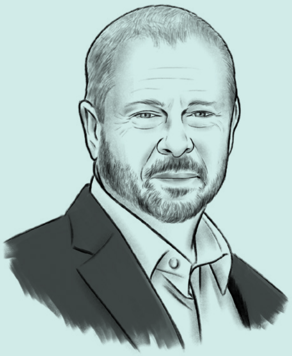
A New Approach to Healthy Aging

An expansive hub for translational research brings together a variety of disciplines to test technology-driven solutions to aging's biggest challenges.

ALSO IN THIS ISSUE

JOHNS HOPKINS ENGINEERING MAGAZINE

Engineering Healthy Aging



As the world becomes more technologically advanced and our population ages—with projections showing that one in six people will be 60 or older by 2030—we have an unprecedented opportunity to harness innovation on behalf of healthy aging. At Johns Hopkins, we are committed to leading at this vital intersection of technology and longevity.

To achieve this, the next chapter of research and care must be shaped collaboratively by clinician-scientists and engineers, merging clinical perspectives with engineering innovation in the field of "geriatrics engineering" (see p. 10).

Research in geriatrics engineering is already underway at Hopkins, making a tangible impact. With the rapid expansion of this demographic and the accelerating breakthroughs enabled by AI, machine learning, and data science, there is an urgent need for transformative, patient-centric discoveries.

"Our goal is to ensure that innovations are accessible to diverse communities."

Engineers play a crucial role in this endeavor. While clinicians contribute invaluable medical insights and a healthy skepticism that tempers expectations, engineers provide the technical expertise required to develop scalable solutions that transition discoveries from the labs to homes, doctors' offices, and community centers for older adults. Our goal is to ensure that innovations are accessible to diverse communities.

In this issue, we are excited to introduce a new facility co-designed by engineers, clinicians, and older adults: a place to test and validate our advancements effectively. This unique translational research hub on our Bayview campus in East Baltimore serves as a testament to the university's commitment to integrating engineering and medicine.

Together, we can redefine the landscape of geriatric care, fostering an environment where technological advancements truly celebrate life and enrich the human experience. Your continued support and engagement are crucial as we embark on this transformative journey.

Sincerely,

Ed Schlesinger
Benjamin T. Rome Dean

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JOEL KIMMEL

Reaching for the Stars

In June, JHU's AstroJays celebrated their most successful launch ever, when their amateur rocket, Stellaris, soared 18,000 feet into the brilliant blue Mojave Desert sky, shattering the sound barrier at Mach 1.3. Powered by a custom M2500 engine called Prometheus, the rocket carried a 2.2-pound payload. The team's second-place finish in the national FAR-Unlimited competition marked the JHU club's greatest achievement yet, breaking previous Johns Hopkins teams' altitude and speed records. Stellaris performed flawlessly, with its automated parachute deployment ensuring a perfect recovery. Club members are already dreaming bigger: next year, 100,000 feet.

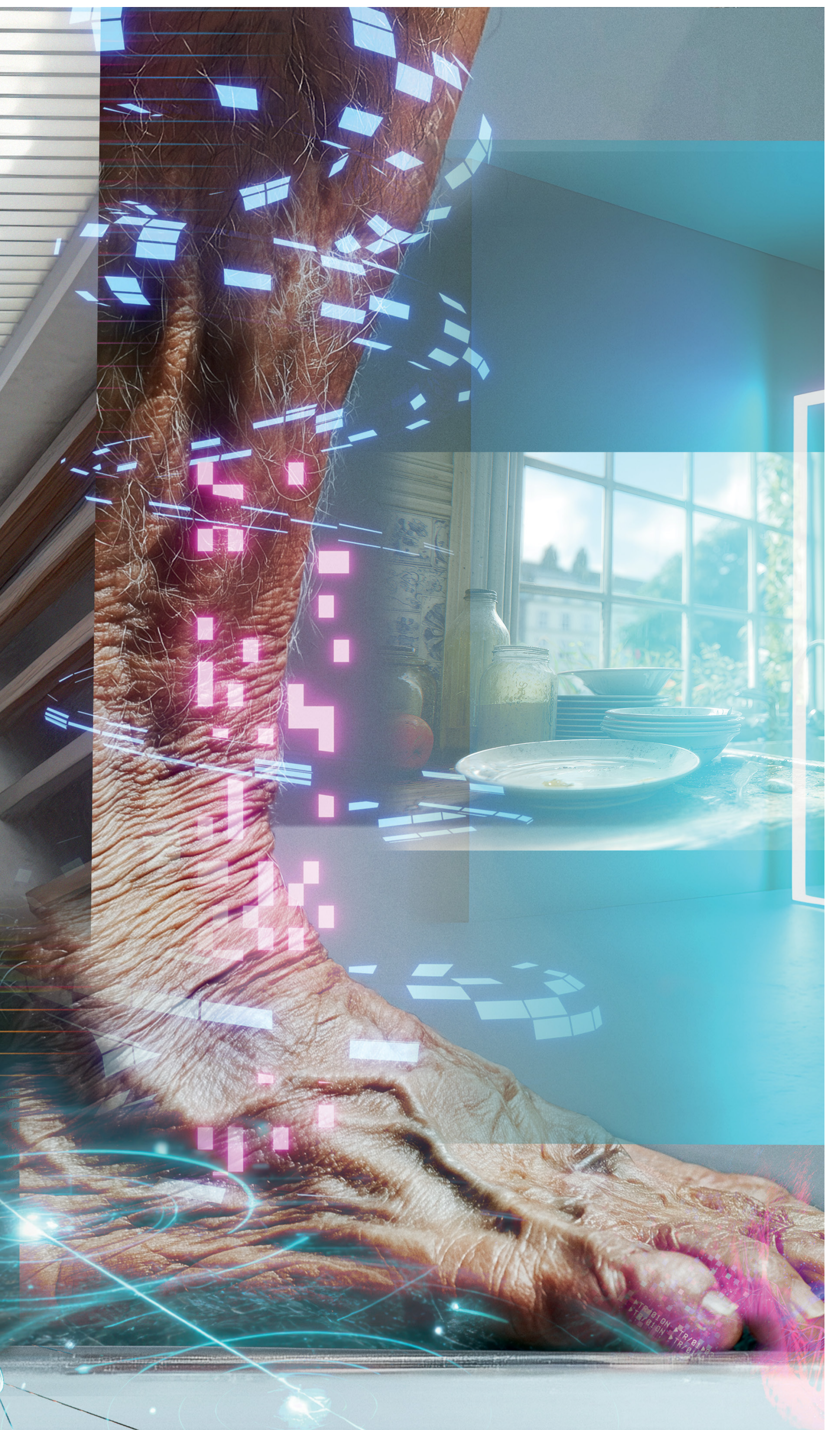
THE M2500 ENGINE

1

LINE ART: CHRIS PHILPOT

JOHNS HOPKINS ENGINEERING MAGAZINE

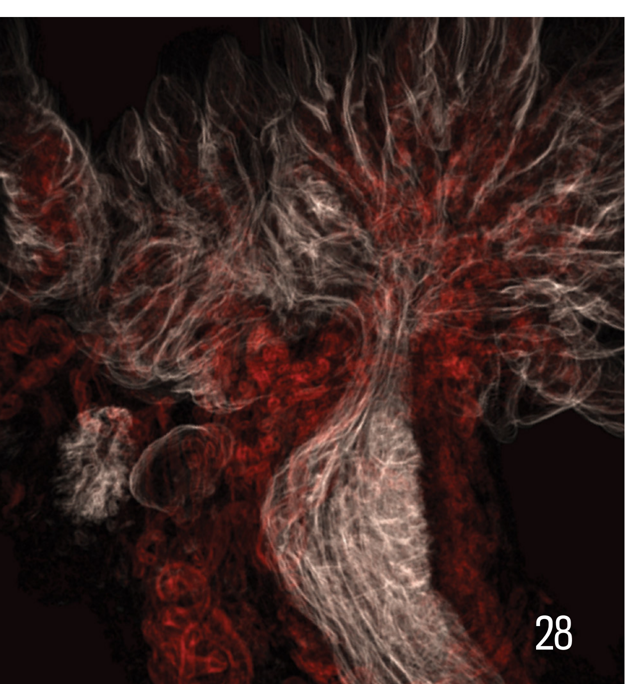
FALL 2025



> “We want our work to have an impact on people, whether it be through clinicians or hospital systems or right-to-end users.”
>
> Jude Phillip

FEATURES

20



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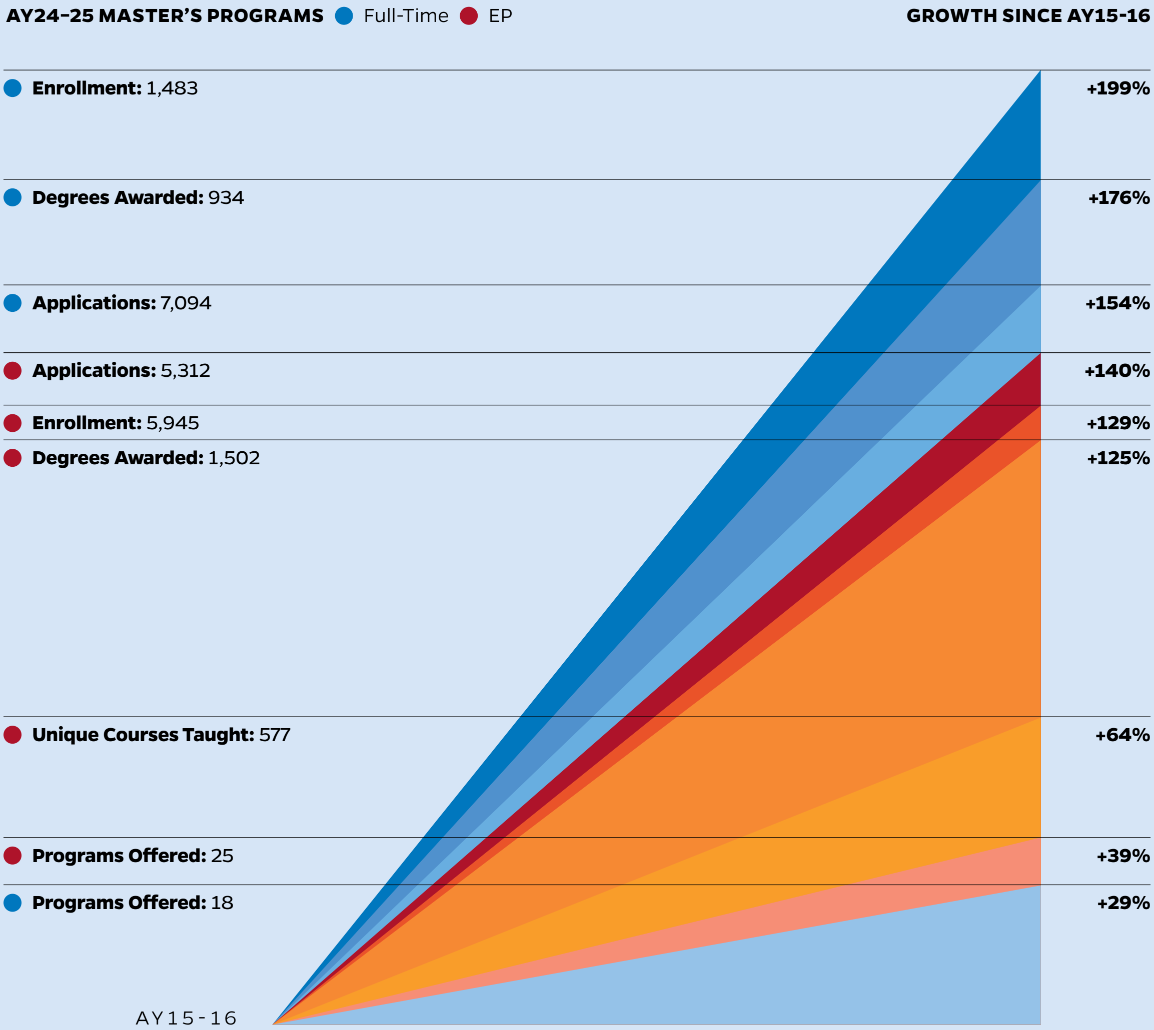


Master's Education Evolves at Johns Hopkins Engineering

2025 *U.S. News & World Report* Rankings

FULL-TIME GRADUATE ENGINEERING PROGRAMS
No. 13 overall

FULL-TIME GRADUATE PROGRAMS RANKED IN THE TOP 20
6

ONLINE MASTER'S PROGRAMS
No. 6 overall

ONLINE MASTER'S PROGRAMS RANKED IN THE TOP 10
5

Once seen primarily as a PhD stepping stone, the master's degree in engineering is now a credential in its own right—and demand is surging. At the Whiting School, full-time master's enrollment has tripled, and Engineering for Professionals (EP) part-time/online enrollment has more than doubled between 2015–16 and 2024–25.

Rapid technological advances, the need for cross-disciplinary expertise, and the promise of higher earning potential are fueling the shift. Today, programs span high-demand fields such as robotics, financial mathematics, data science (full-time), and artificial intelligence and industrial and operations engineering (EP).

This growth has not come at the expense of quality. Johns Hopkins remains highly selective, attracting top talent whose success sustains the school's reputation for excellence. That commitment extends to teaching and support: Residential and EP students learn from Homewood faculty, and expert staff at JHU's Applied Physics Laboratory comprise about 30% of EP's 650 instructors. Strengthened advising, upgraded course technology, and expanded student services ensure rigorous training and a strong overall experience.

Read more about the impact of Engineering for Professionals on p. 20.

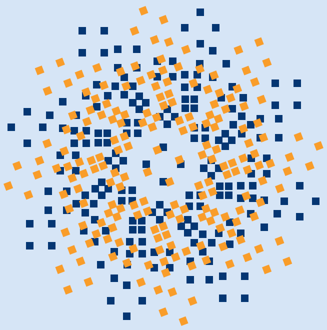
New Amazon Partnerships for Graduate Students

This fall, Amazon announced that it is expanding its support of the Whiting School with two new programs that benefit graduate students—a fellowship program for doctoral students and a mentorship program for master's students.

Johns Hopkins is one of nine academic institutions selected for Amazon's new AI PhD Fellowship program for a cohort of seven to 10 students each year who are studying machine learning, computer vision, and natural language processing. The fellowship includes tuition, a stipend, and fees, as well as mentorship, and Amazon Web Services (AWS) cloud-computing credit to support computational research needs.

Amazon has also launched a professional mentorship program for students completing their capstone projects in the residential data science master's program. In it, student teams select projects and are then matched with Amazon scientists who provide guidance, professional advice, and technical insights as the students manage deadlines and resources and apply critical thinking to real-world problems.

These efforts complement already existing partnerships with Amazon, including the JHU + Amazon Initiative for Interactive AI (AI2AI). Since 2022, Amazon has provided funding for 17 doctoral fellowships and faculty research with a focus on advancing technologies in machine learning, computer vision, natural language understanding, and speech processing.



Cancer AI Alliance Receives National Recognition

The Cancer AI Alliance, a research partnership that includes Johns Hopkins and focuses on AI-driven cancer discovery, has been recognized in *Time* magazine's "TIME100 AI 2025" for reshaping the future through advances in artificial intelligence.

