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Transforming cancer research
Microfluidics yield new insights

Fired up for the future
Wildland firefighting program

Berkeley ENGINEER

Taking up space

Finding solutions for living on Mars—
and a rapidly changing Earth

The CHIPS Act: A call to action

The landmark CHIPS and Science Act of 2022 passed by Congress and signed by President Biden this summer was a clear signal that the country’s leaders are intent on regaining leadership in semiconductor manufacturing, as a secure supply of leading-edge computing chips is necessary to ensure the nation’s long-term economic competitiveness and national security.

For universities and colleges across the country, this legislation is a call to action to educate and train more students for the many tens of thousands of new semiconductor manufacturing and R&D jobs expected to be created over the next few years.

Expanding the skilled labor force with such speed and scale requires collaboration across institutions and close partnerships with industry, which is why I’ve been spearheading the American Semiconductor Academy (ASA) initiative over the past year. Working with the industry association SEMI, the ASA planning team comprises faculty from dozens of universities and community colleges across the country, including many minority-serving institutions.

I advocated for the establishment of a national network for microelectronics education in a Mercury News op-ed and while testifying before the House Committee on Science, Space, and Technology. ASA-SEMI laid out a vision for fueling American microelectronics innovation and growth that was endorsed by more than 40 industry executives. This initiative led to the appropriation of $200 million for the CHIPS for America Workforce and Education Fund via the National Science Foundation (NSF).

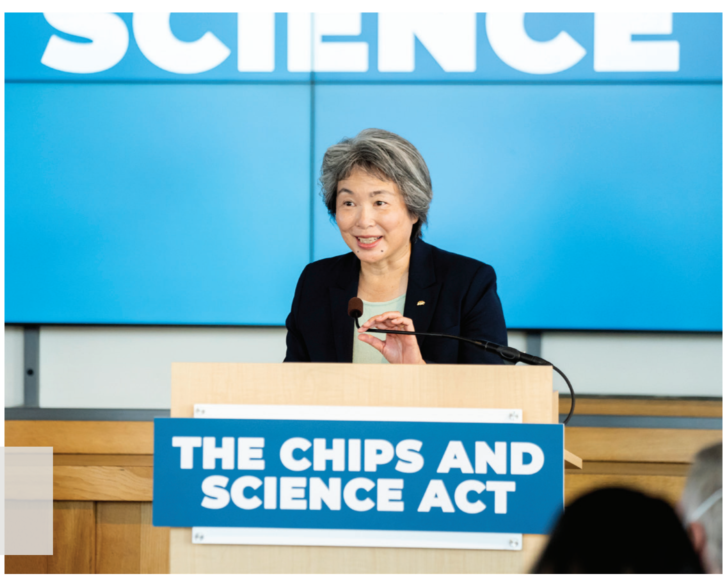
But to be successful, simply increasing the number of engineers is not enough. We must also increase the diversity of the engineering teams designing technologies that will shape our future. Research shows that diverse teams are more creative and effective because they comprise a wider range of viewpoints and skills. That’s why CHIPS for America includes minority-serving institutions and STEM education in rural communities.

Berkeley Engineering will no doubt play a prominent role in national efforts to address the workforce development needs of the U.S. semiconductor industry. I will continue to provide input in the national interest as a member of the NSF Engineering Advisory Board and the Industrial Advisory Committee advising the secretary of commerce on domestic semiconductor R&D. We will share details as they emerge, so please stay tuned.

Fiat Lux — and GO BEARS!

—*Tsu-Jae King Liu*
DEAN AND ROY W. CARLSON PROFESSOR OF ENGINEERING

> Berkeley Engineering will play a prominent role in efforts to address the workforce needs of the U.S. semiconductor industry.

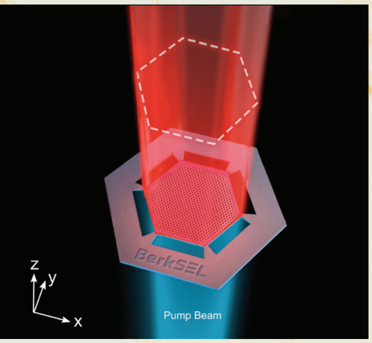


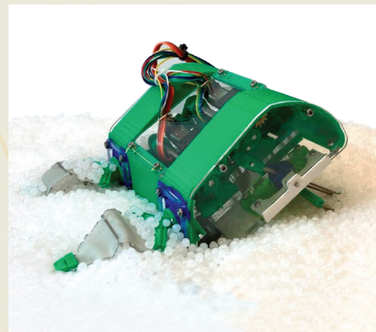
Dean Tsu-Jae King Liu speaks at an event celebrating the signing of the CHIPS and Science Act.

