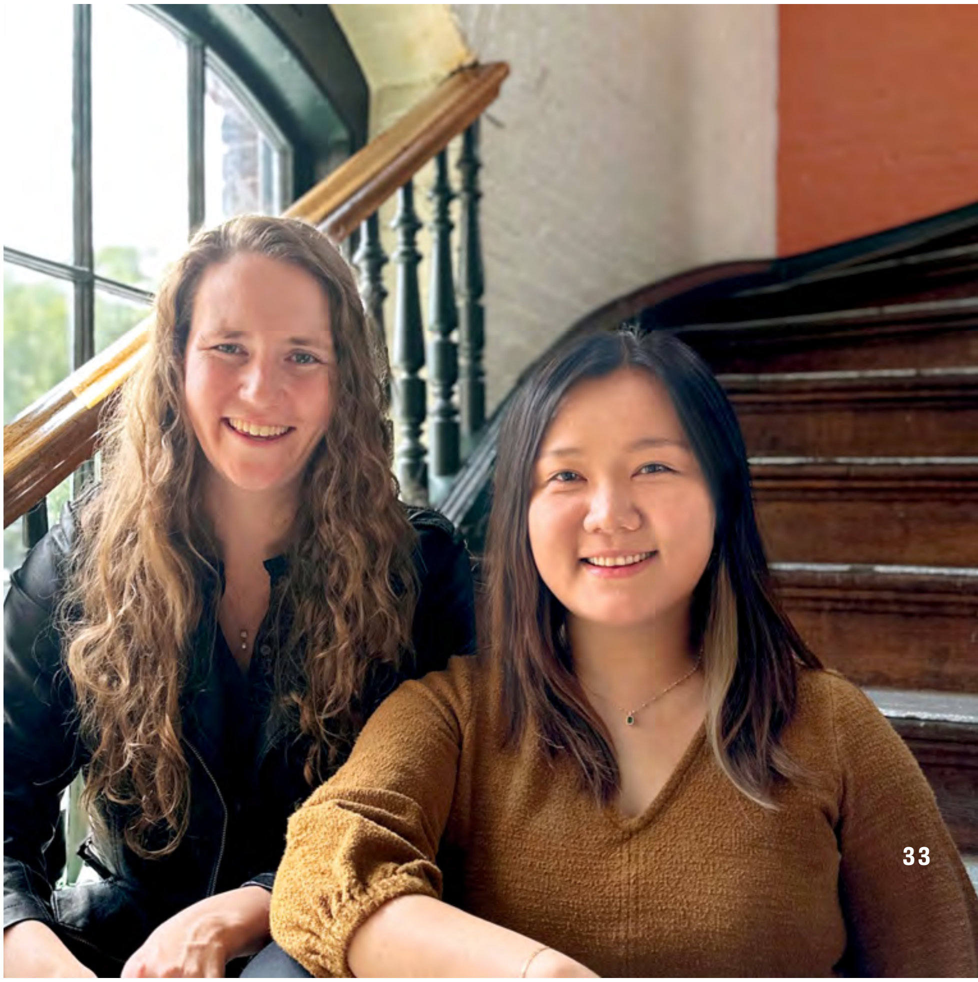
The answer lay in creating a low-cost device that could treat patients locally with a minimally invasive procedure. By freezing the cancer tissue at extremely low temperatures, cryoablation offered a way to do that. But such devices are often prohibitively expensive. The team's innovation was to take a fresh look at the coolant. The typical choice, argon gas, is expensive and difficult to source, while carbon dioxide can be found anywhere that sells Coca-Cola.

The next hurdle was achieving the same cooling power using this less expensive cryogen. The team earned a patent for their process, published papers on its use, and formed a company to continue developing the technology. In tribute to its South African origins, its name comes from the Zulu word for cold—Kubanda.

The pivot from people to pets came when Surtees and Hu saw that the veterinary market faced the same paradox they observed in South Africa: While diagnosis is easier than ever before, treatment remains out of reach for the majority of families. They realized that applying their technology in the veterinary space could serve as a beachhead before expanding into large animals and human medicine—allowing the pair to quickly commercialize the technology while de-risking future growth.

"In fact, our commercial success has accelerated the timeline to use in human medicine," says Surtees. "We love that we're able to use our expertise in cryotherapy to expand access to care while developing a sustainable business model to help pets and people everywhere."