Alexis Battle, a biomedical engineer and director of the Malone Center for Engineering in Healthcare, co-leads Johns Hopkins' involvement in the alliance, which comprises major medical centers and tech companies.

> **"This alliance has the potential to rapidly accelerate innovation in cancer care using AI."**
> Alexis Battle

Battle, an expert in AI and computational genomics, states that with access to vast data generated during routine cancer care at member sites and robust computer infrastructure, "This alliance has the potential to rapidly accelerate innovation in cancer care using AI."

NSF Awards

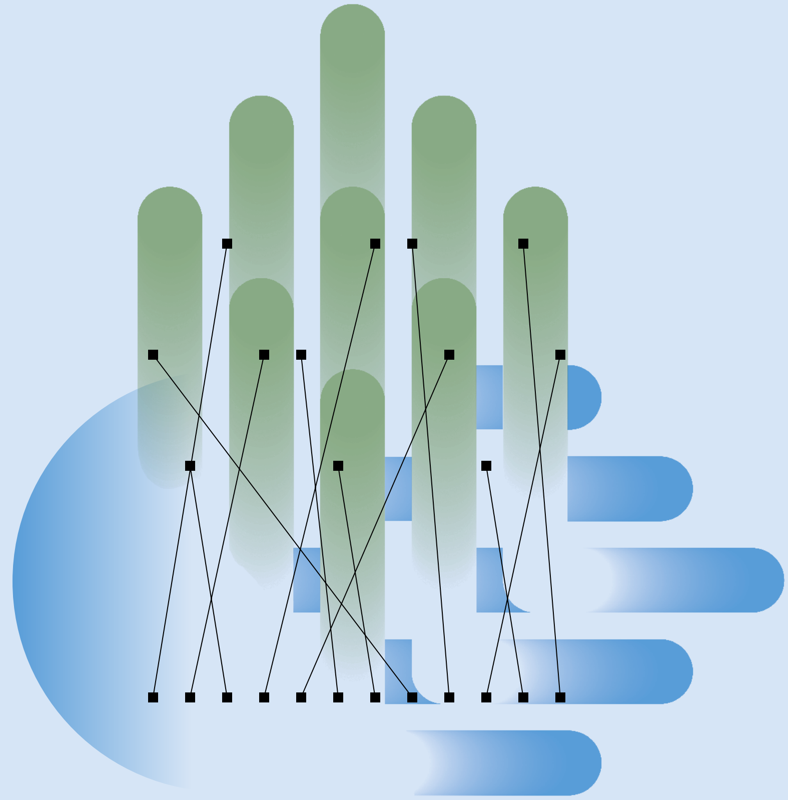
The National Science Foundation honored Yaxing Yao, assistant professor of computer science, with an Early CAREER Award, which recognizes early-stage scholars who demonstrate high levels of promise and excellence.

Problem: How can we effectively teach elementary school children ages five to 10 to understand and protect their personal privacy in our increasingly digital world?

For his project, Yao will design a privacy education framework that enables partnerships among families, schools, and community organizations to teach children essential digital privacy skills.

The NSF also awarded Rebecca Schulman, professor of chemical and biomolecular engineering, an NSF Trailblazer Engineering Impact Award, which supports high-risk, high-reward novel research projects that creatively address major societal challenges, advance U.S. leadership, and merge engineering and science fields.

Problem: How can we get more organs to people on the transplant list to address a critical shortage and save more lives? Schulman's project will create a programmable language for biomaterials that instructs and coordinates tissue growth in lab-grown organs suitable for transplant.



Hopkins Builds Global Energy Partnerships

Researchers, policymakers, and industry leaders convened on Johns Hopkins University's Homewood campus this summer for the Energy Technology and Science Bridge, an international forum aimed at accelerating energy innovation through strategic partnerships.

Co-hosted by the Ralph O'Connor Sustainable Energy Institute (ROSEI), the National Science Foundation's Electric Power Innovation for a Carbon-free Society (EPICS) Center, and the Embassy of Belgium, the event drew diplomats, researchers, and industry representatives from Canada, Europe, and the European Union to explore collaborations with Johns Hopkins' energy research programs.

In his opening remarks, Whiting School of Engineering Benjamin T. Rome Dean Ed Schlesinger highlighted the university's investments in AI and data science. "ROSEI and EPICS will play a significant role in integrating machine learning to develop future energy solutions," he said.

The day featured presentations on three themes: technologies for decarbonization, the role of AI in clean energy, and frameworks for sustainable energy planning.

Diplomatic participants emphasized the importance of science-informed policy. "There's a strong need for a science and diplomacy collaboration, and this event is only the beginning of an opportunity to learn from Johns Hopkins," said Michel Wallemacq, senior economic adviser at the Embassy of Belgium. Javier Sancho Velazquez of the EU Delegation to the U.S. added, "For us, as diplomats, having a fluid relationship with academia is vital to shaping effective policies."

> **"ROSEI and EPICS will play a significant role in integrating machine learning to develop future energy solutions."**
> Dean Ed Schlesinger

ROSEI's Deputy Director and Associate Research Scientist Ben Link, BSPH '03 (MPH) underscored the institute's role in these collaborations. "There are very few programs that support international collaboration in this field, and ROSEI is excited to facilitate essential cross-border partnerships," he said.

— DANIELLE MCKENNA

Progress in Action

Launched in 2023 and based in the Johns Hopkins Whiting School of Engineering, the Data Science and AI Institute (DSAI) unites experts across disciplines—at Johns Hopkins and beyond—to leverage the opportunities and challenges presented by the explosion of data and the rise of accessible AI.

Mark Dredze Named Director of DSAI

Mark Dredze, the John C. Malone Professor of Computer Science, a member of the Johns Hopkins faculty since 2009, and a pioneer in the application of artificial intelligence for language analysis to public health and medicine, has been named the inaugural director of the university's Data Science and AI Institute.

His appointment follows an international search for an individual to lead an institute that brings together world-class experts in artificial intelligence, data science, machine learning, applied mathematics, computer engineering, and computer science to fuel data-driven discovery and innovation in research activities across the institution.

Rendering of the Homewood campus facility that will be home to the new institute

"Mark's research accomplishments, ability to identify and act on opportunities that address real and pressing societal problems, and skill at building partnerships make him an ideal leader for this effort," says Ed Schlesinger, the Whiting School's Benjamin T. Rome Dean. "He has been integral to DSAI's success, and his vision and reputation will enable us to attract the most qualified and innovative faculty and students, and maximize our impact on the world."

Dredze is internationally recognized for his groundbreaking work using machine learning and natural language processing to extract insights from social media data to enhance our understanding of human behavior and inform public health policy and interventions.

This work dates to 2011, when Dredze led a team that released one of the first and most comprehensive studies showing that data from Twitter (now called X) can yield useful and actionable public health information, including forecasting seasonal flu in the U.S. In 2018, his research demonstrated how malicious foreign actors were weaponizing health communications in the U.S. around the vaccine debate.

As one of the founders of this burgeoning area of data informatics research, Dredze's work has provided critical insights into public health issues, such as suicide prevention, vaccine hesitancy, HIV, tobacco, mental health, gun violence, and other topics. In 2017, he co-authored *Social Monitoring for Public Health*, one of the first books surveying this then-nascent field.

Recently, he has pioneered applications of large language models, such as ChatGPT, in medicine. His 2023 study demonstrated the power of AI-enabled chatbots in delivering high-quality medical information to patients.

Dredze is also affiliated with the Malone Center for Engineering in Healthcare, the Center for Language and Speech Processing, the Human Language Technology Center of Excellence, and the Applied Physics Laboratory. He holds a joint appointment in the School of Medicine.

Since its founding, the institute has made significant strides, enabling faculty growth, increasing doctoral enrollment, and funding collaborative research that has meaningful societal impact.

"They chose Hopkins for the chance to collaborate with world-renowned experts and tackle urgent, global challenges," says Benjamin T. Rome Dean Ed Schlesinger.

Another 30 Bloomberg Distinguished Professors with expertise in data science and AI are joining Johns Hopkins as part of the DSAI initiative, with joint appointments in Engineering and other JHU divisions.

Meet our new DSAI faculty

1

Amassing Expertise: Faculty Growth

DSAI's hiring initiative has already added 37 new tenure-line faculty to WSE's Departments of Applied Mathematics and Statistics (9), Computer Science (17), and Electrical and Computer Engineering (11), and 180 faculty members from Engineering and other JHU divisions are currently affiliated with the institute. Over the next few years, the planned 80 total new DSAI hires will account for 45% of overall growth in the engineering school's tenure-line faculty since the institute's launch.

These new scholars bring diverse perspectives and interests that complement the expertise of existing faculty. Their research spans areas ranging from neural networks, computer vision, large language models, and medical robotics to diagnostics and renewable energy.

GROWTH UNDER DSAI

80	Total DSAI engineering faculty to be hired
30	Bloomberg Distinguished Professors to be hired in AI cluster
750	New PhD students to matriculate
37	DSAI faculty hired to date
180+	JHU faculty affiliated with DSAI

Predicting Material Properties

An AI tool by materials scientist Kamal Choudhary analyzes data and models to predict material behavior without testing, potentially accelerating the discovery of advanced batteries and tougher alloys.

Mathias Unberath

2

Supporting Safer, Smarter AI in Surgery

To advance trustworthy AI systems, DSAI launched its Trusted Dataset Awards in 2024 with two inaugural grants that support groundbreaking projects in health care AI.

Computer scientist Mathias Unberath and his multidisciplinary team used the award to advance ambient intelligence in operating rooms. They created over 50 simulated surgical videos, established secure annotation protocols, and developed AI tools for a reliable dataset that improves AI interpretation of complex surgical environments. Additionally, they built a HIPAA-compliant infrastructure for secure data access.

Swaroop Vedula, an associate research professor in the Malone Center for Engineering in Healthcare, is tackling data silos in surgical AI by creating interoperable, shareable datasets that enable reliable surgeon assessment and feedback. The standardized annotations and metadata models foster scalable collaborations across institutions for responsible AI in surgery.

DSAI is helping to advance research by supporting promising faculty projects. Since the institute's launch, it has provided approximately $1 million in research awards, including:

3	Junior Faculty Awards
4	Demonstration Projects
4	Trusted Data Set Awards
10	Discovery & Inquiry Seed Grants

Fluent, Fast, and Fair

In collaboration with Microsoft Research, computer scientist Philipp Koehn and his team developed a machine translation model that excels in 50 diverse languages.

3

Informing AI Policy

As artificial intelligence rapidly reshapes our world, Johns Hopkins is holding events to foster dialogue about its potential and risks. The university's goal is to better equip policymakers with accurate insights and a deeper understanding of AI—knowledge crucial for shaping thoughtful regulation, ethical innovation, and everyday decision-making in an AI-driven future.

These events this year included a panel of Johns Hopkins AI experts presenting research to members of Congress and staff, highlighting innovations from first responder robots to AI-driven medical diagnostics and AI Boot Camp, where Johns Hopkins experts discuss AI's role in government, national security, and ethics with congressional staffers.

Rama Chellappa, Bloomberg Distinguished Professor, electrical and computer and biomedical engineering

4

Investing in Compute Power

Johns Hopkins is enhancing its high-performance computing infrastructure to drive innovative AI and data science research while supporting future growth.

Building on its solid foundation in research computing and data storage, the university is making significant investments in GPU and CPU capacity, network speed, and storage.

Phase one includes expanding GPU and CPU capabilities, increasing network connectivity speeds across research and enterprise systems, and boosting storage capacity.

These upgrades will facilitate cross-campus collaboration, enable large-scale data sharing, and support the expanding community of faculty and graduate students in AI and data science.

5

Building a Global Hub for Data Science and Artificial Intelligence Research

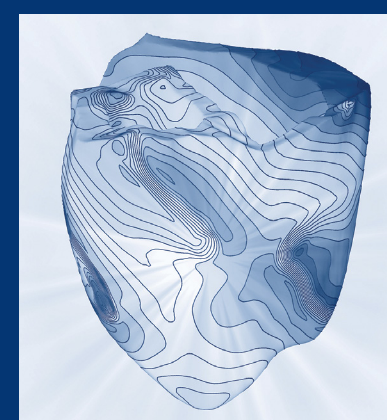
While the institute currently occupies space on JHU's Homewood and Mount Washington campuses, plans are underway for a new home for DSAI at the southern edge of the Homewood campus.

The 476,000 square-foot space spans two connected buildings and will feature laboratories, high-tech classrooms, meeting spaces for collaboration, and offices for faculty and graduate students.

"This hub for data science and AI research will impact the entire university and beyond," says Schlesinger.

2029	Target opening
476,000	Square-foot building
11,000	Projected construction-related jobs

Heart model



Cardiac modeling

Biomedical engineer Murray B. Sachs Professor Natalia Trayanova's AI model analyzes underused heart imaging and diverse medical records to uncover hidden insights into heart health and identify patients at risk for sudden cardiac death.

IMPACT
FACULTY INNOVATION

ALSO IN THIS SECTION

A NEW APPROACH TO HEALTHY AGING

An expansive hub for translational research that opened this summer brings engineers and clinicians together with older adults and their caregivers to test technology-driven solutions to aging's biggest challenges.

BY SUE DEPASQUALE
ILLUSTRATION BY JAMES DAWE

In a cozy apartment, an older woman sits in an armchair, raptly attuned to a scene unfolding on her virtual reality glasses. She chats amiably with a virtual tour guide, who is leading her through the Baltimore Museum of Art. Two Johns Hopkins graduate students—one in engineering, the other in nursing—sit nearby, taking notes to fine-tune this personalized, AI-generated tool. It is aimed at providing social interaction to stave off loneliness, a significant risk factor for cognitive decline in older adults.

Down the hallway, Laureano Moro-Velazquez, an assistant research professor of electrical and computer engineering at the Whiting School, and neurologist Ankur Butala lead a man in his 70s through a series of reading and writing exercises on a digitized notepad. An array of sensors tracks the movement of the man's eyes, the cadence of his voice, and the movement of his hand. The researchers will continue to assess the man's reading and handwriting every few months. Their overarching goal: to detect neurodegenerative diseases like Parkinson's or Alzheimer's in their earliest—and most treatable—stages.

Meanwhile, in a large lab space nearby known as the "motion capture room," Laura McDaniel, a second-year PhD student in electrical engineering, is quite literally putting an older woman through her paces. Sixteen cameras are set up in pairs throughout the room, tracking the woman's gait in real time as she walks across the room, and then moves through a series of exercises on a treadmill. The data McDaniel collects, part of a study led by Rama Chellappa, Bloomberg Distinguished Professor in electrical and computer engineering and former interim director of the Data Science and AI Institute, is aimed at detecting factors—such as misaligned hips or hunched shoulders—that could impair the woman's balance and put her at risk for a fall.

