THE JOHNS HOPKINS WHITING SCHOOL OF ENGINEERING MAGAZINE

JHU ENGINEERING

WINTER 2023

Data Democratizer

With the COVID-19 dashboard, Lauren Gardner found a global voice.

Putting Genetics on the Map

How Michael Schatz and his team were crucial to completing the first human genome.

Harsh Encounters

An ultramarathoner shares tales from the trail.

Sense of Identity

For many students new to campus, finding a group of students with similar interests is everything.

DEAN SCHLESINGER PHOTO: WILL KIRK/HOMEWOODPHOTO.JHU.EDU.

Dear WSE community,

THROUGH THIS ISSUE'S THREE FEATURE STORIES, I BELIEVE ONE CAN SEE HOW RESILIENT WE ARE, EVEN in the most challenging times; how inventive we are, especially as we expand our horizons; and how diverse our community is, while maintaining a cohesiveness that feels like "home" on our Homewood campus. There's a reciprocal relationship: between feeling like you're a part of something and knowing that, because you're part of something, you can cultivate curiosity to inspire change.

I believe this is reflected in the school's vision to "advance data- and science-driven engineering discovery, innovation, and systems applications to help everyone live longer and healthier lives and empower communities and society to thrive even in extreme environments." It's a twofold grand challenge: to improve lives, and to support the creation of resilient communities.

The story of Lauren Gardner and her leadership in establishing the COVID-19 dashboard ("Data Democratizer," p. 14) is a shining example of advancing data-driven systems applications to help everyone live longer and healthier lives—just as the work of Michael Schatz and his team's efforts to map the human genome is science-driven engineering enabling society to thrive ("Putting Genetics on the Map," p. 26). Furthermore, when students, faculty, and staff can find commonalities amid cultural differences, they establish a foundation from which to achieve great things together ("Sense of Identity," p. 20).

As engineers, we have an ever-present and underlying desire to identify problems, develop solutions, and enact those solutions for the benefit of individuals and society. It's how we improve the world. And when we come together and encourage each other toward discovery and solutions that solve the most pressing problems—whether mapping the spread of a global pandemic, studying the origins of disease, or bonding over similarities—we can achieve more. There's that resiliency. It underpins everything we do.

I believe that the next few years are pivotal in the history of our school of engineering, and all of this is just a start as we begin to embark on exciting new fundamental and translational advances around artificial intelligence, machine learning, data science, and the application of these in the fields of medicine, energy, and security. There's an awakening happening here at the Whiting School, a sense of becoming. I can't wait to see the lasting impact I know we'll have.

Best wishes,

ED SCHLESINGER
Benjamin T. Rome Dean

CONTRIBUTORS

MONICA LEIGH A&S '98

SENSE OF IDENTITY (P. 20)

Leigh is a graduate of the Writing Seminars at Johns Hopkins University and a senior writer for its Whiting School of Engineering. Prior to returning to Hopkins, she was a senior managing editor for KWF Editorial, a scholarly publishing services provider for peer review and academic journal workflows. When not writing about science or nudging commas into place, she enjoys time with her family and their goldendoodle.

DANA SMITH

PUTTING GENETICS ON THE MAP (P. 26)

A Boston-based illustrator and photographer, Smith is a widely published magazine artist both nationally and overseas. His work has appeared in *The New York Times Magazine, TIME, Bloomberg, Stern, Technology Review, Nature,* and *Yankee*. He has also worked with many universities, including Harvard, Boston College, Brown, Dartmouth, and MIT.

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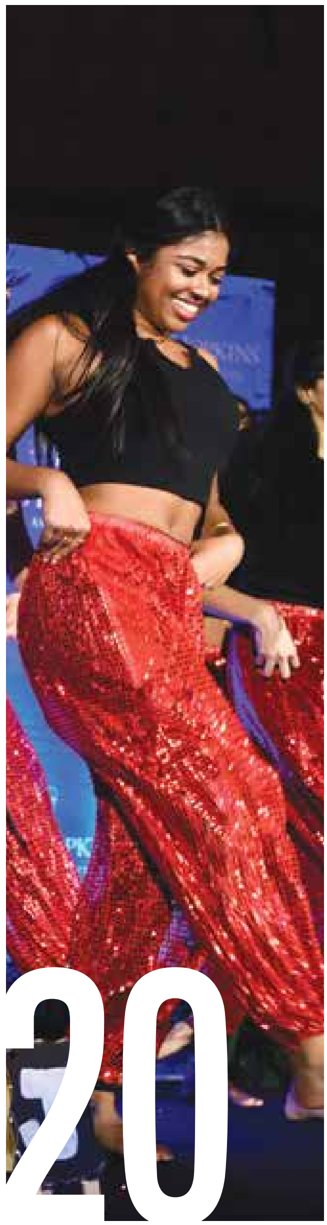


On the Cover: JHU JOSH dancers Sneha Kamada and Asha Shetler; photo by Will Kirk/homewoodphoto.jhu.edu.

Harboring Inclusive NeuroTech Solutions

JOHNS HOPKINS AND HOWARD UNIVERSITY HAVE LAUNCHED THE NEUROTECH HARBOR technology accelerator, a partnership that will fast-track groundbreaking, equitable, and accessible technologies for neurological conditions.

More than 1 billion people worldwide suffer from neurological disorders, such as Alzheimer's and Parkinson's disease, multiple sclerosis, stroke, and migraines. "Potentially life-saving and life-changing solutions addressing neurological conditions are out there, but the pace of their development is slow," says the Whiting School's Sri Sarma, executive director of the new technology accelerator and an associate professor of biomedical engineering who is leading the team of investigators and personnel from both universities.

Supported by the National Institutes of Health with an initial five-year grant, the effort will fund team projects at a level of up to $500,000 per year for four years as well as provide awardees with mentors experienced in commercializing neurotech devices.

Critical to the NTH's approach is the accelerator's focus on bringing together expert leaders and perspectives from around the globe as well as the commitment to increasing the participation of underserved communities in the neurotech ecosystem. Over the next five years, the NTH expects to launch 45 new neurological health innovation projects, at least 15 of which will have one woman or underrepresented minority on the founding team.

"Our collective aim is to provide unique opportunities to innovators from all backgrounds to find effective solutions to neurological conditions that cause substantial suffering in all populations, including underserved populations that historically and continually experience disparities in health outcomes," says Evaristus Nwulia, a Howard University professor of psychiatry and principal investigator of the project.

"Studies show that diversity unlocks innovation, drives growth, stimulates novel thinking, improves outcomes, and produces solutions that work for everyone," Sarma says. "So, we are committed to diversity and inclusion during early-stage translation as the first critical step toward creating lasting and meaningful long-term clinical and societal impact."

— LISA ERCOLANO

TELL US WHAT YOU THINK!

Continue the conversation online, using **#JHUEngineering** on Facebook and Twitter!

AWARDS AND HONORS

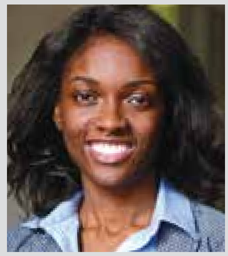
Three Whiting School assistant professors received Young Faculty Awards from the Defense Advanced Research Projects Agency. The DARPA program is focused on "developing the next generation of engineers, mathematicians, and academic scientists who will focus a significant portion of their careers on national security issues."

Awardees and their projects include:

YINZHI CAO, Computer Science, who focuses on the security and privacy of web, network, and mobile systems. Project: "Abstract Modeling of Control- and Data-flow Guards of Inactive Vulnerabilities via Symbolic Object Graph."

YUN CHEN, Mechanical Engineering, who studies how biophysical and biochemical factors are coordinated to achieve homeostasis, or to facilitate disease, across molecular, cellular, and tissue levels. Project: "Fibrosis, Inflammation, Revascularization, and Migration (FIRM) Modulation for Muscle Regeneration."

GREGORY FALCO, Civil and Systems Engineering, who researches mission-resilient autonomy for applications where failure is not an option. Project: "Orbital Resilient Blockchain Interagent Transaction Service (ORBITS) Architecture: A Resilient, Zero-Trust Architecture for Hosted Payloads and Space Infrastructure as a Service."



Toward Better Detection of Breast Cancer

FOR GROUNDBREAKING RESEARCH IN IMAGING TECHNOLOGIES TO IMPROVE BREAST CANCER DETECTION, MUYINATU BELL, the John C. Malone Associate Professor in electrical and computer engineering, was named an inaugural recipient of the Chan Zuckerberg Initiative's 2022 Science Diversity Leadership Awards.

Presented in partnership with the National Academies of Sciences, Engineering, and Medicine, the award recognizes the scientific accomplishments and leadership of early- and mid-career biomedical researchers with a record of promoting diversity, equity, and inclusion in their fields. Each recipient receives a total of $1.15 million over five years.

Bell's project will develop a handheld photoacoustic imaging biopsy approach which, when combined with ultrasound imaging, will provide structural, anatomical, and molecular sensitivity to detect the presence of breast cancer. The design addresses challenges within existing technologies, including poor light penetration through darker skin tones and troublesome acoustic scattering in dense breast tissue.

HOLY GUACAMOLE!

IT WAS AN INVENTION THAT MADE NEWS AROUND THE COUNTRY, CAPTURING THE IMAGINATION OF BURRITO LOVERS ETERNALLY TIRED OF MESSY MEALTIMES. TASTEE TAPE—AN EDIBLE, ADHESIVE TAPE, DESIGNED to keep your burrito from falling apart—not only was a stand-out student project at last spring's Engineering Design Day, it also was named one of *TIME*'s Best Inventions of 2022 in the Food and Drink category.

Before settling on their final recipe, the team of chemical and biomolecular engineering undergraduates tested a "multitude" of ingredients and combinations, ultimately opting for a food-grade fibrous scaffold presented in short two-inch strips affixed to wax paper. Users can peel them off, add water to activate their adhesive qualities, then affix them to their bulging wraps to ensure a tidy repast. Tastee Tape is safe to consume and has the tensile strength you can trust, the students say.

The invention has been featured in more than 700 global media outlets, including on *The Tonight Show Starring Jimmy Fallon* and in *Food & Wine* and *Newsweek*, and it even got a shout-out from Michael Bloomberg. The students now are in the process of patenting the technology.

IMPACT

Designing to Enhance Fire Safety

[redacted]

IN THE UNITED STATES, MAKING BUILDINGS CODE-COMPLIANT AND FIRE-RESISTANT costs tens of billions of dollars annually. Despite these expenditures, major knowledge gaps still exist about how fires affect structures. Filling those gaps could allay costs while further enhancing safety.

"Fire is this very basic hazard that's been with us forever, and yet we still don't fully control or fully understand it," says Thomas Gernay, an assistant professor in the Department of Civil and Systems Engineering. "If we can make improvements in the way we design structures and deal with the hazards of fire, it would have a huge impact given the scale of the problem."

To help achieve this goal of saving more lives and preserving property, Gernay has co-developed an innovative software program dubbed SAFIR (usually pronounced "SAY-fer," a play on the words "safe" and "fire"). The software allows users to create virtual representations of buildings and accurately models the structures' behavior when subjected to fire.

"SAFIR is a state-of-the-art program that brings together thermal models, heat transfer, and structural analysis in a way that couldn't be done before," says Gernay.

The 3D models in SAFIR include straight-line structural elements of beams and columns coupled with planar elements of walls and slabs. Critically, the program accounts for the differing properties of common building materials such as steel, concrete, timber, aluminum, and gypsum, along with standard thermally insulating products. The program captures how certain materials weaken when exposed to fire, diminishing their ability to carry structural loads, and how some materials expand so the structure loses its intended shape. The interplay of these load redistributions and deformations can ultimately lead to dangerous building collapses.

More than 250 institutions worldwide—including universities, research centers, and design offices—are already using SAFIR. By revealing the design and material choices that improve fire resistance and structural integrity, SAFIR can guide engineers and architects toward better solutions for resilient residential and commercial buildings.

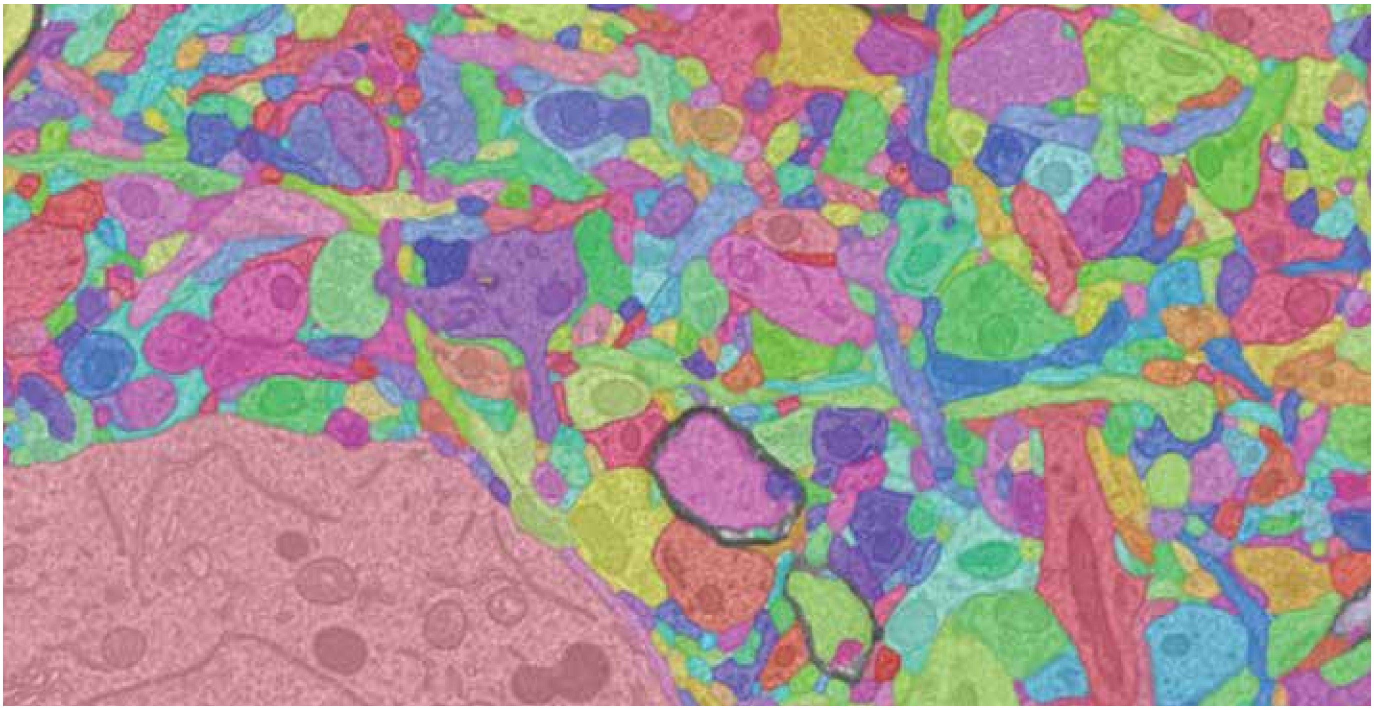
With climate change increasing the risks of wildfires, Gernay says the insights from SAFIR are set to become even more important.