The world has taken notice, including *Forbes* magazine, which this year bestowed its 30 Under 30 in Science Award on Hu. "We'd been nominated as a pair for many years," says Hu. "This year we won, but Bailey missed the cutoff age by a month. I'm representing us both because she is integral to all of it."



LEFT: Bailey Surtees, Chief executive officer and founder, Kubanda Cryotherapy

RIGHT: Yixin Clarisse Hu, Chief technology officer and founder, Kubanda Cryotherapy

NAOMI GORDON

Looking ahead, their focus is on equity. Surtees and Hu are uncomfortable with the discrepancy between the number of people in need and the advanced technologies only available to high-income patients.

"We have all this innovation, but it's still not reaching the point where it needs to be," says Hu. "Seeing that gap is what convinced the both of us to do something about it ... to be the change we want to see."

"Hopkins taught us that," agrees Surtees. "The ability to think more broadly, expand into different areas of research, and secure the resources that you need to bring your big idea to life. Everything thrives when you have interdisciplinary collaboration and relationships with people who have your back."

FLYING HIGH

United's IT Architect

As a teenager growing up around Frederick, Maryland, Becky Selzer, Engr '15 (MS), got hooked on spy shows like *Alias* and devoured cybercrime books like *The Cuckoo's Egg*. "I was always drawn to high-stakes missions," she laughs.

That intrigue led her to an internship at age 17 through a gifted and talented program—unknowingly setting her on a path toward cybersecurity. "Honestly, I didn't even know what computer science was back then," Selzer says. "But I liked math, I liked solving puzzles—and it turned out I was pretty good at this."

Today, Selzer serves as senior principal architect for IT at United Airlines, where she helps advise the technology organization on cybersecurity strategy across the company's sprawling digital operations. "It's analyzing data, helping people understand how to prioritize different cybersecurity risks, and finding the best ways to make our systems more secure," she says.

Selzer joined United more than a decade ago, following early work in the U.S. intelligence community that began with her teenage internships. Her first year at United was a banner one: She helped start the company's public vulnerability disclosure program and helped steer a high-profile internal investigation effort. That performance earned her a United 100 award, the airline's top employee honor.

Over time, Selzer managed areas including application security and vulnerability management and started the aviation cybersecurity and threat intelligence programs at United. During the pandemic, as the airline made major cuts, Selzer stepped up to support multiple cybersecurity teams simultaneously. "We were in survival mode, just trying to keep the lights on," she recalls. She was then selected as chief of staff for United's chief digital officer, supporting the technology organization's strategic efforts.

While working full time, Selzer earned her master's in computer science in 2015 through Johns Hopkins' Engineering for Professionals program. One class in particular—a deep dive into federal cybersecurity standards—turned out to be unexpectedly useful for her work. "Writing a 70-page paper on NIST standards was certainly challenging for me," she says, "but I was surprised to learn how valuable that knowledge has been in my career."

Selzer has championed women in tech and development programs for the next generation throughout her career. She recently wrapped up a term as chief of staff for United's Women in Technology group and previously helped shape programs for interns, apprentices, and early-career hires. She also volunteers with cybersecurity conferences including Hak4Kidz and the Chicago-based Blue Team Con, where she focuses on expanding access for students and nonprofits. "I want fewer girls to be in the situation I was at 16, not even knowing computer science was an option," she says.

— KATIE PEARCE

> **"It's analyzing data, helping people understand how to prioritize different cybersecurity risks, and finding the best ways to make our systems more secure."**
> Becky Selzer

AN EAGER DISRUPTER

Making AI Accessible

Brandon Duderstadt, Engr '18,'19 (MSE), is not afraid of change—he runs toward it, eager to find opportunities to disrupt existing technologies and explore new frontiers. That attitude led him to co-found Nomic AI, which has produced several of the world's most popular AI products.

"The founding insight of Nomic was that there really needs to be a system that's highly interactive and highly visual that's tailored toward the kind of data sets that go into and come out of AI models," he says. "Today, it's petabytes of unstructured text, images, video, and audio with additional metadata sitting on top of it. So it just felt like a totally different problem that required a totally different kind of paradigm."

Founded in 2021 by Duderstadt and Andriy Mulyar, who interned for Duderstadt at startup Rad AI, Nomic AI is valued at $100 million and was kickstarted by $2 million in venture capital funding in 2022.

The company's products include GPT4All, an open-source tool that enables language models to run on a personal computer or smartphone and became the third-fastest-growing repository ever on GitHub, a cloud-based platform for code collaboration. (By comparison, Twitter's algorithm was No. 2.) In addition, there's Nomic Embed, a suite of open-source models that enable AI personalization through a technology called retrieval augmented generation; and Atlas, the unstructured data engine that powers all of Nomic's models.

