VIDEO To dispel movie myths, ask an engineer **RISING STARS** Introducing the Early Career Distinguished Alumni Society
EQUITY Amazon-UMD challenge to make popular tech more inclusive **RESEARCH** Student-designed experiment sent into space

Engineering at Maryland

FALL 2022

Ask Big Questions

P.12

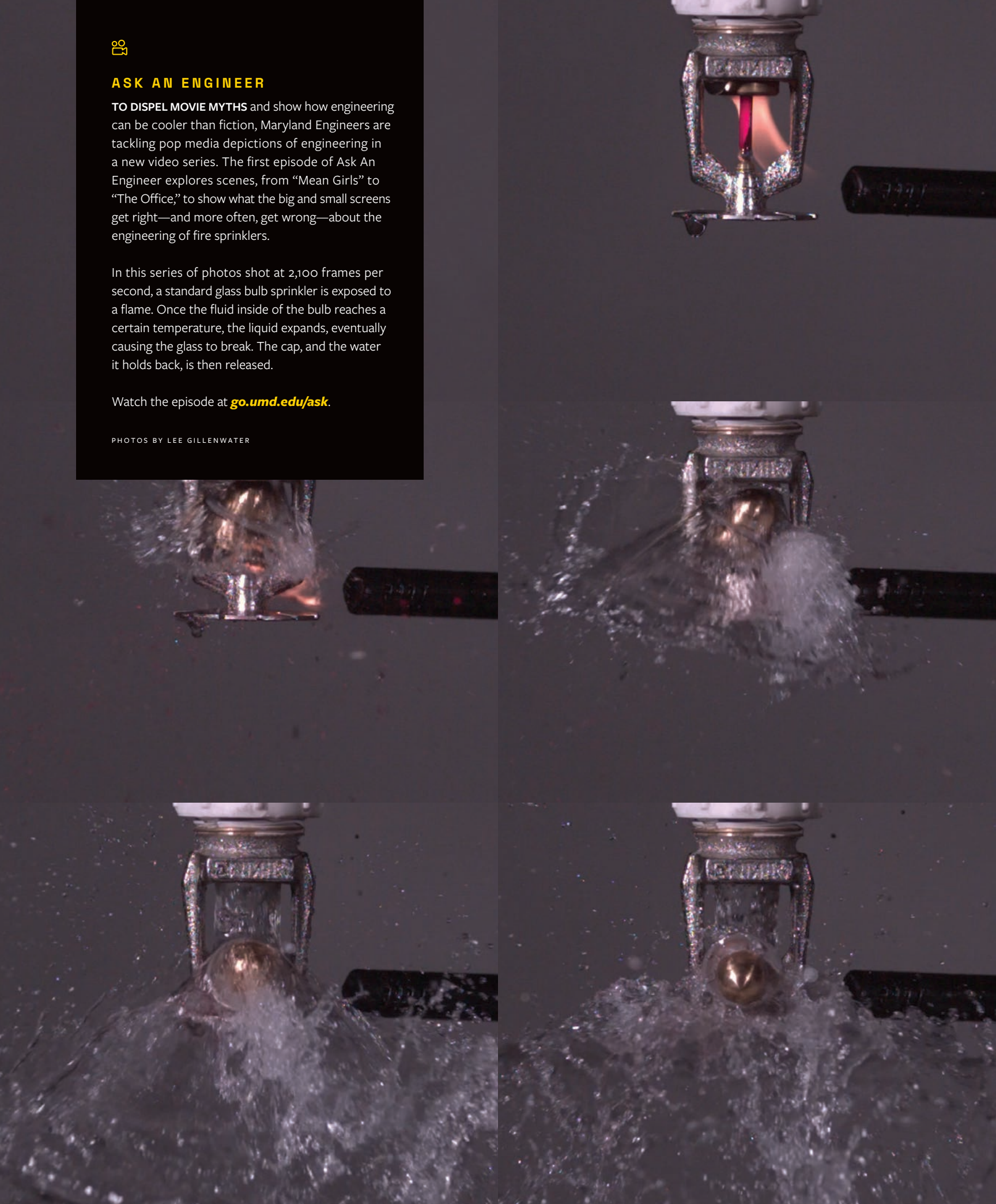
ASK AN ENGINEER

TO DISPEL MOVIE MYTHS and show how engineering can be cooler than fiction, Maryland Engineers are tackling pop media depictions of engineering in a new video series. The first episode of Ask An Engineer explores scenes, from "Mean Girls" to "The Office," to show what the big and small screens get right—and more often, get wrong—about the engineering of fire sprinklers.

In this series of photos shot at 2,100 frames per second, a standard glass bulb sprinkler is exposed to a flame. Once the fluid inside of the bulb reaches a certain temperature, the liquid expands, eventually causing the glass to break. The cap, and the water it holds back, is then released.

Watch the episode at ***go.umd.edu/ask***.

PHOTOS BY LEE GILLENWATER



WELCOME

Clark School Friends and Supporters,

Welcome to the 2022–23 academic year! We are excited to see our students, faculty, and staff—and Clark School champions like you—on campus. Having everyone back in person brings an energy and creativity that helps fuel innovation throughout our school, and we look forward to another year of exciting accomplishments.

In September, we hosted a welcome back celebration for our engineering Terps. Hundreds of Clark School students, staff, and faculty joined us, and the enthusiasm was palpable. Building community is central to the outstanding education we offer at Maryland Engineering. We plan to provide more opportunities to foster inclusion, supporting the entire Clark School.

As you know, Maryland Engineers like you pride themselves on working together and creating technological solutions for the public good. To use an age-old analogy, a rising tide lifts all boats. We at the Clark School are raising the tide.

Our fall magazine details some of Maryland Engineering's work in that pursuit: curbing carbon emissions, protecting people in hostile environments with robots and AI, restoring essential infrastructure for a growing population, and more. Our work, as it historically has, sets trends. After reading about it, we hope that you will help us get more people to take notice.

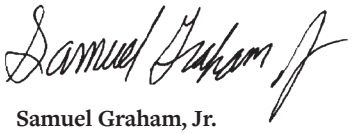
We are in a period of growth that will help shape the future of Maryland Engineering. In 2021, we opened the Southern Maryland Autonomous Research and Technology (SMART) Building in St. Mary's County. In May 2022, we dedicated the E.A. Fernandez IDEA Factory in College Park. This fall, a ceremonial groundbreaking generated excitement for UMD's forthcoming interdisciplinary engineering building, Stanley R. Zupnik Hall. By bringing together engineering and other disciplines, we create more opportunity to address complex societal challenges that require multiple disciplines to solve. We are excited to see how this new space will enable us to lead in crafting those solutions.

301k

Square feet of new facilities (SMART Building, IDEA Factory, and Zupnik Hall)

None of this can be done without your support and collaboration. You help us innovate and educate for the public good, impact the world we live in, and create a better future. For all you do: thank you.

Go Terps!



Samuel Graham, Jr.
Dean and Nariman Farvardin Professor
A. James Clark School of Engineering

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Engineering at Maryland magazine refers to the A. James Clark School of Engineering by that name in all cases, including stories that describe alumni who graduated before the name was established, in 1994, to honor Mr. Clark's outstanding philanthropy.

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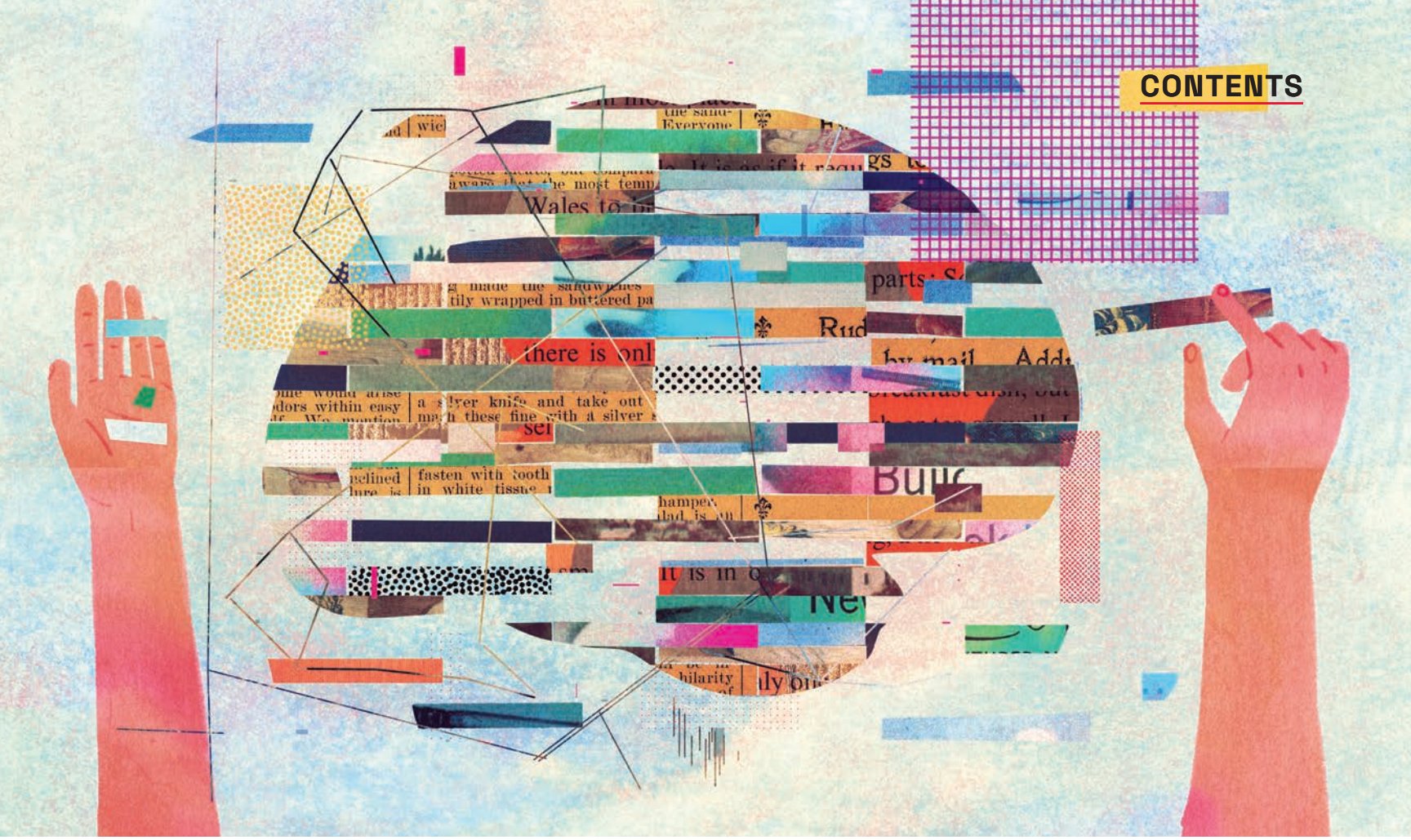

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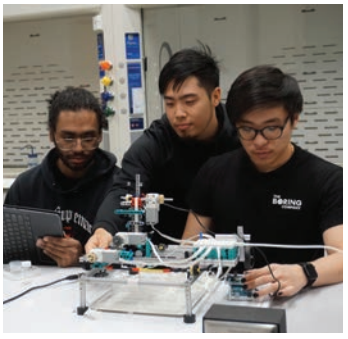
IMPACT



COMMUNITY

CLOCKWISE FROM TOP: ILLUSTRATION BY KEITH NEGLEY; NASA/JPL-CALTECH/ASU/MSSS; PHOTO COURTESY TERPS IN SPACE

Introducing the Early Career Distinguished Alumni Society

THE TIES THAT BIND Clark School alums are more than experiences shared, relationships built, and opportunities earned.

They're risks taken, trails blazed, leadership cemented, and legacies laid.

To acknowledge and honor the accomplishments of Maryland Engineers 40 years old and younger, the Clark School and Dean Samuel Graham, Jr., are proud to announce the Early Career Distinguished Alumni (ECDA) Society and inaugural class of inductees. Established in Fall 2022, the ECDA Society

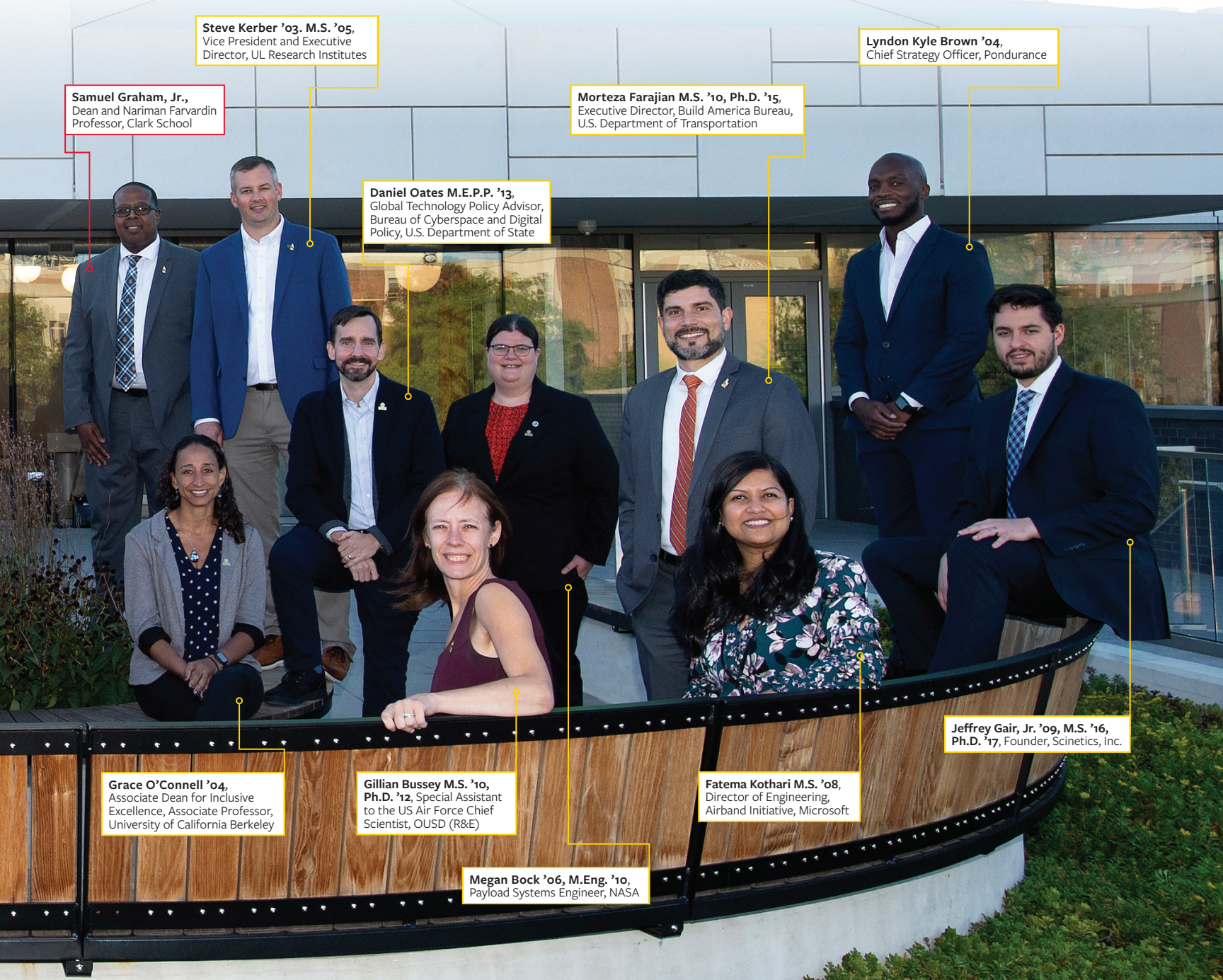
PHOTO BY GREG FIUME

launches an exclusive professional network of Maryland Engineering alums leading the next generation of innovators, entrepreneurs, and change agents.