Adam Lau

in this issue

Berkeley**ENGINEER** **FALL** 2022





MORE >

> COVER ILLUSTRATION: **Artist's rendering of the Mars Ice Home concept. Mars Ice Home is a feasibility study that was conducted at NASA Langley Research Center, in collaboration with SEArch+ and CloudsAO, in 2016.**

IMAGE COURTESY OF **NASA/Clouds AO/SEArch+**

DEAN
Tsu-Jae King Liu

ASSISTANT DEAN, MARKETING & COMMUNICATIONS
Sarah Yang

MANAGING EDITOR
Julianna Fleming

ASSOCIATE EDITOR, ART & PHOTOGRAPHY
Adam Lau

DESIGN
Alissar Rayes

CONTRIBUTORS
Theresa Duque
Marni Ellery
Andrew Faught
Ashleen Knutsen
Kara Manke
Kirsten Mickelwait

WEB MAGAZINE
Steve McConnell

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Marilyn Sargent/Berkeley Lab

SUSTAINABILITY

Waste not

Aiming to tackle the problems caused by electronic waste, a team led by **Ting Xu,** professor of materials science and engineering and of chemistry, and faculty senior scientist at Berkeley Lab, has developed a fully recyclable and biodegradable printed circuit.

The researchers had previously created a biodegradable plastic material — embedded with purified enzymes such as Burkholderia cepacian lipase (BC-lipase) — that could be degraded by hot water. For their biodegradable circuits, the researchers used cheaper, shelf-ready BC-lipase instead of expensive purified enzymes to reduce costs and enable mass manufacturing. By doing so, they were able to develop a printable "conductive ink" composed of biodegradable polyester binders, conductive fillers such as silver flakes or carbon black, and commercially available enzyme cocktails. The ink gets its electrical conductivity from the silver or carbon black particles, and the biodegradable polyester binders act as a glue. The researchers then used a commercial 3D printer to print circuit patterns with the conductive ink onto various surfaces.

To test its shelf life and durability, the researchers stored a circuit in a drawer without controlled humidity or temperature. After seven months, the circuit conducted electricity just as well as it did before storage. Next, the researchers put the device's recyclability to test by immersing it in warm water. Within 72 hours, the circuit materials degraded into its constituent parts. The silver particles completely separated from the polymer binders, and the polymers broke down into reusable monomers, allowing the researchers to easily recover the metals without additional processing. They determined that approximately 94% of the silver particles can be recycled and reused with similar device performance.

NUCLEAR SAFETY

Aiding Chernobyl

After the Russian occupation of the Chernobyl Nuclear Power Plant in Ukraine in spring 2022, scientists returned to the site to find ransacked offices and labs. Computers and other valuable equipment had been stolen or destroyed. Radioactive dust had been kicked up by heavy trucks and small fires, spreading contamination throughout the area.

To help in the relief effort, nuclear engineers at Berkeley have been testing and refurbishing critical equipment to send to Chernobyl, the site of a 1986 nuclear explosion that spread radioactive contamination throughout the region. Dangerous levels of radioactivity still linger at the location. Even before the current war, the scientists working there were often forced to rely on old and outdated equipment.

Since 2017, graduate student **Jake Hecla** and other nuclear engineers at Berkeley have been collaborating with Chernobyl scientists, demonstrating state-of-the-art nuclear detection systems to help monitor the radiation at the plant. Now that the Russian invasion has left these scientists without even the most basic tools, the team is also donating useful equipment.

The first batch of instruments — a set of sodium-iodide gamma-ray detectors for monitoring lingering radiological contamination in soil and vegetation — shipped in July. Hecla and graduate student **Michael Bondin** are also testing much higher-resolution high-purity germanium detectors to potentially send to Ukraine. Over the years, Berkeley scientists have used these detectors as part of systems designed to detect radiological threats to national security and to study radiological background signatures in the environment. Now, they will be used to help Chernobyl scientists rebuild their labs.

The team is also working with Ukrainian scientists and leaders to identify ways that advanced 3D-mapping technologies can address ongoing concerns at the power plant, and more broadly, respond to possible scenarios in which large amounts of radioactivity are released.

"The war has turned what was a desperate situation into one that is absolutely dire," said **Kai Vetter,** professor of nuclear engineering. "We believe strongly in providing the expertise and equipment that we have available."

REINFORCEMENT LEARNING

Just for you

Content selected "just for you" on social media feeds may seem harmless, but new research shows that it can shape preferences in potentially harmful ways — such as promoting videos about political conspiracy theories. The algorithms making these suggestions determine what we see on social media, what videos are recommended to us on YouTube and which ads should be shown to us on the internet.