A self-described "researcher at heart," Duderstadt says he had a number of foundational experiences that put him on the AI path at Johns Hopkins, where he earned a bachelor's in

> **"The founding insight of Nomic was that there really needs to be a system that's highly interactive and highly visual that's tailored toward the kind of data sets that go into and come out of AI models."**
> Brandon Duderstadt

applied mathematics and statistics and a master's in biomedical engineering. He initially thought he'd work with intelligent prosthetics or computer-integrated surgery, but a class in machine learning opened his eyes to the possibilities in that field.

Changing majors led him to impactful professors such as Carey Priebe, director of the Mathematical Institute for Data Science; Avanti Athreya, associate research professor; and Joshua Vogelstein, associate professor of biomedical engineering. In Vogelstein's neuro data design class, Duderstadt says students had to create a "baby startup" and he learned how to develop applications and translate research to development.

Duderstadt still publishes research in conjunction with Priebe's lab, and aims to produce an associated research paper anytime Nomic publishes a new model. It fits with his mission of keeping AI available and approachable.

"A lot of the Nomic ethos is building AI in a way that is open, accessible, and explainable to everybody, and a big part of that is communication of results," he says. "Beyond that, we try to push the envelope in research fields that we think are important."

— MARC SHAPIRO

JOEL KIMMEL

NEWSFEED

Fast Pitch

Engineering students perfected their elevator pitches and explored career options with 20 Whiting School alumni at the school's annual Speed Networking Night, held as part of National Engineers Week in February.

During 10 rounds of rapid-fire, one-on-one meetings with the alums, the students discussed everything from professional paths and job opportunities to graduate schools while honing their networking skills.

Zack Buono, Engr '19, '20 (MSE), a biomedical and aeronautical engineer with the U.S. Army Telemedicine & Advanced Technology Research Center, emceed the event, and Clarisse Hu, Engr '17, '19 (MSE), the co-founder and CTO of Kubanda Cryotherapy (see page 32), was the evening's keynote speaker.

Says Ava Taylor, who is pursuing her master's degree in bioengineering innovation and design, "The alumni were genuinely interested in my aspirations and eager to offer their support." Taylor has since followed up with some of them and says these connections will be valuable as she launches her career.

"The alumni were genuinely interested in my aspirations and eager to offer their support."

Ava Taylor

TOP TO BOTTOM: Biomedical engineering undergraduate Allyson Chiu; Zack Buono, the evening's emcee; data science graduate student Shravya Dasu and Gary Tartanian, Engr '88 (MS).

Two Named to National Academy of Engineering

Two alumni of the Whiting School of Engineering have been elected to the National Academy of Engineering (NAE), one of the highest professional honors in the field.

Ruth DeFries, Engr '80 (PhD), Geography and Environmental Engineering, professor at Columbia University, was honored for her research on human-driven land-use changes and their environmental impact. Her work informs science-based policy decisions, helping to shape a sustainable future. A MacArthur Fellow and member of the National Academy of Sciences, she is a leading voice in environmental sustainability.

Charles Johnson-Bey, Engr '89, Electrical and Computer Engineering, senior vice president at Booz Allen Hamilton, was recognized for his contributions to engineering innovations supporting national security. His work has shaped industrial controls for combat ships, advanced cyber resilience, and guided R&D at major institutions. A mentor and professor, he continues to influence the future of global defense and engineering.

ADAM MURTLAND

Eager to Engage

Serena Savino has been appointed the Whiting School's associate dean for development and alumni relations.

With over 15 years of experience in fundraising as a frontline gift officer, program director, and manager, Savino brings to Johns Hopkins a record of fostering engagement with donors, including alumni and members of industry, and working with faculty and students to drive successful fundraising initiatives. She joins JHU after more than a decade at Cornell. Prior to that, she was a fundraiser for neurosciences at UCLA and at the Leukemia Lymphoma Society.

Benjamin T. Rome Dean Ed Schlesinger observes that Savino's holistic approach as a fundraiser made her an especially strong candidate. "Serena's significant experience in a complex academic environment, her donor-centric approach, and principal gifts fundraising expertise make her an excellent fit for the Whiting School," Schlesinger says.

"This is a terrific opportunity to help advance the school's—and the university's—mission during a period of tremendous growth," Savino says. "Our donors, alumni, faculty, and students are so dedicated to the school's success and are eager to engage."