These three projects are just a few of many efforts that are unfolding—some now, others in the months and years to come—in a new hub for healthy aging research, which opened in July at the Johns Hopkins Bayview Medical Campus in East Baltimore under the umbrella of the Johns Hopkins Human Aging Project (HAP). The 10,000-square-foot center gives the engineering school a prominent presence on the medical campus and is bringing together faculty and students from engineering and medicine—as well as nursing, public health, and business—with older adults and their caregivers to test technology-driven solutions to some of the biggest challenges older adults face.

These include social isolation, mobility issues, and neurodegenerative decline, notes Najim Dehak, associate professor of electrical and computer engineering at the Whiting School and co-director of the new hub. "Our aim," he says, "is to leverage technology to extend the time that older adults can remain living safely and independently at home." Dehak has even coined a term for this new area of translational research, which is reflected in the hub's name: Geriatrics Engineering @Johns Hopkins.

With its plentiful conference rooms, labs, and offices, as well as a model apartment that simulates a realistic living space of an older adult, the hub notably provides a new home for the Johns Hopkins Artificial Intelligence & Technology Collaboratory for Aging Research. Established in 2021 with $20 million in funding from the National Institute on Aging, the AITC currently has 129 pilot projects—like the loneliness-combating VR glasses—up and running. Developed by research teams at Johns Hopkins and universities and tech incubators around the country, some AITC projects have spawned prototypes that are already in market testing.

The goal with AITC projects and other research efforts unfolding in the new facility is to move innovations as quickly as possible into affordable solutions that seniors of all income levels can easily use, says geriatrician Peter Abadir, who co-directs the new facility. He notes that faculty and graduate students from Johns Hopkins' Carey Business School are actively engaged on many projects (see sidebar) to ensure that products can be marketed successfully and made widely available and affordable.

"We aren't just building gadgets. We're creating scalable solutions to meet older adults where they are—in their homes, or senior centers, or their doctor's office," Abadir says. "We're bringing engineers from the Homewood campus together with clinicians in East Baltimore to work shoulder by shoulder, quite literally, to design and validate technology that will help older adults live independently for longer, and with dignity."

Leaders of Geriatrics Engineering @Johns Hopkins, believed to be the first of its kind in the country, point to the nation's rapidly graying population and note that the timing for such work is critical: In 2024, the U.S. population aged 65 and older rose by 3.1%, to 61.2 million people, according to the U.S. Census Bureau. By 2030, an estimated one in five Americans will be retirement age. Meeting the functional, cognitive, and psychosocial needs of this burgeoning wave of older adults with accessible, technology-driven solutions will be crucial—and a complex challenge, says Ed Schlesinger, Benjamin T. Rome Dean of the Whiting School of Engineering, and an early and ongoing champion of the collaborative space.

3.1%

In 2024, the U.S. population age 65 and older rose by 3.1%, to 61.2 million people, according to the U.S. Census Bureau.

> **"We aren't just building gadgets. We're creating scalable solutions to meet older adults where they are—in their homes, or senior centers, or their doctor's office."**
>
> Peter Abadir

"There is really no university today that is better equipped to lead in this area than Johns Hopkins. If anyone can do this, we can," he says, noting that Johns Hopkins is home to the nation's top-ranked biomedical engineering program, which unites the Whiting School and the School of Medicine. Moreover, the Bayview campus is already the site of many well-established, geriatrics-focused clinical programs and research centers, which will afford easy access to, and collaboration with, clinicians and their older patients and caregivers, Schlesinger says. By bringing together a diverse array of experts from many disciplines at Johns Hopkins, he notes, "We aim to ensure solutions that are equitable, inclusive, and ethically sound."

'SMART HOME' OF THE FUTURE

A focal point of Geriatrics Engineering @Johns Hopkins is the model apartment, which includes a living room, kitchen, bedroom, and bathroom. While planners were still in the process of furnishing the living space in early fall, they are intent on creating a look and feel that is both comfortable and familiar for older adults and their caregivers—clutter and all.

"So much technology currently on the market is developed by testing it on young people, then reverse-engineered for older adults, and it's developed in a sterile, studio-like setting," says Abadir. "Here, we are starting with older adults and determining their needs to make sure the technology we develop is relevant to them, in the places where they live."

Dehak concurs. "It's so important for older adults to be included in the design of any new 'smart home.' They need to be a part of the conversation." Toward that end, in the months ahead, both older adults and their caregivers will visit the model apartment to try out and provide feedback on the wearable trackers, robotic assistants, and voice-activated systems that will be tested there.

Driving the new technology are rapid advances in AI and sensor technology, which offer the promise of truly personalized interventions that planners aim to make widely accessible.

One AITC project capitalizing on those advances, Sovrinti: Data for Daily Living, leverages real-time location and device utilization data to identify rising health risks so that family members can intervene before a problem becomes acute. Some sensors measure and track the water temperature of an older adult's kitchen faucet, for example, as well as the oven and dishwasher. Light sensors track how often—and when—the user opens cabinets, drawers, and the refrigerator. A Wi-Fi-equipped router detects and measures the resident's movements throughout the apartment.

"It's so important for older adults to be included in the design of any new 'smart home.' They need to be a part of the conversation."
Najim Dehak

Above: Peter Abadir (left) and Najim Dehak

By automatically quantifying change in an older person's movement and behavioral patterns, Sovrinti—led by a research team at Baylor University—can flag worrisome changes early on. "A caregiver could feel secure in leaving their loved one living on their own if their parent's apartment is equipped with AI-driven tools like that," says Abadir.

While Sovrinti has already moved through early trials, Abadir and Dehak envision similar sensor- and data-driven AITC solutions undergoing testing in the model apartment in the months ahead. They point to an Alexa-type device that uses voice cloning to personalize reminders—"Mom, did you take your morning medication?"—for those in the early stages of cognitive decline, as well as a robot that can help an older adult with teeth brushing.

The long-term goal, says Dehak, who is a leading expert in human language technologies, is to create a model for the personalized senior apartment of the future, where sensors detect infirmities of aging at their earliest stages and voice activation devices can keep older adults safe and feeling socially connected.

"We've already reached a stage with automatic speech systems where we can provide adaptive dialogue," says Dehak. "While in the past, we were limited to scripted dialogue, now it's possible to adjust the response and ask different questions." A voice-activated digital assistant might start with,

Up to the Test

The hub for translational aging research at Johns Hopkins Bayview also offers meeting and research space for the Gerotech Incubator Program, which launched in 2021 and is co-directed by Najim Dehak and Peter Abadir. The program brings together Johns Hopkins students and trainees in engineering, medicine, nursing, and business to work closely with interdisciplinary teams of Johns Hopkins faculty members. Their goal: to develop and bring to market affordable tools and therapeutics aimed at improving the quality of life for older adults.

One group, for example, has developed and piloted a headset that promotes deep sleep that may protect against Alzheimer's and other physical and cognitive decline. Called inWave, it uses electroencephalography to monitor brain activity and an AI algorithm to time the delivery of specialized sounds that enhance the kind of brain activity needed for deep sleep.

"How are you feeling today?" If the senior responds that they are feeling down, the system could respond with, "You often feel sad when it's raining outside. Perhaps you could phone your friends, Mary and Doug, to check in on them?"

Even if an older adult isn't aware they are feeling low, speech technology advances that Dehak has led can now detect the early signs of depression through the intonation and cadence of the person's speech. In the not too distant future, he says, a daily recording device could be used to track an older person's speech and alert their doctor to an early change in their mental health status.

"Most older people only see their doctor every few months. This would allow a much quicker intervention," says Dehak, citing a crucial benefit driving much of the AI-fueled work underway at the center: the ability to provide daily (even minute by minute) monitoring that can detect physical and behavioral changes before they turn into problems.

GETTING GRANULAR

As Butala gestures to the high-tech setup in the new space that he and Moro-Velazquez are using to track the eye movement, voice, and handwriting of older adults, the neurologist foresees a future where doctors can both detect and measure neurological decline in its earliest phases.

"Right now, our evaluations are so subjective," he says. "When I assess an older patient, I might note that his stroll is a little slower than his last visit, or if I ask him to follow the movement of my finger with his eyes, it's a relatively crude measure. What neurologists are lacking is a consistent method of granular, cognitive behavioral characterization."

That's particularly important when it comes to assessing how well a particular drug might be working in treating a patient's Parkinson's disease, a progressive neurological movement disorder impacting about 1 million older adults in the United States, he notes. Levodopa (L-DOPA) is commonly prescribed to help regulate movement in PD, but getting the dosing right is a trial-and-error affair that depends on self-reporting from the patient and can stretch over months or years.

Key to the AI-driven system the two researchers have developed, under the leadership of Dehak, is its "multimodal" aspect. By measuring eye movement, speech, and handwriting simultaneously, the researchers can gather that granular data (known as "deep phenotyping") that can capture minute changes in a patient's condition over time that might otherwise go missed if only one area is examined.

1 million

The number of older adults in the United States with Parkinson's disease, a progressive neurological movement disorder

"The bulk of medical care today is delivered at the primary care level. There are huge swathes of older people who don't have access to neurologists, much less subspecialists."

Laureano Moro-Velazquez

In eye tracking of hundreds of older adults to date, for example, they have found that while healthy people often skip over words as their eyes scan a reading passage, people with early Alzheimer's disease tend to look at every word and spend more time on complicated words. "This in turn influences their speaking pattern," says Moro-Velazquez.

He and Butala are also using a pad and sensors in the shoes of older people with Parkinson's and Alzheimer's to characterize changes in their gait over time.

Ultimately, the two researchers hope the data they are gathering will move out of the lab in Johns Hopkins' hub for aging research and into the offices of primary care doctors across the country, in the form of easy-to-use, affordable diagnostic tools.

"The bulk of medical care today is delivered at the primary care level. There are huge swathes of older people who don't have access to neurologists, much less subspecialists," notes Moro-Velazquez.

Both researchers are adamant that the progress they've already made, and the promising applications on the horizon, would not be possible if they were not working alongside one another and countless other engineers, data scientists, students, and geriatrics specialists on a daily basis. "Sometimes as engineers, we come up with solutions and then look for a problem—creating solutions nobody needs. We need to better communicate with doctors and understand the problems they need us to solve," says Moro-Velazquez.

Abadir concurs. "This new space offers an opportunity to iterate in real time. Clinicians talk with engineers, bring in older adults for their testing and feedback, and then make adjustments. When you bring everyone together, then the magic happens."

Abadir and Schlesinger believe so strongly in this "magic" that they are taking it to a national stage. In an editorial they co-published in July in the *Journal of the American Geriatrics Society* (JAGS), the duo announced the launch of a new section in the journal: JAGS-AI & Tech, which they described as "a multidisciplinary platform for research, innovation, and dialogue at the intersection of geriatrics, engineering, data science, business development, and ethics."

It's notable that the editorial marked the first time that an engineer has authored an article in the medical journal. While Schlesinger won't have an editorial role moving forward, his support reflects a shared conviction, "that the next chapter in geriatric research and care, marked by the emergence of AI and associated technologies, must be co-written by clinician-scientists and engineers working together as peers."

Sniffing Out Diabetes—and Air Pollution

ACETONE CONCENTRATIONS TESTED
5-50 PPM

SENSOR RESPONSE TIME
3 MINUTES

CHEMICALS TESTED FOR COMPARISON
3 (ACETONE, VINEGAR, BATTERY FLUID)

DPP POLYMER VARIANTS SYNTHESIZED
7

A team led by Johns Hopkins materials scientists has developed a new type of potentially wearable sensor with specially designed plastic-like materials that can be used for environmental monitoring to detect harmful chemicals in the air, including detecting acetone in human breath, which when produced in excess amounts can be a marker for diabetes. Their research appears in the *Journal of Materials Chemistry C*.

"This technology could change the game in how we monitor our health and the environment," says lead author Howard Katz, a professor of materials science and engineering. "Imagine having a small wearable device that could sniff out diabetes through your breath or alert you to dangerous air pollution in real time."

Katz's team set out to modify existing organic field-effect transistors, or OFETs (electronic switches made from carbon-based materials that can change their electrical properties when exposed to chemicals) to elicit heightened electrical responses to volatile organic compounds, including formaldehyde, dimethyl carbonate, and acetone.

"We wanted to create a semiconductor, which is a tiny switch that controls the flow of electricity in these devices, using a polymer we had experimented with before. We adjusted the polymer's molecular composition by attaching aniline, a substance commonly used in dyes, because we thought that it would detect gaseous acetone," he says.

The researchers already knew that diketopyrrolopyrrole (DPP) polymers were good conductors of electricity and that aniline is reactive with acetone. They combined the two to make the device especially sensitive to acetone, creating three polymers with varied concentrations of aniline.

Through controlled experiments in an airtight chamber, the team found that when acetone was introduced at 50 parts per million, the current

> **"This technology could change the game in how we monitor our health and the environment."**
>
> Howard Katz

running through the device decreased—indicating the transistors had recognized and responded to the gas. To ensure specificity, they tested other molecularly similar substances like acetic acid and dimethyl carbonate, confirming the device remained selective to acetone.

"We wanted to make the best combination to allow the most possible current to run through the device while maintaining its high selectivity to detect gaseous acetone," says Katz.

Having fine-tuned their device to achieve maximum sensitivity to acetone, the team is now working to bring their technology to market as a potential wearable or flexible device for health monitoring.

This work was funded by the National Science Foundation's Partnerships for Innovation program.

— CONNER ALLEN

Moon Dust in the Wind

When spacecraft land on the moon, their engines unleash huge clouds of dust and debris that can damage expensive equipment and threaten future lunar bases. As space agencies plan to establish a lasting presence on the moon, understanding how these plumes form has become a critical priority.

A research team led by Rui Ni, associate professor of mechanical engineering at Johns Hopkins, is investigating the complex interaction between rocket exhaust and the lunar surface. Since 2021, Ni's team has focused on regularly spaced dust streaks radiating from touchdown points—a pattern first observed during the Apollo era and seen again during Firefly Aerospace's Blue Ghost lander.

The latest findings from Ni's team, which appear in *Nature Communications*, uncovered the fluid dynamics behind this phenomenon and revealed how the moon's vacuum environment amplifies the behavior of dust particles during descent. "These distinctive patterns are the result of the Görtler instability, where curved exhaust flow creates rotating vortices," Ni says.

Understanding this dust ejecta is a practical necessity—high-speed lunar dust can damage landers, habitats, and solar panels. Ni's research offers essential insights for engineering safer landings and protecting future missions.

— JONATHAN DEUTSCHMAN

STAR Robot Surgery

Johns Hopkins engineers have developed a robot that performed a lengthy phase of gallbladder removal surgery without human help, responding to voice commands and adapting like a novice surgeon working with a mentor. The robot operated unflappably across trials with the expertise of a skilled human surgeon, even during unexpected scenarios typical in real medical emergencies.

"This advancement moves us from robots that can execute specific surgical tasks to robots that truly understand surgical procedures," said team leader Axel Krieger, Engr '07 (MSE), '09 (PhD), an associate professor of mechanical engineering and the Carol Croft Linde Faculty Scholar.

The team described its work, supported by the Advanced Research Projects Agency for Health (ARPA-H), in *Science Robotics*.

Built with the same machine learning architecture that powers ChatGPT, the robot's system, called SRT-H, is interactive, responding to spoken commands and corrections while learning from feedback.