"We will need to put a lot of thought into how we build moving forward," Gernay says.

— ADAM HADHAZY

Thomas Gernay

THIS PAGE: FIRE IMAGE IS COURTESY OF THOMAS GERNAY.



Deciphering the Brain

WITH ITS 86 BILLION NEURONS AND MORE THAN 100 TRILLION CONNECTIONS, THE HUMAN BRAIN IS sometimes described as the most complex object in the universe. It comes as little surprise, then, that treating disorders of the brain has proven frustratingly difficult. About a decade ago, the United States government accordingly launched the BRAIN (Brain Research Through Advancing Innovative Neurotechnologies) Initiative, an effort to catalog and decipher the brain's intricacy.

A significant challenge has been correlating the massive amounts of data gathered by the BRAIN Initiative's many independent research teams. Developing community standards to better enable this correlation and to guide revolutionary brain mapping via high-resolution imaging techniques is the goal of Will Gray-Roncal PhD '16, a principal research scientist at the Johns Hopkins University Applied Physics Laboratory (APL) and an instructor in the Whiting School's Engineering for Professionals and Lifelong Learning programs.

"In the research community, there are numerous really smart neuroscientists collaboratively collecting data," says Gray-Roncal, "but they organize their experiments differently and approach research and collect data in slightly different ways."

Gray-Roncal is the principal investigator for BENCHMARK (Big-data Electron-microscopy for Novel Community Hypotheses: Measuring And Retrieving Knowledge). Funded by a $1.3 million grant from the National Institutes of Health, BENCHMARK seeks to enable BRAIN Initiative researchers in the areas of electron microscopy and X-ray microtomography to share data and insights with the broader community.

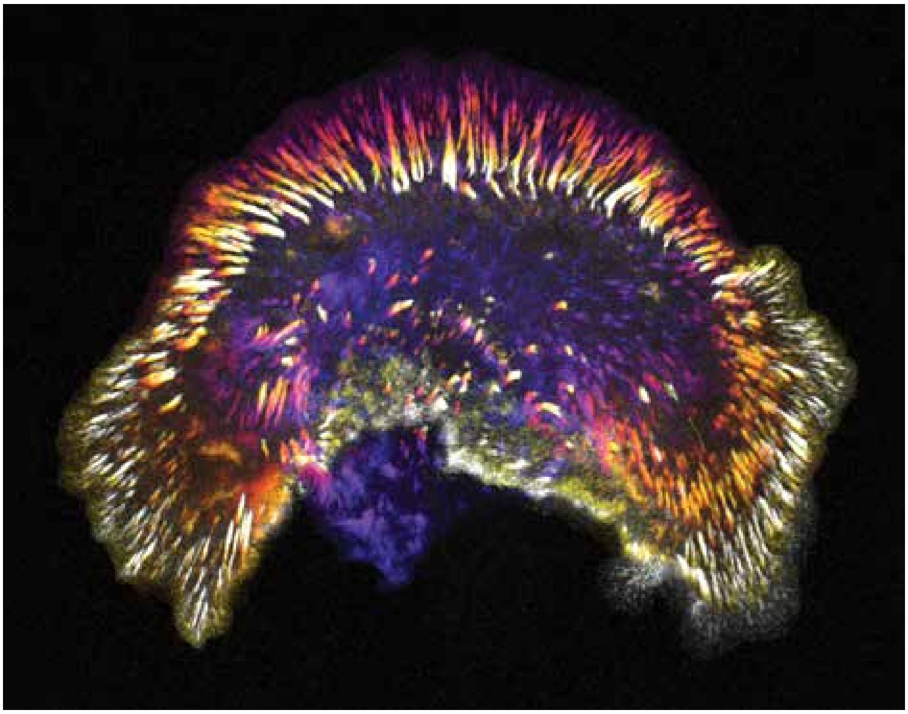
BENCHMARK further supports loading voluminous imagery into a single, consistent public database called BossDB, which is maintained by APL. Pooling multi-institutional knowledge in this way enables scientists to vastly expand the scope of their queries and the reproducibility of their findings. That ability to dynamically peruse diverse datasets opens up new possibilities, for instance, in comparative connectomics, a hot-topic area where researchers explore neural wiring similarities between species.

"By seeing a common structure across, say, mouse, fly, and human experiments, we may arrive at profound insights about how biological brains work," says Gray-Roncal.

Overall, BENCHMARK is making the BRAIN Initiative's lofty objectives more achievable by democratizing access to the whole research community.

"I think of BENCHMARK as the mythical Tower of Babel in reverse, where instead of all of us speaking different languages, we all wind up speaking the same language," says Gray-Roncal. "We'll need this common language to process the deluge of data we're seeing as we continue working on comprehending the brain."

— AH



These findings could inspire new treatment for mucus-related illnesses, including chronic lung diseases and mucinous cancer, the deadliest subtype for lung and ovarian cancer.

Image: Focal Adhesion Fireworks

Cells form contact points with their environment to facilitate adhesion and migration. Those contact points, known as focal adhesion, rapidly grow in numbers when cells are exposed to highly viscous fluid, as an adaptive response to move faster.

Life in the Fast Lane

HUMAN CELLS ARE SURROUNDED BY BIOLOGICAL FLUIDS LIKE MUCUS AND saliva that have varying degrees of thickness and stickiness. Patients with certain kinds of cancer and those with life-threatening lung diseases—including asthma, COVID-19, cystic fibrosis, and chronic obstructive pulmonary disease (COPD)—secrete honey-like mucus that is 2,000 times thicker than normal.

Surprisingly, cells move twice as fast in this thicker liquid than they do in thinner, normal mucus. Why and how? The answer may shed light on the causes of cancer and lung diseases and help scientists develop better treatments.

Observing cells in various fluid environments, a team of engineers led by Yun Chen, an assistant professor of mechanical engineering, discovered that adherent cells (cells that must be attached to a surface to grow) do not just passively experience the fluid surrounding them. Instead, they use "ruffles"—cell membranes that wave up and down—to flatten, probing the fluid around them and adapting instantly to its viscosity. The interplay between these ruffles and the fluid propels the cells to move faster in syrupy fluids than they do in thinner, water-like ones. Previously, ruffles were considered to be of little importance to the cell, akin to a human appendix.

These findings, which appeared in *Nature Physics*, could inspire new treatment for mucus-related illnesses, including chronic lung diseases and mucinous cancer, the deadliest subtype for lung and ovarian cancer.

High viscosity (thick mucus) can result in immune cells moving quickly into the lungs, causing excessive and damaging inflammation. In the case of cancer, high viscosity may help spread cancer cells more quickly throughout the body. Though mucus-thinning drugs exist, they currently are used to help patients breathe by coughing sputum out of their airways. Insights from this study could provide direction for repurposing these drugs to treat inflammation and thwart cancer metastasis.

— LISA ERCOLANO

Yun Chen

Opening Access to Windfarm Data

WIND POWER PRODUCES OVER 8% OF OUR NATION'S ELECTRICITY, BUT ONE IMPEDIMENT TO INCREASING RELIANCE ON THIS CLEAN, SUSTAINABLE power source is the vast size of many windfarms and the challenge of understanding turbine-turbine and turbine-atmosphere interactions.

High performance computer simulations can help by providing detailed insights into fluid mechanical effects associated with turbine placement, layouts, and environmental factors. But these simulations are expensive and produce huge datasets, putting them out of reach of researchers without the requisite computational skills, substantial financial resources, and/or access to technology required.

An initiative spearheaded by Whiting School mechanical engineering faculty members Dennice Gayme, the Carol Linde Croft Faculty Scholar, and Charles Meneveau, the Louis M. Sardella Professor in Mechanical Engineering, both researchers in the Ralph O'Connor Sustainable Energy Institute, is poised to change that. The two have started a new project to create a public database of windfarm simulations. It will allow anyone with an internet connection to easily access and analyze the data in order to conduct research, generate knowledge, and evaluate models or wind field data to be used in windfarm planning or development projects. Potential users of the database therefore span academia and national laboratories to engineers working on windfarm projects.

"Each type of user will be able to very easily access and analyze data that is of interest to them. They will be able to take data from a synthetic windfarm and explore all of its spatio-temporal facets, at a level of detail that is impossible to achieve with existing datasets," says Gayme. "The fact that you can come back and look at one location in detail and ask some very specific questions within this big simulation will be unprecedented."

— **WICK EISENBERG**

3 Questions

Howard Katz on the Power of Plastics

Interview by Lisa Ercolano

Plastics are known for being robust and flexible, but most aren't particularly good conductors of electricity; in fact, they are often used to insulate power cables. A team of Johns Hopkins engineers led by Howard Katz, professor and chair of the Department of Materials Science and Engineering, used a new polymer (plastic) material combination to create a conducting material blend that has the superior ability to remain stable at a variety of temperatures and is more capable of generating electrical power from waste heat than are previous plastic blends. Their results recently appeared in *Advanced Materials*.

1 What were you trying to do?

We wanted to create a material that is flexible and printable and that can be used to conduct electrons. Flexibility allows use on nonrigid surfaces like skin and paper. Printability allows deposition of the materials without using expensive vacuum processes or high temperatures. The most successful commercial electrically conducting polymer-based material primarily conducts positive charges. We created a material with a highly analogous structure that primarily conducts electrons, which are negatively charged.

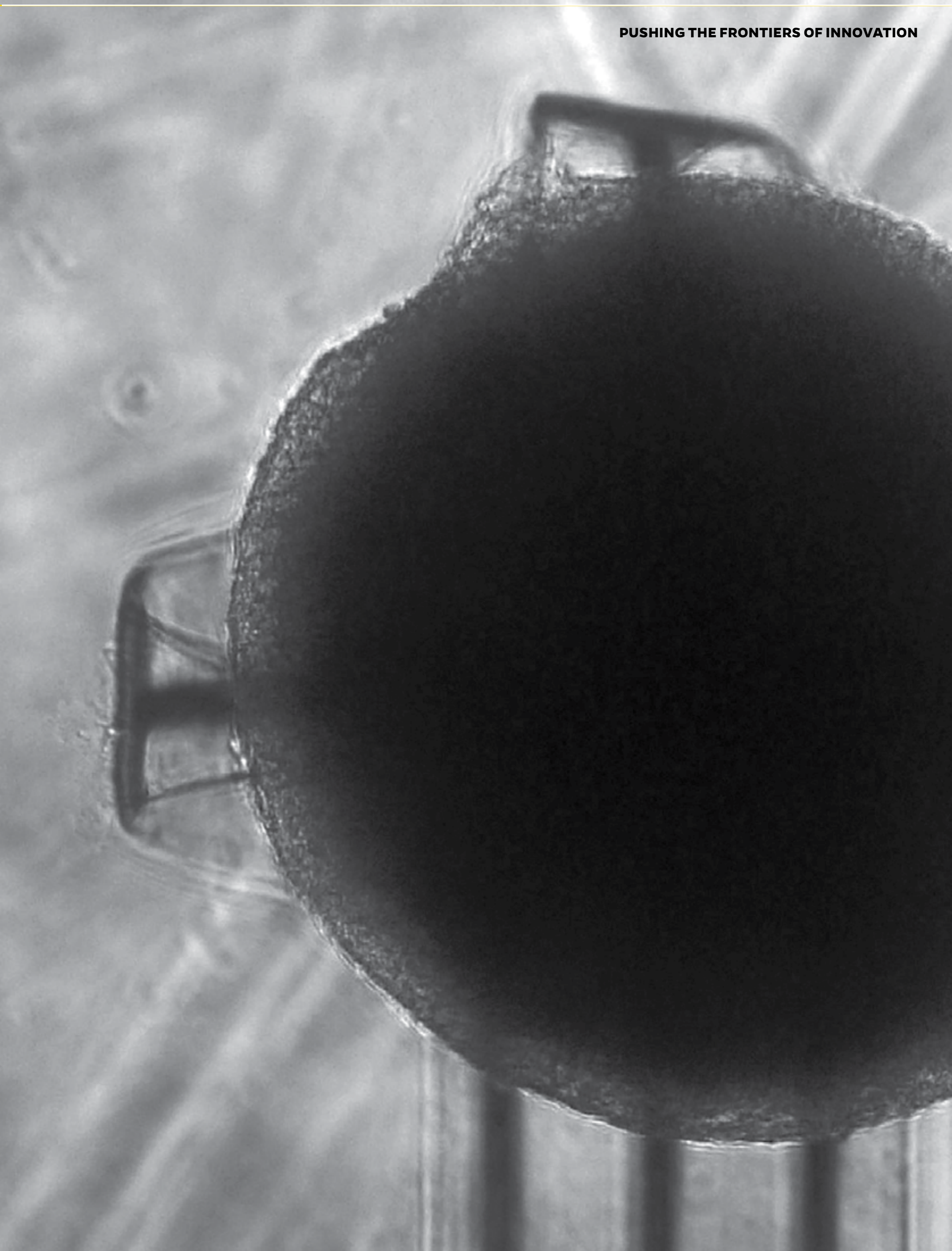
2 How did you give plastic the ability to conduct electricity?

We used a polymer of a positive salt ion to alter the composition and characteristics of another polymer to enhance its ability to conduct electrons—a process called "n-doping." N-doping has been used in creating organic transistors, solar cells, photocatalysts, and light-emitting diodes (LEDs). Using such salts as dopants is relatively new. We were simply the first to think of combining the salt and polymer dopant concept for electrons, and it worked. We were inspired by polymers that primarily conduct positive charges, called "holes." The most commercially successful of these materials uses a second polymer to form the holes, and my team thought this approach could work for us too.