Trading Transformed

The must-have tech tool for traders the world over.

BY ABBY LATTES

The Bloomberg Terminal revolutionized finance by putting real-time data, analytics, and communication tools at traders' fingertips. Launched in 1982 by Michael R. Bloomberg, Engr '64, the keyboard-heavy device used by investment banks and traders quickly became essential, transforming market analysis, trade execution, and financial decision-making.

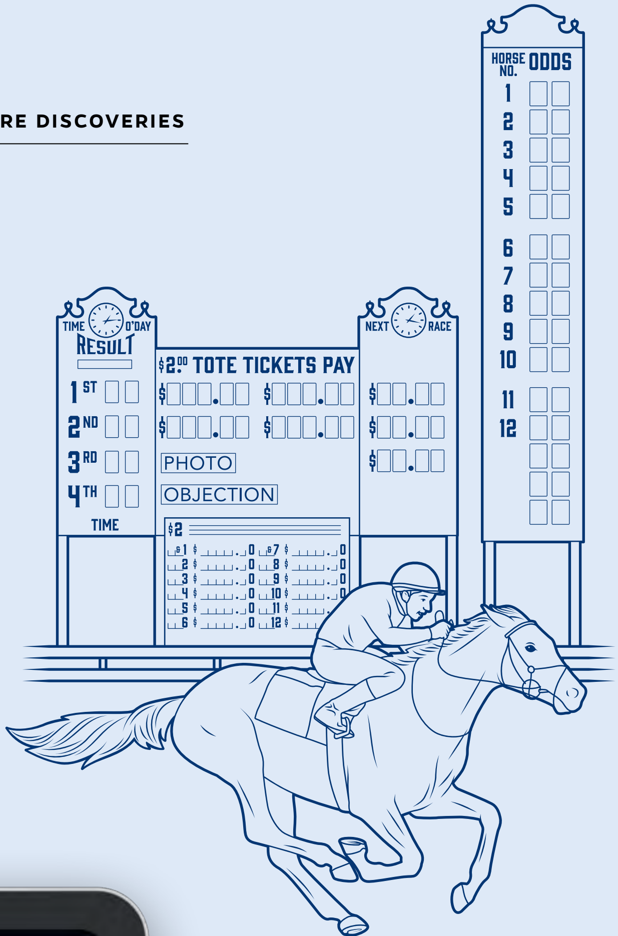
Its power lies in its speed, customization, and vast proprietary data across asset classes, as well as the variety of data and functions it integrates. It includes a messaging network for deal-making, financial intelligence, news, economic indicators, regulatory and compliance tools, and more.

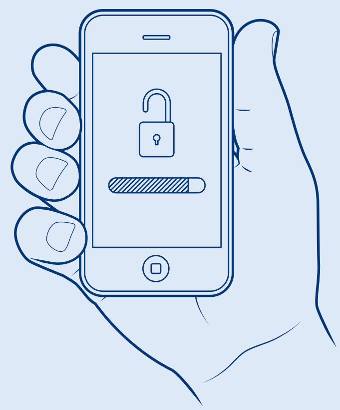
Today, the Terminal is a sleek, cloud-based platform accessible on mobile, integrating AI and machine learning for deeper market insights—making it one of the most powerful and widely used financial data tools worldwide.