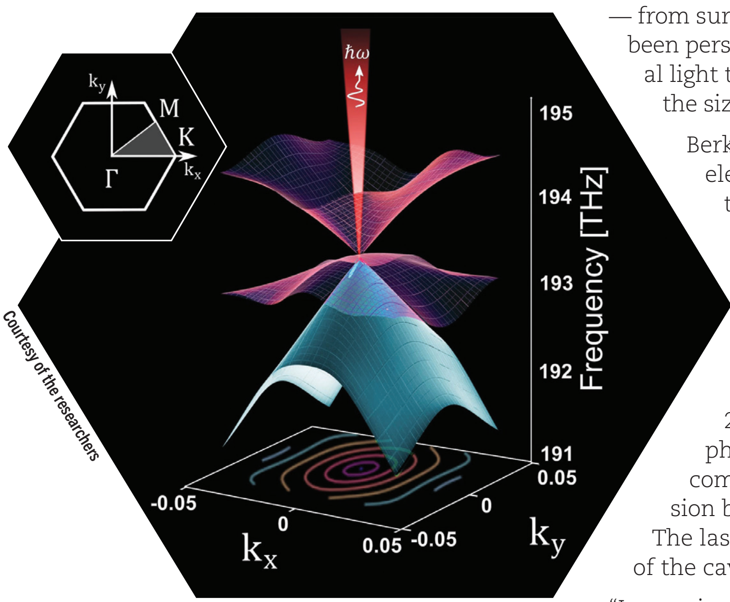
A team of Berkeley engineers have developed a model that can evaluate whether these algorithms, known as recommender systems, are manipulative or not. The research, which focused on reinforcement learning (RL)-based recommender systems, is particularly timely because RL recommenders are starting to be used on many popular platforms, including YouTube.

Their findings showed that using the RL recommenders could lead to manipulative behavior toward users. When the team attempted to model a user's natural preference shifts — which are shifts that occur in the absence of a recommender — these proved to be very different from the preference shifts induced by the RL recommenders. To counter the risks from this technology, the team proposed a way for recommenders to mimic natural shifts, while still optimizing key metrics like engagement. This framework could be used to assess whether current recommendation algorithms are already manipulating users and to create new algorithms to avoid undesirable effects on preferences.

The study was conducted at the laboratory of **Anca Dragan,** associate professor of electrical engineering and computer sciences, with Ph.D. student **Micah Carroll, Dylan Hadfield-Menell** (Ph.D.'21 EECS) and computer science professor **Stuart Russell.**

OPTICS

Next-gen lasers



Courtesy of the researchers

Despite the vast array of applications ushered in by the invention of the laser — from surgical tools to barcode scanners to precision etching — there have been persistent limits to its use. The coherent, single-wavelength directional light that is a defining characteristic of a laser starts to break down as the size of the laser cavity increases, requiring external amplification.

Berkeley engineers led by **Boubacar Kanté,** associate professor of electrical engineering and computer sciences, have created a solution: a new type of semiconductor laser that can emit a single mode of light while maintaining the ability to scale up in size and power.

Their invention, dubbed Berkeley Surface Emitting Lasers (BerkSELs), was designed with an innovative membrane perforated with evenly spaced and same-sized holes that are etched using lithography. The membrane — made of a 200-nanometer-thick layer of indium gallium arsenide phosphide, a semiconductor commonly used in fiber optics and telecommunications technology — enables the single-mode light emission because of the physics of the light passing through the holes. The laser emits a consistent, single wavelength, regardless of the size of the cavity, allowing it to cover longer distances for many applications.

"Increasing both size and power of a single-mode laser has been a challenge in optics since the first laser was built in 1960," said Kanté. "Six decades later, we show that it is possible to achieve both these qualities in a laser."

The study's co-lead authors are Ph.D. student **Rushin Contractor, Wanwoo Noh** (Ph.D.'22 EECS) and postdoctoral researcher **Walid Redjem. Scott Dhuey, Wayesh Qarony** and **Adam Schwartzberg** from Berkeley Lab and Ph.D. student **Emma Martin** also contributed to the study.

EDUCATION

Fired up for the future

To meet the need for more wildland firefighters, the Marin County Fire Department and Berkeley Engineering's Disaster Lab have partnered to form FIRE Foundry (Fire, Innovation, Recruitment and Education), a program that recruits young adults from underrepresented communities for a career in fire service and trains them on cutting-edge firefighting technologies. Earlier this year, FIRE Foundry welcomed its first cohort: Of the 19 recruits, the majority identify as Latine and African American, and eight identify as women or nonbinary.