3 How might this new material be used?

We think that it could be particularly useful in thermoelectrics, in which heat is used to generate electrical power. Thermoelectric devices are made with subsections that each conduct positive and negative charges exclusively. The material could be used as a conductive layer on the side of solar cells or LEDs where electron conduction is needed. There are many design changes that we could make in the polymers to improve performance further; this work is in progress.

TECH TOOLS



Tiny Caps for 'Mini Brains'

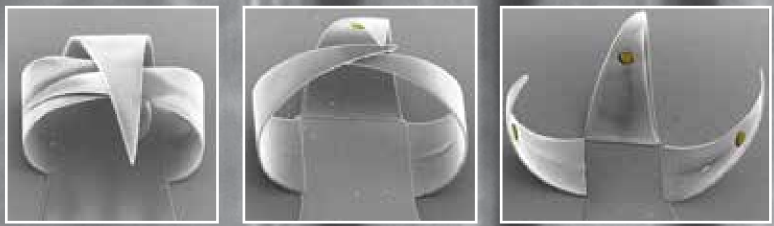
It could be the world's tiniest EEG electrode cap, created to measure activity in a brain model the size of a pen dot. Its designers expect the device to lead to better understanding of neural disorders and how potentially dangerous chemicals affect the brain.

This engineering feat, led by Johns Hopkins University researchers and detailed in *Science Advances*, expands what researchers can accomplish with organoids, including mini brains—the lab-grown balls of human cells that mimic some of a brain's structure and functionality.

"This provides an important tool to understand the development and workings of the human brain," says David Gracias, a chemical and biomolecular engineering professor and one of the creators. "Creating micro-instrumentation for mini organs is a challenge, but this invention is fundamental to new research."

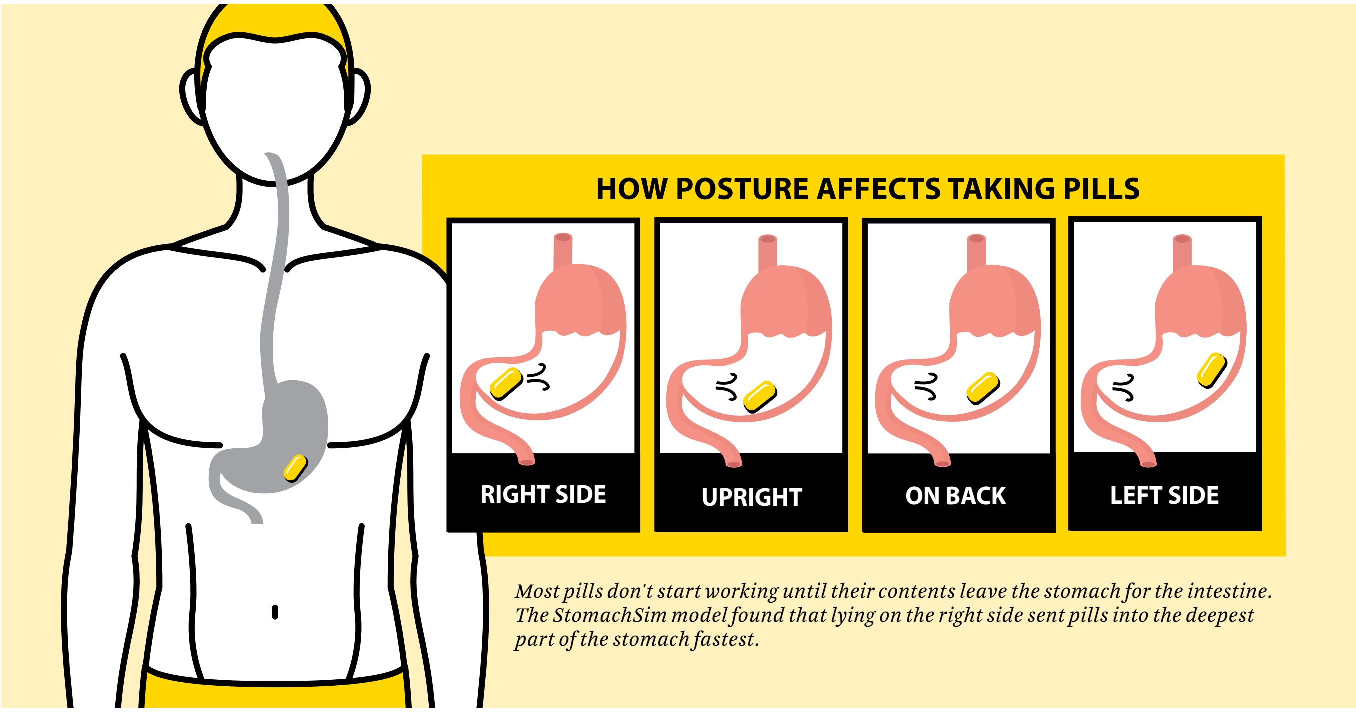
Inspired by the electrode-dotted skull caps used to detect brain tumors, the team created tiny EEG caps for brain organoids from self-folding polymer leaflets with conductive polymer-coated metal electrodes. The microcaps wrap around the entirety of an organoid's spherical shape, enabling 3D recording from the entire surface, so that, among other things, researchers can listen to the spontaneous electrical communication of neurons during drug tests.

— LAURA CECH



Scanning electron microscopy (SEM) images showing that the microcaps can be made in tunable sizes by varying design and fabrication parameters to fit a range of organoid sizes. The recording electrodes are indicated by golden coloring.

THIS PAGE: QI HUANG, GAYATRI PAHAPALE (GRACIAS LAB, JHU)



Most pills don't start working until their contents leave the stomach for the intestine. The StomachSim model found that lying on the right side sent pills into the deepest part of the stomach fastest.

Prime Posture for Pill Taking

WHEN YOU HAVE A HEADACHE AND REACH FOR A PAIN reliever, you're probably not thinking about your body position when you swallow that pill. But a new study by Johns Hopkins engineers finds your posture can make a big difference in how quickly your body absorbs the medicine.

The findings are based on what's thought to be the first model to simulate the mechanics of drug dissolution in a human stomach.

"We were very surprised that posture had such an immense effect on the dissolution rate of a pill," says senior author Rajat Mittal, a professor of mechanical engineering and expert in fluid dynamics whose team's work appeared in *Physics of Fluids*.

In recent years, models have been created to authentically represent the workings of several major organs, notably the heart. The model developed by the team, called StomachSim, appears to be one of the first to be able to conduct a realistic simulation of the human stomach. Blending physics with biomechanics and fluid mechanics, StomachSim mimics what is happening inside a stomach as it digests food or—in this case—medicine.

Most pills do not start working until the stomach ejects their contents into the intestine. So the closer a pill lands to the lower part of the stomach, the antrum, the faster it starts to dissolve and empty its contents through the pylorus into the duodenum, the first part of the small intestine. If you're aiming a pill for this part of the stomach, posture is critical to both gravity and the natural asymmetry of the stomach.

The team tested four postures. Taking pills while lying on the right side was by far the best, sending pills into the deepest part of the stomach to achieve a dissolution rate 2.3 times faster than even an upright posture. Lying on the left side was the worst. The team was very surprised to find that if a pill takes 10 minutes to dissolve on the right side, it could take 23 minutes to dissolve in an upright posture and over 100 minutes when laying on the left side.

"For elderly, sedentary, or bedridden people, whether they're turning to the left or to the right can have a huge impact," Mittal says.

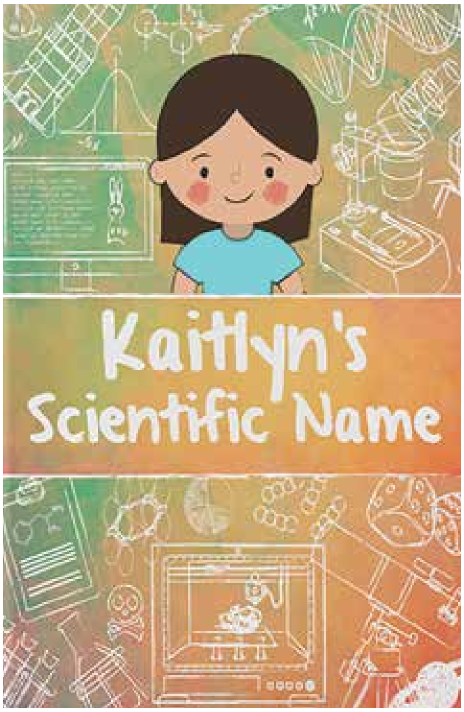
Standing upright was a decent second choice, essentially tied in effectiveness with lying straight back.

The team also considered what stomachs that aren't functioning at full strength meant for pill dissolution. The impact of stomach disease, such as gastroparesis caused by diabetes or Parkinson's disease, on drug dissolution was similar to that of posture—which underscores how significant a difference posture makes.

"Posture itself has such a huge impact, it's equivalent to somebody's stomach having a very significant dysfunction as far as pill dissolution is concerned," Mittal says.

— JILL ROSEN

OPPOSITE PAGE: WILL KIRK/HOMEWOODPHOTO.JHU.EDU.



Jean Fan

"By measuring what genes are being expressed in what cells while maintaining the spatial organization of the cells in tissues, we can begin tackling important questions in clinical oncology."

—JEAN FAN

How Cancer Cells Organize

THERE IS A CERTAIN CLASS OF PEDIATRIC BRAIN CANCERS THAT IS "UNIVERSALLY DEADLY," WITH a median survival of 15 months and few, if any, viable treatment options. The key to combating these cancers might be in analyzing how the cells within tumor tissue—cancer cells, immune cells, and others—express genes and organize themselves spatially, says Jean Fan BS '13, assistant professor of biomedical engineering and a member of the Center for Computational Biology.

"We want to understand how [these cells] are interacting with each other to promote disease development, and how those interactions might enable different responses to treatments," says Fan, whose lab specializes in developing computational models and statistical analysis. "By measuring what genes are being expressed in what cells while maintaining the spatial organization of the cells in tissues, we can begin tackling important questions in clinical oncology."

There are many questions to answer: What are the different states and subpopulations of cancer cells, and how are they organized? What happens to those cells when a patient receives clinical intervention? How do the cell populations shift in proportion to the intervention? What role do spatial organizational patterns play?

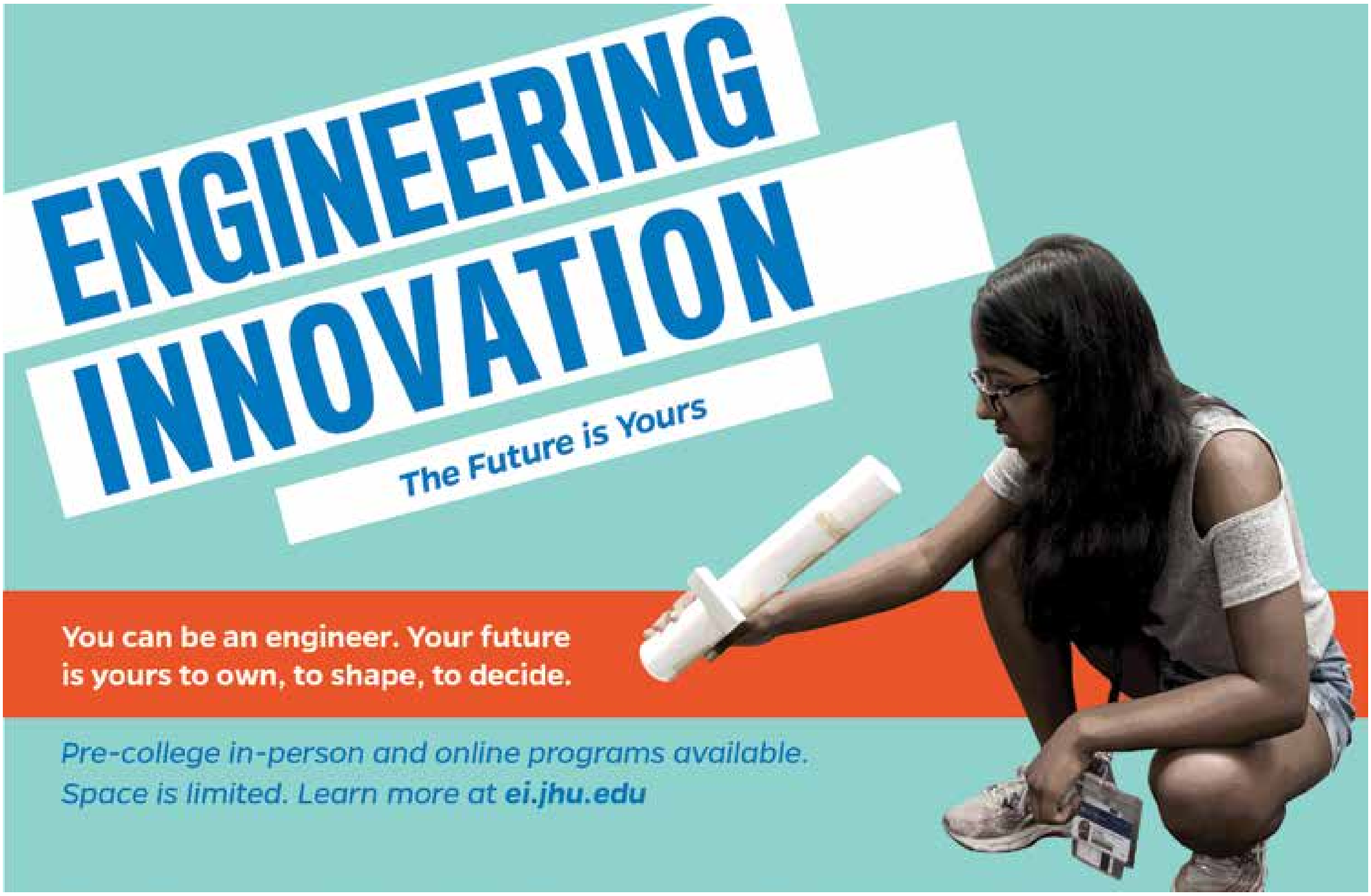
These questions were unanswerable just a few years ago. Before recent advances in spatial transcriptomics technologies, researchers would have to dissociate cells in a tissue, losing the cell's spatial organization, if they wanted to study many genes in a single cell at once, Fan says. Cellular spatial organization with fine cell state information was beyond their grasp.