"We charge our graduates with the responsibility of improving society through engineering, and these Maryland Engineering alums have done just that. It's therefore our privilege to recognize the innovations, leadership, and impact made by the Clark School's inaugural class of Early Career Distinguished Alumni Society inductees," said Dean Graham. "We're proud to highlight their accomplishments and hope they serve as inspiration, especially for our students and early-career engineers."

ECDA Society inductees were welcomed back to campus on September 23 for a day of networking with fellow alums and campus leaders, behind-the-scenes tours, and opportunities to share their experiences with engineering students, culminating with a reception and induction ceremony.

Learn more ***go.umd.edu/society***



NOT PICTURED: Imraan Faruque (M.S. '10, Ph.D. '11), Assistant Professor, Oklahoma State University; **Edmon Perkins (Ph.D. '15)**, Assistant Professor, North Carolina State University; **Kajal Pancholi ('02, M.S. '04)**, President & CEO, Avatar Technologies

Bringing into Focus Health Care's Vision of Tomorrow

UMD leads multi-institutional effort to advance medical innovations for extended reality

ULTRASOUND DATA displayed directly on a patient via augmented reality headsets. Immersive "grand rounds" for medical students and faculty, even when they're in different locations. Virtual reality landscapes matched with classical opera to transport people with painful injuries outside of themselves, reducing the need for potentially addictive opioids.

These medical examples of extended reality (XR)—the umbrella term used for technology based in virtual and augmented reality or other immersive media—are already being prototyped or tested in clinical trials. But its widespread use in hospitals and other health care settings is currently hampered by technical challenges and sparse regulatory guidelines.

Now, with funding from the National Science Foundation and technology titans including Google, Microsoft, and Meta, UMD is leading a multi-institutional effort that will focus on developing, testing, and certifying XR technologies in medicine and health care.

The new Center for Medical Innovations in Extended Reality, known as MIXR, joins UMD engineers and computer scientists with physicians and clinicians at the University of Maryland School of Medicine and the University of Michigan to improve medical training, patient management, and health care outcomes across all areas of clinical practice. Another key partner in the MIXR initiative will be federal regulatory experts working at the U.S. Food and Drug Administration, ensuring that safe, effective, and innovative clinical solutions make it to patients as soon as possible.

As the lead-site co-PI, Maryland Engineering Professor Joseph JaJa will support the integration of high-performance computing and machine learning into the XR technology being developed and use his extensive experience working with industry to foster stronger collaborative efforts.

Learn more ***go.umd.edu/xr***

PHOTO COURTESY MARYLAND BLENDED REALITY CENTER

Using Machine Learning to Shed Light on Cannabis Effects

Growing legalization, rising use create need for greater understanding

THE U.S. HOUSE OF REPRESENTATIVES' VOTE earlier this year to legalize cannabis exemplifies the growing acceptance of the drug both for medical and recreational use, but much remains to be understood about how it affects health—including how it might impact the cardiovascular system when smoked.

To help fill that knowledge gap, Maryland Engineering Assistant Professor Eleonora Tubaldi is partnering with physicians at the University of Maryland School of Medicine in a bid to use machine learning and advanced computing to obtain hitherto elusive answers about the hidden links between cannabis and heart health. The research is supported by an MPower seed grant awarded by the University of Maryland Strategic Partnership: MPowering the State, which leverages the complementary strengths of University of Maryland, Baltimore and the University of Maryland, College Park.

To obtain their findings, the researchers are using the UK Biobank, a massive database that includes more than 40,000 images; Tubaldi will then develop algorithms and a machine learning framework that will allow a computer to quickly and accurately compare MRI views of the cardiovascular systems of cannabis smokers to those of non-users.

Machine learning can often detect changes that are too subtle to be registered by a human observer, Tubaldi says. "We have limited vision and can see only some aspects of an image," she explains. "Machine learning can tell us about the texture of the image, or about contrast features that even a clinically trained eye might not be able to detect. It's like a super-eye."

The team's focus is on images obtained through a type of MRI known as T1 mapping, which tracks the relaxation rate of a certain tissue over a set time period. If the approach is successful, the scope may ultimately expand to include other types of imaging.

"There is a strong need to study this topic, and to be able to determine how much cannabis can be tolerated by the body," Tubaldi says. "Such research can assist medical professionals and also inform policymakers."

PHOTO BY STEPHANIE CORDLE

Advancing Multiple Sclerosis Research

New approach could target immune response, preserve patients' ability to fight other illnesses

MPOWER PROFESSOR and Minta Martin Professor of Engineering Christopher Jewell was awarded a National Institutes of Health R01 grant to advance biomaterial-based therapeutic vaccines aimed at combating multiple sclerosis (MS).

Nearly 2.5 million people worldwide have been diagnosed with MS, a disease that causes the body's immune system to mistakenly attack myelin, the insulation that surrounds and protects nerve fibers in the brain and spinal cord. This leads to neurodegeneration and a loss of motor function that creates a tremendous burden on patients and their families as MS progresses.

Jewell and his lab are collaborating with researchers at the University of Maryland School of Medicine to develop specially designed, controlled-release biomaterial depots to be injected directly into lymph nodes, the tissues that coordinate immune response. The team's goal is to teach the existing myelin-reactive cells in the body to adopt a protective regulatory function instead of a dangerous inflammatory function. Jewell's new grant is supported by exciting data showing that a single dose of depots reverses disease-induced paralysis in mouse models of MS.

Adding to College Park's Quantum Ecosystem

New company founded by UMD professor further solidifies College Park area's status as global hotspot for quantum-related startups

CREATED BY RONALD WALSWORTH—a serial entrepreneur, Maryland Engineering professor, and director of UMD's Quantum Technology Center—the company Quantum Catalyzer (Q-Cat)'s mission is to identify the most promising ideas in quantum technology and create companies that can translate that technology into solutions for society.

"While traditional technology incubators support young companies already in existence, Q-Cat has a unique model where we help identify technology well-suited for commercialization and build companies from scratch, serving as co-founders and providing critical, multifaceted support to help them grow," says Walsworth.

200+

Number of engineers and scientists at UMD who are exploiting the unique properties of quantum physics to usher in a new age of technology

Examples of technological advances Q-Cat hopes to explore include efficient green energy generation at scale, more reliable navigation, next-generation microelectronics, and lower-cost health care imaging.

Q-Cat joins the ranks of IonQ and other companies fueling College Park's reputation as a world leader in quantum commercialization. According to research by McKinsey, investments in quantum startups doubled from 2020 to 2021, exceeding $1.7 billion last year. To date, Q-Cat has created four quantum companies from technology developed in Walsworth's and collaborators' labs.

PHOTO COURTESY ION STORAGE SYSTEMS

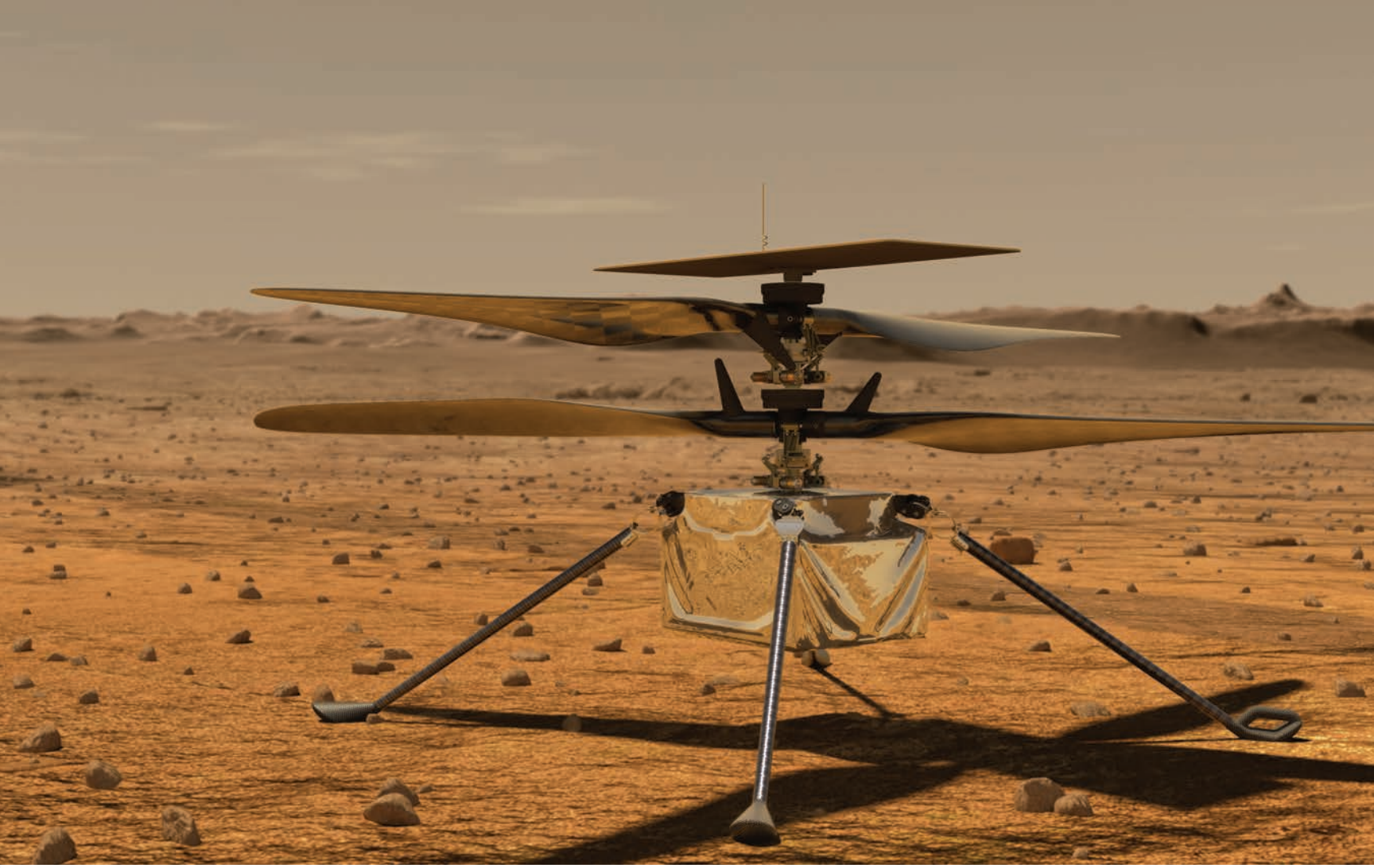
Rethinking the Architecture of Solid-State Batteries

With private and public funding, company founded by UMD professor aims to offer a longer-lasting power source

AN INNOVATIVE BATTERY TECHNOLOGY COMPANY founded at UMD will ramp up battery cell manufacturing at its Beltsville, Md., headquarters, thanks to new investments as part of its Series A funding round. The company welcomed investments from Toyota Ventures, Tenaska, Bangchak Corporation, and others, in addition to its lead investors.

Ion Storage Systems (also known as ION), founded by Distinguished University Professor and Director of the Maryland Energy Innovation Institute Eric Wachsman, creates solid-state lithium metal batteries that are safer, lighter, and have higher energy density than current lithium-ion battery technology. ION's nonflammable technology offers greater abuse tolerance, and both volume and weight reduction. The company touts advances that will give engineers and innovators new freedom in designing futuristic products, from automobiles to robotics to mobile technology.

"ION's bi-layer cell design is a breakthrough for the industry," says Lisa Coca, Climate Fund partner for Toyota Ventures. "The architecture addresses the technological barriers that have historically plagued solid-state batteries, and it enables critical next-generation performance metrics for widespread adoption. We believe this is a game-changing technology and are proud to support ION's expert team as they work to unlock the potential and power of solid-state batteries."