"FIRE Foundry is unique because it aims to remove both the barriers that prevent underrepresented groups from pursuing careers in fire service and the barriers that impede technology adoption in that field," said **Thomas Azwell,** who leads Disaster Lab, a program that develops innovative engineering solutions for environmental challenges. "We hope that it may serve as a template for future recruiting and training programs."

FIRE Foundry was started two years ago, when the Marin County Fire Department's **Jason Weber** approached Azwell about increasing diversity in the fire service. Azwell was on board to create a partnership — including the Marin County Office of Equity, several Marin fire agencies, the College of Marin and the Conservation Corps — that would draw from the resources of Disaster Lab and educate this next generation of firefighters on new technologies.

"We created a program that provides the wraparound services — from financial support to mentoring — to support recruits through the education piece, their Emergency Medical Technician [EMT] certification and Firefighter 1 Academy," said Azwell. "We want them to have what they need to not only be qualified but to be the most exceptional candidates applying for fire service careers."

Support begins with the coursework, offered through the College of Marin, and continues through the fire academy and job interviews. After a year, participants earn certificates for Emergency Medical Responder and EMT. Once graduates are hired and work for a year or so, they'll return as mentors for future recruits.

Azwell also works with colleagues to integrate the fire detection and response technologies being developed through Disaster Lab into the program. Because Disaster Lab brings together research resources from a host of organizations — including Berkeley labs, startups, fire agencies, the Department of Defense and multiple branches of the military — recruits are introduced to some of the latest firefighting tools and methods. Many technologies were developed by startups incubated through the CITRIS Foundry and the Sutardja Center for Entrepreneurship & Technology.

"Having that kind of applied opportunity isn't only good for the scientists innovating, but it's also good for the firefighters who are the potential adopters of this technology," said Azwell. "Then they get to communicate their needs directly to the innovators."

Technologies have already found their way into today's firefighting toolbox. Recruits can utilize these technologies — including visual AI that detects fire and smoke using hillside cameras, sensors that detect power line failures, and autonomous bulldozers — as they are adopted. Azwell hopes these collaborations can help move innovation into the field.

"By bringing that experience and extra education into their careers, our recruits not only stand out when applying, but also can help the fire service make informed decisions around adoption and shape the future of firefighting," he said.

Thomas Azwell

A DANNAR remote-controlled electric utility vehicle and energy platform is tested for use during wildfires.

ROBOTICS

Digging deep

Adam Lau

The unassuming Pacific mole crab, Emerita analoga, is about to make some waves. Berkeley Engineering researchers have debuted a robot inspired by this crustacean that may help evaluate soil and rock conditions, as well as collect marine data.

Hannah Stuart, assistant professor of mechanical engineering, and her team demonstrated one of the first legged robots that can self-burrow vertically. This digging robot, called EMBUR (EMerita BUrrowing Robot), uses a novel leg design that emulates the way Pacific mole crabs bury themselves in beach sand.

Mole crabs make burrowing look easy, but, according to Ph.D. student **Laura Treers,** it is difficult to move downward through granular media, like sand and soil. To overcome this challenge, the researchers designed the legs of the robot to have an anisotropic force response, which means that they experience much greater force in one direction than another. Like a swimmer, the soft fabric legs of this robot expand for large forces during the power stroke, but fold and retract during the return stroke.

To design the legs on EMBUR, the researchers worked with **Robert Full,** professor of electrical engineering and computer sciences and of integrative biology, and Ph.D. student **Benjamin McInroe** to observe mole crabs in the lab. They realized that the animal's five leg pairs can be split into two groups, which sweep in opposite directions. They also noticed a pattern of insertion, sweeping and retraction, with the latter appearing to reduce drag on the return stroke. The team then reproduced both features in the robot's leg design, using physics models to estimate the forces on the legs.

The researchers also devised a way to prevent sand grains from entering the robot's mechanisms and jamming them. "We created a cuticle, which is analogous to the arthrodial membrane found on the mole crabs," said Treers. "It's a soft, flexible material that lines the openings of joints to prevent grains from getting inside but still allows free movement."

The researchers consider EMBUR a first step toward creating a system that can burrow under a wider range of conditions and types of substrates. "Eventually, I'd love to have this robot be able to dig in real beach settings, like the animal, and switch between running, swimming and digging," said Treers.

See video at **engineering.berkeley.edu/magazine.**

PUBLIC HEALTH

Into the drink

Worldwide, one in four people don't have access to safe drinking water, particularly those living in low-income countries. Children in those regions often suffer from diarrhea and, as a result, are commonly treated with antibiotics. To inactivate many of the harmful pathogens present, drinking water can be treated with chlorine. However, scientists have yet to determine if water chlorination has any negative effects on the bacteria inside our digestive system.