"It's like we were taking pictures, but they were black and white," says Fan, whose interest in studying cancer genes was fostered during undergraduate work with biomedical engineering professor Rachel Karchin. "Now we can take much richer pictures with 10,000 different colors, each corresponding to different genes."

While her lab work hasn't yet reached pediatric patients, Fan found another way to share her passion with children. She noticed when volunteering at an after-school science club for second-grade girls that the students didn't see themselves as scientists, even as they were experimenting. "They would casually say things like, 'I'm not a math person,'" Fan remembers.

At the end of the program, Fan wrote and illustrated personalized storybooks that depicted each girl in various science, technology, engineering, and math careers. Fan then established CuSTEMized, a nonprofit that uses computation to make it possible for anyone to personalize these STEM-focused stories. "Computation has a lot of potential," Fan says, "and when we empower our students with computational skills, they will do great things."

— CHRISTINA HERNANDEZ SHERWOOD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The Future is Yours
You can be an engineer. Your future is yours to own, to shape, to decide.
Pre-college in-person and online programs available.
Space is limited. Learn more at ei.jhu.edu


Alumni Weekend
APRIL 14-16, 2023

“It’s about time. It’s fantastic. Now I can stop asking the guy at Chipotle to staple my burrito.”

5/18/22, THE TONIGHT SHOW STARRING JIMMY FALLON
Jimmy Fallon, on the invention of “Tastee Tape,” an edible adhesive invented by a group of chemical and biomolecular engineering undergrads.

“The act of taking a huge piece of metal and putting it up into the sky is going to be an enormous carbon footprint.”

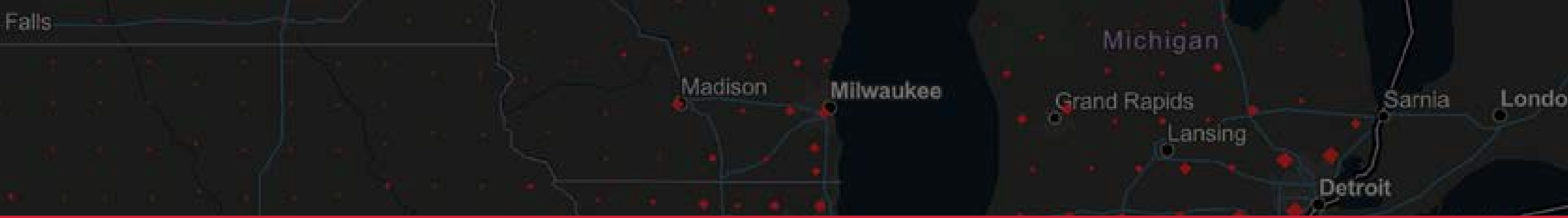
8/2/22, *WASHINGTON POST*
Peter DeCarlo, Environmental Health and Engineering, on the carbon footprint of private jets used extensively by celebrities from Taylor Swift to Drake.

“The perfectly harmless conversation you had yesterday might come back to hurt you years from now. That’s why we don’t write down every spoken conversation and keep it forever. Encryption is just a way to give digital communications the same basic protections.”

7/5/22, *WIRED*
Matt Green, Computer Science, on end-to-end encryption’s role in digital privacy in a post-Roe world.

“So let’s stop arguing about the precise source of the pandemic, and start taking steps to prevent the next one.”

11/7/22, *FORBES*
Steven Salzburg, Biomedical Engineering, talking about a *Vanity Fair/Pro-Publica* expose on the origins of SARS-CoV2.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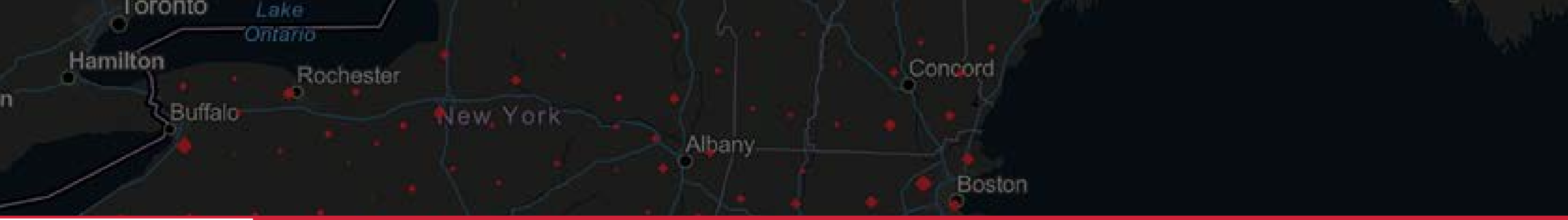
Lansing
Sarnia
Londo
Detroit

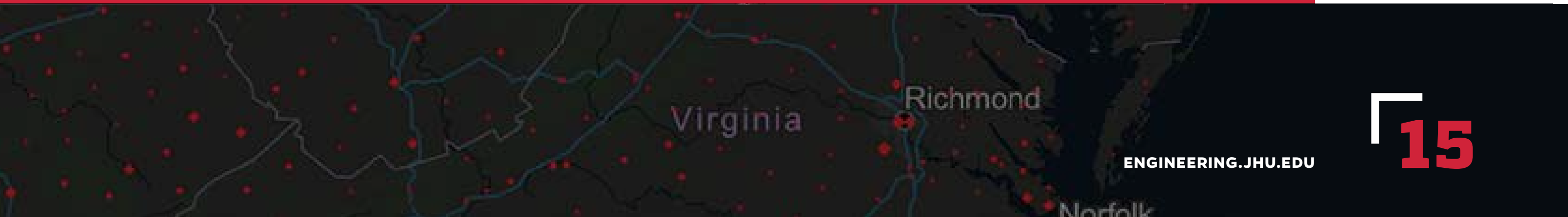

28-Day Cases
12,919,777
NORTH AMERICA
North Pacific Ocean
South Pacific Ocean
SOUTH AMERICA
Incidence
Case-Fatality Ratio



DATA DEMOCRATIZER

With her COVID-19 dashboard that proved critical to mapping the deadly virus's trajectory, Lauren Gardner went overnight from an unassuming engineer to a global voice championing the value of data science in public health.

STORY BY Andrew Myers
PHOTOS BY Chris Vaccaro



Lauren Gardner knows a measure of fame that engineers are rarely afforded. She did not invent a new gadget. She did not found a hot startup. She did not get rich with an IPO. She did it with data.

Gardner, an associate professor of civil and systems engineering and director of the Center for Systems Science and Engineering at the Whiting School of Engineering, is the primary driver behind the globally recognized COVID-19 dashboard. Throughout 2020, as the worst public health crisis in a century made a relentless march across the world, a minimalist map that began as a pet project between like-minded professor and graduate student, Ensheng Dong, transformed into a dashboard tracking cases, deaths, and, in time, vaccinations worldwide. It became the go-to resource for data scientists, epidemiologists, public health officials, politicians, journalists, and, yes, everyday citizens the world over.

The dashboard enjoyed a modest start. Gardner introduced it with a simple tweet on January 22, 2020, just two days after the first case of COVID-19 on U.S. soil was announced. Almost from the moment she hit send, Gardner was thrust into a spotlight she never expected or sought.

"It was immediate. Within hours, it just blew up," recalls Gardner, who is the Alton and Sandra Cleveland Professor at the Whiting School. "I had a feeling when we created it that it would grow. What I didn't know was that what we created would become the tool for the world."

The COVID-19 dashboard became the most cited source for information about COVID-19, and Lauren Gardner became its reluctant-but-resolute face. Overnight, she went from an unassuming engineer to a global voice championing the value of data science in public health.

The world was watching. *TIME* named Gardner to its 2020 list of the world's 100 most influential people. Then, this past fall, Gardner topped it, receiving the Lasker-Bloomberg Public Service Award for her work creating the COVID-19 dashboard and curating its underlying database. The Lasker Foundation credits Gardner for creating "the world's most influential source for real-time reliable and easily accessible data" about COVID-19's spread and outcomes.

For almost 80 years, the Lasker Foundation has recognized individuals and organizations who have improved the public's understanding of medical research, public health, or health care. The public service award is widely acknowledged as the highest-profile recognition in public health communication. Past winners include Bill Gates and Melinda Gates, Betty Ford, Anthony Fauci, Henry Heimlich, the National Institutes of Health, and Médecins Sans Frontières (Doctors Without Borders).

"I am extremely honored to be awarded the Lasker-Bloomberg Public Service Award. It's been an exceptional experience to play such an integral role in keeping the world informed during a global public health crisis, and perhaps equally important, changing the expectations around public access to data and information," Gardner says. "I am also excited for the opportunity to highlight the value and impact of quality data science and engineering. These tools, combined with good science communication, are critical for addressing the multitude of problems facing societies today, whether that be a public health crisis, climate change, or improving basic access to services in a community. I sincerely hope these tools and skill sets continue to be invested in and integrated into the public sector in the years to come."


Photo: LaskerAwards 2022 ©KateMilford

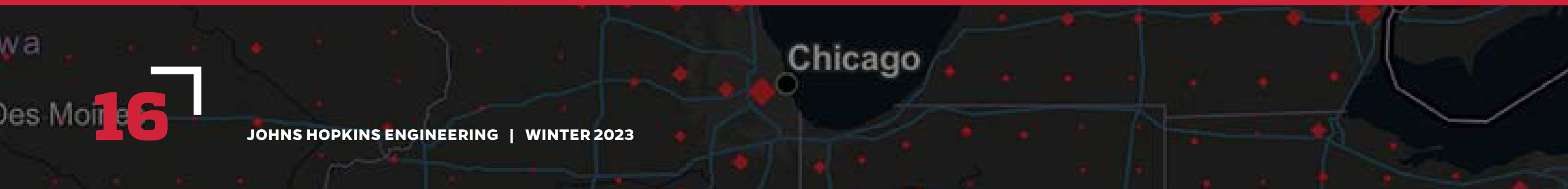
On September 28, 2022, Gardner received the Lasker-Bloomberg Public Service Award, America's top biomedical research prize.

Engineering Intersections

How an engineer with a background in transportation engineering ended up as a leading voice in global public health is a story in and of itself. Gardner counts herself among a growing branch of engineers who use the traditional tools of civil engineering to model the spread of diseases.

"I began by studying the intersection between human mobility and infectious disease," Gardner explains. "The tools behind it all, specifically the mathematical modeling, flows out of engineering."

It turns out that the movement of people, data, objects, anything really, between nodes in a network can be adapted to the movement of disease among people and



cities. These days, it is not uncommon to find data scientists, like Gardner, from various engineering fields applying similar skills to broad societal concerns, from traffic jams to the opioid epidemic.

"We've branded ourselves as 'systems engineers,' an interdisciplinary science grounded in data and math models to solve problems," Gardner says. "These are interdisciplinary problems, which rely heavily on data and modeling tools, to support evidence-based decision making."

"When I first saw the dashboard, I was stunned that it was an engineer behind it," says Beth Blauer, a professor and the associate vice provost for public-sector innovation at Johns Hopkins, who heads the Coronavirus Resource Center. "But, then again, that's the Hopkins way, finding talent that cuts across the silos of the university. That's Lauren."

The dawning realization that their dashboard was about to explode produced in Gardner's team a momentary what-have-we-wrought soul searching. At first, Gardner imagined (hoped, really) that some higher-profile organization—the Centers for Disease Control and Prevention, the World Health Organization, or the National Institutes of Health perhaps—might assume the responsibility for the dashboard or offer up its own variation. But that moment never came.

Gardner and her small team of data scientists would soon face a go/no-go decision, the answer to which would consume the next three years of their lives.

"Our first reaction, 'We can't do this,' evolved into 'We have to do this … and we have to do it well,'" Gardner recalls of apprehension turning to resolve.

From then on, the only question was: How?

Stars Align

It was measles that first brought Lauren Gardner and Ensheng Dong together. Dong was among the first recruits Gardner made when she arrived on the Homewood campus in 2019. Dong's graduate work modeling measles outbreaks was just getting underway when COVID-19 emerged. His skills and Gardner's research interests quickly aligned.

"Ensheng and I began tracking the earliest cases of COVID and decided to build out a dynamic dataset and make it open for the research community," Gardner says.

The timing was fortuitous. In the latter part of 2019, Dong was keeping a close eye on the mysterious new virus emerging in his home country. A native of Taiyuan, a city of five million in northeast central China, Dong had recently completed his master's degree in geographic information systems at the University of Idaho. While there, he did an internship with the GIS mapping company, Esri, charting health data on maps. Dong's expertise in mapping health data was not the only head start the team would enjoy. His facility in Mandarin proved an invaluable asset in parsing the spotty, often inscrutable information about the nascent disease seeping out of China.

Doctoral student Ensheng Dong's expertise was vital to the COVID-19 map that he and Gardner launched in January 2020.

"Chinese fluency, data science, mapping, and public health experience all merged at just the right time," Dong says.

It was a potent brew. But the researchers still lacked a key ingredient: data.

Putting Data on the Map

At this point it was early January 2020. Almost no one was aggregating information about where and how the disease was spreading worldwide. The U.S. had yet to report a single case. The World Health Organization was pushing out updates, but in flat tables in PDF format. Few outside public health fields could understand them, much less internalize their meaning.

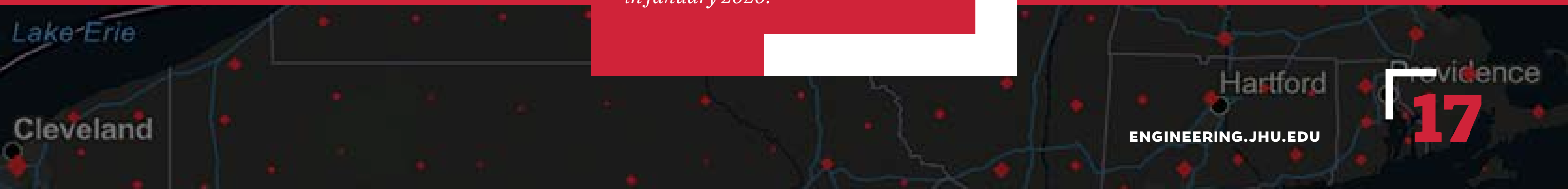
In the void, Gardner and Dong did what engineers do—they began to build a database themselves. From necessity, they went from modelers to aggregators, pulling together any and all sources into a single database. In the earliest days, that meant inputting numbers by hand and updating them periodically throughout the day.