After watching videos of Johns Hopkins surgeons performing the procedure on pig cadavers, the robot achieved 100% accuracy in its surgical performance, demonstrating that autonomous robotic systems can handle complex procedures with remarkable robustness.

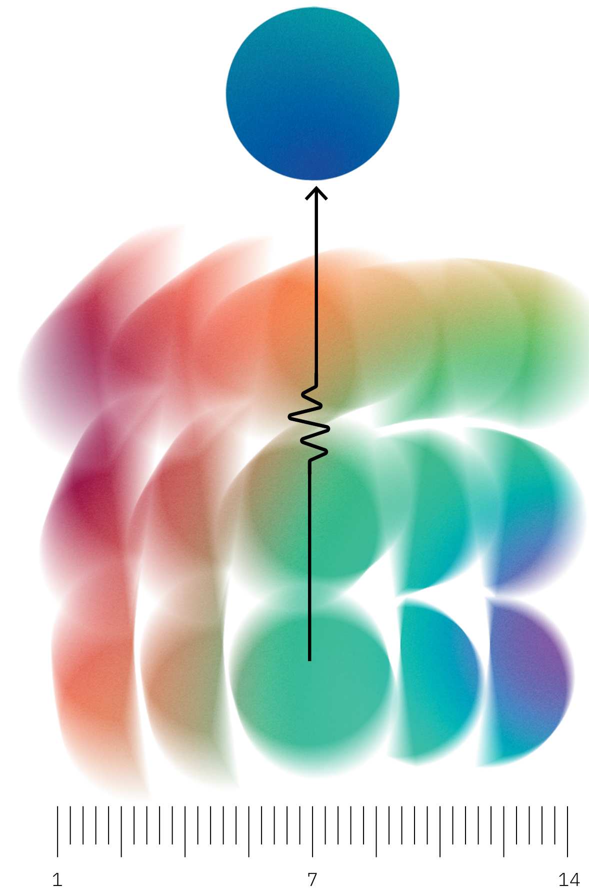
— JILL ROSEN

HOW IT WORKS

Removing Carbon from Wastewater

The process of cleaning wastewater, which flows down our drains and toilets, can drastically raise carbon dioxide (CO_2) levels in nearby waterways due to the release of CO_2 during the breakdown of organic matter and the use of chemicals that contain carbon. Environmental engineer Ruggero Rossi and his graduate student Nakyeong Yun found a new way to reduce levels of this common greenhouse gas by running the treated water through a process that uses an electrical current. Their method, published in the *American Chemical Society ES&T Engineering*, marks a major step forward in decarbonizing water infrastructure.

— LISA ERCOLANO



HERE'S HOW IT WORKS

1. It taps into existing infrastructure.

CO_2-rich treated wastewater is pumped into a cell at the water treatment facility before the water is released. Because it is installed at the end of the process, treatment plants do not need to change their existing processes or equipment.

2. It uses electricity to remove carbon.

The electrochemical cell uses electricity to change the water's pH in opposite directions at once, making it very acidic at the anode and very basic at the cathode. This chemical shift converts the inorganic carbon, in the form of bicarbonate, into CO_2 gas and solid metal carbonates. Both forms can be easily removed, unlike the original bicarbonate. The decarbonized water is returned to the environment. By remixing the solutions flowing out of the cell, the pH is returned to a neutral 7, thereby avoiding any issues downstream of the plant.

3. It can be tweaked to accommodate different wastewater properties.

Geography, seasons, and even the time of day can change the composition of untreated wastewater, meaning carbon-capture cells are not a one-size-fits-all solution. Team members identified key factors, such as conductivity and dissolved carbon content, that affect performance and optimized the system to work with real-world wastewater. Over 50 hours of continuous operation proved the system was stable.

4. It must be powered by renewables to be carbon-neutral.

With just a few adjustments—like tweaking the flow rate or electrode spacing—performance can be improved while keeping energy use low. However, the process still requires power. To ensure the approach stays carbon-negative, it must be powered by renewable energy. At larger scales, this could become a cost-effective addition to carbon removal strategies.

Brandon Bukowski
Associate professor of chemical an biomolecular engineering

Chao Wang
Associate professor chemical and biomolecular engineering

SUSTAINABLE SOLUTIONS

A Greener Recipe for Ammonia

While ammonia production is critical to the world's food supply—up to 90% of ammonia goes toward making fertilizer for agriculture—the process of converting hydrogen and nitrogen to ammonia leaves a significant carbon footprint, contributing to 1 to 2% of global energy consumption and CO_2 emissions annually.

Global ammonia production was nearly 180 million tons in 2021, so any mechanism that uses less energy during production is a net positive. In addition, ruthenium, the catalyst typically used for this reaction, is expensive, and those capital costs matter even if catalysts are recovered after production.

Two chemical and biomolecular engineers, Chao Wang, associate professor, and Brandon Bukowski, assistant professor, have developed a new catalyst that could improve how ammonia is made. Based on experimental and computational studies, their carbon-coated manganese nitride promises to operate at temperatures at least 100°C lower than current catalysts and ensures the integrity of the air-sensitive catalyst until it's activated in situ. Another advantage: Manganese is readily available and about 10,000 times less expensive than ruthenium.

The researchers, who published their results in *ACS Catalysis*, explain that nitrogen vacancies present on the manganese nitride surface readily adsorb nitrogen to gradually weaken the strong nitrogen-nitrogen bond and proceed with the hydrogenation required to produce ammonia. Such an "associative" instead of a dissociative mechanism requires much less activation energy and makes it possible to synthesize ammonia production at lower temperatures and pressures.

"Chemical plants operating the Habor-Bosch process spend a lot of energy to pressurize the gaseous reactants and heat up the reactor. So, reduced operation temperatures and pressures enabled by our novel manganese nitride catalyst would make the ammonia production more energy efficient," Wang explains.

To arrive at the manganese nitride catalyst, Wang and Bukowski ran models to predict the energy it takes to break a chemical bond and evaluated catalysts by their potential to lower that number. While laboratory experiments confirmed the successful use of manganese nitride, molecular models helped confirm the associative mechanism down to the molecular level.

"The molecular model can try to make inferences on the data and shortcut the process of doing very expensive physics calculations," Bukowski says. It took the team hours, instead of days, to crunch the data.

The researchers say that the multiple advantages of manganese nitride for synthesizing ammonia are good news for an industrial process that has long expended too much energy.

— POORNIMA APTE

LORENZO GRITTI

Toward Better Drug Delivery

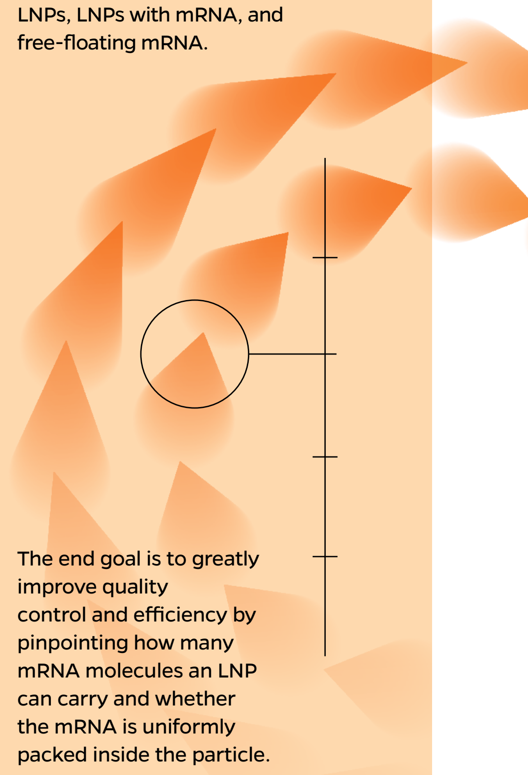
Johns Hopkins engineers have developed a breakthrough technology that could revolutionize how researchers analyze drug delivery systems, providing crucial insights into how medications are packaged and delivered at the molecular level.

The molecular detection platform, called cylindrical illumination confocal spectroscopy (CICS), began development in 2017 and recently received funding from the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL). The project is led by Tza-Huei (Jeff) Wang, the Louis M. Sardella Professor in Mechanical Engineering, and Hai-Quan Mao, a professor of materials science and engineering and director of the Institute for NanoBioTechnology.

Medicine delivery is rapidly becoming smaller and less invasive. One key component is the lipid nanoparticle (LNP), which carries therapeutic mRNA payloads into the body. Currently, it has been challenging to accurately discern how many mRNA molecules an LNP carries and whether the mRNA is uniformly packed inside the particle. The Johns Hopkins team's platform not only makes such detailed analysis feasible but also accelerates the process while creating a more compact and user-friendly system.

"Current analytical methodologies and techniques cannot provide this really granular information," says Sixuan Li, Engr '24 (PhD) a postdoctoral fellow who has worked on the project since his PhD studies. "Our primary focus has been to develop a really capable technology to precisely analyze and report these critical parameters."

The CICS platform works by tagging mRNA and LNP components with fluorescent signals and passing the sample through a detection plane. The detection plane reads the fluorescent signals and measures their intensity before comparing the strength of their intensities with that of a single mRNA molecule. This allows researchers to peer inside nanoparticles and differentiate between empty LNPs, LNPs with mRNA, and free-floating mRNA.



The end goal is to greatly improve quality control and efficiency by pinpointing how many mRNA molecules an LNP can carry and whether the mRNA is uniformly packed inside the particle.

"Even if doctors know that 100% of the mRNA has been loaded into the injection medium, they don't know that it's all been loaded evenly into the LNPs themselves," Li said. "A percentage hasn't loaded well or at all, resulting in inconsistent treatment."

Private pharmaceutical companies have shown interest, and with further refinement, CICS could potentially be used in the drug manufacturing pipeline, the researchers say.

— JONATHAN DEUTSCHMAN

QUIZ ME

Can AI Outperform Doctors?

An AI model developed by biomedical engineer Murray B. Sachs Professor Natalia Trayanova and her team is more accurate than doctors at spotting which patients with hypertrophic cardiomyopathy—a common inherited condition that thickens the heart muscle—are most likely to suffer from sudden cardiac death. The linchpin is the system's ability to analyze long underused heart imaging, alongside full medical records.

TAKE OUR QUIZ TO LEARN MORE

Hypertrophic cardiomyopathy, the condition at the study's center, affects:

A. 1 in every 2,000 people

B. 1 in every 200–500 people

C. 1 in every 20,000 people

Answer: B
About 1 in 200–500 people worldwide live with this disease. Most lead normal lives, but some face a much higher risk of sudden cardiac death, particularly young people and athletes.

Current guidelines for spotting high-risk patients are accurate about:

A. 90% of the time

B. 50% of the time

C. 25% of the time

Answer: B
Just 50%—"not much better than throwing dice," says Trayanova, senior author of the study, which was published in *Nature Cardiovascular Research*.

What makes the new Johns Hopkins AI model, nicknamed MAARS (for Multimodal AI for ventricular Arrhythmia Risk Stratification), different?

A. It studies DNA sequences

B. It can read MRI heart scans in a way doctors cannot

C. It listens to heartbeats through smartwatches

Answer: B
For the first time, AI can detect scarring patterns in MRI images that doctors have struggled to interpret, combining that with other medical data to sharpen risk predictions.

When tested on real patients, how accurate was MAARS?

A. 63%

B. 75%

C. 89%

Answer: C
89% overall—and 93% for patients aged 40 to 60, the group most at risk.

Beyond saving lives, what's another benefit of MAARS?

A. It eliminates MRIs

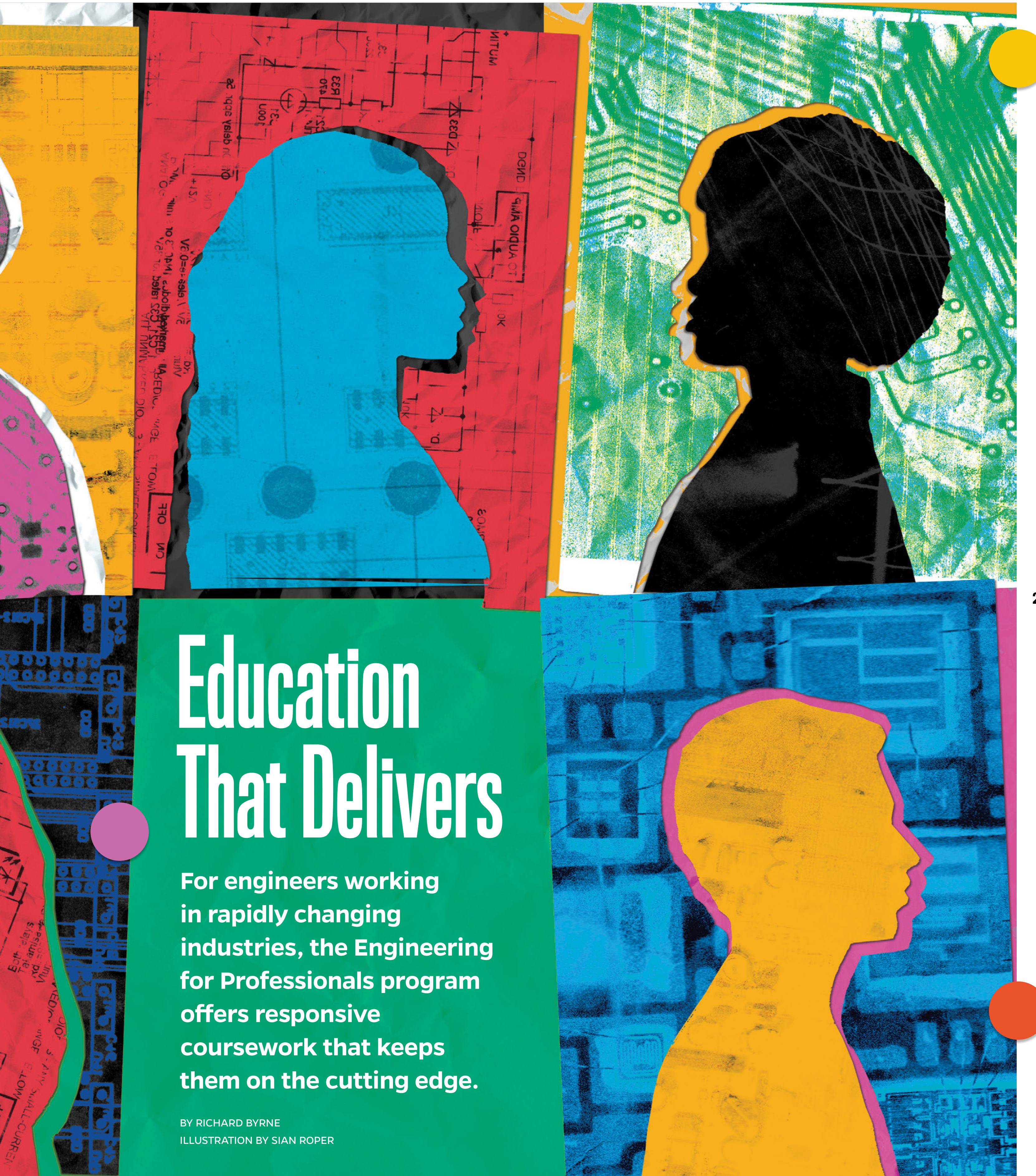
B. It could spare patients unnecessary defibrillator implants

C. It requires no medical records

Answer: B
Many patients receive defibrillators that they may never need. By predicting outcomes more precisely, MAARS could help doctors avoid the cost and risks of those unnecessary procedures. The team plans to expand the model to other heart conditions, potentially transforming clinical care.