To investigate this possibility, a team of researchers led by **Amy Pickering,** assistant professor of civil and environmental engineering, examined the gut microbiome of children living in Dhaka, Bangladesh, one year after chlorination devices were installed in shared taps across their community. The study cataloged both bacteria species and resistance genes present in the gut microbiomes of 130 children and then compared results between those who drank chlorinated water and those who did not.

The researchers found that children drinking chlorinated water had a significantly higher abundance of certain bacteria, with some populations more than twice as abundant as compared to the non-treated group. These included several bacteria linked to improved gut health. These differences, while minor, could be related to the 23% reduction in diarrhea and 7% reduction in antibiotic use found in the larger study. There were also several antibiotic resistance genes that were found to be more abundant in children drinking chlorinated water; however, these were most likely a result of an increase in the presence of harmless strains of E. coli commonly found in mammals, which frequently harbor antibiotic resistance genes. Overall, the researchers found that chlorination did not reduce the richness or diversity of bacteria species and had no negative impact on the children's gut microbiome.

Fine print

Glass is the preferred material for creating complex microscopic objects, including lenses in compact, high-quality cameras used in smartphones and endoscopes, as well as microfluidic devices that analyze or process minute amounts of liquid. Berkeley engineers have developed a system called micro-CAL, a new way to 3D print glass microstructures that is faster and produces objects with higher optical quality, design flexibility and strength than current manufacturing methods.

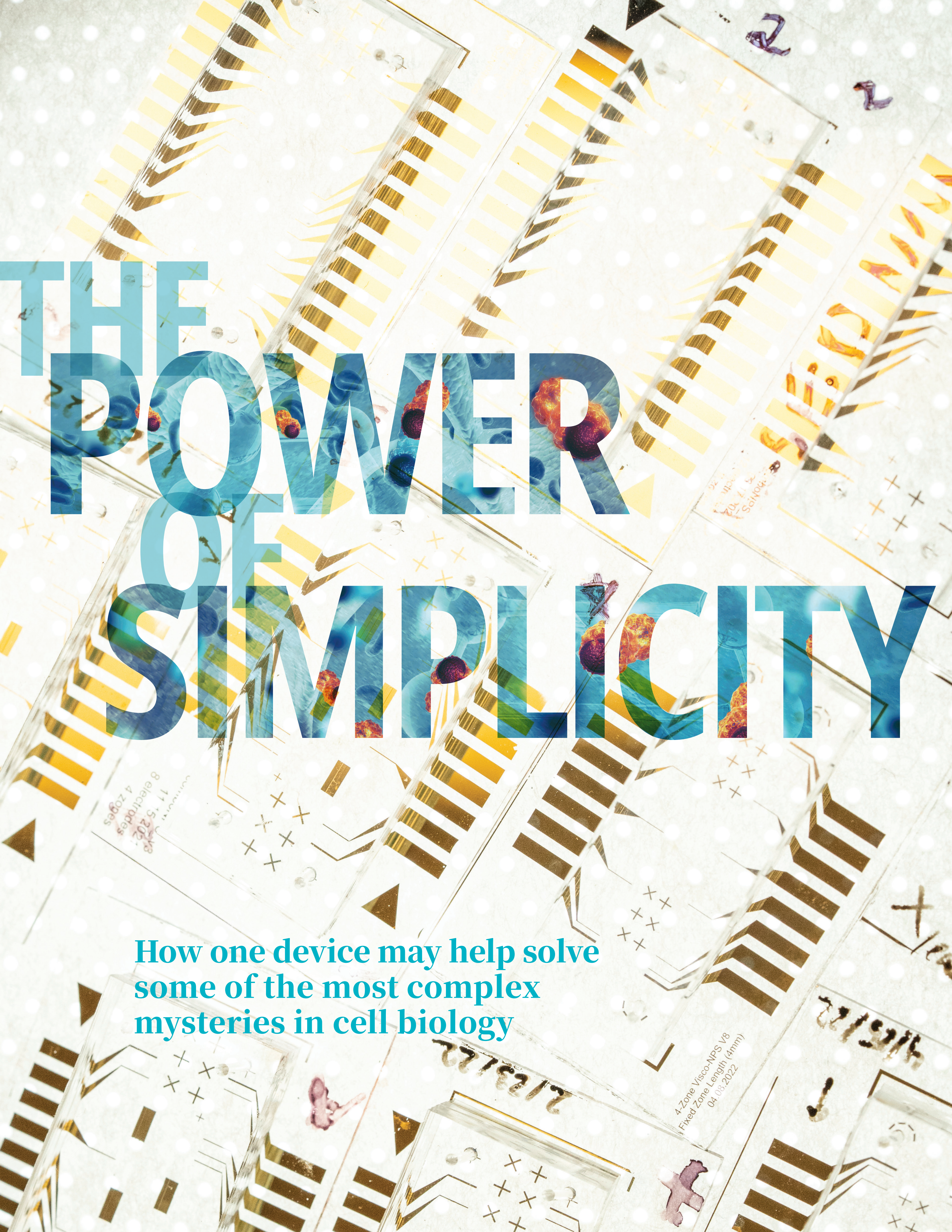
Micro-CAL expands the capabilities of a 3D-printing process the researchers developed three years ago — computed axial lithography (CAL) — to print much finer features and to print in glass. "With micro-CAL, we can print objects in polymers with features down to about 20 millionths of a meter, or about a quarter of a human hair's breadth," said **Hayden Taylor,** associate professor of mechanical engineering. "This method can print not only into polymers but also into glass, with features down to about 50 millionths of a meter."