"Ever since, I've been wearing two hats, doing two completely parallel jobs of running the data collection, while also using the data in various modeling projects to help improve our understanding of COVID-19," Gardner says.

Among the team's more prescient decisions was the one to plot their data on a map. Dong's GIS experience and ability to transform data into easy-to-read, easy-to-grasp visual representations made the dashboard resonate in ways that plain numbers never could.

"Mapping was essential to the dashboard's popularity," Gardner says. "That simple, intuitive, and accessible nature of the dashboard is all Ensheng. He pushed for the mapping."

Mapping democratized the data. Suddenly, everyone from inveterate data geeks to the lay public could visualize COVID-19's reach. The dashboard was deluged. Servers crashed. Dong dropped a course to keep up. Gardner became a household name.



Scraping By

With all attention focused on their data, seemingly small decisions grew in significance. Gardner and Dong chose to plot their numbers on a stark black background with red dots representing the scale of an outbreak—larger dots meant more cases, more deaths. Intense debate about the sizing and color of the dots ensued. Making the dots too large, the researchers worried, would risk overemphasizing the disease's scale and lead to hopelessness. Undersizing them, on the other hand, might mask COVID-19's true impact and compromise response efforts.

Soon, collecting data by hand became overwhelming. To meet those challenges, Gardner and the team partnered with Johns Hopkins Applied Physics Lab (APL), Dong's former employer, Esri, and the Sheridan Libraries to help build out the more extensive data collection infrastructure to crawl the internet and news sites for reports of new cases and deaths and "scrape" relevant numbers, entering them in the database automatically. Some 3,500 data points arrived every half hour.

While scraping eased the burden of collecting, compositing, and curating data, it raised new concerns about the data's validity and the potential for double counting. Those worries, in turn, begot new algorithms trained to spot anomalies among the incoming numbers. Much time and innovation went into those validation technologies, Gardner says, but they did not completely erase the team's worries.

"I had a nightmare that I had gotten some data from French Guyana wrong," Dong recalls of the way a sense of duty played on his psyche. "When I woke up, I went to my laptop to check that the data was right."

Insight from Imperfection

Despite the team's Herculean collection efforts, there was no escaping the fact that their numbers would never be perfect. Reporting methods country to country, state to state, and county to county, were too inconsistent, if they were available at all. Data points didn't always align. A confirmed case to one authority might only be a possible case to another.

Politics crept in. Some leaders clamored for more testing, while others questioned the value of testing at all. Data became a piñata. It grew so intense that Gardner and her team initially refused federal funding in fear it would compromise credibility. Other than a small grant from the National Science Foundation in mid-2020, the dashboard has received no direct federal funding.

"Even though we felt like the data collection and sharing should be the government's responsibility, we were seriously concerned with the ongoing politicization of the pandemic, and believed acting as an independent source for information was critical for retaining public trust," Gardner recalls.

Through it all, Gardner remained unbowed. Imperfect and incomplete data were better than none at all. The patterns they revealed proved crucial in anticipating the disease's next moves, assessing the severity of its impact, and developing public health policies in response.

"All we ever claimed is that we accurately reported what was being publicly reported,"

Lauren Gardner's graduate student team (standing, left to right): Felix Parker, Kristen Nixon, Gardner, Ayoyemi Oladimeji; (seated, left to right): Hongru Du, Andreas Nearchou, Sonia Jindal, Maximilian Marshall, Ensheng Dong, Samee Saiyed, and Naomi Rankin

Gardner says. She suspects the true number of cases might have been 10 or even 20 times higher than reported. Perfection was the goal, but she knew it was an impossible standard.

"What we are doing is engineering, not epidemiology," Gardner says. "Post-processing of the data to smooth the trends out, fill the gaps, and clean up the anomalies is still required to accurately represent the true disease dynamics, and more generally, improve our understanding of COVID-19 risks. But, the availability of data is the necessary first step in this process."

Gardner's faith in the data was rewarded through insights that helped public health decision makers set effective policies. These insights also identified profound inequities inherent in the public health system.

"In every crisis there are always disproportionately affected groups," she says. "Data can help expose those truths. Hopefully, there will be more effort to address those kinds of things in the future."

Storytelling likewise proved a crucial piece of the dashboard puzzle. In that respect, Blauer's Coronavirus Resource Center was an invaluable ally. Good data is important, but it needs context. The Coronavirus Resource Center helped frame the nuances in the data in new and deeper ways.

"We were in a continual environment of misinformation back then," Blauer recalls. "The Coronavirus Resource Center's storytelling gave a voice to the data, allowed us to assert our expertise and build trust to blunt the force of that misinformation."

The CRC's storytelling explored new meaning in the data and the trends. Using dashboard data, the CRC brought to light that lower-income people and people of color were bearing the brunt of COVID-19's wrath, for instance. The dashboard became integral to CRC's influence and vice versa.

Gardner and Blauer worked very closely and had multiple conversations each day to help support the broader universitywide CRC effort. Gardner focused on leading the team collecting the data and delivering the global map, while a large team at CRC focused on the communication aspects of the data and contextualizing it.

"Lauren has a unique combination of skills," Blauer says. "She understands the data, but also that key translational piece to tell us what it all means."

Life Lessons

Looking back, Gardner says the past two-plus years are still a blur. "The first year was pretty insane the whole time," she says.

One data point that remains unreported is that Lauren Gardner did it all while pregnant. In December 2020, she welcomed a new baby and commenced a maternity leave in early 2021. When she came back to work, she took a more strategic role with the data management, and returned to the work she loves most—creating models, exploring the meaning behind the data, and applying the lessons they impart to help support evidence-based policy and decision making.

> "In every crisis there are always disproportionately affected groups. Data can help expose those truths. Hopefully, there will be more effort to address those kinds of things in the future."
>
> *— Lauren Gardner*

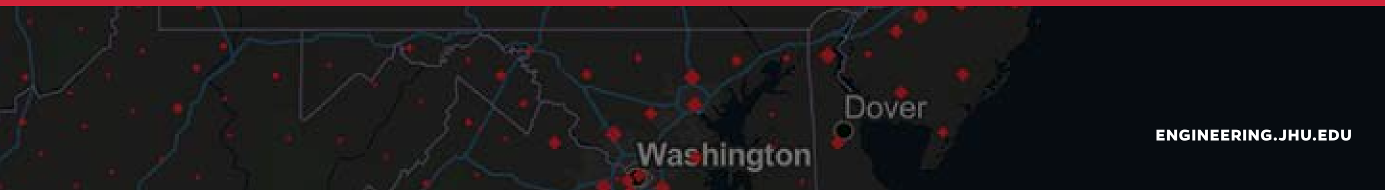
Her continuing influence now includes regular consultations with the CDC and the White House to improve their ability to gather data and to effectively communicate what the data mean—a shortcoming the pandemic laid bare.

She is also involved in efforts to design and build sustainable infrastructure for future data sharing and modeling that will help us be more prepared for the next pandemic. She is folding into her models many disparate forces influencing infectious disease, including data on climate change, human mobility, policy initiatives, and behavioral and sociodemographic information. That infrastructure does not yet exist, but it is ripe for engineering's unique perspective and skills.

As the dust storm of the last two-and-a-half years has settled, what endures for Gardner is an affirmation that, however incomplete or imperfect the data may be, it can still tell us volumes about a deadly disease's trajectory. And that knowledge saves lives.

Whatever the future holds, Gardner is certain engineers must play a leading role. They are problem solvers after all, and these large societal challenges are, at their core, engineering problems. These problems deserve the very best the tools the field can offer—mathematics, computer science, data science, and artificial intelligence.

Whether the next challenge takes the form of climate change, another pandemic, or some other unexpected crisis, Gardner says viable solutions will always require timely, high-quality, accessible data, presented in a way that's understandable and actionable, to produce the very best decisions possible. ■



SENSE of IDENTITY

When first-year students come to Homewood, they step into a world of boundless possibility, but they also leave behind their family and community, their cultural customs, and treasured traditions. In the stories that follow, six Whiting School students share how they were able to maintain, define, and redefine their sense of identity at Johns Hopkins.

By Monica Leigh
Photos by Will Kirk

A Path to Leadership

ZACH GOLD '25

Hillel Student Board, JHU Jewish Student Association

Zach Gold, who is studying biomedical engineering, took a gap year between his final year of high school and his first year of college in order to focus on religious growth. That time allowed him to travel to Israel as well as research Jewish student groups at Hopkins. Identifying Hillel ahead of time allowed him to actualize on potential connection, he says. "I came from an Orthodox Jewish household, school, family, and community. Before I came to Hopkins, I was worried about having to toe the line of maintaining my identity in an environment where everyone else was not Orthodox. Finding the Johns Hopkins Hillel group helped me solidify a path for how I identified as a Jew, and even became a path to leadership. I am now the prospective student liaison, the Jewish Learning Chair on the Hillel Student Board, and help facilitate weekly Shabbat services. Being part of this group helps us build connections and community, which helps us strengthen our sense of identity," says Gold.

'It's Part of Who I Am'

STEVEN DOCTORMAN '24

Welcome Squad, JHU Jewish Student Association

Steven Doctorman, who is studying chemical and biomolecular engineering, says he was "disconnected from faith" when he came to Johns Hopkins as a first-year student. "I didn't feel like a practicing Jew when I first arrived at Hopkins. During my first year, we were remote because of COVID, and I struggled to find students to relate to or with whom I identified," he says. But then he had coffee with a senior in the Hillel Welcome Squad, a program now managed by Rachel Gordon, an Israel Engagement Professional with Johns Hopkins Hillel.

"That senior welcomed me to campus and consistently invited me to events and religious services. I realized there was a community for me after all. I am now part of the Welcome Squad, to welcome first-year students who identify as Jewish on their college application. This helped me become a meaningful part of the community," says Doctorman. "Now most of my closest friends are Jewish; it is part of who I am. The Welcome Squad changed the course of my college life, and being part of it provides me with the opportunity to do the same for others, to provide access to a community."

'A Family Here on Campus'

SNEHA KAMADA '23

Officer and choreographer, JHU JOSH

Sneha Kamada, who is studying biomedical engineering, is one of the captains of JHU JOSH, an all-female and nonbinary fusion group incorporating Indian classical dance styles (Bharatanatyam, Kathak), hip-hop, South Indian Kuthu, and occasionally Bhangra, Raas, and Latin styles. (The word *josh* comes from the Hindi language and means energy.)

As a multicultural group, participants consciously aim to reflect the unique cultural identities of their members and to provide an inclusive space for members to express themselves through dance. "I grew up in a small town where I was the only Indian girl in my year [at school]," says Kamada. "I had no cultural outlet, which is what I was looking for when I came to Hopkins. This group allows me to express my culture through choreography and to have a family here on campus. When we perform at cultural events, it feels much less intimidating to do so together," she says.

'A Safe Space'

EM AMBROSIUS '24

Co-president, Diverse Sexuality and Gender Alliance

Em Ambrosius, who is studying applied math and chemistry, became a board member of the Diverse Sexuality and Gender Alliance in the spring of their first year at Hopkins. "I learned about DSAGA during a JHU orientation event. We struggled with membership during COVID, but I am excited for in-person meetings this year," says Ambrosius. "One of the best parts of our meetings is how we go around and introduce ourselves at the beginning of every meeting. If you're trying out new pronouns or experimenting with a different name, it doesn't have to be through some big announcement that you change the way people refer to you; you can just introduce yourself and try it out," says Ambrosius, who uses they/them pronouns.

"Membership is confidential, so students don't have to worry about revealing their identity if they're not out yet. For me, it's a safe space where I can totally be myself, within my nonbinary identity, and everyone's okay with that," they say. DSAGA caters mostly to queer students but is also welcoming of their friends and allies. The group's main goal is to foster a sense of community, to provide a space for conversations and connections.

Empowering Other Women

MICHELLE MOKAYA '23

President, Knotty By Nature

Michelle Mokaya, who is studying chemical and biomolecular engineering, has been a member of Knotty By Nature since her first year at Hopkins. A Baltimore native, she grew up in predominantly Black spaces and regarded Hopkins as a predominantly white institution. "Coming to Hopkins was a culture shock, and I wasn't sure how I was going to navigate. I purposefully put myself in Black affinity spaces so I could find a sense of community. At Whiting, especially as a Black female, there are not a lot of people who look like me. Being part of KBN instilled confidence and made me feel like I belong," says Mokaya.

KBN is a natural hair club that focuses on the empowerment of natural hair among the Black community. "Knotty By Nature empowers others to talk about the politics associated with natural hair—as a form of identity or culture. General pop culture does not regard natural hair as a beauty standard. It's seen as 'unkempt.' We want to change the narrative," she says.

The Black hair experience isn't exclusive to natural hair; it also includes protective styling such as braids, wigs, and even includes those who have lost their hair. "We understand that people have different needs and circumstances, so we want KBN to be a safe space no matter what hair journey someone is in. You could have natural hair, be in a transitioning phase, or still use relaxers or texturizers," she explains. Wearing a wig or braiding hair with extensions are popular hairstyles for Black women, which provides protection for hair while it is growing out to avoid breakage, says Mokaya.

KBN holds community events to educate city students about natural hair care and to introduce new Hopkins students to local hair care resources. "I always want to make sure I am involved with groups that continue to cultivate a positive Black experience at JHU," she says. "My friends and I have been active in these Black affinity groups since our freshman year."

Knotty By Nature hosted a DIY conditioning night to help students create their own hair care products.