Flying with Ingenuity

Mars helicopter Ingenuity team honored for accomplishing the first powered flight on another planet

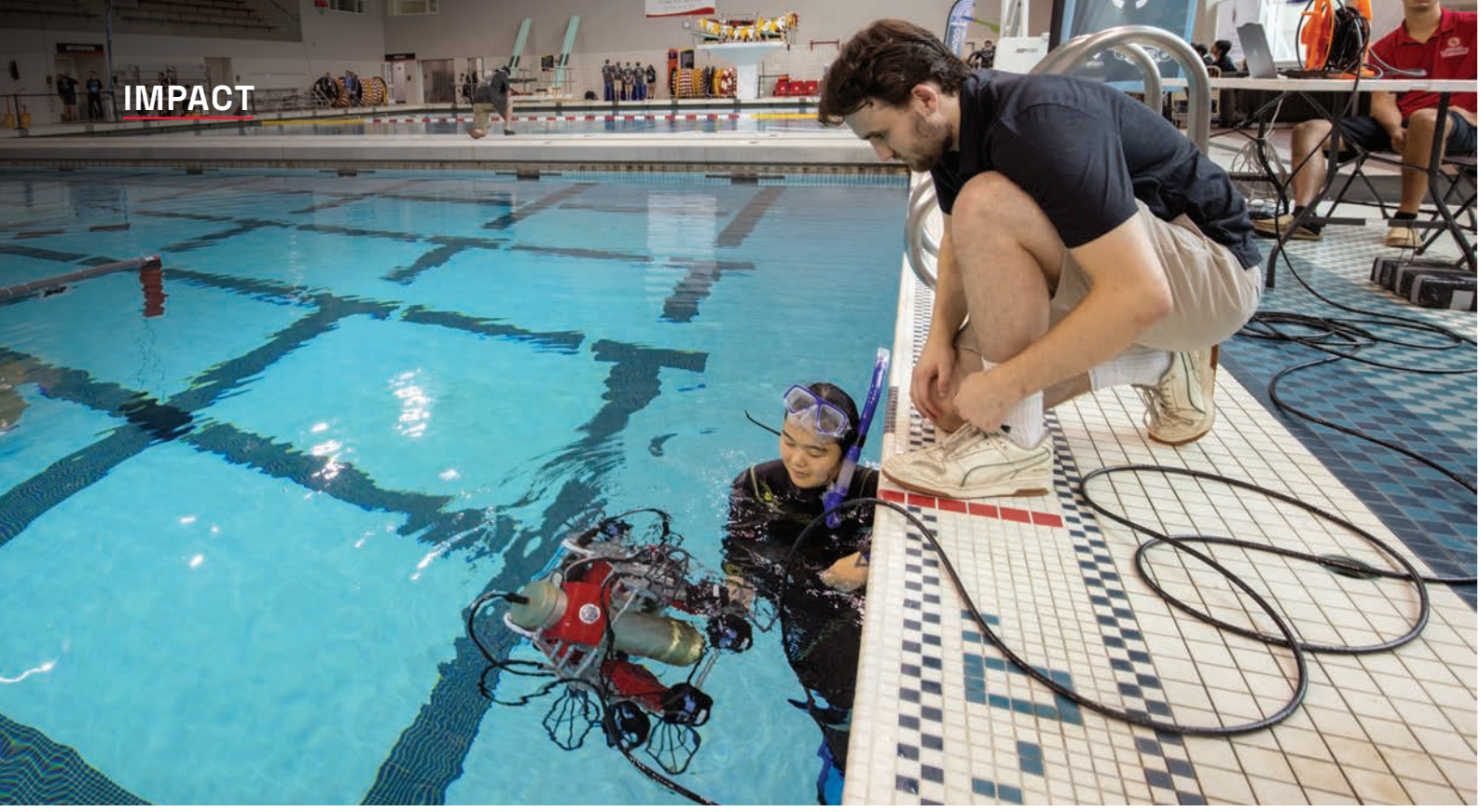
THE UNIVERSITY OF MARYLAND and other organizations involved in developing the Mars helicopter Ingenuity are this year's recipients of the Vertical Flight Society's (VFS) Howard Hughes Award, given in recognition of an outstanding improvement in fundamental vertical flight technology. It was presented at the 78th annual Forum and Technology Display on May 12 in Fort Worth, Texas.

As a Maryland Engineering graduate student in 2000, Associate Professor Anubhav Datta (Ph.D. '04) led a UMD design competition team that established the feasibility of Martian rotary-wing flight and whose blueprint for a Mars rotorcraft paved the way for Ingenuity. The students devised innovative solutions for the distinct problems posed by Martian flight, which include ultra-low atmospheric density, low speed of sound, wildly fluctuating temperatures, and low oxygen levels. Ingenuity, in turn, incorporated key features of the earlier UMD design—most notably, two-bladed coaxial counter-rotating rotors mounted on a square fuselage.

INSPIRED DESIGN
An artist's concept showing Ingenuity on the Martian surface. A blueprint for a Mars rotorcraft, created by a UMD design competition team in 2000, paved the way for the Mars Helicopter.

Datta, who worked for the U.S. Army Aviation Development Directorate at NASA Ames after earning his doctorate, contributed his expertise as plans to build an actual Mars rotorcraft gained traction. With the support of his mentor and supervisor Roger Strawn and assisted by UMD doctoral students William Staruk and Elizabeth Ward, he helped model and calculate the dynamic loads and stability of the ultra-thin, yet ultra-stiff rotor system needed to keep the unusual craft aloft safely on Mars.

NASA/JPL-CALTECH



Making a Splash, with Robots

UMD hosts RoboNation international student competitions

DESPITE THE DISTINCT SMELL of chlorine and roped-off lanes at Maryland's Eppley Recreation Center, the students huddled along the edges of the pool weren't there for an ordinary swim meet. Instead, gliding under the water were wires, propellers, and sensors.

It was all part of the 25th running of RoboSub, an international competition that challenges student teams to design and build robotic submarines—also known as autonomous underwater vehicles (AUVs)—that can complete a series of tasks while submerged. UMD's team Robotics @ Maryland was among 39 groups participating; they made it all the way to the semifinals.

After taking place for several years in San Diego and then shifting online during COVID-19, the annual event was held for the first time at UMD, July 27 through August 2.

"It's been very exciting to host," said engineering student Dillon Capalongo, Robotics @ Maryland's mechanical lead. "Everyone who's been helping volunteer has been supporting us, saying, 'Go Terps! This is our school!'"

This year marks the UMD team's RoboSub return since the pandemic began, and its robot, Qubo, took the plunge. Qubo, which debuted in the 2017 competition, is smaller, more mobile, and more modular than its predecessor, Tortuga IV, Capalongo said. Tweaks over the years have further streamlined the bot, with the team—around 30 Terps from a variety of majors—developing and practicing with it in UMD's Neutral Buoyancy Research Facility, the only such tank in the world on a college campus.

Teams that included powerhouses like Carnegie Mellon University, the University of Alberta, and the National University of Singapore—the eventual winner of the competition—huddled around laptops, carted around equipment, and tested their tech at Eppley. Bringing together budding engineers from around the world in such competitions is "fantastic from the standpoint of engineering education," says Dave Akin, Robotics @ Maryland team advisor and professor of aerospace engineering. The hands-on experience mimics real-world systems used for underwater exploration, seafloor mapping, and more.

"Think of it this way," he tells students. "When the time comes that you are interviewing for your first job, you're not going to be stuck saying, 'Well, I took this course and I took that course.' You can say, 'I built a robot and competed with it underwater.'"

A Trifecta of Competitions

ROBOSUB WAS ONE OF THREE RoboNation competitions hosted by UMD in Summer 2022.

During the first week of June, the SeaPerch K–12/pre-college underwater robotics competition drew more than 130 teams of 1,000 students, parents, and teachers to Eppley. Each team brought a customized, remotely operated robot and navigated it in the pool through a series of real-world obstacles that test maneuverability, control, and utility. Teams came from as far as New Zealand, the United Arab Emirates, the Cayman Islands, and Egypt, as well as from across the United States.

In mid-June, RoboNation brought its International Student Unmanned Aerial Systems drone competition to the St. Mary's County Regional Airport and UMD's UAS Research and Operations Center in southern Maryland. This competition featured 71 teams and required undergraduate and graduate students to design, integrate, report on, and demonstrate a UAS capable of autonomous flight and navigation, onboard remote sensing, and task executions.

PHOTO BY STEPHANIE CORDLE

Opening Apps to All

Student wins Amazon-UMD Design Challenge with idea to make popular tech more inclusive

A RE-ENGINEERED SPOTIFY EXPERIENCE that helps people with autism better access the calming power of music took top honors this past spring in the first Amazon-University of Maryland Design Challenge, a student competition to redesign an app, website, or experience for a more inclusive world.

Developed by Maryland Engineering student Elyas Masrour, the streamlined Spotify concept was one of just three entries selected from 40 proposals that earned a spot in the April 8 UMD Amazon Day symposium. Masrour grabbed first place—and $2,500—through a live poll by Amazon employees and UMD faculty, administrators, and students.

Sponsored by Amazon and the Clark School's Center for Minorities in Science and Engineering (CMSE), the Design Challenge sought to break down barriers in product design that prevent universal experiences for individuals due to ability, race, gender, or other differences. Open to all undergraduates across the University System of Maryland and institutions in the National Science Foundation-funded Louis Stokes Alliances for Minority Participation, the Design Challenge required no technical skill—just good ideas. With guidance from Amazon's design team, students researched and plotted to build a better, more inclusive product that offers an enriching, universally accessible, even transformative experience.

"The Reason I Jump," a documentary that examines the successes and struggles of people with nonverbal autism, was the inspiration for Masrour's design by demonstrating how technology could radically change how individuals with autism engage with the world. When research pointed to music as a powerful way for people with autism to alleviate the crushing assault of surrounding sights, sounds, and input of the world around them—a common struggle called sensory overload—Masrour set his sights on Spotify, the world's leading music app and home to an active community of users with autism. But because many in the autism community—over 80 percent in some studies—also struggle with motor difficulties, fiddly app user interfaces can be frustrating for people incapable of precisely using a touchscreen densely packed with controls.

Masrour's more inclusive redesign relies on nesting groups of buttons to reduce the number of options per page while increasing their size. The streamlined screen places the most important actions—search, playlists, and settings—front and center, and prioritizes controls such as volume, pause, fast forward, and rewind. The concept, he says, has potential to extend beyond a soothing playlist by helping individuals connect on social media apps such as Facebook or Reddit, navigate streaming apps like Netflix, or order food through UberEats. Nesting options and bigger buttons can also benefit individuals with arthritis, visual impairments, or other physical disabilities.

"This project started with a limited scope," says Masrour. "It really just scratches the surface for how inclusive Spotify can be, but hopefully is a step in the right direction."

The event highlights the growing partnership between Amazon and UMD and Amazon's investment in creating more diversity and representation in STEM-related fields. Last year, Amazon launched AmazonNext in partnership with CMSE, the company's first pilot program to increase enrollment and retention of students who are underrepresented in STEM majors.

INCLUSIVE TECH
Masrour's redesign relies on "nesting" groups of buttons to reduce the number of options per page while increasing their size (above).

Amazon-UMD Design Challenge winner Elyas Masrour, an electrical and computer engineering major (left).

SCREENSHOT COURTESY ELYAS MASROUR; PHOTO BY GREG FIUME

BY MAGGIE HASLAM

TO TACKLE TODAY'S MOST PRESSING CHALLENGES, FEDERAL PARTNERS NEED ENGINEERS WHO ASK BIG QUEST

IN 1921, AS THE U.S. GOVERNMENT began stitching together America's roadways with the nation's first interstate highway system, the University of Maryland's College of Engineering was examining the road ahead—quite literally. At the request of the U.S. Bureau of Public Roads, students and faculty launched a research study, the very first under the college's new Engineering Experiment Station, to examine the performance of concrete pavement, with young engineers testing the strength of four-inch road samples in a small lab on campus.

A century later, Maryland Engineers are again tackling U.S. roads—this time, to help fix them. Through its latest collaboration with the U.S. Department of Transportation (DOT), Maryland will lead the national effort to connect local governments with the tools they need to access federal dollars for repairing roads and bridges and installing bike lanes and EV chargers. Launched in April 2022, the Build America Center at the University of Maryland (UMD) will assist regional, state, local, and tribal authorities as they implement landmark infrastructure legislation adopted by Congress in late 2021. (Learn more, page 20.)

"Some communities lack the knowledge and capacity to take advantage of federal programs; it can hamper their efforts to get funding but also keeps them from thinking outside the box," says Morteza Farajian (M.S. '10, Ph.D. '14), executive director of DOT's Build America Bureau. "Our question was: How can we close that gap?"

The gumption to ask these kinds of big questions propels the research and discovery required to solve them. What UMD brings to the table in tackling them, says Farajian, is the innovative and ambitious thinking—free from politics and bureaucracy—that can turn challenges into opportunities.

"Those cutting-edge solutions are where universities like Maryland can really impact our work, because they have the time, bold ideas, and unbiased thinking to focus on these challenges," he says.

Maryland Engineering generated $182 million in research expenditures in fiscal year 2022, working on the front lines of energy storage, autonomy, robotics, human and machine learning, infectious disease, and more. Although having DOT, the U.S. Department of Defense, National Institutes of Health, Department of Agriculture, NASA, and other federal agencies as neighbors provides a proximal landscape for cutting-edge collaborations, the allure is more than geographic.

$182 MILLION

Research expenditures in fiscal year 2022, a 24% increase since 2016
(includes computer science)

Maryland Engineering Dean Samuel Graham, Jr., explains that the college's successful legacy of federal research partnerships boils down to one common denominator: its diverse community of faculty, students, and staff eager to help solve challenges of critical importance to our nation.