INQUIRING MINDS
STUDENT DISCOVERY

ALSO IN THIS SECTION



Education That Delivers

For engineers working in rapidly changing industries, the Engineering for Professionals program offers responsive coursework that keeps them on the cutting edge.

BY RICHARD BYRNE
ILLUSTRATION BY SIAN ROPER

Scott Heines' experience as a student in Applications of Power Electronics Design began with the delivery of a big box.

The package arrived before the first session of the online course offered by Johns Hopkins' Engineering for Professionals (EP) program. It contained all the gear required to create and test a working circuit board that is the students' final class project.

"I'm a pretty hands-on engineer," says Heines. "I learn best by being able to apply things going on in the classroom or in lectures. So this was very exciting."

Juan Ramirez, a senior staffer at the Applied Physics Laboratory, teaches the course. (He won a 2023 faculty award for designing it.) He notes that each box contains an assortment of different electrical components—including a resistor, capacitor, and magnetic cores.

"Enough is provided that they can go ahead and build the circuit to whatever their design is," says Ramirez. "They wind their own magnetics. No two students will have the same exact transformer, because they're designing their own."

Northrop Grumman engineer David Clancy took the course in spring 2025 as part of his work toward a master's degree through the EP program. He says that the box—and his sense of accomplishment in assembling its contents—"is something I didn't get with any other course I have taken."

Ramirez says that even though his course is fully remote, like all EP offerings, it's important to him to offer a hands-on component. "A lot of students go through their undergraduate education in electrical engineering and maybe never get the opportunity to learn how to solder electrical components onto a circuit board," he says. "They have that opportunity in this course. We send them a solder station in the box."

Juan Ramirez
Senior staff member at the Applied Physics Laboratory

"A lot of students go through their undergraduate education in electrical engineering and maybe never get the opportunity to learn how to solder electrical components onto a circuit board. They have that opportunity in this course."

Juan Ramirez

RESPONSIVE TO INDUSTRY

The course balances flexibility and academic rigor in a way that EP students find both attractive and useful. Yet Ramirez's course took shape in response to students' desire to put the learning acquired in prerequisite courses into direct practice.

"When I was starting my work in industry, and even being involved with recruitment and mentorship as I was progressing in my career, I was continuing to see this same discussion about the gap between the fundamentals that we learn in school and how to actually apply them," Ramirez says.

Dan Horn, A&S '92 associate vice dean for professional education and lifelong learning at the Whiting School, says that finding and filling these gaps is the center of the EP enterprise. "The program chairs do a magnificent job of surveying industry, identifying critical needs, and building coursework to help Engineering for Professionals students meet those needs," he observes.

Existing program faculty are the engine for EP offerings, continues Horn, "but if we don't have someone who can teach a particular course in a new area, we recruit an expert in the field to develop and deliver that course. What sets EP apart from our peers is that our faculty are in roles to which students aspire." Instructors for the EP program have been drawn from AT&T, KBR, and the U.S. Army Research Laboratory to teach courses in areas such as Generative AI for Cybersecurity, Advanced Concepts in Agile Technical Management, and RF Power Amplifier Design Techniques.

The skills developed by EP students boost their career trajectories as well. Clancy is close to finishing his master's degree with support from Northrop Grumman. He adds that a course like Applications of Electrical Power Design "allows me to essentially have a practice run before I have to go do it in my professional career. I made all the mistakes when it didn't really matter.... Now I have the knowledge to just build something, test it, and capture my own data."

Satisfaction with EP offerings is a two-way street with benefits for recruiting and the mobility of seasoned engineers, says Raytheon's Raul Almazan, who is an engineering technical leadership development lead at the aerospace and defense company. As a key corporate partner with the EP program in systems engineering, Raytheon selects annual cohorts of 20 to 24 employees to enter Johns Hopkins' Master's in Systems Engineering program, Almazan notes.

Raytheon's collaboration with the EP program "is built upon our own priorities," he says. It has become a key element both in the company's success in recruiting talent, as well as in creating "a mobility ladder for all of our employees who are in the cohorts." Raytheon has graduated over 500 people through the EP program.

"It's been a great opportunity to accelerate career development and talent pipelines," says Almazan.

TEAM LEARNING

Successful online education requires active shepherding of enrolled students—especially the widely scattered cohorts that take challenging courses in addition to navigating their busy working lives. So Ramirez designed the class to have multiple checkpoints to assess progress. He also encourages students to create teams to provide each other with a steady stream of peer feedback.

Heines says that it was a highly effective tactic: "My team was a team of three, because there were three of us on the West Coast, so it made sense from a time zone perspective." The safety net offered stability and structure for the experience. "There was only so far that you would stumble before you had an obvious check-in point where Juan, or somebody else, could help you," he says.

Clancy says he enjoyed the opportunity that Applications of Power Electronics Design provided to "apply theory to actual application. A lot of time, theory gets applied to simulation—and simulation doesn't always actually model the real world."

Student responses such as these are something that Ramirez finds satisfying. "The thing that is most exciting to me is their excitement when they've got a physical board that they designed from scratch, and built, and have tested. Some students have taken previous coursework and learned the fundamentals but never really had to put that all into practice. This is an opportunity for them to build something that actually works."

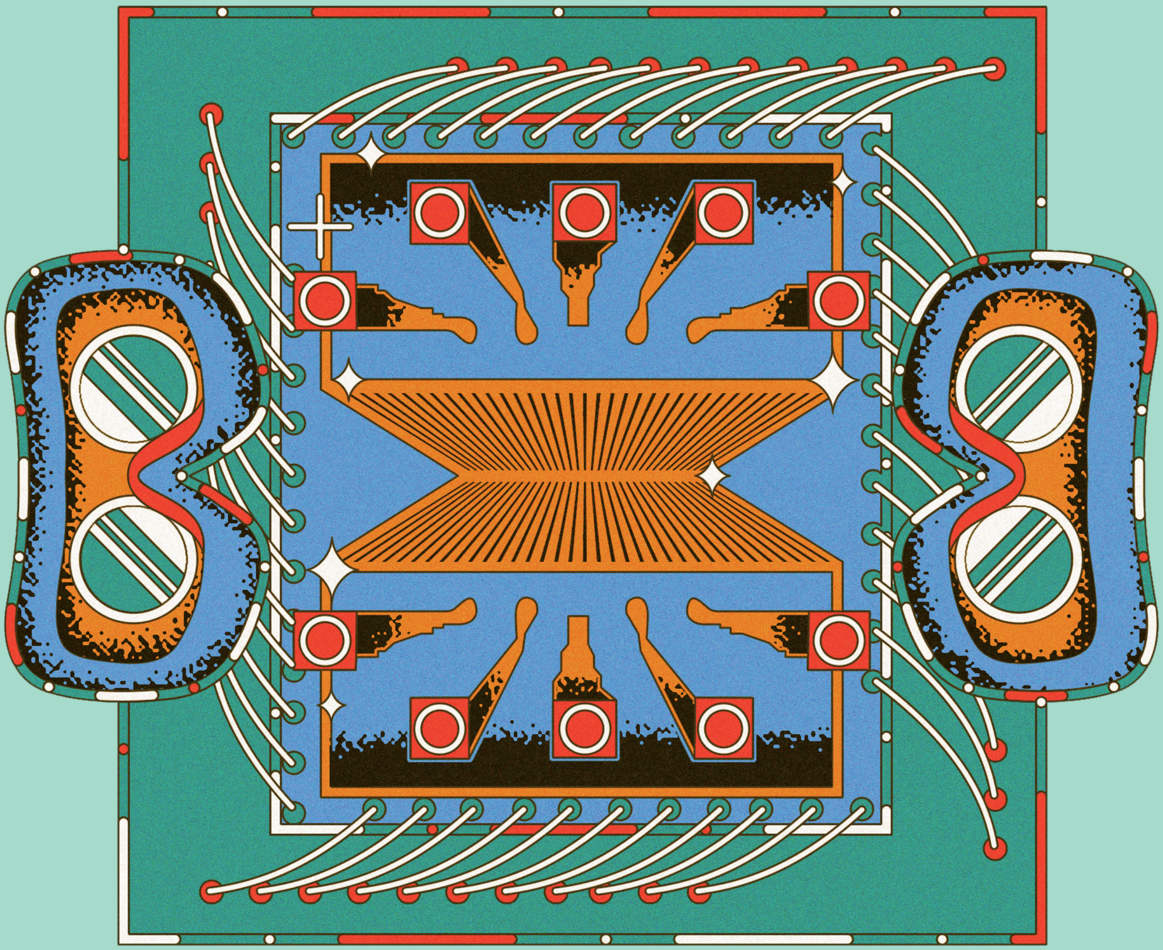
Heines says that he held onto the board he made for his final project in 2023 and keeps it close at hand. "I've shown this to people on job interviews since that class has ended," he continues. "[Interviewers] always want to know:' 'What have you done?' You can hold up the board and say: 'I built this, and it works.' It really does give you that sense of pride and accomplishment."

"The program chairs do a magnificent job of surveying industry, identifying critical needs, and building coursework to help Engineering for Professionals students meet those needs."

Dan Horn

"[The program] applies theory to actual application. A lot of time, theory gets applied to simulation—and simulation doesn't always actually model the real world."

David Clancy



CHANGE AGENTS

Microchips, Major Vision

While his kindergarten contemporaries were stacking Lego bricks, Jacob Heisler was building electronics. With one grandfather working in the energy industry and the other for IBM, technology was in his blood. “Between the two of them, they had me building a lot of circuits and learning how to solder,” remembers Heisler. Those early skills stuck with him, leading to his first job at age 12 in his family’s microelectronics manufacturing business in York, Pennsylvania—a role he grew into over the years, ultimately serving as the company’s engineering manager until 2024.

Now a student in Johns Hopkins’ Engineering for Professionals program, Heisler is pursuing a master’s degree in electrical engineering with a focus on solid-state devices. At the same time, he is running his own venture: Heisler Semiconductor, a prototyping and design for manufacturing firm he launched in July 2024. Early support from his University of Maryland professors and UMBC’s SCALEUP Maryland accelerator proved critical, with both institutions becoming some of his first customers. In just over a year, the company has earned the trust of universities, startups, and military contractors, bringing in about $20,000 in monthly sales.

“The average person interacts with 1,000 semiconductors every day without realizing it,” Heisler explains. Semiconductors—materials like silicon—allow electricity to be controlled with extreme precision, making them the foundation of microchips that power everything from smartphones to solar panels.

Much of the U.S. semiconductor industry was outsourced overseas in the 1980s, particularly to Taiwan and other parts of Southeast Asia. Recent legislation, including the CHIPS and Science Act, aims to bring more manufacturing back to the U.S. But large West Coast firms dominate the market, leaving smaller companies needing microchips underserved.

“We work with universities and startups that need niche, one-off prototypes. If that one sample doesn’t function, their budget is gone and the project ends,” says Heisler. “A lot of organizations wouldn’t put in the care and effort needed to make these products successful.” He says Heisler Semiconductor differentiates itself by offering hands-on partnerships, competitive pricing, and integration into clients’ supply chains, ensuring a smooth transition from prototype to production. The approach has already garnered repeat business, from companies designing products ranging from communications systems to wearable medical devices and virtual reality goggles.

Despite his technical background, Heisler knew he needed to strengthen his business skills. At the suggestion of Megan Howie, Johns Hopkins Engineering’s senior associate dean of corporate and global partnerships, he applied to the Pava Marie LaPere Center for Entrepreneurship’s Fuel program, a venture accelerator for student entrepreneurs, designed to help committed ventures get market/investor ready. The program provided training, networking, and mentoring from legal and financial experts, helping Heisler hone critical skills just a few months after Heisler Semiconductor’s launch.

“We worked closely with Jacob on refining his storytelling and improving his business plan,” says Paul Davidson, the Pava Center’s associate director. “Jacob started the cohort with strong product and technical experiences, but in order to grow, founders must help customers and investors understand why

Heisler can provide the best solutions to their needs."

Perhaps the program's biggest benefit was helping Heisler build a team. After the offshoring of semiconductor knowledge decades ago, the last remaining industry professionals in the U.S. are now retiring, leaving an inexperienced workforce to take up the reins. Today, four of Heisler Semiconductor's employees are Johns Hopkins students. "I'm creating a talent pipeline from Hopkins and other universities to help close the knowledge gap—especially here on the East Coast," he says.

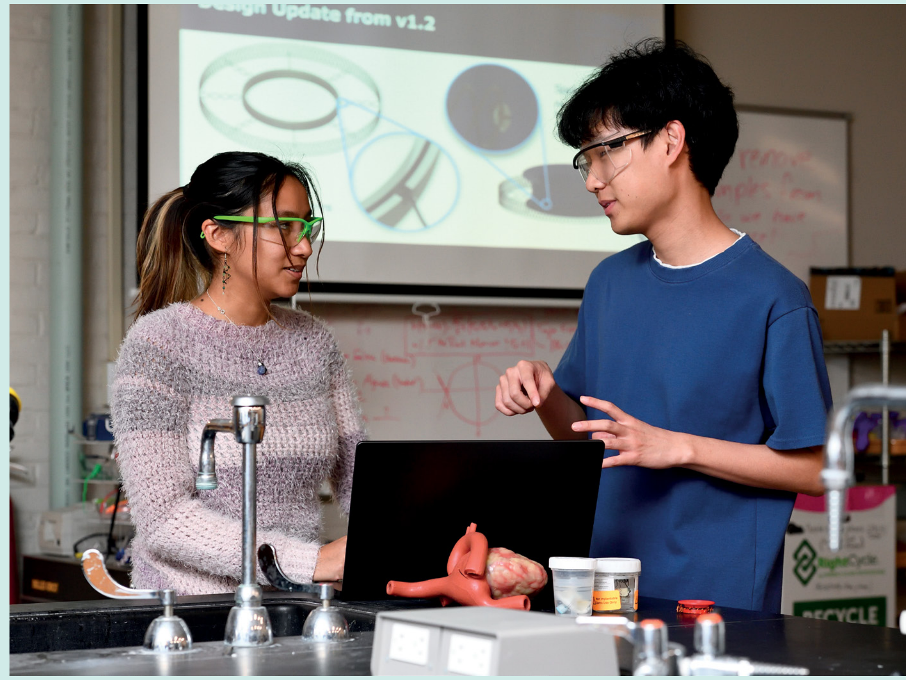
Davidson agrees. "There is enormous potential in the Baltimore–D.C. region for Jacob's venture to support government, university, and industry innovation. We look forward to continuing to support his growth."