'I Never Thought of Myself as Super Cuban'

CRISTINA DE JONG '23

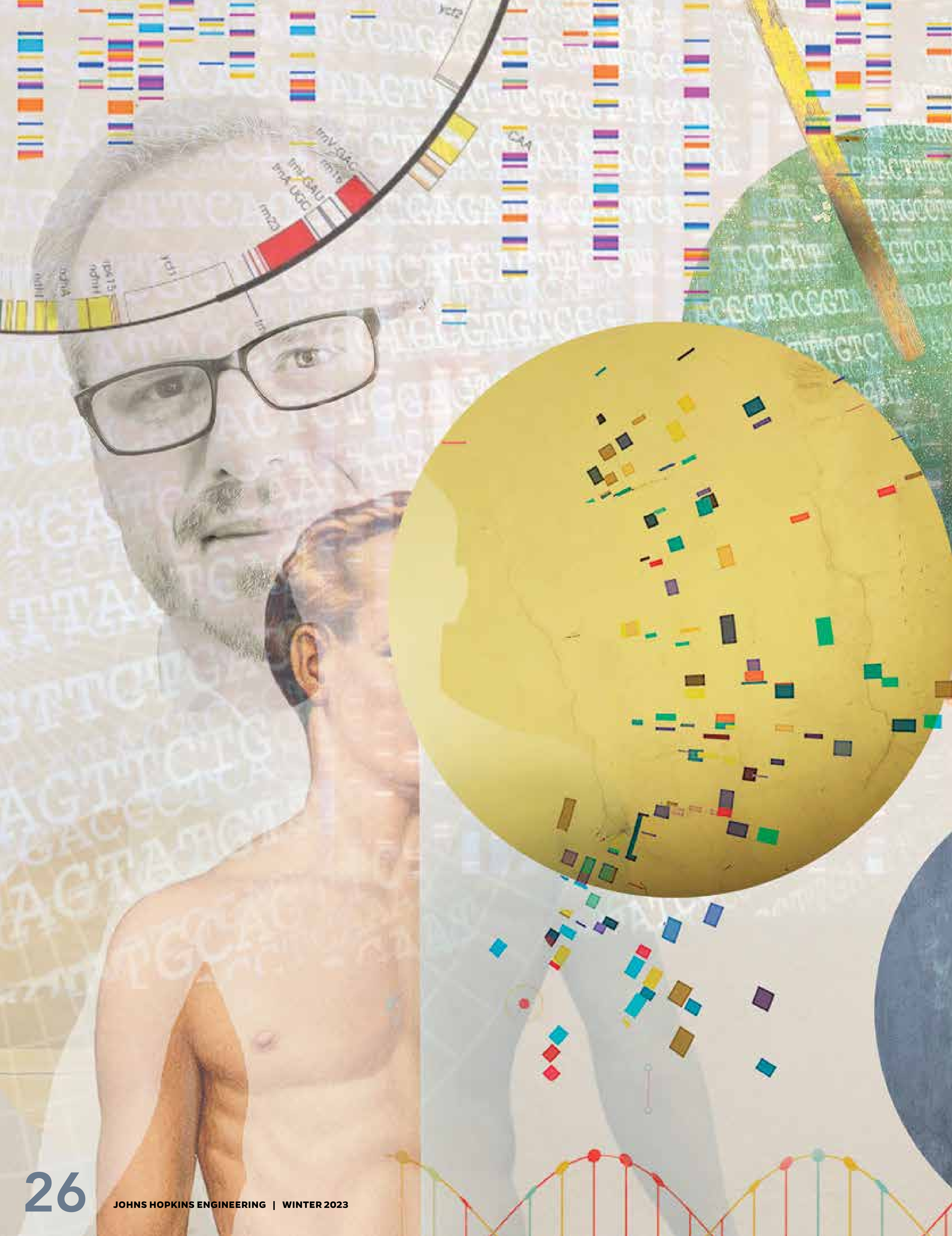
Secretary and former co-president, Cuban American Undergraduate Students Association

Cristina De Jong, who is studying materials science, has been a member of the Cuban American Undergraduate Students Association since her first year at Hopkins when a fellow sorority sister exclaimed, "Hey, girl—you're Cuban. You have to come to CAUSA!"

"I never thought of myself as super Cuban," says De Jong. "I'm not from Miami; I don't speak Spanish that well; don't know slang; my mom is Cuban, but my dad is not. I didn't feel very well connected to my culture before coming to Hopkins, but this group has helped me reconnect to that part of my identity," says De Jong.

"In CAUSA, I get to meet people with the same experience with culture that is common to all of us," she says. Especially after the COVID-19 disruption, she is excited to be back to in-person events. "So much of the draw of our membership is offering a physical community, and often with food," she says.

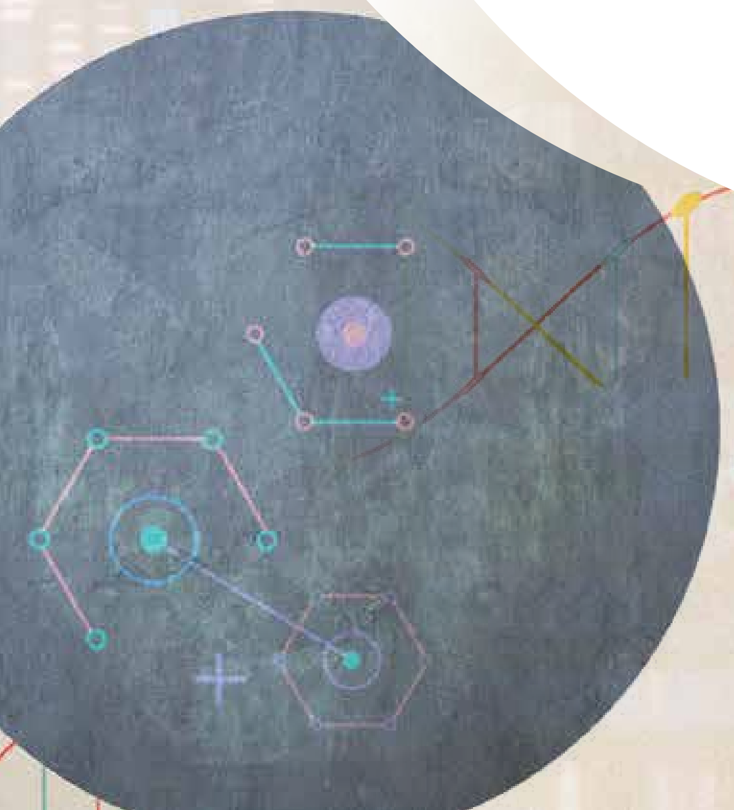
"I am most excited about our upcoming domino tournament. We actually started planning it a few years ago and are finally able to have it," she says. "Playing dominoes is a well-known part of our culture. You see all the old guys in the park playing it. And there will be prizes. I am hoping we can have empanadas." CAUSA co-hosted the tournament with the Puerto Rican Student Association since playing dominoes is also inherent to their culture.



Putting GENETICS on the Map

Written By **DAVID GLENN**
Illustrations By **DANA SMITH**

Crucial partners for ambitious geneticists the world over, computer scientist Michael Schatz and his lab most recently contributed to an astounding accomplishment: the first truly complete human genome.



Want to create an extremely accurate, high-quality genomic analysis of, say, a tomato or a human being? No problem. All you need are several million dollars, a good cellular specimen, a small army of skilled postdoctoral fellows, and access to the latest sequencing technology. And one more thing: You'll probably want a superb computer scientist by your side.

For many geneticists working at the highest levels of the field over the last decade, that role has been played by Michael Schatz, a Bloomberg Distinguished Professor of Computer Science and Biology at the Whiting School of Engineering and Krieger School of Arts and Sciences. Schatz has never formally trained in biology, and he hasn't handled a petri dish since college. But his lab has established itself as a crucial partner for ambitious geneticists both inside and outside Johns Hopkins. He and his graduate students are beloved by biologists because they design software that can effectively resolve the raw data generated by modern sequencing technology, with a minimum of errors and a maximum of efficiency.

Over the last year, Schatz's lab has reached a new level of prominence. He and his colleagues were a key part of the international consortium that achieved a major milestone in 2021: the first truly complete human genome. Schatz was one of four members of that consortium to be honored on *TIME* magazine's list of the 100 most influential people in the world in 2022.

"I love collaborating with Mike because he's passionate about the work, and because he has no fear," says Zachary Lippman, a professor of genetics at Cold Spring Harbor Laboratory who has worked with Schatz for more than a decade. "He always thinks about ways to use the latest technology to allow us to look at aspects of the genome that weren't evident before."

In the wake of the human-genome triumph and the *TIME* award, Schatz hasn't taken much pause for rest. His lab is engrossed in several projects, some of which are collaborations with the Johns Hopkins University School of Medicine. They are studying the genome of the tomato, with an eye toward increasing global crop yields; they're examining newly discovered familial risk factors for early-onset pancreatic cancer; and they're scrutinizing older libraries of genetic data in light of the newly completed human reference genome.

Schatz has an affable, unpretentious presence, and it's easy to see why he has won teaching awards. When he describes his research, he makes plain that he feels passionate about the potential human consequences. His algorithms are no abstract card trick. "Why is a computer scientist interested in genetics?" he asks. "It's because it's so meaningful and it's so intellectually interesting. We get to study origins of diseases, we get to look at patterns of evolution, we get to look at agriculture, medicine, fuels, food. It's incredibly meaningful work to be able to do all of this."

'Let's Ask the RIGHT Questions'

As a fledgling programmer in high school and college, Schatz had no particular interest in biology and no idea that his career would center on genetics. Schatz's undergraduate training in computer science at Carnegie-Mellon University was, he says, "all about core techniques—how to program, how to think about algorithms, how to look for patterns in data and reason about data."

After graduating from CMU in 2000, Schatz took a programming job at a small firm that focused on network security. "We were developing codes and breaking codes for encryption and authentication," he says. "And it turns out that was excellent training for genetics." After Schatz had been there for roughly a year, one of his colleagues left the firm to take a job at The Institute for Genomic Research (TIGR), an independent nonprofit center founded by the legendary geneticist J. Craig Venter. The work sounded interesting to Schatz, so—almost on a whim—he applied for a job at TIGR too.

This serendipitous move was the critical transition point, Schatz says. His first roles at TIGR were meat-and-potatoes programming tasks. But as he got to know the biologists and geneticists who comprised the core of TIGR's staff, Schatz became more and more intrigued by the problems they were tackling. He also met the head of TIGR's bioinformatics department, who would become the most important mentor of his career: Steven Salzberg.

Salzberg, now Bloomberg Distinguished Professor of Biomedical Engineering, Computer Science, and Biostatistics at the Whiting School and the Bloomberg School of Public Health, was one of the earliest computer scientists to plunge fully into genetics. In his spare time as a graduate student at Harvard in the 1980s, he'd audited courses in cellular biology. It was clear to him, he says, that genetics was the most exciting place to be.

To appreciate why an institution like TIGR required the skills of pure computer scientists like Schatz and Salzberg, it helps to understand the basic challenges of genome assembly.

A complex organism's genome contains hundreds of millions of base pairs—that is, matched pairs of the DNA bases adenine, thymine, guanine, and cytosine, whose various combinations encode instructions for all of the organism's cellular activity. The human genome is around 3 billion base pairs long, and its largest chromosome is around 250 million base pairs long. In an ideal world, we could read the genome by uncoiling the DNA from each chromosome, running it through an electron microscope, and directly reading the sequence of bases. That isn't physically possible, so over the last 40 years scientists have MacGyvered an awkward-but-ingenious procedure for decoding genomes: They make many copies of a cell's DNA. They splice those copies into tiny bits. They use machines to read the splices (from as few as 70 base pairs at a time to as many as a million, depending on the technology). And then, having amassed a huge pile of fragmented, duplicative base-pair data, they use algorithms to infer the cell's full DNA sequence.

It's at this last stage—writing algorithms to guide the final assembly of the genome—that computer science comes in. "You can't read 250 million base pairs at once," Schatz says. "So we get little pieces of the genome, and then we have to stitch them together like a jigsaw puzzle."

It was during an early project at TIGR that Salzberg first became impressed by Schatz's intellectual dexterity. The team was compiling a genome using a novel software system, Salzberg recalls. "And what Mike started doing right away was saying, 'Oh, let's play around with this assembler. Let's change things'—it had a lot of parameters you could adjust. Mike said, 'Let's try to optimize it for each genome. Give me the raw data, and I will assemble it 12 different ways and give you a much better assembly than what would have come out if we'd just run it in the default mode.'"

In 2005, Salzberg left TIGR for the University of Maryland, and he took several of his proteges with him. Schatz enrolled as a doctoral student there, with Salzberg as his primary adviser. "I had a huge advantage when I started my PhD," Schatz says, "because I'd already been working in the trenches at TIGR for almost four years. I'd had early exposure to the key problems, the key technologies."

Schatz's years at the University of Maryland, from 2005 to 2010, happened to coincide with the advent of so-called "second-generation" sequencing techniques. These new technologies were far faster and cheaper than previous sequencing systems—which meant that Schatz and his fellow genome-assemblers were suddenly being asked to write algorithms that could digest much larger quantities of data.

In addition to improving his assembly algorithms, Schatz also became concerned during his grad school years with the problem of managing the sheer volume of data being generated by second-generation sequencing. The task of analyzing a single genome might be more than a single server could handle—so Schatz created one of the earliest distributed cloud-computing systems for processing and storing genetic data, a project known as CloudBurst. Today, he helps manage AnVIL, a vastly larger cloud-computing resource for geneticists.

When he completed his doctorate in 2010, Schatz was hired as a faculty member at Cold Spring Harbor Laboratory on Long Island. There he began his long collaboration with Zachary Lippman, one of the most prominent plant geneticists of his generation. "I immediately could sense that Mike has the same enthusiasm and passion for science that I do," Lippman says. "If I proposed something ambitious, he'd say, 'Let's go for it. Let's just make sure we can get it done. Let's get the right people together. Let's ask the right questions. Let's get the right amount of money.' Every aspect of how he was pushing the science was exactly the way that I push my own science."

Schatz left Cold Spring Harbor in 2015, when he was hired by Johns Hopkins as a Bloomberg professor. But he has maintained

Schatz lab members: (left to right) Alaina Shumate (Salzberg lab), Steven Salzberg, Samantha Zarate (Schatz lab), Paul Hook (Timp lab), Michael Schatz, Winston Timp, Roham Razaghi (Timp lab), Rajiv McCoy, Dylan Taylor (McCoy lab), and Ariel Gershman (Timp lab).

> “Why is a computer scientist interested in genetics? It's because it's so meaningful and it's so intellectually interesting. We get to study origins of diseases, we get to look at patterns of evolution, we get to look at agriculture, medicine, fuels, food.”
>
> *— Michael Schatz*

active collaborations with Lippman and others at his old institution. Last year, Schatz assisted Lippman's team as they used CRISPR gene-editing technology to produce a tomato variety that matures faster and grows more compactly than typical tomato cultivars —an innovation that might help increase global crop yields. Soon they hope to use similar techniques with other staple crops.