"We're fortunate to have outstanding faculty and students who are creative in defining problems and creating solutions; staff who implement a supportive environment to sustain the research enterprise; and outstanding collaborators and partners in federal agencies who believe in our abilities and support us through research grants," says Dean Graham. "We are also very fortunate to have local proximity to federal agencies, allowing us to work together when possible. This is part of what makes Maryland Engineering unique: Their experience and interaction with us helps our faculty, students, and staff move technological solutions forward for the nation."

From tackling America's infrastructure crisis to conceiving an alternative future for food scraps, here are some of the ways Maryland Engineers are not just asking, but also answering, society's big questions:

ILLUSTRATIONS BY KEITH NEGLEY

1 IN A RAPIDLY WARMING CLIMATE, HOW DO WE PUT CARBON EMISSIONS ON ICE?

BIG CHILL
The global carbon emission problem requires new technologies that are innovative and accessible to all. UMD's Center for Environmental Energy Engineering is developing "out-of-the-unit" ideas for revolutionizing the energy-sucking inner workings of forced air that contribute to carbon output.

ILLUSTRATION BY KEITH NEGLEY

THERE ARE TWO BILLION AIR CONDITIONERS in use today around the world, accounting for roughly 20 percent of the world's energy consumption. According to the International Energy Agency's latest report on cooling, that number will triple by 2050.

It doesn't take an engineer to understand the math. Under the stress of growing populations, more urbanized settlements, and a rapidly warming climate, air conditioners will need to work smarter—not harder—to both efficiently cool the planet and reduce the heat-trapping carbon they produce.

The U.S. Department of Energy (DOE) is banking that researchers at Maryland Engineering can help. Last year, the agency awarded UMD's Center for Environmental Energy Engineering (CEEE) $7.2 million to fund the development of "out-of-the-unit" ideas for revolutionizing the energy-sucking inner workings of forced air that contribute to carbon output—such as heat pumps, compressors, heat exchangers, and refrigerants—making them smaller, lighter, and more efficient.

"When people turn on their air conditioner, they don't think of it as contributing to carbon emissions," says Research Professor Vikrant Aute, who, along with Minta Martin Professor Reinhard Radermacher and Research Professor Yunho Hwang, directs the center at UMD. "They will spend $1,000 on a new iPhone, but it is hard to get that sort of enthusiasm for a more efficient air conditioner that will save hundreds of dollars in energy bills.

"We want to make the iPhone of air conditioners."

The CEEE researchers know what's at stake. The carbon emission problem is a global one, says Aute, and will require new technologies that are at once innovative and accessible to all. Working with DOE to develop the Life Cycle Climate Performance evaluations for air conditioning and refrigeration systems—essential guidelines for assessing carbon emissions—CEEE has an established track record for developing the collaborations and best practices required for a global carbon-neutral approach. Through an international working group, emission guidelines are now being globalized. Over their 30-year history, CEEE has been the trusted research partner for top refrigeration manufacturers around the world, collaborating to develop new and novel technologies.

Federal and private partnerships are funding not just research but also the next generation: CEEE has trained more than 250 graduate students for research and industry so far. That community, says James Tancabel, a Ph.D. candidate who has worked with CEEE for six years, is integral to pushing ideas—and urgency—forward.

"When you turn on the air conditioner to make it cold in your house, you have to make it hot somewhere else," he says. "It takes experts in the field to help people see that impact, and to design for that future."

IN THE RACE TO CUT CARBON EMISSIONS, THESE DISCOVERIES ARE DOWNRIGHT COOL

"Shaping" HVAC for Net-Zero

On a hot day in Los Angeles, the groan of the regional power grid—the result of millions of HVAC units simultaneously conditioning homes and offices—is almost audible. But advancements in thermal storage units could significantly lighten the load. CEEE researchers are developing units that draw energy at night, when temperatures are cooler and grid usage is low, and store it in phase change materials (materials that release or absorb energy as they change in composition, like water to ice). In hotter daytime hours, units tap into the stored energy instead of going to the grid. In the lab, graduate students like Jangho Yang are experimenting with different phase change materials that could deliver more energy in smaller amounts, leading to more compact and efficient thermal storage units.

While researchers are focused on easing stress to the grid, the ultimate goal is to go off it completely. In the future, says Yang, renewable energies like wind and solar could be harvested and stored to power a building's heating and cooling, virtually carbon-free.

"This is about pushing forward sustainable technology," he says. "If we can combine renewable sources with thermal energy, that whole system would be carbon-free. That's the future we want."

Battery-inspired Cooling

CEEE researchers are working with Professor Chunsheng Wang and his team to develop a variety of ways to improve compressor technology and efficiency—the power-hungry and heavy systems that pressurize and circulate the cooling refrigerant—including a compressor with no moving parts. The proposed system employs a clever application of electricity and a membrane, similar to a fuel cell found in a battery, significantly improving efficiency and reliability. Fewer parts also equal less weight, which reduces the carbon created in producing and shipping.

Lose the Liquid

The average grocery store has enough refrigerant pumping through its miles of metal veins that a small leak within it could dwarf the cumulative leaks in a small city. Moving away from refrigerants—a notorious greenhouse gas producer—will be critical in the fight against climate change. CEEE researchers are working with Professor Ichiro Takeuchi and his team to integrate shape memory nitinol alloy (special tubes that heat when extended and cool when they spring back, a process called elastocaloric cooling). Still in its early stages, the technology could conceivably replace liquid refrigerants in small units like commercial refrigerators and in single-family homes.

Wood for Good

Commercial and residential buildings account for one-third of the carbon pollution released into the atmosphere each year, placing the construction industry at the starting line in the race against global warming. Ongoing work by Herbert Rabin Distinguished Professor Liangbing Hu and his start-up InventWood will support the development of new vacuum insulation panels that have a more climate-friendly structure composed of low-cost, nanoporous wood chips. The new panels could potentially deliver an overall panel insulation of R15, minimize edge losses, and increase service life while costing less than $1 per square foot for an inch-thick panel.

2 IN THE FOG OF WAR, CAN ROBOTS PROVIDE A CLEAR PATH?

WHEN FIGHTING BESIEGED the Ukrainian city of Severodonetsk in June, 12,000 residents sought shelter in bunkers beneath a chemical plant. Racing against time and deteriorating conditions, U.N. humanitarian officials were essentially blind, unable to reliably determine the civilians' well-being or secure them a route to safety.

But what if, in situations of heavy fire, robots could provide eyes on the ground?

New technology currently underway through a research partnership between the U.S. Army Research Lab (ARL), University of Maryland, College Park, and University of Maryland, Baltimore County might soon make that a possibility. The cooperative agreement known as ArtIAMAS establishes a cross-institutional, multidisciplinary collaborative for developing safe, effective autonomous systems that assist humans by mitigating some of the dangers found in complex environments, from search-and-rescue operations to military engagements.

Spanning expertise in engineering, robotics, computer science, operations research, modeling and simulation, and cybersecurity, researchers are developing game-changing advancements towards a future where robots work not just with each other, but independent of humans—for example, small robots that navigate piles of rubble or squeeze through tight spaces to locate signs of life and establish communication, or aerial drones that perceive on-the-ground terrain and relay a reliable pathway to a rover below.

"This is a big partnership with an

ILLUSTRATION BY KEITH NEGLEY

ambitious vision: We want to change the world by quickly getting AI and autonomy into the hands of the people who need it," says Maryland Engineering Professor Derek Paley, lead researcher on the agreement. "ARL is looking for cooperative research, but also something bigger. For an academic partnership, this is really unique."

Off the battlefield, the technology has almost limitless applications. Advancements in aerial drones coupled with pathfinding robotics and swarm technology could help quickly locate people that go missing in dense areas; AI and autonomous robots could revolutionize the delivery of goods, ensure the welfare of an aging parent, or simply help locate your missing car keys.

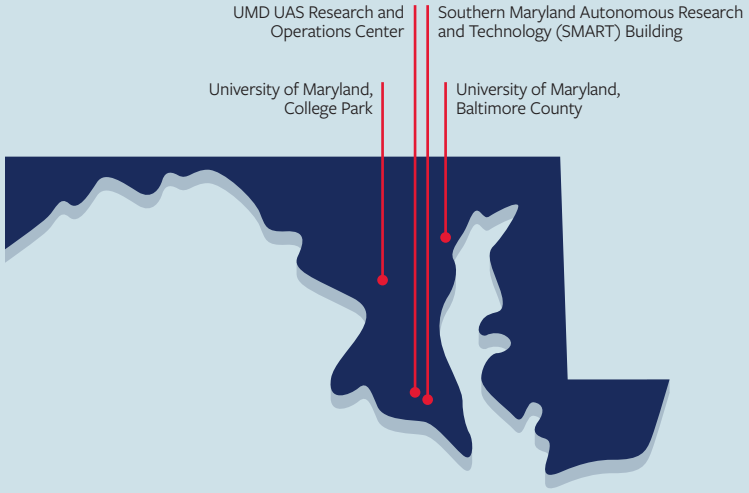
"In many ways what ARL is supporting is pushing these technologies to the next level," says Distinguished University Professor Dinesh Manocha, co-lead researcher on the agreement. "Once developed, they will have tremendous applications, including home robots, social robotics, autonomous driving, use of robots for construction and repair, delivery services, and more."

Under the new partnership, ARL is funding the research work of faculty, postdocs, and more than 100 students. The funding to-date has fortified existing programs and established new ones, including the new ARL Summer Student Team Research, a program geared towards students underrepresented in STEM that was so in-demand, two cohorts were established—one at College Park and one at Baltimore County.

"ARL has many accomplished scientists, engineers, and researchers, but what they don't have—that we do—is students," says Paley. "They are heavily invested in creating student opportunities and developing tomorrow's research workforce."

GROUND SUPPORT

The Southern Maryland Autonomous Research and Technology (SMART) Building—a state-of-the-art new facility located in St. Mary's County at the University System of Maryland at Southern Maryland (USMSM) that includes underwater, air, and land testing facilities—gives researchers unparalleled resources for innovating the next generation of AI and autonomous systems. Together with the UMD UAS Research and Operations Center, a Maryland Engineering facility that has operated next-door to USMSM since 2014, the SMART Building forms "the southern node of an AI and autonomy network spanning the state of Maryland," says Paley.



MAP BY MATT LAUMANN

BUILDING A MORE INTUITIVE ROBOT

ADARSH JAGAN SATHYAMOORTHY (**M.ENG. '09**) pays a lot of attention to little decisions. Whether maneuvering through a crowded room or decelerating his car over a speed bump, Sathyamoorthy is acutely aware that his intuition can help him not just navigate the world, but also build a better robot.

"We take minute decisions for granted that, for a robot, would be difficult to make," he says. "In a car, humans are more likely to pick smooth asphalt over off-roading; on foot, they might take a shortcut across grass but know better than to walk across a flowerbed. We're trying to give a robot that same intuition and perception."

Sathyamoorthy worked professionally in robotics before enrolling in Maryland's flexible Professional Master of Engineering program offered through Maryland Applied Graduate Engineering. As a M.Eng. student, he worked with Paley to develop guidance, navigation, and control system prototypes that enable autonomous aerial package delivery. Today as a Ph.D. student, he specializes in robot navigation in unstructured environments. Under Manocha's mentorship and together with other students, they have developed a ground robotic system that can navigate uneven terrains and remain upright; another project tackles different surfaces, with robots intuitively deciding to speed up or slow down, or identifying preferred paths based on surface type. Next up for the team is a legged robot able to climb stairs and new perception technologies that can differentiate between pliable vegetation that can be traveled through (like tall grass) and non-pliable vegetation (like a tree trunk).

"Through these partnerships, the University of Maryland is doing fundamental research on very hard problems," adds Manocha. "The result is that we're creating students with the skills in AI and robotics that are in demand for taking on tomorrow's big challenges."

BIG ACTION
In the face of unknown challenges, partnering with intelligent systems could be one of our greatest assets: in search-and-rescue missions after a catastrophic natural disaster, for example, where establishing risk and response is both urgently needed and assuredly dangerous.

3

IN A WORST-CASE DIAGNOSIS, CAN WE ENGINEER NEW HOPE FOR PATIENTS?

THE SIX WORDS EVERY CANCER PATIENT hopes to hear from their surgeon are, "We got all of the tumor." But for patients diagnosed with glioblastoma (GBM)—the most common and aggressive form of brain cancer—those words can ring hollow: In more than 90 percent of patients, the tumor returns; the average length of survival is 14 months.

An ongoing research collaboration led by Maryland Engineering Ph.D. candidate James Shamul could renew hope for patients and their families by leading to novel therapies that one day may eradicate the cancer for good. Together with Maryland Engineering Professor Xiaoming "Shawn" He, National Cancer Institute (NCI) Stadtman Investigator Shuo Gu, and Mayo Clinic Chair of Neurosurgery Alfredo Quiñones-Hinojosa, M.D. (known to colleagues—and viewers of Netflix's "The Surgeon's Cut"—as Dr. Q), the team is developing an unconventional approach to treatment, inspired by the building blocks of human life.

"Glioblastoma is an extremely lethal cancer: Even with months of chemotherapy and radiation, recurrence is virtually inevitable," says Shamul. "What we're doing right now to treat the primary tumor is not enough."

The reason GBM tumors are so tenacious lies in their origin: GBM stem cells, the provenance of almost all cells within the tumor. Stubbornly drug-resistant and highly tumorigenic, it's estimated that GBM stem cells comprise up to 1–5 percent of the tumor. When a GBM tumor is resected, on average 2–10 percent of it is inadvertently left behind. Chemo and radiation make handy work of eradicating non-stem cells but do little to damage true GBM stem cells, which self-renew and build a new tumor.

The key, explains Shamul, is to identify which cells are true GBM stem cells in the first place, a process that, until now, had not yet been done. But by isolating individual tumor cells from Dr. Q's patients and observing which ones replicate, Shamul and his colleagues in He's lab have successfully created a pure population of true GBM stem cells.

"We call this approach 'bio-inspired' because it mimics early embryonic development," explains He. "By isolating true GBM stem cells we can then identify what characteristics make them unique to develop targeted therapies."