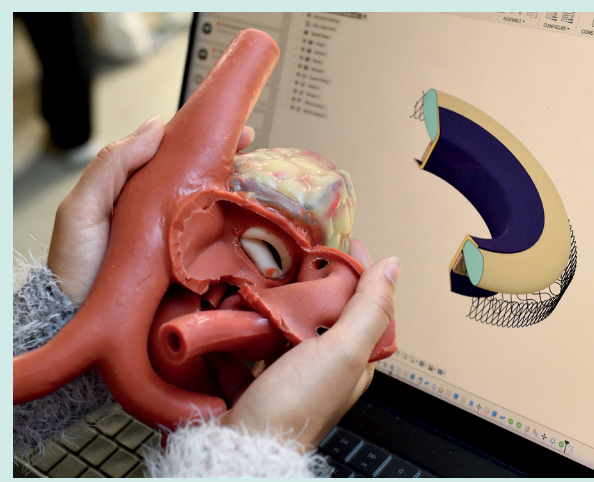
"I'm creating a talent pipeline from Hopkins and other universities to help close the knowledge gap–especially here on the East Coast."

Jacob Heisler

Looking ahead, Heisler Semiconductor is developing its flagship technology: 3D chip stacking. "Most chips today are arranged on a flat, 2D plane," Heisler explains. "Stacking them vertically allows for smaller devices with greater computing power." While large manufacturers have invested heavily in this approach, mid- and low-volume producers can't access it at scale. "That's the gap we're trying to fill."

— ERIN P. LEWIS





AARON LOWELL DENTON

Skipping the Stitches

Heart valve replacement is one of the most common cardiac surgeries, but it comes with a time crunch. Surgeons can spend up to an hour stitching a new valve in place while the patient's heart remains on bypass. Every extra minute increases surgical risks.

A team of undergraduate materials science and engineering students is developing a solution: an artificial mitral valve for the heart's left side that doesn't require stitches. Their design uses a flexible nickel-titanium alloy mesh that expands to push against the surrounding tissue, potentially making heart surgeries simpler and safer for patients.

The project emerged from the Whiting School's design program, which challenges students to tackle real-world problems with innovative solutions. The team presented its solution at last spring's Design Day but continues to refine its prototype.

"A heart surgeon at Johns Hopkins Hospital approached us with this challenge because aortic surgery is already sutureless, but mitral valve replacement still requires all that time-consuming stitching. We wanted to bring that same efficiency to mitral valve procedures," says team leader Vara Qi Gunananthan.

During their research, the students learned that their valve would need to be versatile enough to fit a range of irregular valve shapes caused by calcification, which occurs when calcium buildup causes heart valves to stiffen.

"Our prosthesis must conform to the shape of calcified valves and push against them with enough force to secure itself against the pressure of the heart pumping," says Gunananthan.

The team is using computer-aided design (CAD) to conduct simulations using their model.

"Moving forward, we want to continue testing and eventually find a manufacturer to produce the nitinol mesh with the prosthesis so we can test our simulations in real life," she says.

Gunananthan is working with Olivia Smith, Katalin Maji, Charlie (Yucheng) Sun, Jay Kim, Tyler Lee, Admy Palacios-Gonzalez, and Andrea Wat on the project.

— CONNER ALLEN

On the Trail of Carbon-Negative Cement

An army of sustainability-minded scientists is currently working on ways to remove the leading greenhouse gas, carbon dioxide, from the air. “Humans generate those emissions. We should be able to remove them,” says one of those scientists, Hadas Elazar-Mittelman, Engr ’23 (MSE), a doctoral student in the Department of Materials Science and Engineering, who has made carbon sequestration the focus of her research at the Ralph O’Connor Sustainable Energy Institute (ROSEI).

Noting that a remarkable 8% of all carbon dioxide in the atmosphere is produced during the manufacturing of a single product, cement, Elazar-Mittelman has taken on that particular source as her cause. Many carbon sequestration scientists are working to turn captured carbon dioxide into other valuable products, like alcohols, which can be used as sustainable fuels. Unfortunately, with fuels, the carbon simply returns to the skies when the fuel is burned. That is, the carbon is sequestered only temporarily.

Elazar-Mittelman is instead turning harvested CO_2 into solid carbon that can be used in new cement—sequestering it permanently. Her recent work is focused on scaling up a promising CO_2 conversion reaction that uses magnesium as the reducing agent.

“The reaction between CO_2 and magnesium vapor yields a carbon-ceramic nanocomposite with high hardness and compression strength that can be blended into new cement,” she explains. “This way, the captured CO_2 can be permanently stored as a solid.”

So far, the reaction has only been conducted on small scales because the heat generated is so intense. On the other hand, Elazar-Mittelman says, “all that heat can be used in cement-making, so I think we can potentially make carbon-negative cement.”

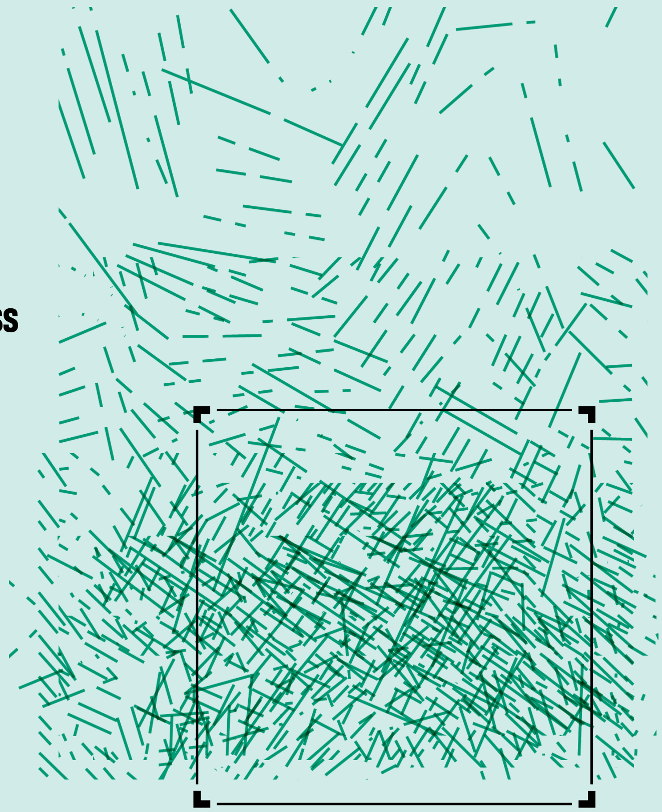
This work requires a deft blend of cross-disciplinary engineering skills, evident in the fact that Elazar-Mittelman has two doctoral advisers, Jonah Erlebacher, professor of materials science and engineering, and Michael Tsapatsis, Bloomberg Distinguished Professor of chemical and biomolecular engineering.

Elazar-Mittelman is now working on ways to do the CO_2 conversion at larger scales and studying how this carbon product can be integrated into cement. “This technology will only make sense if we can bring down the cost to compete in a sector defined by high volumes and razor-thin margins,” she says.

— ANDREW MYERS

“The reaction between CO_2 and magnesium vapor yields a carbon-ceramic nanocomposite with high hardness and compression strength that can be blended into new cement”

Hadas Elazar-Mittelman



COURSE AUDIT

Taking Flight

For students taking the Aerospace Structures course, words are not minced on the first day.

“I will treat you as I would any newly hired engineer,” says Tom Dragone, adjunct professor of mechanical engineering at the Whiting School, a program listed as No. 10 in *U.S. News and World Report*’s annual ranking of graduate programs, and technical fellow/chief scientist at Northrop Grumman Corp. “You will often feel overwhelmed and underprepared, which is how you commonly feel in the industry.”

With his decades of experience in the aerospace industry, Dragone takes his class of master’s students and undergraduates through the history of flight engineering, from the Wright Brothers to the space shuttle. The course culminates with a multiday, out-of-class design project related to a single aerospace vehicle structure.

KEY TAKEAWAYS

TAKING WING ONE STEP AT A TIME
Students learn the universal elements of aircraft engineering—functionality, load bearing, stability, durability, economy, and safety—through lectures, readings, problem sets, and a trip to the National Air and Space Museum’s Steven F. Udvar-Hazy Center.

SOMETIMES YOU HAVE TO FALL BEFORE YOU CAN FLY
Dragone stresses the importance of failure—and learning from what didn’t work. By going through the evolution of terrestrial and eventual spaceflight, and having students work through exponentially challenging problem sets, they learn that failure is part of the process.

BUILDING A REAL AIRPLANE, NOT JUST A PAPER ONE
“This course gives you an opportunity to get insight from an industry perspective, not an academic perspective, which I think is really valuable,” Dragone explains to his students. “The skills you learn are skills that you can use on your first day at the job, should you decide to choose a career in aerospace structures design.”

— JONATHAN DEUTSCHMAN

“With its emphasis on using spreadsheets to solve our homework questions, this [course’s] form of problem-solving seems more applicable to the professional engineering environment, so I thought it would be a great course to take before I start my full-time job.”

Grace Nockolds, Engr ’25, mechanical engineering master’s student

“The capstone of the course is where the students pull it all together. And it’s also the most challenging.”

Tom Dragone, adjunct professor of mechanical engineering and instructor in Engineering for Professionals programs

“I am [particularly] interested in the final project, where we get to design our own wing box, and then build and test it.”

Alexander Pivovarov, Engr ’25, mechanical engineering master’s student

JOSE SACCONE

A New Era for Organoids

By mapping the myriad cells in human organs with 3D precision, Denis Wirtz and his team are growing living human tissues in the lab.

BY ANDREW MYERS

Researchers have long grown three-dimensional living tissues called organoids to study how healthy tissues work, what happens when disease strikes, and to test new drugs and other therapies, all without risk to humans. Now, a team led by Denis Wirtz, the Theophilus Halley Smoot Professor of chemical and biomolecular engineering and vice provost for research, is mapping entire organs in exquisite detail, cell by cell, creating tissue blueprints that allow scientists to culture organoids with far greater precision.

Wirtz's team built the first complete 3D cellular model of the human pancreas, revealing that most people have precancerous lesions previously considered definitive cancer markers. Wirtz likens these lesions to skin moles: Many people have moles, but not all become cancerous.

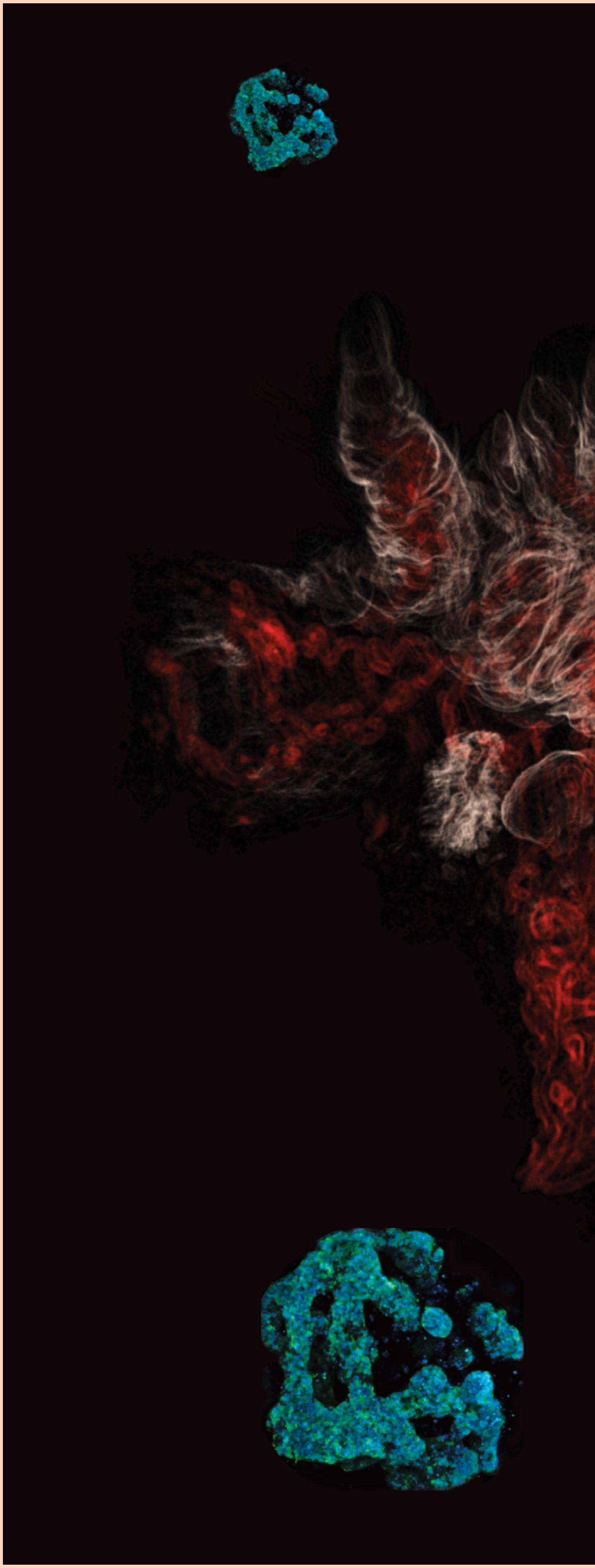
Such knowledge can serve as a guardrail against expensive and unnecessary overtreatment. He's done similar work on ovaries, fallopian tubes, and endometrial tissues to study ovarian cancer and endometriosis. His team even mapped every cell in a fetal rhesus macaque monkey, Wirtz says, cueing up a dramatic illustration.

"This is the first-ever 3D reconstruction of the auditory system of any organism. The nervous system. The skeletal system. The GI tract. The whole urinary system," Wirtz says.

The crux of their approach is their ability to identify and locate every cell type in a tissue sample at submicron resolution across the entire organ.

"We have this completely cutting-edge computing advantage," Wirtz says. "With it we can see, 'Oh, epithelia go here, muscle here, blood vessel over there.'"

The result is not just finely accurate 3D digital models, but better blueprints for bioprinters to realize a new era of organoid science. "We're building next-gen organoids. Maybe from here we can really go nuts and not do one organ but 25, because … why not?" Wirtz asks. "Now, we have the tools to do it."



IN 3D

Left: Image of a human fallopian tube alongside organoids developed by Wirtz's research group. These 3D maps aid in culturing biomaterials in vitro that replicate the complexity of real organs and potentially can contribute to advances in 3D bioprinting.

ASHLEIGH CRAWFORD

"We're building next-gen organoids. Maybe from here we can really go nuts and not do one organ but 25, because... why not? Now, we have the tools to do it."
Denis Wirtz

PATHWAYS TO ENTREPRENEURSHIP

Faculty turn their discoveries into impactful commercial ventures.

BY ADAM HADHAZY
ILLUSTRATION BY MARIA CORTE

"Through one or more of the entrepreneurial pathways, we're here to support faculty on their journey, especially junior faculty who are new to this kind of enterprise."

Elizabeth Burger

Benefiting society is a prime motivator for many scientists and engineers. A direct way to pursue this aim is via entrepreneurship, where discoveries in the lab can translate to the commercial sector. Yet for many faculty members, finding the time to launch a business, given their myriad other responsibilities, is inherently daunting.

To help navigate the challenges of entrepreneurship at Johns Hopkins, the university established a tech incubator, Johns Hopkins Technology Ventures (JHTV), over a decade ago. JHTV guides researchers on whichever path makes the most sense for their particular innovation. The paths available include creating a startup company (often the most readily thought of), as well as obtaining a patent or seeking corporate collaboration and licensing opportunities.