Unlike today's industrial 3D-printing, micro-CAL prints the entire object simultaneously. It does so by using a laser to project patterns of light into a rotating volume of light-sensitive material, building up a 3D-light dose that then solidifies in the desired shape. The material — developed by scientists from the Albert Ludwig University of Freiburg, Germany — contains nanoparticles of glass surrounded by a light-sensitive binder liquid. Digital light projections from the CAL printer solidify the binder; the researchers then heat the printed object to remove the binder and fuse the particles together into a solid object of pure glass.

The researchers, including Ph.D. student **Joseph Toombs,** found that micro-CAL's glass objects had more consistent strength than those made using a conventional printing process. "Glass objects tend to break more easily when they contain more flaws or cracks, or have a rough surface," said Taylor. "CAL's ability to make objects with smoother surfaces than other, layer-based 3D-printing processes is therefore a big potential advantage."

STORY BY MARNI ELLERY, PHOTO BY ADAM LAU

A 3D-printed, trifurcated microtubule model displayed beside an insect.



THE POWER OF SIMPLICITY

How one device may help solve some of the most complex mysteries in cell biology

STORY BY MARNI ELLERY | PHOTOS BY ADAM LAU

When asked to describe her microfluidic device, Berkeley mechanical engineering professor Lydia Sohn keeps it simple.

"Here's what I tell my family: It's like we're taking a straw, and we're drinking tapioca boba balls," says Sohn, who holds the Almy C. Maynard and Agnes Offield Maynard Chair in Mechanical Engineering. "Some boba are bigger than others, and some of these may take more time to squeeze through a straw than smaller ones."

Now imagine that the boba are cells and the straw is one of many microscopic, fluid-filled channels that the cells must pass through. Along the way, researchers measure different physical characteristics of the cells. That's Sohn's device, mechano-node pore sensing (NPS), in a nutshell.

On the surface, her device — which looks to be about the size of a quarter — is a marvel of simplicity, using technologies from the 1960s and 1970s. Yet the data collected by mechano-NPS is expanding our understanding of cell biology in remarkable ways.

Sohn's device enables researchers to measure the biophysical properties of cells, from their diameter to how easily they can be squished, as they flow through a maze of channels, each about one-tenth as wide as a human hair and through which current flows. As cells pass through, changes to their shape and other properties are measured by fluctuations in the current.

"Just seeing that drop off in current as a cell passes through different sections of our device, we can translate that into the size of the cell, how stiff or soft it is and how well it recovers," says Sohn.

Sohn and her research team have shown that these mechanical properties can provide important clues about a cell's future. A cell's stiffness or transit time through a channel, for example, may shed light on whether that cell will remain healthy or become cancerous. For certain cancers, it could also indicate whether therapies that use a particular drug could be effective. Now, less than five years since its initial development, this simple device is already showing promise as a tool for better cancer detection and treatments.

A new approach to microfluidics

Decades before Sohn developed mechano-NPS, researchers had been using microfluidic channels to measure cells and molecules. These channels, measured in microns, typically contain as little as tens of nanoliters of fluid.

Sohn and her students introduced a new approach to microfluidics in 2013. "One group of students said, 'If this channel is like a wire, we can change its shape, and we could possibly measure different things,'" says Sohn. "And that's how node pore sensing came about."

The pore, or channel, used in node pore sensing has the unique ability to detect particles from tens of nanometers to several microns in size. Nodes inserted along the channel produce a series of electronic pulses as single cells pass through the device. This series of pulses is like a signature for each cell, which ensures that even the smallest particles do not pass through the device undetected, a challenge with previous microfluidic platforms.