Shamul first researched GBM as a student at Johns Hopkins, connecting with Dr. Q through his advisor at the time, Professor Jordan Green. One of the foremost brain surgeons in the world, Dr. Q became both a collaborator and cheerleader for Shamul, inviting him into the operating room and bolstering his hours in the lab. When Shamul chose bioengineering at Maryland for his Ph.D., he proposed to He the idea of continuing his work with Quiñones-Hinojosa.

"I know these cells well, and I wanted to keep working with Dr. Q on finding a cure," says Shamul. "Dr. He said to go for it. Really, Dr. He and Dr. Q are the ultimate pair: They both love developing impactful, cutting-edge therapies that shift the landscape of medicine for the benefit of patients."

In 2020, a NCI fellowship connected Shamul with Gu's RNA research expertise. Gu is now working with Shamul and He to identify novel targets of GBM stem cells, and use a nanotechnology-driven platform to either destroy the cells or transform them into cells susceptible to therapies like chemo and radiation.

That they are inching closer to solving the puzzle, says Shamul, would not be possible without key pieces in place:

Dr. Q's clinical perspective combined with Shamul, He, and Gu's research prowess is a magic formula that could lead to a different outcome for GBM patients: permanent remission.

"We have to change the narrative to one that doesn't include the expectation of recurrence for these patients," says Shamul. "Advancing the field requires thinking differently. While risky, we're nowhere without that mentality and nowhere without the overwhelming support of bold and fearless collaborators."

TO DECIMATE BRAIN TUMORS, RESEARCHERS BRING THE HEAT

FOR 20 PERCENT OF GBM CASES, the biggest obstacle to treatment is the tumor's location. When a tumor is beyond the reach of a doctor's scalpel, neurosurgeons like Graeme Woodworth, M.D. at UMD Baltimore opt for a new, minimally invasive approach called laser interstitial thermal therapy (LITT). The procedure blankets the tumor in light using robotically controlled laser probes, heating it to a temperature high enough to kill the tumor cells.

"LITT is minimally invasive, and it can also help patients who do not respond to radiosurgery," says Assistant Professor Huang Chiao "Joe" Huang. "But what Dr. Woodworth and others in the field noticed is that up to 40 percent of patients treated with LITT experience side effects, such as brain swelling and seizures, from the heating. Heat transfer in the brain is a complicated process and very tough to control."

A collaboration between Huang's lab at Maryland Engineering and UMD Baltimore's Department of Neurosurgery are working to minimize thermal damage to healthy brain tissue, which can cause intense pain and seizures, with the help of targeted gold nanoparticles. Prior to the laser treatment, the nanoparticles are injected into the brain and latch onto cancer cells by looking for overexpression of proteins unique to brain tumors; when the laser is applied, the nanoparticles absorb the light energy and convert it into concentrated, tumor-targeting heat.

The therapy, says Huang, could prove effective for tumors that are hard to reach and those that metastasize or recur—and potentially for other complex cancers like liver and prostate tumors.

It's a great example of the cross-institutional collaborations critical to creating promising treatments and hope for patients, Huang says. Behind the scenes is a big team, including bioengineering Ph.D. student Sumiao Pang and Woodworth, Anthony Kim, Jeffrey Winkles, Paul Anastasiadis, and their lab members at UMD School of Medicine.

While LITT probably won't replace existing therapies like chemotherapy or radiosurgery, it will likely make them more effective. "If you treat a tumor with LITT and follow it with radiosurgery, the radiosurgery will be much more pronounced," says Huang. "Like us, LITT will be an excellent team player."

BIG AMBITION

More than 13,000 Americans are expected to receive a glioblastoma diagnosis in 2022, according to the National Brain Tumor Society. Research led by Maryland Engineering could lead to novel therapies that one day may eradicate the cancer for good.

ILLUSTRATION BY KEITH NEGLEY

4 AMID A NATION OF CRUMBLING BRIDGES, HOW DO WE REBUILD THE ROAD AHEAD?

ON A SNOWY JANUARY MORNING IN 2022, Pittsburgh's 447-foot-long Fern Hollow Bridge collapsed and fell more than 100 feet. The tangled mess of concrete and cars injured 10, hours before President Joe Biden was set to announce his ambitious infrastructure plan in a press conference just miles away. Of the 43,578 structurally deficient bridges in poor condition in the United States, Pittsburgh (nicknamed "the City of Bridges") is home to 29.

In its journey to build a safe, modernized transportation infrastructure system, the U.S. has a long road ahead. A $1.2 trillion Bipartisan Infrastructure Law passed by Congress in late 2021 promises federal dollars for updating bridges and roads and integrating bike lanes and light rail. The biggest transportation infrastructure investment since former President Dwight D. Eisenhower signed the Federal-Aid Highway Act of 1956, those dollars will be a windfall for the thousands of local government agencies who will benefit, if they can navigate the mire of federal regulations and requirements.

"EVERYONE COMPLAINS THAT IT TAKES THE U.S. YEARS TO BUILD INFRASTRUCTURE PROJECTS, OFTEN DECADES, BUT WE CAN'T WAIT ANOTHER DECADE."

Qingbin Cui
Professor and Director,
Build America Center

"This is an unprecedented opportunity, but—unlike state agencies—local governments don't have the experience or capacity in applying for these grants," says Maryland Engineering Professor Qingbin Cui, a leading expert in highway project financing.

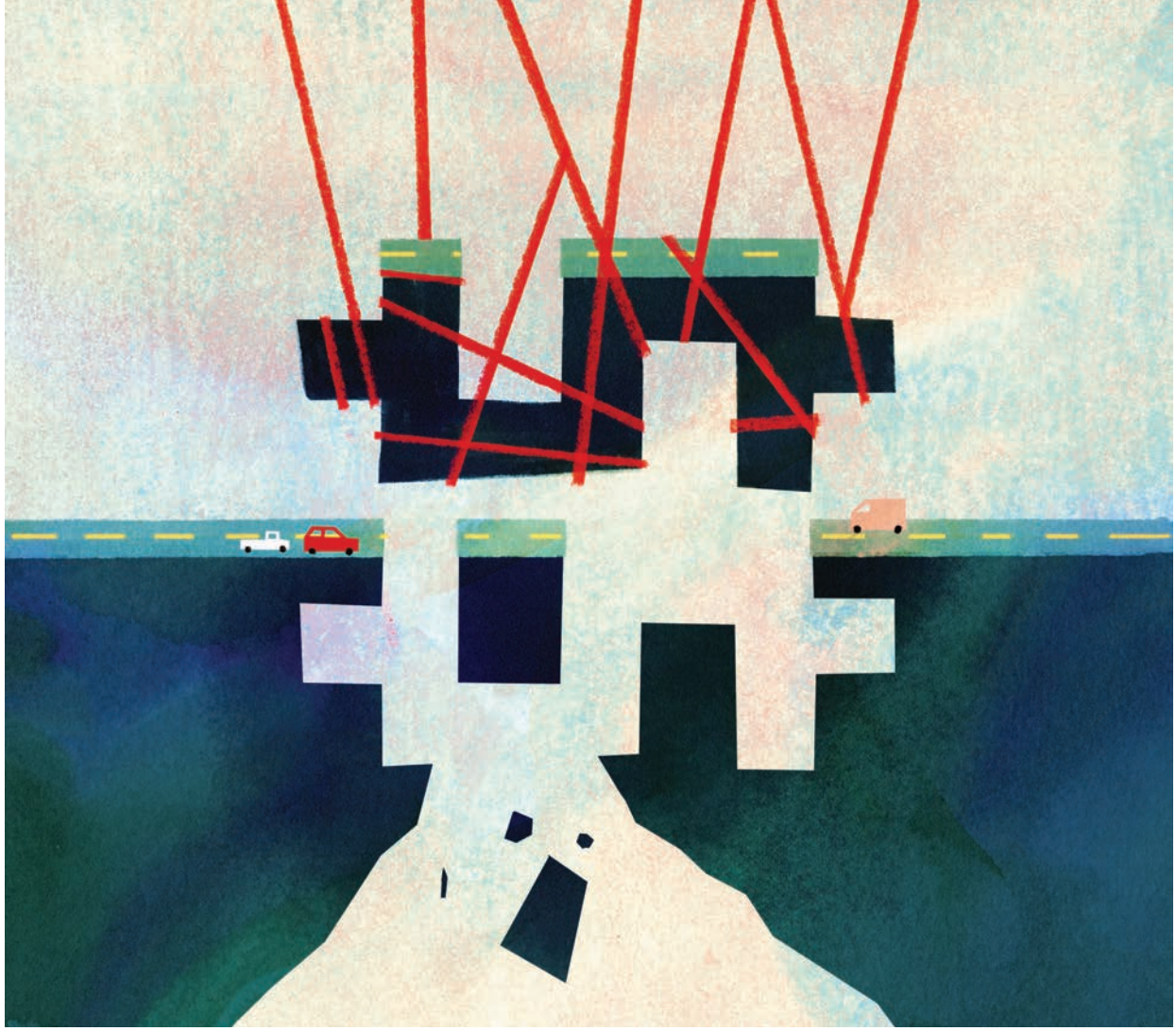
Cui is at the helm of an ambitious pursuit to help local municipalities identify their most pressing projects, navigate the federal system, and glean best practices for modernizing America's transportation infrastructure. UMD's Build America Center—a national think tank for identifying new and innovative financing mechanisms and helping more than 60,000 local public agencies access billions of dollars earmarked for on-the-ground, localized transportation infrastructure projects—is funded by a $5 million investment from the U.S. Department of Transportation. With Cui as center director, Maryland Engineering serves as national lead; Virginia Tech, Georgia Tech, Purdue, and Stanford are regional leads.

Leveraging expertise and big data from UMD research powerhouses including the Maryland Transportation Institute, Center for Advanced Transportation Technology, School of Public Policy, and National Center for Smart Growth (as well as national associations like AASHTO, ARTBA, NACo, NGA, and NLC), Cui says the center will arm state and local governments with the resources and data they need to fund and deliver on a broad range of projects, from road repair to municipal EV charging stations. This includes navigating federal regulation compliance, complicated aspects of federal law that can easily stall a grant application or halt a project.

"There's a tremendous amount of money flowing into states, but federal money is not free. Finding those resources can be a big challenge," explains Cui. "These forums allow stakeholders to share experiences and knowledge. It's an idea exchange forum in a space previously very siloed."

Cui hopes that the Build America Center's resources, opportunities, partnerships, and best practices will create a benchmark for the streamlined, equitable, and transparent systems that will make tomorrow's roads and bridges shovel-ready.

"Everyone complains that it takes the U.S. years to build infrastructure projects, often decades," says Cui. "But we can't wait another decade."



BIG MONEY
According to the 2022 ARTBA Bridge Report, 1 in 3 U.S. bridges needs repair or replacement. UMD's Build America Center will help more than 60,000 local public agencies access billions of dollars earmarked for transportation infrastructure projects.

SMARTER SYSTEMS TO KEEP CITIES RUNNING SMOOTHLY

WHEN A WATER MAIN BREAKS on Washington, D.C.'s Massachusetts Avenue, flooded streets can quickly become a ripple effect that disrupts transit, traffic, and other systems across the city. But what if digital doppelgangers working behind-the-scenes could help real-life city systems quickly react to manage problems? As part of her dissertation, Maryland Engineering alum Maria Coelho ('15, M.S. '17, Ph.D. '22) explored how "digital twins"—virtual simulations of city systems that use artificial intelligence and real-time data from sensors—can help cities monitor systems performance and intervene before inconveniences become major issues. A concept widely used in aerospace and manufacturing, Coelho addressed several challenges associated with digital twins in urban environments, using D.C.'s Metrorail network as one of her case studies. While the idea is in its infancy, her work, she says, provides the theoretical foundations that could eventually help put digital twins to work in urban environments—and make cities smarter. "It's an exciting area of research, and there's so much more to be done," says Coelho, who today is a research scientist at the Department of Energy's Idaho National Laboratory. "Right now, we're only touching the tip of the iceberg."

BRIDGING CLIMATE CHANGE AWARENESS WITH ENGINEERING PRACTICE

THE EFFECTS OF INTENSE heat, flooding, and other symptoms of climate change on the nation's infrastructure are undeniable, taking environmental, economic, and human tolls. But a new partnership between Maryland Engineering, the American Society of Civil Engineers (ASCE), and the National Oceanic and Atmospheric Administration (NOAA) will harness NOAA's climate science for resilient infrastructure solutions. Led by Maryland Engineering Professor Bilal Ayyub and Dan Walker, associate director of UMD's Center for Technology and Systems Management, the collaboration will create a foundation for updated, climate-smart ASCE codes and standards. The 2023 Leadership Summit coming up in February will engage nearly 100 stakeholders from UMD, ASCE, NOAA, NIST, FEMA, industry, and more in conceptualizing new technology, services, and plans for designing climate-resilient infrastructure.