"We work with a lot of faculty to get their ideas out of academia and out into the world," says Elizabeth Burger, the senior director of strategic initiatives at JHTV. "Through one or more of the entrepreneurial pathways, we're here to support faculty on their journey, especially junior faculty who are new to this kind of enterprise."

One young faculty member who is working with JHTV to realize the profound potential of his research is Jude Phillip, Engr '15 (PhD), an assistant professor of biomedical engineering who joined Johns Hopkins in 2023. His lab focuses on developing technologies that can predict and modify aging trajectories, overall helping people live healthily into their 70s, 80s, and beyond. "We're applying engineering to aging research," says Phillip. "We want our work to have an impact on people, whether it be through clinicians or hospital systems or right-to-end users."

Boosting older adults' welfare is a largely unmet and increasingly dire issue; by the mid-2040s, it's estimated that more people will be over 60 than under 18 years of age across much of the developed world, including the United States. Given this urgency, Phillip and colleagues are presently exploring all three entrepreneurial pathways. Over the last few years, the researchers have submitted several reports of invention to Johns Hopkins. These discoveries are presently being evaluated for potential patenting or commercial application by JHTV, which meets with Phillip regularly to offer development feedback and strategy.

Meanwhile, companies in the pharmaceutical and venture capital spaces have also begun reaching out to Phillip about possible partnerships, investment, and licensing. In light of such buzz, Phillip and his team are additionally considering creating their own startup, again leveraging JHTV's expertise. "We have a lot of ways we can go at this time, and JHTV has been super-instrumental in getting us to this stage," says Phillip, who serves on the JHTV faculty advisory committee.

One key discovery from Phillip and colleagues is that senescent cells—aged cells that no longer divide and proliferate—are not all the same, as had been thought. Studies have tied the buildup of senescent cells to age-related disease, due to these cells releasing pro-inflammatory molecules that degrade tissue function. Phillip revealed, however, with machine learning and imaging techniques that at least three subtypes of senescent cells exist, only one of which strongly correlates with unhealthy aging.

Those findings, in turn, have spurred development of screening platforms for gauging how different senescent cell subtypes respond to so-called senolytics—an emerging new drug class that targets senescent cells and could, in theory, lessen the brunt of some age-related maladies. "The goal here is not to

"We have a lot of ways we can go at this time, and JHTV has been super-instrumental in getting us to this stage."
Jude Phillip

Below: Jude Phillip, assistant professor of biomedical engineering. Right: Alex Marder, assistant professor of computer science.

kill all senescent cells, because some have beneficial roles," says Phillip. "We just want to kill the bad ones."

Phillip and his colleagues continue to mature their techniques while assessing the most advantageous entrepreneurial approach. In this vein, JHTV has also connected Phillip with alumni entrepreneurs who've successfully pushed out companies, as well as hosted lunch-and-learn workshops where businesspeople have shared their startup, patent-filing, and licensing experiences.

"We're really excited about what our work could do for the critical challenge of aging populations," says Phillip.

SECURING NEXT-GENERATION COMMUNICATIONS

Another junior faculty member walking the entrepreneurial path is Alex Marder. Like Phillip, he joined Johns Hopkins a couple of years ago. Marder's research centers on enhancing the security of 5G communications networks, initially for use by the Department of Defense (DoD). 5G is continuing to roll out worldwide, offering much higher speeds and data capacities than today's 4G. For the federal workforce, though—especially the military—accessing new, public 5G can pose significant security concerns because third-party network infrastructure might contain unknown and untrusted hardware. As a result, sensitive communications could be intercepted by adversaries.

"The issue is that the DoD needs to be able to use cellphones and other devices, both tactically and not tactically, in military and other settings, and it's not yet known how to do that securely," says Marder, who is an assistant professor of computer science. "But we've come up with a solution."

Marder and colleagues have developed mobile device software that can identify the hardware on cell towers before the device proceeds with data transfer. Rather than trying to fingerprint hardware through physical properties of manufacturing, as prior approaches have explored, Marder's platform instead observes the behavior of the hardware. That behavior gives telltale signs that reveal the hardware's maker, helping DoD workers to assess and avoid risks.

"The phone basically looks at the equipment that lives on the cell tower and even beyond, and gauges if this is equipment we want to be connecting to," says Marder.

To commercialize the technology, Marder and colleagues created a startup last year called Revelare Networks (pronounced "rev-UH-layr," derived from a Latin word meaning "reveal"). The company, supported by DoD funding, has now grown to seven

employees and is further implementing Marder's network visibility and reliability tools. Field testing has also begun, with Marder and team having recently shipped several phones to U.S. Special Forces in Okinawa to vet cellular networks.

JHTV has advised Marder through the startup process which, he says, is indeed significantly time-consuming, as one might expect. To help shoulder the load, Marder and colleagues have outsourced some of the chief financial officer-centric tasks to an outside company, and may look to bring in a fractional or full-time CEO down the road.

Marder has also filed two patents for the underlying technology, with one of the patents going through Johns Hopkins and receiving process assistance from JHTV on how to protect as much of the intellectual property as possible. "JHTV has been an invaluable resource for us," says Marder.

Marder's hope is—as has happened previously with technological innovations like the internet and the Global Positioning System—that his team's 5G-securing technologies are proven effective in the defense sector and will eventually translate to the everyday civilian sector. "We're looking forward to seeing Revelare grow and our tools potentially allowing everyone to have a secure 5G experience," says Marder.

"JHTV has been an invaluable resource for us. We're looking forward to seeing Revelare grow and our tools potentially allowing everyone to have a secure 5G experience."

Alex Marder

CHANGE MAKERS
ENTERPRISING ALUMNI

ALSO IN THIS SECTION

The Perfect Blend

Data is key for distillery manager Courtney King.

BY MARY ZAJAC

Despite the current rise of cocktail culture, it's a good bet that most of us order our Old Fashioneds or Manhattans without a lot of consideration about how the spirits in our glass are produced. But not Courtney King, Engr '18. King's role as distillery manager—the person responsible for running all operations—at Bulleit Distillery in Shelbyville, Kentucky, has her thinking about bourbon most hours of the day.

"We are a 24-7 facility," King explains. "I may go home each night, but the plant doesn't stop running."

King's path to the distilling world was serendipitous. While still a chemical and biomolecular engineering student at Johns Hopkins, she knew she wanted a career focused on manufacturing but couldn't pinpoint the right field. When her father casually joked that if she took a job far from her Virginia home, she should be living somewhere and doing something that would make her family want to visit. It was, she says, "a lightbulb moment."

"I can't imagine not being in this industry. I love it. It's like that perfect blend of engineering and art."
Courtney King

Keeping in the back of her mind her family's love of food and drink, and focusing her search on companies that had leadership training, King discovered Diageo, the parent company of high-profile beverage brands like Tanqueray, Guinness, and Johnnie Walker. She submitted an online application, was called the next day for an interview, and was hired soon after.

After completing three one-year rotations in manufacturing, project management, and what Diageo calls "Manufacturing Excellence"—a deep dive into learning the company's business model—as part of the company's supply leadership development program, King moved to Bulleit Distillery in 2022 as a distillery team lead. Just under a year later, in January 2023, she was promoted to distillery manager, where she oversees the entire production process from the intake of raw materials through mashing, fermentation, and distillation.

A distillery manager, says King, does "a little bit of everything."

Courtney King,
Bulleit Distillery Manager

She evaluates the quality of grain used to make the liquid—industry speak for the variety of products a distillery produces—and builds out annual plans that help her extrapolate the amounts of raw material, including grain, yeast, enzymes, and barrels the distillery will need. "When we're actually in the weeds of production," says King, "I look a lot at our conversion efficiency—how well are we converting our starches in the grains we're receiving into sugars and then alcohol. I'm looking at the quality of that liquid and making adjustments as needed."

Although much of King's current work focuses on planning and special projects, she says she calls on her chemistry and engineering backgrounds on a regular basis.

Bulleit's quality control team routinely uses HPLC (high-performance liquid chromatography) to identify components in a sample and NIR (near-infrared spectroscopy) to analyze starch content in grains. "I took a materials class at Hopkins as an elective," King recalls. "And I remember going through a lot of those analytical instruments, and here I am using them again."

There's also more engineering involved in distilling than most people might think, says King. Historically, bourbon production has focused more on the art of production: Each producer would tweak a traditional method or combination of ingredients to produce a signature style in small batches, she explains. With the rise of larger companies relying more on automation, she says, the depth and breadth of available production data to analyze and track have grown.

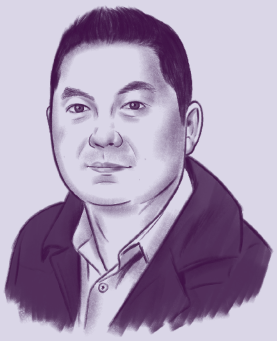
"I've got data that I'm analyzing all the time," says King. "I look at quality data, temperatures, flow rates, proofs, mass balances, and heat balances."

"When I first started in the industry, I knew separations and heat transfer from my classes at Hopkins," she says. "In fact, our professor used distillation and whiskey production as examples for separation! Still, I didn't expect to use these lessons on a day-to-day basis as much as I do."

King adds that in retrospect, another required class at Johns Hopkins—focused on soft skills and taught by Bob Graham in the school's Center for Leadership Education—made a significant impact on her career. "I've had five roles in six years," she says. "I wouldn't be where I am without the soft skills. The technical stuff you can learn. To communicate effectively, to have difficult conversations, to write an email professionally—those things are core to what I do now."

King says she is thrilled to be a part of Bulleit and to work with people who share in the joy of producing a quality product.

"I can't imagine not being in this industry," she says. "I love it. It's like that perfect blend of engineering and art."



FASTER DIAGNOSIS

Breaking Barriers to Autism Care

Every year, thousands of families in the U.S. wait months—sometimes much longer—for an autism diagnosis for their child. Without that diagnosis, insurance won't cover vital therapies, and treatment delays can have lifelong consequences. "It's the biggest barrier to care," says Justin Ho, Engr '00. "You can't access services if you don't have the paperwork, and that paperwork is very hard to get."

Ho decided to change that. In 2021, the Johns Hopkins biomedical engineering graduate founded a telehealth psychology clinic, Jigsaw Diagnostics, which is focused on speeding up autism evaluations for children. The mission was clear: cut monthslong diagnostic wait times to just weeks and make care accessible to more families.

"Without a diagnosis, kids can't access critical services, and those services can cost up to $70,000 a year without insurance," he explains. "We're ending that bottleneck."

The clinic—which has 12 clinical psychologists on staff—has already served more than 2,500 families and currently sees 130 to 140 new patients each month, most of them referred through insurance companies. "We're building the kind of system that should have already existed," he says.

Ho, who moved from Taiwan to New Jersey at age 10, has always wanted to make an impact. "I was interested in health care from the start," he says. "But I didn't want to become a doctor. I wanted to use engineering to help more people at scale."

That mindset drew him to Johns Hopkins. "Biomedical engineering teaches you humility," he says. "You learn to prioritize, to problem-solve, and to focus on what really matters."

"Without a diagnosis, kids can't access critical services, and those services can cost up to $70,000 a year without insurance. We're ending that bottleneck."

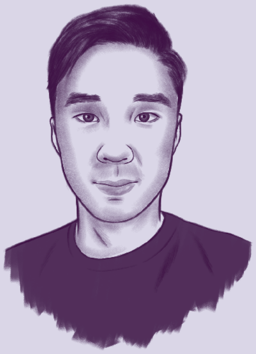
Justin Ho

After a stint in consulting and earning an MBA from Duke, Ho gravitated toward roles in health tech, eventually leading product development at an AI startup focused on autism diagnostics. "We had something that was FDA-cleared and could help people, but the system didn't know how to pay for it," he explains. "That's when I realized we had to build something new—something both families and insurers could use."

Today, Jigsaw is growing, expanding into attention deficit hyperactivity disorder (ADHD) and neuropsychological evaluations, and offering limited in-person options for families who need them. He's also exploring how to bring more AI into the background, automating report writing and workflows while keeping humanity at the heart of care. "Parents don't want to talk to a chatbot," says the CEO. "They want a real person to guide them."

His biggest lesson for aspiring health tech founders? "It's not enough to have a great idea. You need to get in the weeds to truly understand the system—how billing codes work, what insurers will cover. The unglamorous stuff makes the innovation possible."

— HEATHER LOWE



GREENER DRYWALL

Building a More Sustainable Future

For Taein Lee, Engr '22 (PhD), inspiration struck when a pipe burst in his downtown Baltimore rowhouse one winter. "The whole ceiling, the insulation, everything just fell," he says. As Lee cleaned up the damage, he realized all that soggy drywall would have to be thrown away and replaced. Was there a way to make more sustainable construction materials, he wondered? "Being an engineer, I try to take things into my own hands," he says.

And so he did.

In 2022, Lee formed a company, JJ Innovative Materials, with two other Johns Hopkins alumni: Mark B. Wo, Engr '16, who serves as chief operations officer, and Chu Ding, Engr '20 (MSE), '22 (PhD), director of compliance. Lee is CEO. Their goal is to make construction materials that are better for the planet.

According to the Environmental Protection Agency, the U.S. generates 600 million tons of construction and demolition waste each year. Most of it ends up in landfills. Traditional drywall is mostly made from gypsum, which, under certain conditions, can decompose into toxic chemicals over time.

Lee's idea was to develop a plant-rock bonding technology that integrates plants and cementitious materials to make a more sustainable drywall product. "Recycled waste materials currently make up over 65% of our drywall," he says. "We want to boost that to 95%. Our goal is to make our drywall carbon negative." This means that the materials and process not only reduce carbon emissions, but actually remove more carbon dioxide from the atmosphere than is emitted.

To make their drywall cost-effective as well as sustainable, Lee's company uses plant waste called "hemp hurds" from industrial hemp farms. "There are tons of bales of these rotting away on farms," he explains. The plants are used not just as filler but also processed to be completely physically and chemically integrated into the materials matrix.

JJ Innovative Materials is currently scaling up its manufacturing capacity in a warehouse in Baltimore's Hampden neighborhood to serve its first customers—residential construction firms.

"Recycled waste materials currently make up over 65% of our drywall. We want to boost that to 95%. Our goal is to make our drywall carbon negative."
Taein Lee

While Lee's PhD focus was on organic electronic materials, he's happy with the unexpected turn his career has taken. "I wanted to get my hands on more immediate problems that I could tackle with my specialty. I wanted to make tech that could really have an impact."

— ABIGAIL GREEN

SYSTEMS MINDSET

Transforming Care for the Most Vulnerable

As a child riding on the New York City subway, Ari Moskowitz, Engr '94, was captivated by the colorful and iconic transit map. But what fascinated him most wasn't the trains—it was the system itself. "It reminded me of the human body," he recalls. "Vessels, organ systems, control mechanisms … everything working together to move something essential from one place to another."

That early curiosity in how systems function laid the foundation for a career that has spanned biomedical innovation, medical device development, and now, global health advancement. As a deputy director at the Gates Foundation, Moskowitz works with industry and clinical leaders, heading a portfolio of investments and a talented team focused on medical devices and AI—tools that are transforming the way primary health care is delivered in underserved communities around the world.