However, if two or more cells enter a channel, signature overlaps occur, making it difficult to track data measurements to the correct cell. To assist with signal processing for the device, Sohn collaborated with Michael Lustig, professor of electrical engineering and computer sciences. "I work on MRI, but I saw that some classical ideas in signal processing of radar and digital communications could be used for this application," says Lustig.

Together, Sohn and Lustig coded the signal for different channels, so that cells would issue special patterns as they passed through them. Researchers could then determine which cell or channel the signal corresponded to, like a cellphone tower differentiating between different signals from countless phones that are transmitting on the same frequency.

The addition of signal processing to Sohn's device was a game changer. It resulted in significantly higher throughput — multiple cells could be pushed through the channel and studied, and multiple channels could be used, rather than a single cell at a time in a single channel. It also improved the signal-to-noise ratio, so signals from even the smallest particles could be detected.

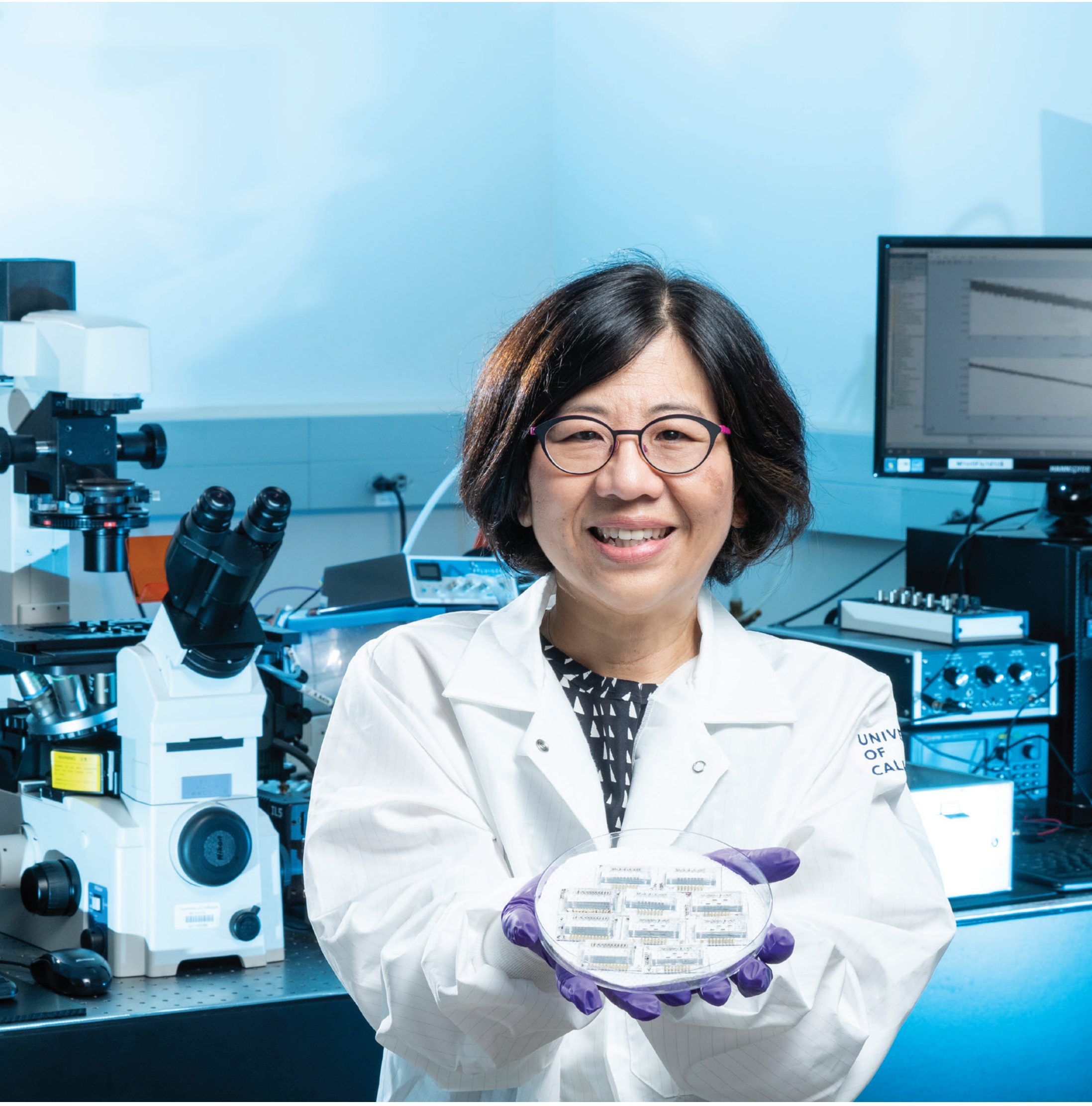
In 2018, Junghyun Kim (Ph.D.'18 ME), then a graduate student in Sohn's lab, developed what became the initial platform for mechano-NPS. "He wanted to measure mechanical properties of cells, and he was going to make this [new] device by modifying our general device," says Sohn. "I said, 'Well, okay, let's see what happens in a couple months.' And you know what? His instincts were right. He really opened up this whole new field for us."