ILLUSTRATION BY KEITH NEGLEY

5

By Chris Carroll
and Maggie Haslam

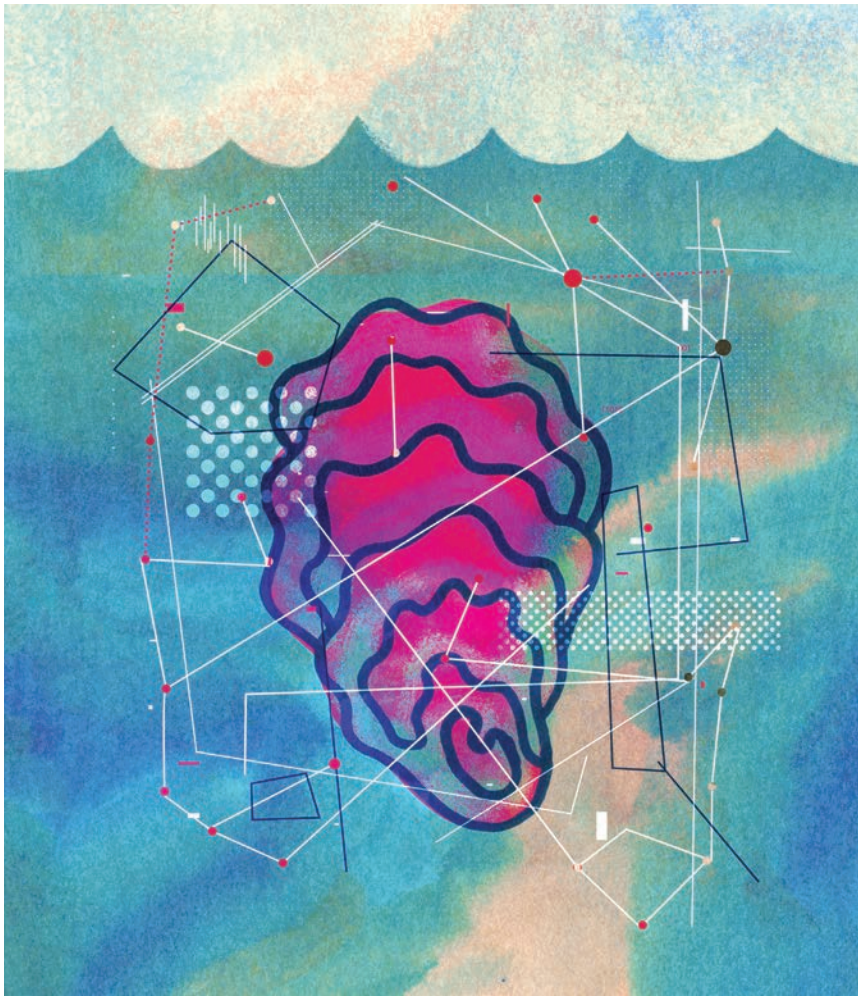
TO REVIVE AN AGE-OLD FISHING INDUSTRY, CAN SMART TECH BRING SOLUTIONS TO THE TABLE?

MORE THAN 150 YEARS AGO, Maryland launched its "Oyster Navy" to fight off illegal harvesting by rapacious pirates who'd stripped the shellfish from the waters of their own states and were now plundering the bounty of the Chesapeake.

Despite the seagoing police force's efforts (sometimes backed by rifles and cannons), centuries of overharvesting, mismanagement, and devastating diseases squandered those natural riches. Maryland's yearly oyster harvests plummeted from 19th-century highs of 15 million bushels to just 26,000 in 2003. The 540,000 bushels taken this year—the most in 35 years—is still less than 4 percent of the 19th century record.

Today, a multi-institutional team of researchers led by Maryland Engineering is developing a modern-day analog to the Oyster Navy, fighting to restore oyster populations—not with gunboats, but with underwater robots.

The project funded by a $10 million grant from the U.S. Department of Agriculture (USDA) seeks to infuse the Maryland shellfish industry with technologies that have revolutionized land-based agriculture. So-called "precision farming" often uses robotic aerial drones mounted with sensors to scan fields for factors like topography and soil content, giving farmers data to plan



BIG VISION
One day, a swarm of robots could zoom through an area and quickly provide an oyster farmer with a map showing a host of metrics, including where oysters are ready to harvest, where they're immature, and empty zones.

ILLUSTRATION BY KEITH NEGLEY

THE U.S. HAS A PROBLEM WITH FOOD WASTE, BUT MARYLAND ENGINEERS ARE COOKING UP SOLUTIONS

Spoiler Alert

The common hamburger faces an arduous journey from its source to your dinner plate; in fact, nearly one-third of meat products in the U.S. never reach their destination because of spoilage, prompting the federal government to announce a campaign to cut food waste in half by 2030. Emerging sensor technology developed by Assistant Professor Cheng Gong could help keep meat in our refrigerators and out of landfills by detecting spoilage-causing bacteria. The technology, which employs nano sensors armed with graphene, detects the presence of gas emissions at the very early stages of degradation before spoilage sets in. It has potential to not only help restaurants, stores, and consumers reduce waste, it has implications beyond meat—including milk, eggs, and other non-shelf stable products. The technology won the top prize in UMD's annual Invention of the Year competition in Spring 2022. (Learn more, page 25.)

Food as Fuel

The greenhouse gases produced by food waste each year in the U.S. are equivalent to 42 coal-fired power plants. But what if, instead of heating our planet, food waste could heat our homes? Student researchers in Assistant Professor Guangbin Li's lab are exploring the use of anaerobic digestion reactors for converting discarded food into energy-producing biogas to power homes and cars, nutrient-rich fertilizer, and a sustainable carbon source for wastewater treatment. With food waste a pressing issue for the EPA and USDA, the work by Li and his students could change how the nation handles its leftovers.

seeding or harvesting schedules, or apply fertilizers in exact amounts where needed.

Overall project leader Miao Yu, an engineering professor who specializes in robotic sensing, says Maryland's archaic oyster trade needs modern methods to augment its traditions.

"The shellfish industry in the Chesapeake Bay is mostly using the same technology from 200 years ago, with most things done very laboriously by hand," she says. "It has not evolved, not adapted like terrestrial farming." Decisions as basic as where to plant oyster larvae and steer a boat to find fully grown ones are still based on intuition and experience, rather than objective data.

On a recent data-gathering trip on the Choptank River, a major Chesapeake Bay tributary, Yu's doctoral student Keshav Rajasekaran struggled in an open boat against glaring sun and murky water to control a pair of microwave oven-size aquatic drones fitted with optical and acoustic sensors.

Working with Alan Williams, a master's student studying with fisheries scientist, and project co-lead Matthew Gray of the University of Maryland Center for Environmental Science, Rajasekaran hunched over his laptop directing the robots to gather visual and sonar imagery of oysters.

"The idea is: The sonar can see the oysters through the turbid water from a distance although with low resolution, while the camera has high resolution, but can only see the oysters close up—so we plan to use both," he says.

"BY DEVELOPING AND INCORPORATING ADVANCED TECHNOLOGIES INTO SHELLFISH FARMING, WE CAN BRING ABOUT A MAJOR BOOST IN PRODUCTION."
Miao Yu
Professor and principal investigator

With all that and a type of artificial intelligence known as machine learning, Yu and her collaborators are teaching a computer system to recognize sonar signatures of marketable oysters. One day, a robot—even a swarm of them—could zoom through an area and quickly provide an oyster farmer with a map showing a host of metrics, including where oysters are ready to harvest, where they're immature, and empty zones.

Beyond oyster visibility, the USDA and NSF project could lead to a range of revolutionary practices, Yu says: Underwater robots planting tiny oysters affixed to shells, or "spat," in perfect spots, or harvesting with delicate precision that takes only viable shellfish and leaves growing ones and the bay bottom undisturbed. "People think we're dreaming if we mention all that," Yu admits.

Another aspect led by Yang Tao, an engineering professor who specializes in the application of machine vision to industrial automation, is examining how to plot perfect dredging paths to avoid immature oysters while using as little fuel as possible. Other collaborators hail from the UMD Department of Computer Science, University of Maryland Eastern Shore, Louisiana State University, Pacific Shellfish Institute, Virginia Tech, Georgia Tech, and the Fraunhofer Center for Experimental Software Engineering. Together, the technologies could be applied to other types of seafood, from mussels to crabs.

Don Webster, a UMD Extension principal agent focused on aquaculture and one of the projects co-leads, says advanced aquaculture technologies could reshape the industry and make oysters once again a staple in the American diet.

"As I tell my growers, 'I want to see Wendy's, Popeye's, and Burger King arguing over who's got the best oyster sandwich,'" he says.

Tracing the Roots of a Supercomputer

WITHIN THE CLARK SCHOOL'S Innovation Hall of Fame (IHOF), David Bader (Ph.D. '96)—the hall's 2022 inductee—joins a distinguished community of inventors who use their knowledge, perseverance, innovation, and ingenuity to change the world.

Bader "democratized" supercomputing by designing the first Linux Supercomputer RoadRunner for open use by the national science and engineering community from a prototype he built in 1998 using commodity off-the-shelf parts. His computer was first used in April 1999; the top 500 supercomputers operating in the world today have roots in Bader's early work.

In a Q&A, Engineering at Maryland asks Bader about his path to IHOF:

You learned to program before you could read or write. How did this shape the direction of your future work?

My father was a physical chemist and an early computational scientist and my mother is an inorganic chemist, so they both get a lot of credit for my appreciation of the sciences and engineering.

In the 1970s, "programming" really meant the thoughtful use of resources, because every computer was limited in terms of memory size, cost of operations, etc. It set me in a direction of thinking about algorithms and how we can accelerate algorithms to run even faster.

Your work on supercomputers and high-performance computing began in the 90s. What drove you?

At the time, I had a couple areas of focus that I was very passionate about; one was thinking about our nation's security and how we spread peace to everyone on the planet.

For me, understanding large data sets was important. Exploring data sets from remote sensing of the Earth, biological sequences, and social networks led the way to what we see today with big data and the massive scale of data science, high performance data analytics, and the area that I've pioneered in massive graph analytics.

As we have access to more and more data sets, we can now think about the power of combining these together to solve today's global grand challenges. To me, that's just a tremendous opportunity to improve the world and to make it a better place for everyone.

Why was "democratizing" supercomputers important to you?

I grew up in a first-generation American family. My mother was a child Holocaust survivor from Europe, and my dad's parents immigrated to the United States. In the late 1970s when I was in 5th grade, I started delivering newspapers to earn enough money to buy my own computer. In the early 1980s I discovered parallel computing, but to get into supercomputing you needed millions of dollars to buy a unique commercial system.

I had a passion to harness multiple processors together to solve important and computationally demanding problems, and I recognized early that this would require harnessing the economics of commodity-based systems to make supercomputing ubiquitous.

To me, democratizing supercomputers means making them accessible to anyone in the world who wishes to work on these kinds of big problems. Solutions to real-world grand challenges can come from anyone, not just from people who can afford million-dollar supercomputers.

What do you hope for the future?

I would like to see the continued leveraging of commodity technologies and miniaturization of technologies so that we could deploy supercomputers ubiquitously. These systems must integrate new architectures that combine scientific computing capabilities with new technologies for supporting data science, machine learning, and artificial intelligence.

There are so many phenomenal uses that if everyone had access to a supercomputer—maybe we will see them in our next generation of smartphones—then we would see a tremendous amount of change.

That's really my dream: to make supercomputing access as simple as driving a car or reading a book or carrying your smartphone, so that everyone with a question can solve real-world grand challenge problems quite easily.

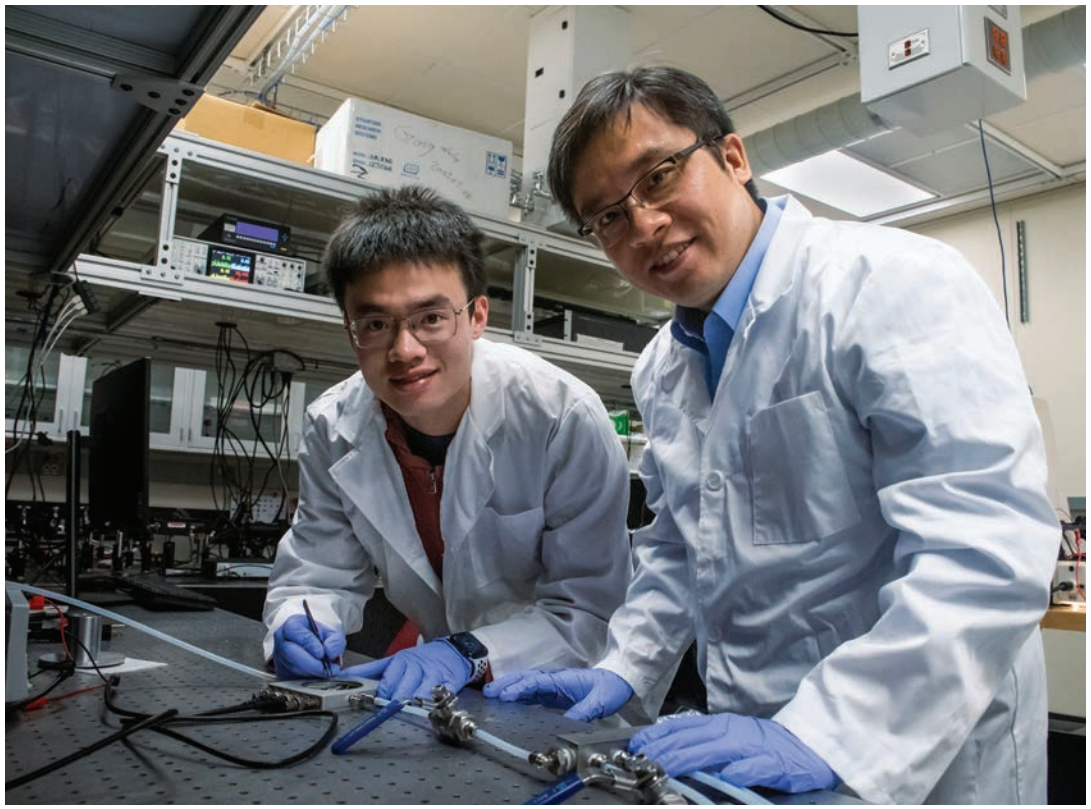
NOMINATE A GAME-CHANGER TO IHOF

Inspiring students—inspiring anyone—is a challenge. At Maryland Engineering, we celebrate the innovators who make positive impact on society and serve as inspiration for our young engineers, professors, staff, and corporate and government partners through the Clark School Innovation Hall of Fame (IHOF).

Within IHOF, inductees like Bader join other notable inventors who see the world differently—including the late Maryland Engineering alum George Laurer ('51), creator of the Universal Product Code (UPC), which freed cashiers everywhere from manual price input.