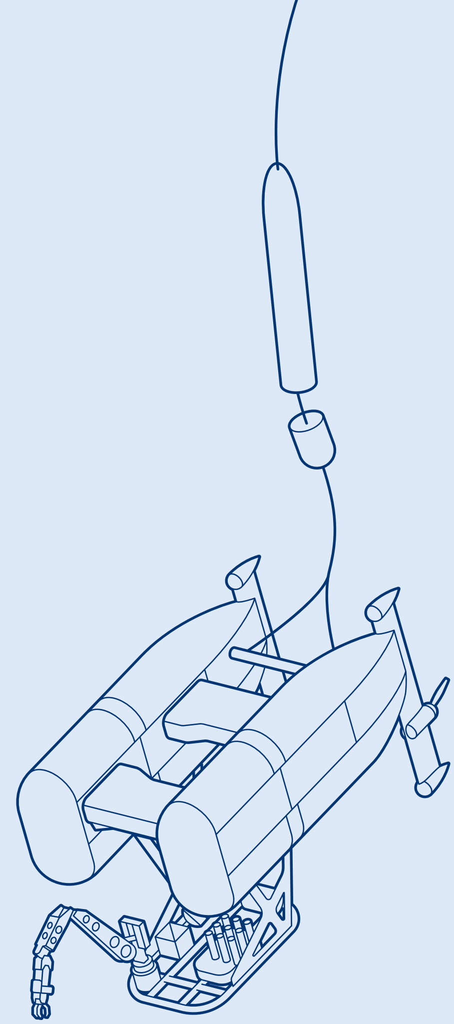
1983 Chiclet vs. Present-day tablet

The original keyboard was hand-assembled. During the pre-internet era, each keyboard required a special cable that ran from the user's desks to an equipment room that contained the Bloomberg Controller and dedicated telephone lines connecting to a local network hub.

Now, the Bloomberg Terminal connects more than 350,000 financial professionals worldwide with real-time data, news and analytics.







LINE ART: CHRIS PHILPOT

THE BET THAT PAID OFF BIG

In 1928, Harry L. Straus, Engr ’17 transformed racetrack betting with his invention, the electric totalizator, or “tote board”—an electromechanical system that could instantly print and issue betting tickets, automatically calculate parimutuel odds, and display real-time updates on a board. Straus founded the American Totalisator Company in 1932 to manufacture the machines whose unprecedented speed and accuracy soon made them a staple at racetracks worldwide, paving the way for modern large-scale racetrack betting.

HACKERS WITH A CAUSE

The day after the iPhone’s June 29, 2007 launch, Avi Rubin, computer security expert and professor emeritus of computer science, issued a challenge to researchers at his company, Independent Security Evaluators: Try to hack the device, and he’d buy them all iPhones. His goal? Uncover vulnerabilities and help Apple fix them. Just two weeks later, they did it—extracting data files and transmitting them to an attacking computer, making them the first to hack the iPhone.

NAVIGATING THE DEPTHS

Exploring the Challenger Deep—Earth’s deepest ocean point at 6.8 miles down—requires precision navigation in an extreme, high-pressure environment. In 2009, *Nereus*, a completely new type of unmanned deep-sea robot, became the first vessel to successfully reach the bottom of the Mariana Trench, guided by a navigation and control system developed by mechanical engineering professor and roboticist Louis Whitcomb, an international leader using robots to boldly go where none have gone before.

Why send a ferret to a cocktail party?

Mounya Elhilali
Charles Renn Faculty Scholar and professor of electrical and computer engineering

"Last time you attended a crowded cocktail party, amid the talking and schmoozing, you could tune into a single conversation. To understand how we do this, we taught ferrets—whose auditory systems are remarkably like ours—to recognize a target word, and then put the ferrets in noisy, crowded situations and recorded their brain activity. Turns out the brain has a sort of neural volume knob that filters out background noise, letting them focus on a single voice. What we've learned could help improve hearing technologies."

Michael Shields
Associate professor and chair of the Department of Civil and Systems Engineering

Can computer models simulate traumatic brain injury?

"Computer models enable us to do something extraordinary: map what happens to the brain under extreme impacts without putting anyone at risk. Using advanced imaging and machine learning, we can simulate events like car crashes and explosions, creating detailed models that show exactly how brain tissue deforms under severe stress. It's like having a virtual crash test dummy for the brain, allowing us to understand potential injuries in ways we never could before."

Amitabh Basu
Professor of applied mathematics and statistics

Is more data always better?

"Using a method built on decades-old optimization theories, algorithms can now solve complex problems with only a few key pieces of information. For example, imagine optimizing FedEx package routes. While in the past, this required massive amounts of data, a new analysis now enables algorithms to estimate and fill in missing information while maintaining their general computational logic and accuracy. It's like figuring out what a jigsaw puzzle depicts using only a few pieces. By avoiding analyzing unnecessary details, the method makes problem-solving more efficient and cost-effective."

A LETTER FROM THE FUTURE

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"With John Malone's support through my endowed professorship, we are building the future of AI-assisted health care—enhancing disease diagnosis and enabling safer, less invasive surgeries—which has the potential to impact all our lives."

Mathias Unberath,
Johns C. Malone Associate
Professor of Computer Science

John C. Malone, Engr '69 (PhD), is advancing innovation and interdisciplinary research at Johns Hopkins through his support of endowed professorships, Malone Hall, and the Malone Center for Engineering in Healthcare. His generosity enables the Whiting School to recruit world-class faculty who, in turn, attract the most qualified and driven graduate students.

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