Moskowitz arrived at Johns Hopkins at age 16, drawn to a biomedical engineering major by a love of problem-solving. His hands-on work in a materials science lab, helping develop an artificial hip simulator under the mentorship of former professor James Wagner, Med '78 (MS), Engr '85 (PhD), gave him an early taste of how research, building, and testing can directly impact patient care.

That theme continued throughout his career, from developing resorbable stents and brain shunt systems, to leading diagnostic imaging programs at Boston Scientific, and even living in Ireland and Japan to identify novel technologies, support global product launches, and forge strategic partnerships.

But it was his pivot to the Gates Foundation in 2022 that marked a profound shift in focus from product innovation from high-income markets to systems transformation for the world's most vulnerable populations.

In this role, he works across an expert peer group focused on the maternal and newborn health space, spanning data, nutrition, microbiome, diagnostics, and drug product innovation and introduction. The medical devices and AI portfolio he heads encompasses approximately $200 million in global investments. The primary aim, he notes, is reducing mortality and morbidity in low- and middle-income countries through pregnancy risk stratification.

"Many low- and middle-income countries don't need more specialized tech; they need accessible, affordable tools that nonspecialists can use effectively," Moskowitz says.

One example is a handheld ultrasound tool that replaces bulky, expensive hospital systems with an easy-to-use device designed for nurse midwives in community clinics. Based on simple sweeps of the pregnant patient, it uses software to automatically assess gestational age, fetal health, and risk factors without requiring imaging expertise.

Another part of his team is working on wearable devices for risk monitoring during labor. Once the innovations are developed, Moskowitz and his team of four program officers plus regional advisers work with companies and governments to make sure they can be supplied and serviced at a reasonable cost.

The challenge is sustainability. "If a health ministry can't afford it, we haven't succeeded. We're working at the intersection of engineering, policy, and economics to make these solutions more viable and easier to adopt," he says.

Moskowitz says it's the systems mindset, nurtured at Johns Hopkins, that ties it all together. "The problems are complex, but solvable. And increasingly, fields are converging to create entirely new solutions. I still love figuring out how parts connect to serve something bigger. That's how we will equalize health care."

— HEATHER LOWE

"Many low- and middle-income countries don't need more specialized tech; they need accessible, affordable tools that nonspecialists can use effectively."
Ari Moskowitz

JOEL KIMMEL

150 Years of Innovation

Highlighting Johns Hopkins Engineering's enduring impact as we celebrate JHU's sesquicentennial.

BY ABBY LATTES

In 1948, a groundbreaking weekly educational television show, *The Johns Hopkins Science Review*, debuted in Baltimore.

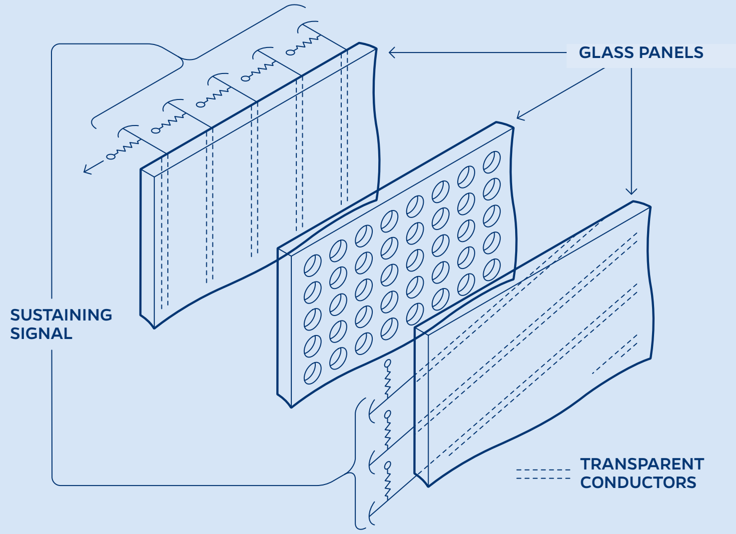
Hosted by JHU's public relations director, Jim Poole, it gave viewers an "over-the-shoulder" glimpse into the work of Johns Hopkins engineers, scientists, and physicians through lab demonstrations and interviews on topics from breast cancer and industrial waste disposal to water usage.

A 1950 *New York Times* article praised it as "a thoroughly worthwhile and encouraging example of educational television," noting that it had "the most needed attraction of good education: It was interesting."

By the time it went off the air in 1955, the show had reached a national audience, earned two Peabody Awards, and helped shape the future of science programming, paving the way for offerings from Bill Nye the Science Guy to the Discovery Channel.

WATCH EPISODES FROM THE SHOW

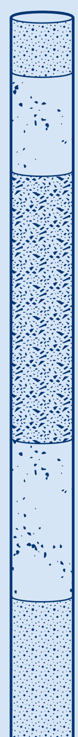
On the set of *The Johns Hopkins Science Review*



CORE UNDERSTANDING

Since the 1970s, paleoecologist Grace Brush, an environmental engineer and professor emeritus, has helped reveal how historical human activity continues to shape the Chesapeake Bay's ecology.

By analyzing sediment cores dating back to 12,000 B.C., she traced a surge in ragweed pollen and algae to European settlement, linking deforestation and agriculture to long-term declines in water quality, sedimentation, seagrasses, and fish populations. Her work was key to understanding the bay's ongoing environmental challenges through the lens of its past.

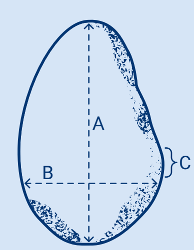


BRIGHTER, FLATTER, THINNER

Hiram Gene Slottow, Engr '52 (MSE), revolutionized display technology in the 1960s as co-inventor of the plasma screen, earning him a place in the National Inventors Hall of Fame and an Emmy Award for Technical Achievement.

His flat-panel design was a breakthrough—brighter, thinner, more energy-efficient, and a major leap from bulky cathode-ray tubes.

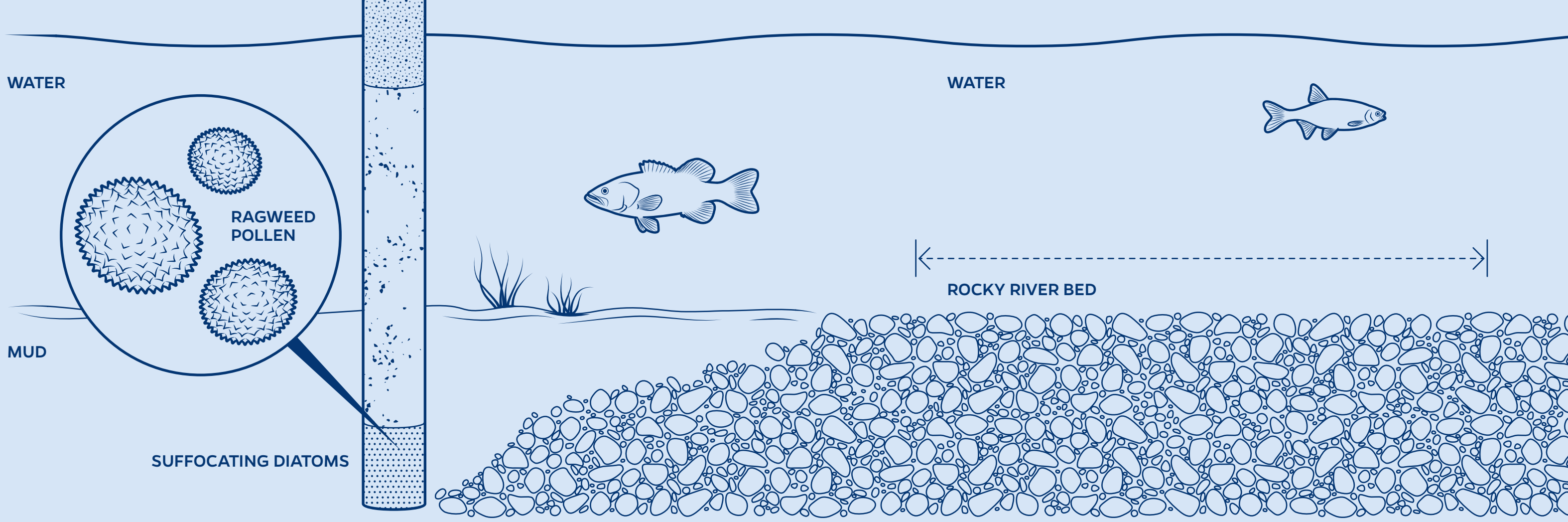
The technology enabled wall-mounted TVs and high-resolution displays, transforming home entertainment and digital signage, and paving the way for today's screens, from smartphones to stadium jumbotrons.



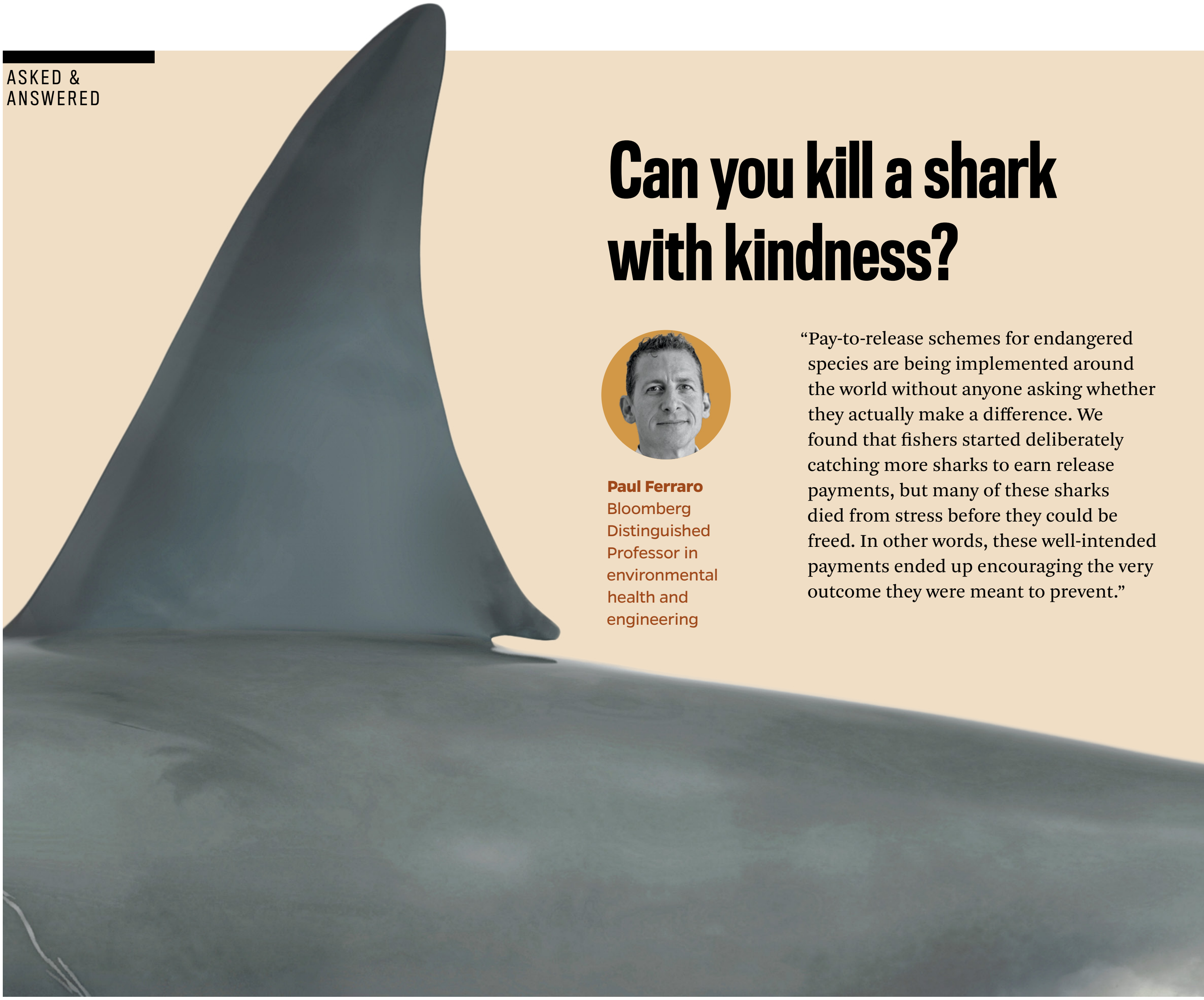
SEDIMENT STANDARD

M. "Reds" Wolman, A&S '49, a geographer and member of the Johns Hopkins faculty for 52 years, redefined river science by developing the Wolman Pebble Count, a simple yet powerful method for measuring streambed sediment that became the standard for geomorphologists everywhere.

His work changed how scientists assess river health, erosion, and sediment transport, provided new ways to think about the effects of land use, urbanization, and environmental management and restoration, and helped shape the field of environmental science.



CHRIS PHILPOT



Can you kill a shark with kindness?

Paul Ferraro
Bloomberg Distinguished Professor in environmental health and engineering

"Pay-to-release schemes for endangered species are being implemented around the world without anyone asking whether they actually make a difference. We found that fishers started deliberately catching more sharks to earn release payments, but many of these sharks died from stress before they could be freed. In other words, these well-intended payments ended up encouraging the very outcome they were meant to prevent."

Jeremias Sulam
Assistant professor of biomedical engineering, William R. Brody Faculty Scholar

Can you judge a tumor by its neighbors?

"Think of a breast cancer tumor like a neighborhood: It's not just the cancer cells themselves, but all the different types of cells living around them and how they're organized spatially. When we can identify recurring patterns in these cellular neighborhoods—cancerous cells, specific types of noncancerous cells, and their arrangements—they're like little flags saying, 'Turn your attention over here, we may be important for predicting how this patient will do.' This line of AI-informed research could ultimately help oncologists provide more accurate, personalized diagnoses and treatment."

Rama Chellappa
Bloomberg Distinguished Professor in electrical and computer engineering and biomedical engineering and former interim director of the Data Science and AI Institute

Does AI have a weight problem?

"In a word, yes. We've found that AI computer vision systems used to identify people in public safety and surveillance operations rely too much on body mass index as their primary identifying feature, even when BMI is not explicitly included in their training. The potential for misidentifying individuals if their weight changes is a significant vulnerability, which is why these systems should focus on more stable identifying features, such as gait or facial features."

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"With George Sykes' support, we created a stethoscope that combines artificial intelligence with advanced sensing materials to enhance diagnostic accuracy. It's already helping patients at Johns Hopkins Children's Center and has the potential for global impact."

Mounya Elhilali,
Charles Renn Faculty Scholar
and Professor, Electrical and
Computer Engineering

The Charles Renn Faculty Scholar award was created by George Sykes, Engr '91, and his wife, Elsa, to honor Elsa's grandfather, Charles Renn, a distinguished faculty member at Johns Hopkins from 1946 to 1970 and an expert on water pollution and waste management control. George and Elsa's support empowers Whiting's faculty and students to build upon Charles' important contributions.

GIVE TODAY