Getting the FULL PICTURE

The work that won Schatz the *TIME* magazine honor—the creation of a genuinely complete human genome—was the product of the Telomere-to-Telomere (T2T) Consortium, a project that involves hundreds of scholars and dozens of universities. The project was launched in 2018 by Karen Miga, an assistant professor of biomolecular engineering at the University of California at Santa Cruz, and Adam Phillippy, the head of the Genome Informatics Section at the National Human Genome Research Institute (and a member of Schatz's grad-school cohort).

Prior efforts to construct a complete human genome had not quite gotten the full picture, thanks to the limitations of the sequencing technologies that existed a decade ago. The primary human reference genome in use since 2013 particularly lacked information about regions in the centers of chromosomes (centromeres) and at the distal ends (telomeres) of certain chromosomes' arms. Those regions were not believed to contain many protein-coding genes, but they are sites of structural variations whose significance is only now beginning to be fully appreciated.

“We knew that there is a good reason to try this,” Schatz says, “but it was totally unknown what it would take to actually sequence a complete human genome from scratch.” Schatz mostly watched the project from the sidelines until early 2020, when Miga and Phillippy announced that they had successfully sequenced a complete X chromosome. With that proof of concept in place, it was time to get serious about sequencing and assembling the other 22 chromosomes—and for that, they needed the expertise of Schatz's lab.

“I remember meeting with Adam before the pandemic,” Schatz says. “The initial plan was that we'd just do a few chromosomes a year. We thought it would be incredibly difficult and that it would take a decade.” But when the pandemic struck, Schatz says, he and many other people in the consortium started to work from home, concentrating extensively on the T2T project. (Schatz notes here the crucial involvement of current PhD student Samantha, former PhD students Melanie Kirsche and Mike Alonge, and former postdoctoral fellow Sergey Aganezov.) In that atmosphere of intense focus, problems were solved faster than Schatz and his colleagues had expected, and the complete genome was finished by the spring of 2021. (After a year of peer review, the major T2T papers were published in *Science* in March 2022.)

“This new genome gives us a much better map than we'd had before,” says Winston Timp, an associate professor of molecular biology and biomedical engineering at Johns Hopkins who was a key member of the project. “There are areas called segmentally duplicated genes that we can now really start to understand for the first time.” Compared to the 2013 reference genome, the T2T genome adds roughly 200 million base pairs and resolves roughly 10 million previously erroneous base pairs. Contrary to expectation, the T2T Consortium also discovered new protein-coding genes—at least 140 of them.

Schatz says that he is excited to see scientists from outside the T2T Consortium beginning to use the new reference genome. But he recognizes that many scholars are now coping with a potential headache:

Should they re-analyze their existing libraries of human genomes to correct for the errors and additions that were discovered by the T2T team? "Some mutations that were previously considered variants of concern now appear to be potentially benign—just artifacts of the errors and biases of the previous reference genome," Schatz says. "But it is complicated to re-process millions and millions of old genome sequences unless there is substantial knowledge to be gained."

Rajiv McCoy, an assistant professor of biology, brought his lab into the T2T project in order to help Schatz compare the new reference genome to an existing genome model. "It was immediately clear to me that this was going to be a high-impact contribution to the field," McCoy says. "The opportunity kind of came out of nowhere, but I was able to shift my lab's resources toward it for much of 2021, and we're still working on related projects. Mike has been incredibly supportive of me ever since I was hired here. Knowing that he's had my back has made a huge difference."

Sharing 'GREAT MYSTERIES'

One of Schatz's major projects this year is a collaboration with Alison Klein, a professor of oncology and pathology at the Johns Hopkins University School of Medicine. Klein has developed a library of specimens from patients who have experienced early-onset pancreatic cancer. "It looks like there's a strong genetic component to these cases," Schatz says, "although it hasn't been recognized using any of the standard approaches." Together with Winston Timp's lab, Schatz hopes to help Klein discover previously invisible genetic risk factors for pancreatic cancer.

Why would a high-risk genetic variation still be difficult to detect in 2022? Because, Schatz explains, some genetic risk factors for cancer and other diseases can only be noticed via "long-read" sequencing, rather than the short-read sequencing techniques that are most commonly used in clinical settings. In the clinic, Schatz says, the most commonly examined mutations are changes in just one or two nucleotides that can set off cancer. That's true in some cases—but "it's also common for there to be much larger sets of changes," Schatz says. "Cancer often involves changes on the scale of hundreds of thousands of nucleotides. Those patterns can only be seen with long-read sequencing."

Even one of the best-known cancer-associated genetic variants—BRCA1, which tends to cause breast and ovarian cancer—still has not been completely mapped. In 2018, Schatz and his colleagues studied germline and tumor cells from patients with breast cancer in New York and discovered patterns of large-scale structural variation. "We found mutations in BRCA1 that are effectively invisible to short-read sequencing," Schatz says. "They're invisible to the cancer [lab] panels that you might get for regular patient care. You can only detect them using long-read sequencing."

Klein says that she is excited to collaborate with Schatz and Timp as she searches for previously unrecognized variants in her registry of pancreatic cancer cases. "My lab could never do this with off-the-shelf software," she says. "To do work at this level, you need to work with experts in sequencing and genome assembly."

Beyond his research, Schatz says that he loves every opportunity to teach. In 2019, he won the Johns Hopkins Alumni Association Excellence in Teaching Award from the Whiting School. In recent years, he's co-taught courses in genetics and computational biology with McCoy, drawing both biology majors and engineering majors. "Students bring so much energy, with their own questions and their own curiosity," Schatz says. "It's a privilege to get to share these great mysteries with them."

"Mike is sitting at just the right spot," says Timp. "He's developing techniques that are then used worldwide to solve problems in biology. It's typical of Hopkins that he's been able to take advantage of sitting at the intersection between engineering and the clinic." ■

Katya Echazarreta

#Steminist in Space

GROWING UP, KATYA ECHAZARRETA MS '22 WAS FASCINATED BY SPACE, AN INTEREST inspired by Carl Sagan's *Cosmos*, which was her favorite book. But as a teenager, she kept quiet about her dream of working at NASA. When she voiced her aspirations, she saw doubt in people's eyes, so she stopped talking about it.

"I remember wanting it so badly, but more than that, I told myself that I would," recalls Echazarreta, who on June 4, 2022, became the first Mexican-born woman to travel to space on a suborbital flight with Space for Humanity.

Echazarreta, who moved to the United States from Guadalajara, Mexico, when she was seven, decided as a college student that electrical engineering would be her path to space. At UCLA, she landed an undergraduate internship with the NASA Jet Propulsion Lab (JPL), which turned into a job there.

"When I got the email to interview at JPL, I cried," she says. "Everything I had been working for was falling into place."

She applied to Space for Humanity in 2019 as a college senior, but COVID-19 delayed her journey. The nonprofit sends "purpose-driven" leaders to space for a grander perspective meant to inspire their efforts to tackle challenging social issues. During her 11-minute flight late last spring, Echazarreta pinched herself, her Mexican flag tucked in her bag. "Even now, it feels like a dream," she says.

Echazarreta worked on five NASA missions at the Jet Propulsion Laboratory before leaving in September 2021 to focus on science advocacy/education and to begin her master's degree coursework in the Johns Hopkins Engineering for Professionals program. "I needed more education on the professional side of engineering and to network with like-minded individuals," she explains.

Today, Echazarreta, who favors the #steminist hashtag, is dedicated to ensuring that other women and girls, especially minorities, can voice and achieve their STEM dreams. She lectures and hosts her own segment, *Electric Kat,* on the CBS children's show *Mission Unstoppable*. She also co-hosts a Netflix YouTube series, *Netflix IRL*, and consults for *Space for Humanity*. She hopes to write a book about her untraditional journey to space.

Most meaningful, she says, is when she gives talks in Mexico and sees little girls, dressed like astronauts, recording her every word. "I see how important it is for them to have a role model," says Echazarreta. "Life has given me a huge gift, and I definitely plan to use it for good."

— SARAH ACHENBACH

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Hands-On Learning, Forged by Fire

THE RHYTHMIC PING OF STEEL HAMMERS ECHOING BEHIND THE WYMAN PARK BUILDING ANNOUNCES the presence of the Blue Jay Blacksmithing Club, a new student group dedicated to the timeless craft of working hot metal with hand tools.

At the group's third working meeting, six members in leather aprons take turns shaping small steel rods into hooks. A propane-fueled portable forge heats the metal to more than 2,000 degrees. Using tongs, the student blacksmiths move glowing rods to an anvil, where each member has about 30 seconds to hammer theirs into shape before the steel cools. It will take many heating and hammering sessions to stretch the rods out to points that can be curled to form hooks.

Club founder Beryl Artman, a sophomore mechanical engineering major, did some smithing in high school, though is quick to say none of the 30 or so members have much experience, and they are all learning together.

"Most of us are mechanical engineers, or engineers of some sort, so we've learned about the properties of different metals and alloys," Artman says. "But it's very different to work with them by hand. This is as basic as you can get. If you can understand this, then you can get some intuition into what we're designing in class."

He calls the repetitive labors of blacksmithing fun, fulfilling, and therapeutic.

"It's primitive," he adds. "I guess deep inside we all have this primal need and calling to play with fire."

— **BRENNEN JENSEN**

Lending a Hand to Future Astronauts

Rene DeBrabander

ASTRONAUTS ON FUTURE NASA MISSIONS WILL EXPLORE COMPLEX TERRAINS ON THE MOON AND Mars wearing next-generation spacesuits designed to provide improved ranges of motion. However, these crewmembers' increasingly demanding forays outside their vehicles put them at high risk of ergonomic injuries.

In an effort to prevent such injuries, fourth-year biomedical engineering student Rene DeBrabander spent his fall semester interning with NASA Johnson Space Center's Applied Injury Biomechanics team, designing experiments to test motion-capture gloves, which are equipped with an array of sensors that capture data related to hand and finger movements. The team wants to use motion-capture technology in fully suited experiments, but first needs to prove that the gloves can produce viable data.

"The goal of my research is to determine the validity of motion capture, or mocap, glove implementation in a pressurized suit environment. I designed experimental procedures to compare data collected from a pair of mocap gloves in two environments," says DeBrabander, who worked remotely from the Homewood campus.

In both experiments, the subjects perform tasks that involve pulling, grasping, twisting, and shoveling—the most common motions astronauts perform in space. In the first, the subject carried out those tasks while wearing the mocap gloves. In the second, the subject completed the motions with their arms inside a glove box: a sealed container with built-in suit gloves commonly used for astronaut-dexterity training.

Once the data from each was collected, DeBrabander used a dynamic time warping algorithm to align it and calculate averages for each test. A statistical analysis then helped him determine similarities between the control and experimental data.

In order to provide ergonomic feedback to astronauts and predict risk in real time during activities they conduct outside of vehicles, it will be necessary to monitor their motions via wearable sensors, says DeBrander.

"Real-time monitoring of suit motions can be used to inform the crew of potentially hazardous ergonomic positions and movements, as well as allow for prediction of metabolic burden. The work I am doing is the first step toward implementing real-time motion capture technology in a suited environment," he says.

DeBrabander worked closely with two mentors at Johnson Space Center during his internship. Biomechanical specialist Nathaniel Newby helped him create a protocol that balanced subject safety and data acquisition to ensure a safe and effective experiment. Kyoung Jae Kim is a human performance data engineer who helped DeBrabander conduct experiments and develop software used to analyze motion capture data.

"These mentors have been the best part of my internship," says DeBrabander.

— SARAH TARNEY

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Marisa Thomas

"People really care about food access and the power and justice that comes from growing your own food, and I've really gotten to see the power of the Black community, especially in securing more food security."

— MARISA THOMAS

Cultivating Food Security

AN INTEREST IN THE INTERSECTION OF COMMUNITY WORK AND FOOD systems led Marisa Thomas, a senior in environmental health and engineering, to spend last summer at Whitelock Farm in Baltimore's Reservoir Hill community, planting, watering, and harvesting produce.

The experience was part of the university's Community Impact Internships Program—one of the most popular internship programs available to the university's undergraduate students. The program gives students the opportunity to gain real-world experience while being directly involved in the Baltimore City community. Since the program's inception, interns have worked more 100,000 hours with more than 100 Baltimore City nonprofits, community groups, and government agencies.

Whitelock Farm, which is split between two lots on either side of Whitelock Street, began in 2010 as a community garden—transforming vacant lot space into a haven of fresh produce. Last summer, Whitelock sold its produce through a community-supported agriculture program, as well as a Saturday farm stand, where volunteers from partner organizations also occasionally held cooking demonstrations aimed at bringing the community together while transforming the produce into delicious meals.

Through her internship, Thomas not only gained experience with agriculture, but also enjoyed engaging with the farm community and surrounding neighborhood.

"It's therapeutic to spend so much time in nature and working with plants that will eventually end up on someone's table," she says. "I've also learned that I really appreciate working with other people. I've been so fortunate to meet so many other folks in the Baltimore farming community, and it has helped me gain a better understanding of Baltimore because I didn't realize how many urban farms were operating in the city.

"People really care about food access and the power and justice that comes from growing your own food, and I've really gotten to see the power of the Black community especially in securing more food security. We can't do it all by ourselves so having the balance and community support can make a big difference."

— JAMIE CROW

Shawna Stepp-Jones

Innovating for Beauty

THE BLACK HAIR INDUSTRY IS FLOURISHING, AND WIGS AND HAIR EXTENSIONS, WHICH ARE FUELING what *The New York Times* called a "fantasia of Black hair innovation," are a big part of the market. The global hair wig and extension market is valued at $5.8 billion and is expected to reach $13.3 billion by 2026, according to industry projections.

But the technology to care for today's wigs and extensions hasn't evolved. Consumers have to wait as long as 24 hours for their hair to air dry after washing it because there is no convenient way to quickly dry detached hair pieces, also called "bundles." Existing hair dryers, which were made for hair that grows naturally, are inefficient and take hours to dry wigs and weaves.

Shawna Stepp-Jones MS '10 wants to change this. Stepp-Jones is the inventor of Spundle, a heat-free dryer for wigs and bundles that uses two centralized airflow channels to reduce drying time to 15 minutes, saving consumers hours.