Sound like a Clark School innovator you know? Nominate them to IHOF today: ***go.umd.edu/nominate***

PHOTO COURTESY DAVID BADER



Tackling Grand Challenges

From nanosensors to wearable devices, engineering innovations abound at Invention of the Year awards

THE "USE-BY" DATE may have just expired.

A sensor made from a futuristic quantum material that can monitor food freshness to help grocery stores and production facilities slash waste—keeping food supplies safe, abundant, and affordable—won the top prize in UMD's annual Invention of the Year competition. It was announced May 3 at Innovate Maryland, a yearly celebration of UMD's growing penchant for turning intriguing bench science into creative and exciting real-world products.

Some 30–40 percent of the U.S. food supply goes bad, is ruined in production, or is simply thrown out before it ever reaches a table, according to a U.S. Department of Agriculture estimate. To rein in that shameful statistic and bolster the nation's food security, the federal government aims to cut food waste in half by 2030—and a Maryland Engineering researcher's innovative sensor system could be a big part of the plan.

SNIFF TEST
Gong (pictured above at right, with Ph.D. student Zhiyin Tu) explains that "In the early stages of spoilage, meat produces an odor. That odor can be 'smelled' by our nanosensors."

Assistant Professor Cheng Gong developed technology to allow stores, warehouses, and other users to accurately determine the freshness of meat. His tool is based on graphene, a two-dimensional quantum material that's a single layer of carbon atoms thick. In Gong's sensor, it helps determine the presence of specific gas emissions from meat degradation. This new sensor system surpasses arbitrary "use-by" and expiration dates in providing useful information, while being both cheap and effective; it also promises to be useful for applications beyond just meat.

PHOTO BY SAGE LEVY

Invention of the Year finalists from Maryland Engineering

INFORMATION SCIENCES CATEGORY

Anti-counterfeiting Method, invented by Assistant Professor Po-Yen Chen and colleagues

Deepfake Detection Tool, invented by Distinguished University Professor Dinesh Manocha and colleagues

LIFE SCIENCES CATEGORY

Fully Automated Point-of-Care Diagnostics, invented by Associate Professor Ian White, Ph.D. candidate Micaela Everitt, and Ph.D. student David Boegner ('20)

Suture-free Repair for Surgery, Cuts, and Wounds, invented by Professor Srinivasa Raghavan and Ph.D. student Leah Borden

Wearable Devices for Measuring Gut Microbial H_2S, invented by Professor Reza Ghodssi, Visiting Assistant Research Professor Santiago Botasini, and colleagues

PHYSICAL SCIENCES CATEGORY

The Coronalyzer: Sensor System for Detecting COVID from Human Breath, invented by Assistant Professor Kevin Daniels, Chief Engineer John Rzasa, and colleagues

OtoPhoto: AI-enhanced Otoscope for Diagnosing Pediatric Ear Disease, invented by Chief Engineer John Rzasa and colleagues

Sensors for Rapid Monitoring of Meat Freshness, invented by Assistant Professor Cheng Gong

Wearable Micro Air Cleaner for Respiratory Health, invented by Margaret G. and Frederick H. Kohloss Chair Professor Jelena Srebric, Associate Research Professor Shengwei Zhu, Research Assistant Nicholas Mattise, Ph.D. candidate Sebastian Romo Duenas ('18, M.S. '21), Ph.D. student Lingzhe Wang, graduate student Avery Layne ('19), and recent graduate Nicholas Rabchevsky ('22)

Faculty Honors & Awards

DEPARTMENTS
AE: Aerospace Engineering
BIOE: Bioengineering
CEE: Civil & Environmental Engineering
CHBE: Chemical & Biomolecular Engineering
ECE: Electrical & Computer Engineering
FPE: Fire Protection Engineering
ME: Mechanical Engineering
MSE: Materials Science & Engineering
PHY: Physics

INSTITUTES
IREAP: Electronics & Applied Physics
ISR: Systems Research
JQI: Joint Quantum
MEI²: Energy Innovation
REFI: Biomedical Devices

Distinguished University Professor, Minta Martin Professor, and Department Chair **BALAKUMAR BALACHANDRAN** (ME) was awarded the Robert R. Scanlan Medal by the American Society of Civil Engineers' Engineering Mechanics Institute. He was honored for his distinguished contributions in nonlinear engineering mechanics with a focus on structures and aeroelasticity.

Balachandran was also named a UMD Distinguished University Professor. The highest honor the university bestows, the title is conferred to established scholars held in the highest esteem by professional colleagues nationally and internationally, in recognition of impact and significant contribution to the nominee's field, knowledge, profession, and/or practice

Keystone Professor **MEL GOMEZ** (ECE) received the UMD Gemstone Honors Program 2022 Outstanding Mentor Award. This award recognizes an outstanding Gemstone faculty mentor who has provided dedicated service to and demonstrated exemplary support and guidance of a student team. The honor is based on nominations from the students.

Dean and Nariman Farvardin Professor **SAMUEL GRAHAM, JR.** (ME) received the 2022 Allan Kraus Thermal Management Medal, which recognizes outstanding achievements in thermal management of electronic systems and his or her commitment to the field of thermal science and engineering, by the American Society of Mechanical Engineers. Graham was cited for expertise in the thermal engineering of wide bandgap semiconductor devices and interfaces, including heterogeneous integration methods for thermal management.

Associate Professor **KATRINA GROTH** (ME/MEI²) was awarded the Landis Young Member Engineering Achievement Award, a highly competitive national-level accolade from the American Nuclear Society. She was recognized for her sustained technical excellence in nuclear safety, probabilistic risk assessment, and human reliability analysis.

Herbert Rabin Distinguished Professor **LIANGBING HU** (MSE/MEI²) was one of 31 finalists for the 2022 Blavatnik National Awards for Young Scientists offered by the Blavatnik Family Foundation and the New York Academy of Sciences; Hu, for the fourth year in a row, was one of 10 finalists in the physical sciences and engineering category. The awards celebrate the innovative achievements of young scientists early in their careers.

Hu was also a winner of the 2022 R&D 100 Awards in the mechanical/materials category by R&D World magazine. The prestigious awards program, referred to as "the Oscars of innovation," honors pioneers in research and development and their revolutionary ideas in science and technology. Hu, who has previously won three R&D 100 Awards, won this year for his project "Expanded Cellulose Super Ion Conductor."

Minta Martin Professor **CHRISTOPHER JEWELL** (BIOE/REFI) was elected by the Controlled Release Society to its College of Fellows. Elevation to Fellow recognizes an exceptional individual in the field of controlled release who has made outstanding and sustained contributions to the field of delivery science and technology.

Professor **ALIREZA KHALIGH** (ECE/ISR) received the 2022 IEEE Power Electronic Society Vehicle and Transportation Systems Achievement Award. He was cited for contributions to the advancement of power electronics for electrified transportation systems including electric vehicles and more electric aircraft.

Assistant Professor **ALICIA KOLLÁR** (PHY/ECE/JQI) received the Alfred P. Sloan Foundation's 2022 Sloan Research Fellowship, which stimulates fundamental research by early-career scientists and scholars of outstanding promise. The two-year fellowships are awarded yearly in recognition of distinguished performance and a unique potential to make substantial contributions to their field.

Distinguished University Professor **EDWARD OTT** (ECE/PHY/IREAP) was elected by the National Academy of Sciences to its 2022 class of members in recognition of his exceptional and continuing achievements in original research. The number of UMD faculty members in the academy is 24.

Professor **REZA GHODSSI** (ECE/ISR) was named the 2022–28 president of the Transducer Research Foundation (TRF). The international organization stimulates research on technologies related to transducers, microsystems, and nanosystems, and fosters relationships between academic, industrial, and government researchers. In June, Ghodssi was general chair of TRF's biennial workshop on solid-state sensors, actuators, and microsystems.

Associate Professor **ODED RABIN** (MSE) was selected for a 2022–23 Fulbright U.S. Scholar Program award offered by the U.S. Department of State and the Fulbright Foreign Scholarship Board. He is among 13 U.S. scholars who will conduct research and/or teach in Germany to enhance collaborations between U.S. and German institutions. Rabin will be stationed in Dresden at the Leibniz Institute for Solid State and Materials Research and will seek to advance research on thermoelectrics.

Minta Martin Professor and Department Chair **JI-CHENG "JC" ZHAO** (MSE) was awarded the prestigious Humboldt Research Award from the Alexander von Humboldt Foundation. With this award, Zhao will foster collaborations to accelerate the development of new alloys for a range of potential applications with colleagues at the Germany-based Max Planck Institute for Iron Research, Karlsruhe Institute of Technology, and Fraunhofer Institute for Mechanics of Materials.

Assistant Professor **YOU ZHOU** (MSE) was selected for the Department of Energy Office of Science's Early Career Research Program in support of his project "Probing and controlling novel electronic and magnetic ordering in electron-hole Wigner crystals." The program is designed to bolster the nation's scientific workforce by providing support to exceptional researchers during crucial early career years.

Welcome, New Leadership

Confronting society's most pressing grand challenges and inspiring the next generation of engineers who will do good for our communities: both require fearless leadership. Join Maryland Engineering in welcoming five new faculty leaders to our team:

AKUA ASA-AWUKU (CHBE) is associate dean for diversity and equity, effective Spring 2022. In this role, she works with college leadership to strengthen diversity, equity, and inclusion as foundational characteristics of the Clark School's program. Asa-Awuku is a professor in the Department of Chemical and Biomolecular Engineering, associate chair for the department's strategic initiatives, and president of the American Association for Aerosol Research. She was honored alongside UMD faculty Candice Duncan and Ebony Terrell Shockley by the Audubon Naturalist Society as Taking Nature Black® Environmental Champions for their National Science Foundation-funded Providing Educational Access to Research & Learning in Geosciences program to recruit students with non-traditional backgrounds.

NII O. ATTOH-OKINE (CEE) is chair of the Department of Civil and Environmental Engineering, effective September 1. He heads a department that has established an international reputation in fields that include transportation engineering, disaster resilience, and water resource management. Attoh-Okine's research expertise is in resilient infrastructure with a focus on cybersecurity and digital technologies applied to transportation and civil infrastructure. He served as lead representative from the University of Delaware to the Digital Innovation Hub, a U.S.-Japan University Consortium. In recognition of his leadership, he was selected as one of only 18 international speakers to attend the G20 Ministerial Meeting held in Japan in 2019.

ALISON FLATAU (AE) is chair of the Department of Aerospace Engineering, effective August 1. She joined Maryland Engineering in 2002 and has served in multiple leadership roles for the department and college, including Clark School Associate Dean for Research. Flatau's teaching and research interests focus on smart materials and structures with an emphasis on magnetostrictive actuator and sensor technologies. She was a principal investigator of a Multidisciplinary University Research Initiative (MURI) on magnetostrictive alloys that made important contributions to the Department of Defense and aerospace industry. She is a Fellow of the American Society of Mechanical Engineers and the American Institute of Aeronautics and Astronautics, and in 2018 was an IEEE Distinguished Lecturer.

REZA GHODSSI (ECE/ISR) is executive director of research and innovation for the Clark School at the University System of Maryland at Southern Maryland, effective September 1. In this role, he helps initiate new state- and federally funded research activities; create partnerships with academic institutions and industry and federal agencies; and develop outreach programs with the local community. Ghodssi is a UMD Distinguished Scholar-Teacher; Fellow of IEEE, American Society of Mechanical Engineers, and American Vacuum Society; and president of the Transducer Research Foundation, a nonprofit whose mission is to stimulate research in science and engineering and to foster the exchange of ideas and information between academic, industrial, and government researchers.

THOMAS E. MURPHY (ECE/IREAP) is interim chair of the Department of Electrical and Computer Engineering, effective September 30. Murphy joined the UMD faculty in 2002; he leads a group that conducts experimental research in areas including 2D optoelectronics, microwave photonics, and nonlinear dynamics. He is a Keystone faculty member, UMD Distinguished Scholar-Teacher, and recipient of the Clark School's Junior Faculty Outstanding Research Award and E. Robert Kent Outstanding Teaching Award. Murphy served as IREAP's director from 2012–22.

DEAN'S CIRCLE SPOTLIGHT

A Blueprint for Human-Oriented Innovation

ASK ANTHONY EPHREMIDES about his blueprint for success, and he'll answer with two guiding principles: "Anything you do should be (1) innovative and (2) human-oriented." It should come as no surprise then, that Ephremides—the founder of the field of ad-hoc wireless networks—is also one of Maryland Engineering's most philanthropic faculty members.

Fresh from earning his M.S. and Ph.D. degrees from Princeton, the native of Athens, Greece, joined the faculty of UMD's Department of Electrical and Computer Engineering (ECE) in 1971. Today, ECE's graduate program ranks in the top 10 among public universities, but 50 years ago, the department's reputation was more modest. Still, Ephremides saw potential: "As we say in the mathematics of our profession, the derivatives of its trajectory were all positive."

Echoing the path of ECE's ranking since, Ephremides has enjoyed an overall positive trajectory in his career. His scholarly focus spanning all aspects of communications systems, Ephremides was already making waves in the '70s—while consulting at the Naval Research Laboratory, he developed the first-ever algorithms for the distributed organization and control of wireless networks—and hasn't stopped since. He was a founding member of UMD's Institute for Systems Research, one of the original six National Science Foundation Engineering Research Centers; he is a former co-director of the Maryland Hybrid Networks Center; he has served the Institute of Electrical and Electronics Engineers and other professional organizations in a myriad of leadership capacities; and he continues to conduct breakthrough research, including recently published work on remote reconstruction of network signals in the emerging "Internet of Things."

Looking back, Ephremides says, the networks he values most are interpersonal ones. He has found fulfillment in his roles of teacher and advisor, having supervised the dissertations of more than 40 Ph.D. students—many of whom now hold prominent positions in academia, industry, and research labs and with whom Ephremides keeps in touch. "They still seek my advice, though now I also seek theirs," he says. "This element of human relations has been the most important aspect of my work."

In keeping with this idea, Ephremides and his wife of 48 years, Jane, have established a legacy of philanthropy to benefit the faculty and students of Maryland Engineering. Recognizing the career gains Ephremides received when named the Cynthia Kim Professor of Information Technology, in 2007 the couple established the Anthony Ephremides Chair in Information Sciences and Systems. Today, the title is held by Professor Sennur Ulukus, whose research interests span information theory, wireless communications, machine learning, and signal processing and networks.

When considering the importance of student support, Ephremides reflects that his Princeton education would have been unattainable were it not for the fellowship he was awarded. In return, he and Jane established the Anthony Ephremides Endowed Graduate Fellowship and the Jane Ephremides Distinguished Endowed Graduate Fellowship in 2016 to help further the careers of deserving students.

The couple says that Ephremides' long tenure at UMD has instilled in them a feeling of responsibility, and they're that pleased to see the results of their philanthropy in real-time. "Giving now allows us to witness the effects of our contributions and share in the academic achievements of the recipients," says Jane, who retired from the U.S. Environmental Protection Agency in 2003. "This has given both of us a special sort of satisfaction."

THE DEAN'S CIRCLE recognizes those who have given $100,000 or more during their lifetime to the Clark School. To learn how your charitable donation can make a significant difference in the future of the Clark School, contact Almarie Wood, director of development, at 301-405-9836 or aiwood@umd.edu.

At the game-changing edge of not just research but also student and faculty support, Ephremides hopes the couple's philanthropy will motivate imitators. When it comes to giving back, he says, "It's important to leave a legacy—to benefit others, and to inspire others to give back, as well."

PHOTO BY GREG FIUME

Cementing His Legacy

Builder, alum Stanley R. Zupnik's latest gift expands innovation footprint of Maryland Engineering

STANLEY R. ZUPNIK ('59) knew from a young age he wanted to be a builder and real estate developer. The Washington, D.C., native began nurturing his entrepreneurial mindset while still in high school (he had a photography business taking photos at weddings, bar mitzvahs, and proms, and later, a TV repair and hi-fi installation business). The summer before college, Zupnik worked on construction sites and learned all he could from his "street-smart" grandfathers, both of whom invested in real estate. Zupnik recalls one grandfather's lesson on risk: "When investing, don't tell me how much you could make. Tell me how much you can afford to lose."

For Zupnik, the first in his family to attend college and earn a bachelor's degree, a Maryland Engineering education was a low-risk/high-reward investment that would give him an edge in the industry—and in life. A civil engineering major, Zupnik started his education having already worked as an engineer on job sites. But he knew those skills could take him only so far: "The knowledge and discipline I gained at Maryland were unbelievable, because they taught me how to think," says Zupnik. "I've benefited from other people's hard work and knowledge—now I take the opportunity to give back."

To help position the next generation of engineers to build a smarter future for the good of all, the real estate mogul who never forgot the impact of his Maryland Engineering education made a $25 million naming gift toward the state-of-the-art, 157,000-square-foot Stanley R. Zupnik Hall. UMD's newest facility for research, innovation, entrepreneurship, and education—which ceremonially breaks ground in November 2022—will foster collaboration between a number of engineering disciplines.

The lessons Zupnik learned, both from his grandfathers and as a UMD student, stuck. After graduating, he went to work in the construction industry as one of a few builders he knew with the advantage of an engineering degree. Industry leaders were his mentors for how to build houses, then midrise and hi-rise apartment buildings and office buildings, and how to apply new innovations such as post-tensioning and high-strength, 60 psi billet-steel rebars. In 1964, Zupnik launched his own construction firm, Majestic Builders, which quickly became among the greater Washington, D.C. region's top residential construction management and general contracting firms; Majestic was also among the first firms to use IBM System/36 computers for project management and scheduling. "Engineers," Zupnik explains, "think at least five years ahead."

Still hard at work, today Zupnik is a mentor to his six grandchildren. During the pandemic, he began holding lessons in investing over Zoom; he has covered dividends, price-to-earnings ratio, and growth stocks. Some of his lessons harken back to his own childhood ("pennies make nickels, nickels make dimes, and dimes make dollars").

For the proud alum and longtime UMD supporter (his philanthropic legacy includes the Stanley R. Zupnik Fellowship Fund for graduate students, the Stanley R. Zupnik Endowed Scholarship for undergraduate civil engineering students, and the naming of Stanley R. Zupnik Lecture Hall and the Stanley R. Zupnik '59 Forum), giving back to Maryland is an investment in the future. He compares philanthropy to a building project: "When you build, the space is never used in just the way you think it's going to be used. The same goes for students.

"We need young people with vision—you never know what problems these engineers will solve."

STANLEY R. ZUPNIK HALL is made possible by the lead gift from the A. James & Alice B. Clark Foundation's *Building Together: An Investment for Maryland* and the state of Maryland.

PHOTO BY MIKE MORGAN

Giving Students "Space" for Galactic Discovery—and a Launch into Research

Terps who designed microgravity experiment send their work to the International Space Station

DESPITE ITS INFINITE REACH, real estate in outer space is a precious commodity.

Nowhere is that more apparent than within the tiny plastic tube, roughly the size of a magic marker, that a group of four Maryland students filled with silicon and iron oxide this fall in preparation for a 420-kilometer trip skyward.

They hope that, once closer to the stars, their miniature laboratory (the fifth unique student experiment to spend time aboard the International Space Station, or ISS, as part of the University of Maryland's Terps in Space program) will offer insight into how planets form. It's an experience that's truly out of this world: the opportunity to design an experiment, write a compelling proposal, and vie for the chance to have your work tended to by astronauts in near gravity.

At Maryland, it's an opportunity made exclusively to undergraduate students, thanks to a legion of dedicated staff, faculty, and graduate student mentors. At the helm is Daniel Serrano (M.S. '10, Ph.D. '14), a UMD alum-turned-senior faculty specialist who—after serving as a proposal reviewer in 2014—made a pitch that Maryland become one of just a handful of universities to participate in the National Center for Earth and Space Science Education's Student Spaceflight Experiments Program.

Space missions—even pint-sized ones—come with a hefty price tag: All told, sending one experiment costs $25,000 *before* materials and personnel. Serrano works with external sources, as well as departments and schools on campus, to secure funding each year for Terps in Space.

"The behind-the-scenes administration and mentorship is critical for this to even happen," says Serrano, who works for UMD's Institute for Physical Science and Technology. "Many of those same volunteer faculty who were with me on that first review in the basement of the Smithsonian Air and Space Museum come back and make this possible, year after year."

The Terps in Space program has grown a dedicated following, with many participants returning after graduation to assist with logistics and provide student support. Jason Hipkins ('21), who participated as an undergraduate and now advises for both Terps in Space and Maryland's Students for the Exploration and Development of Space chapter, says it's an experience that rivals any you can get at Maryland: an extra-curricular activity that's inclusive and interdisciplinary, and that also offers a foray into research at a pivotal time.

"If you're a curious person, programs like Terps in Space are a really valuable experience and a great introduction to research," Hipkins says. "It's fundamental to advancing UMD's activities as a research institution. I would attribute Terps in Space as one of the reasons I stuck with research."

While Serrano concedes that sending an experiment to space is resume gold, what keeps him running the program is the bevy of skills students gain before the rocket is launched. Writing, teamwork, critical thinking, planning, communication, and even fundraising (teams are responsible for funding their own materials) are skills both integral to Terps in Space, and alien to the typical undergraduate project.

"It's the real deal," says Serrano. "The vision of the program is to expose students to the full spectrum of the scientific profession in a condensed period. Terps in Space is an opportunity for students to gain skills that aren't conventional for an undergraduate experience, but that will really resonate as they begin their professional journey."

From Powder to a Planet: An Inside Look at this Year's Space-Bound Experiment

IN 2022, TEAM OBSIDIAN—the fifth Maryland team to participate in the Student Spaceflight Experiments program through Terps in Space—beat out 10 other Maryland teams for a coveted spot aboard the International Space Station.

The experiment, developed by students Vincent Lan (materials science and engineering), Brian Sun (mechanical engineering), Adrian Seemangal (geospatial information science), and Joseph Niba (math)—with the help of graduate student mentors Michael Kio (chemical and biomolecular engineering) and Anmol Sikka (aerospace engineering)—aims to better understand the mechanisms of planet formation by exploring how small particles of dust coalesce.

While only the size of a magic marker, the experiment capsule offers flexibility, including the ability to separate materials. Team Obsidian will put a mix of silicon dioxide nanopowder and glycerol on one side and a mix of iron oxide and glycerol on the other, which astronauts will later mix on board the ISS.

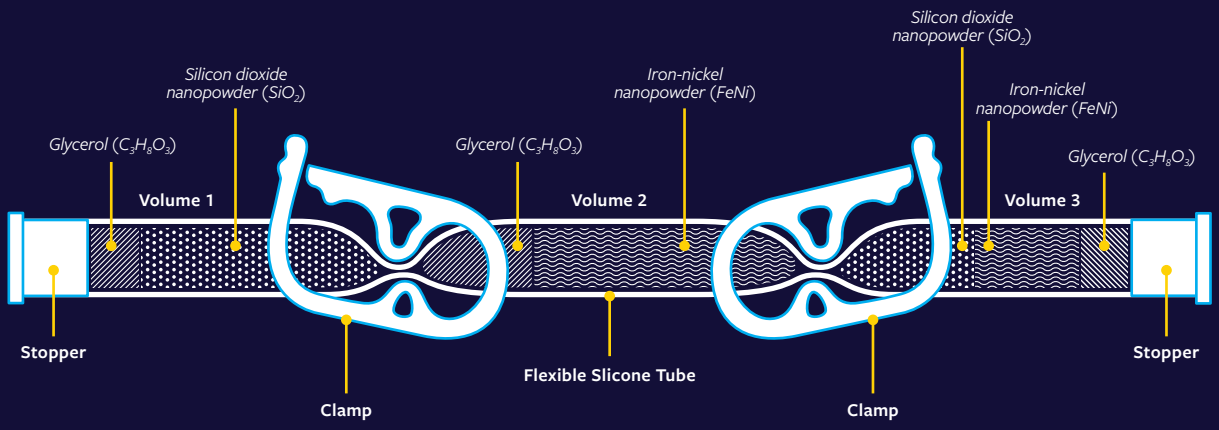
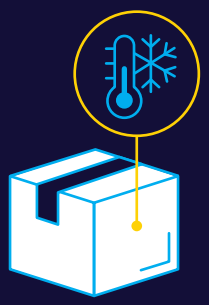


Fig. 1



Refrigeration during its journey prevents particle interaction until the tube reaches ambient conditions on board the ISS.

Fig. 2

To complete the experiment, the ISS crew will shake the tube gently for 120 seconds. After approximately 30 days, the tube returns to earth, where it will be compared with the ground experiment conducted simultaneously by the team.

Fig. 3

The Student Spaceflight Experiments Program (SSEP) is a program of the National Center for Earth and Space Science Education (NCESSE) in the U.S. and the Arthur C. Clarke Institute for Space Education internationally. It is enabled through a strategic partnership with Nanoracks LLC, which is working with NASA under a Space Act Agreement as part of the utilization of the International Space Station as a National Laboratory.

ILLUSTRATIONS BY MATT LAUMANN

Campus Snapshots

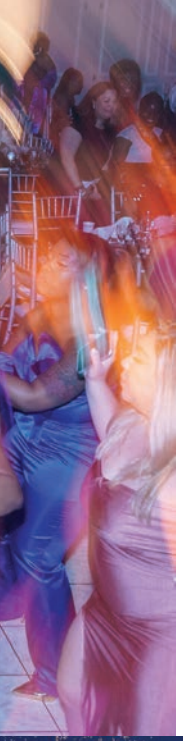
Black Alumni Weekend

More than 700 Terps returned to UMD in April for the first Black Alumni Weekend to reconnect, reminisce, and revel in the accomplishments of their peers. The three-day celebration featured more than a dozen events, including a brunch hosted by the Clark School's Center for Minorities in Science and Engineering (1) in conjunction with the center's 41st alum celebration, the Gift of Giving Gala (2), and a "Terpchella" music festival (3).

30 Years of QUEST

On November 12, the QUEST Honors Program celebrated 30 years of hands-on education in quality management, process improvement, and system design with a celebratory event at The Hotel. Since the start of the program, more than 1,700 undergrads majoring in engineering, business, and/or science have participated. The interdisciplinary QUEST curriculum includes team-building activities (4), company site visits (5), and poster sessions at the biannual QUEST conference (6).

(1) PHOTO BY GREG FIUME; (2-3) PHOTOS BY KOREY HOPKINS; (4) PHOTO BY RACHEL DiDONNA; (5) PHOTO COURTESY McCORMICK & COMPANY; (6) PHOTO BY LISA HELFERT; (7) PHOTO BY ROBERT HERSCHBACH; (8) PHOTO BY JOHN T. CONSOLI; (9-12) PHOTOS BY STEPHANIE S. CORDLE



Maryland Day

UMD's biggest event of the year regularly draws more than 80,000 people to campus. To tease this year's Maryland Day, students from the Leatherbacks Combat Robotics Team chatted with Steve Rudin at WJLA-TV (7). Among the day's hundreds of family-friendly events and interactive exhibits included fishing for toy terrapins in the ODK Fountain (8) and the Steel Bridge student team displaying their 20' bridge designed to hold 2,500 pounds from the 2021–22 AISC Steel Bridge Competition (9).

IDEA Factory

In May, UMD dedicated the E.A. Fernandez IDEA (Innovate, Design and Engineer for America) Factory (10), designed to foster technology innovations through collaboration across engineering, the arts, business, and science. Guests were welcomed inside (11) for tours of the new building, where they chatted with students, faculty, and staff (12) about UMD's newest competitive advantage.

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↑ 1 increase

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