She encountered the bundle-drying issue firsthand in 2016, and knew that as a Black female engineer, she was uniquely prepared to devise a solution.

"I felt like I could be that bridge to stylists in the Black community and beyond, and to the tech world to help revolutionize the industry," says Stepp-Jones, founder and CEO of Divaneering Lab, "where engineering meets fab."

Stepp-Jones grew up in West Baltimore and earned a BS in electrical engineering from Morgan State University. She was 23 and just starting in the Engineering for Professionals (EP) graduate program at the Whiting School when Hopkins instructor Samuel J. Seymour said something that still inspires her: "To be a leader, you have to be a visionary, and you have to be polarizing and revolutionary," she recalls. "Those were new concepts to me, and as soon as I heard them, I knew I wanted to emulate them."

The former patent examiner and mother to Sachi, 13, also seeks to encourage girls to pursue STEM careers. Stepp-Jones' Divaneering Lab has reached hundreds of K-12 girls with workshops that challenge them with engineering design tasks like building the strongest, lightest, tallest beehive hairdo.

She has her first prototype and will be actively fundraising while bootstrapping Spundle using the revenue she generates from her STEM and innovation workshops. Stepp-Jones expects the dryer to be on the market in August 2023.

"There is no way I'm going to be a girl from Baltimore who studied engineering at Morgan and Hopkins and has all this knowledge and not transfer it to the young ladies coming behind me so that they too can innovate and solve our problems," she says. "No one is solving our problems for us. We have to solve our own problems."

— MARIA BLACKBURN

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Healing from Hash Browns

TOOTHPASTE. PLAY-DOH. A PLATE OF HASH BROWNS. "I CAN GET INSPIRED BY VERY COMMON things," admits Allen Y. Wang MS '06, PhD '08, the Global Technical Lead at Ethicon Biosurgery, Johnson & Johnson MedTech.

"I look at a lot of things in my daily life," says Wang, a native of Taiwan. "My brain is always kind of turning, thinking."

Take those hash browns.

During his breakfast at a pancake house near Johnson & Johnson's global headquarters in New Brunswick, New Jersey, the fried potatoes sparked the idea for a solution to a scientific question that Wang had been wrestling with: How could surgeons control the broad oozing of wounds that occurs in more than 50% of all surgeries? Examining the potatoes' woven surface, Wang hypothesized that "a hemostatic powder with a lattice structure like the hash browns on my breakfast plate could cover a larger area and penetrate the blood surface and stop the bleeding quickly during the surgery."

"The hash brown structure triggered this idea that widespread bleeding could be stopped using a small aggregate composed of oxidized regenerated cellulose fibers that break apart after contacting blood."

The result of this breakfast brainstorm became SURGICEL® Powder Absorbable Hemostat, which launched in late 2017 and has since been widely adopted by surgeons in more than 40 countries. When Wang first witnessed the product in use, he was overcome with emotion and wept. "It really touches me to see the impact of my work," says Wang. "I feel like all the years spent developing the product (and it was maybe seven or eight years) really paid off."

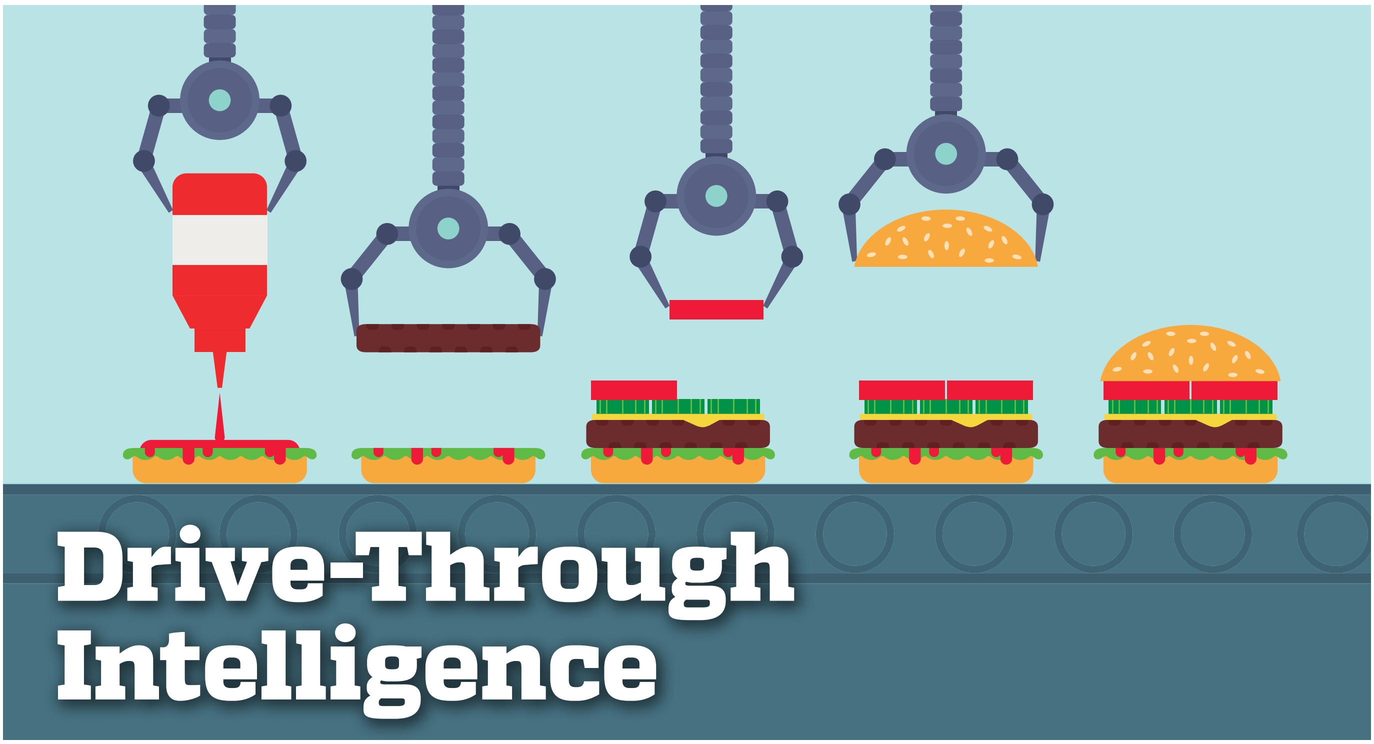
The holder of 70 patents, Wang is motivated by wanting to make a difference through creating innovative medical devices and products that address unmet surgical needs. Wang is also proactive in creating internship opportunities for Johns Hopkins students, so they can witness firsthand the collaborative efforts that go into product development.

Wang, a 2021 Johns Hopkins Alumni Association Distinguished Alumnus Awardee whose many accolades include renowned international awards such as the 2018 gold Medical Design Excellence Award, 2018 R&D 100 Award, a 2020 Johnson Medal, the most prestigious award within J&J, as well as a 2022 Society for Biomaterials Technology Innovation and Development Award, says patience and persistence drive him, and that he owes much of his success to his "very solid training" at the Whiting School. "Dr. Michael S. Yu, my PhD adviser, gave me a lot of freedom and encouraged me to reach out to collaborate and be proactive.

"But I don't let what I've already learned stop me," he adds. "I keep trying to learn new things all the time."

— **MARY ZAJAC**

Allen Y. Wang



Drive-Through Intelligence

WHEN ATIF KUREISHY MS ’04 WAS A KID IN THE 1980S, enjoying a fast-food lunch was simple. His parents would pull into a single-lane, fast-food drive-through, order, and pay in cash. Within minutes, he’d be tucking into a meal of hot chicken nuggets with barbecue dipping sauce, crispy fries, and an icy soft drink.

Quick-service restaurants aren’t that simple anymore. The global pandemic, labor shortages, supply chain disruptions, and the popularity of third-party delivery services have challenged the $799-billion-a-year restaurant industry. Meanwhile, consumers want more choices about how to order, customize, pay for, and receive their food.

Kureishy’s solution? Artificial intelligence.

“The restaurant business is changing and can no longer just throw people at its problems because the labor turnover rates are too high, and the guest experience suffers,” says Kureishy, founder of Vistry, a San Diego–based company that uses artificial intelligence and voice ordering to help restaurants improve efficiency, speed, and quality of service. “There has to be another solution, and that’s the pursuit of automation and using AI-based techniques.”

Artificial intelligence systems are not one-size-fits-all in the fast-food restaurant industry. For one big chain, Kureishy’s company is using computer vision to collect data and analytics to track the life span of a french fry to maximize crispiness and reduce waste. To improve order accuracy in another restaurant chain—a problem in many restaurants—he’s using deep learning to validate the contents of take-out bags against the original orders before they go to the customer.

And to make the drive-through experience more efficient, Kureishy has developed a system that collects data to understand how long customers are waiting so restaurants can better serve more people faster. “If you think of a fluid dynamics problem, that’s exactly what you’re trying to turn the drive-through into,” he says.

Kureishy completed his bachelor’s degree in physics at University of Maryland, Baltimore County, and worked as a software engineer for Lockheed Martin and other companies while earning a master’s degree in distributed computing through the Whiting School’s Engineering for Professionals program. “The foundational understanding I got from Hopkins got me on the path of being a persistent learner and underpins everything I do today,” he says.

It may be a year or two before your local quick-service restaurant will be using some of the systems Kureishy created to improve their food and customer experience. But be warned: Being asked “Do you want fries with that?” at a fast-food joint may soon be a relic of the past. The voice bot he’s developed to automate order taking may already know the answer.

— MB

OPPOSITE PAGE: PHOTO COURTESY OF HILA LEVY.

"The idea of service has always motivated me, and lifelong learning and curiosity are what drive me."

— HILA LEVY

Making Antarctic Sustainability a Priority

HILA LEVY MS '14 WAS 11 YEARS OLD WHEN SHE TOLD HER PARENTS SHE WANTED TO JOIN THE AIR FORCE. They thought she would eventually change her mind, she confides. But in 2008, her determination earned her Top Graduate honors (she was No. 1 out of 1,026) from the U.S. Air Force Academy.

"The idea of service has always motivated me, and lifelong learning and curiosity are what drive me," says Levy, a major in the U.S. Air Force Reserve who is a native of Puerto Rico and the daughter and granddaughter of both Israeli and U.S. military service veterans.

Five academic degrees later (including a master's degree—her third—in environmental planning and management from the Whiting School's Engineering for Professionals program), this heady trifecta of ambitions coupled with an openness to embrace change, has led Levy to every continent and around the globe before her current stop in Washington, where she recently completed a one-year appointment as a White House Fellow in the Office of Science and Technology Policy.

The highly competitive, leadership-oriented fellowship is designed to give early to mid-career nongovernment or military professionals from an array of backgrounds the opportunity to observe and participate in the highest level of government. Maybe not the most obvious choice for an Oxford University graduate with a DPhil in zoology who wrote her dissertation on Antarctic penguins, but Levy has always been eager to build on her varied experiences and take a step toward a long-term goal of working in high-level federal public service.

As a Fellow, and now in her continued role at the Office of Science and Technology Policy, Levy has used her expertise to call attention to current challenges the polar regions face—including impact from overfishing, climate change, pollution, and threats of resource exploitation—and has made it a priority to make sure the Antarctic is represented in national policy.

"Our office works a lot on catastrophic risks, and on any given day, we're thinking about how we can protect the planet," explains Levy.

"Antarctica is such a meaningful place for me. The region as a whole makes up about 10% of the world in surface area," Levy says. "What happens there affects all of us, particularly with the risk of ice sheet melt and sea level rise."

— MZ

Disclaimer: The views expressed here do not represent those of the White House, the White House Office of Science and Technology Policy, or the U.S. Air Force.

Harsh Encounters

"The hardest part is figuring out what I'm going to need for two weeks in the wilderness, and how I'm going to pack it in such a way that I can put it all on my back and carry it every day."

— SCOT MILLER

AS AN ULTRAMARATHONER AND AVID HIKER IN SOME OF THE PLANET'S MOST HARSH ENVIRONMENTS, Scot Miller has encountered a lot of hazards: a violent sandstorm, a charging moose, a kidney stone coming on in the middle of nowhere.

For Miller, an assistant professor in the Department of Environmental Health and Engineering, the toughest challenge was a 100-mile hike along the Wind River Range in Wyoming.

"It was incredibly difficult. Some days we'd be walking through an alpine meadow. Other days would be climbing over boulders the size of cars. Other days we'd run into a 2,000-foot cliff and have to figure out how to get around it," says Miller. "It was difficult, but it was incredibly rewarding."

Despite the grueling demands of trekking hundreds of miles across rough and often isolated terrain, the biggest challenge is the preparation, says Miller.

"The hardest part is figuring out what I'm going to need for two weeks in the wilderness, and how I'm going to pack it in such a way that I can put it all on my back and carry it every day," he says. It helps that he dehydrates all his own food, a process that can take up to two weeks in advance of a trip.

Given Miller's love of the outdoors, it's no surprise that he became a climate scientist whose research focuses on understanding how greenhouse gases affect, and are affected by, the environment.

"Most of what I do is analyzing satellite data and doing modeling on supercomputers. But for me, it's also important to see the places that I'm trying to understand in my research. It's one thing to model ecosystems on a computer, where every tree or mountain is a pixel. It's another thing to wake up in a tent in the morning and actually get a sense of how these systems and environments function," he says.

— DANIELLE UNDERFERTH

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A Mathematical Solution to Urban Blight

Mathematician and astrophysicist Tamás Budavári models the universe to understand how galaxies cluster. But in recent years, he's aimed his expertise at a different problem: Baltimore City's more than 14,000 vacant and abandoned properties, which attract crime and lead to lower property values.

"One of the things we hope to do is to help city planning and housing officials analyze the history of every property and reconstruct the state of contiguous rowhomes," Budavári says.

In a recent study published in *Journal of Planning Education and Research*, he and his team took a different approach: using what he calls "the language of math" to look at what could best improve quality of life in communities affected by blight.

"Instead of focusing only on how to demolish the greatest number of decrepit buildings, our goal was to optimize the happiness of city dwellers, [while working] within a given budget [for the city]," says Budavári.

City officials were part of the study team and will continue to work with Budavári's team as they expand this novel approach to urban planning to include options that combine demolition with rehabilitation, development, the addition of green spaces, and more.

— **LISA ERCOLANO**