Kim demonstrated how the mechano-NPS platform could be used to simultaneously measure a single cell's diameter, resistance to compressive deformation, transverse deformation and recovery from deformation. Using these mechanical properties, researchers could accurately differentiate between cell types and forgo the time-consuming process of attaching tags, or labels, to individual cells to identify them. In this way, mechano-NPS also proved to be a more efficient and faster way to study populations of cells.

Understanding breast cancer risk

Sohn was determined to find real-world applications for her device. "As an engineer, it's not just about making platforms and getting data; it has to have a real use," she says.

Colleagues suggested using mechano-NPS to study cancer cells. The relevance appealed to her, and a family history of cancer — both of her parents have been treated for the disease — factored into her decision. "If there's an easier way to do detection and monitoring than we have now, that would help the patient and the doctor," says Sohn.



Mechanical engineering professor Lydia Sohn holds a petri dish containing mechano-node pore sensing (NPS) devices, which are shown in a close-up image, right.

Mechano-NPS sparked a yearslong collaboration between Sohn and Mark LaBarge, a professor of population sciences at City of Hope, a national cancer center located about 20 miles northeast of Los Angeles in the city of Duarte. LaBarge was previously a scientist at Berkeley Lab, where he met Sohn 10 years ago. Intrigued by each other's work, they decided to use mechano-NPS to determine which women might be more susceptible to breast cancer as they get older.

LaBarge proposed using mechano-NPS on primary breast cells for women of different ages to see if they could spot a difference in the way the cells responded as they passed through the microfluidic channels. The results were startling.

"We found that in younger women, the breast cells, most of the time, recover [from being squished] much faster than older women's breast cells," says Sohn. "We could see the older cells just taking longer to recover."

They then explored how the mechanical properties of the breast cells changed if they pushed them through a malignant progression — the molecular stages that a cell undergoes as it transforms from a normal cell into a cancer cell.

"Each one of those stages has its own unique mechanical portrait," says LaBarge. "We even found that we could tell the difference between cells from a woman in her 30s versus cells from a woman in her 50s with a pretty high level of accuracy."

After this discovery, they worked with Kim to look at breast cells obtained from a biopsy or a fine-needle aspiration to see whether cellular mechanical properties — such as deformation from passing through the microfluidic channel, or the recovery

“You need a lot of data to take advantage of machine learning, and that’s one thing that I think the mechano-NPS device does that no other device in mechanobiology can do — measure lots of cells very efficiently.”

time needed to return to the original shape — indicated malignancy of cancer cells and their metastatic potential.

Their findings showed that mechano-NPS could indeed distinguish between malignant and non-malignant human breast cells. They could even measure the changes to the protein structures, or the cytoskeleton, inside the malignant cells. Also, using only these mechanical properties, Sohn, LaBarge and Kim could differentiate between cell sub-lineages and chronological age groups of normal breast cells.

“We have this theory that a woman has a chronological age, and her breast tissue has a mechanical age; how far apart those two are is going to define the true susceptibility of breast cancer,” says Sohn. “Of course, we have to prove it. But a lot of preliminary data is showing that we’re on the right track.”

With each year, they seem to be getting closer to meeting that goal. Using mechano-NPS, one of LaBarge’s postdoctoral fellows, Stefan Hinz, discovered a cytoskeletal component, a type of keratin, that is directly related to why women are more susceptible to breast cancer as they age. “We think [it] is responsible not just for the difference between young cells and old cells, but also the difference between cells in women that are likely to get cancer and those that are not likely to get cancer,” says LaBarge.

Sohn’s device can measure hundreds of cells in minutes, allowing LaBarge to study populations of cells and create algorithms for classifying them based on age. “You need a lot of data to take advantage of machine learning, and that’s one thing that I think the mechano-NPS device does that no other device in mechanobiology can do — measure lots of cells very efficiently.”

This was particularly valuable when LaBarge looked at breast cells from young women with different breast cancer-related mutations. While molecularly distinct from one another, from a mechanical point of view, they all appeared to have accelerated aging. “When we ask the machine learning algorithm to tell us if [the breast cells] are young or old, they all come out looking 20 or 30 years older than they really are,” says LaBarge.

With this newest research, LaBarge and Sohn think mechano-NPS could make the leap from the lab to the clinical setting. “We might be one or two grant cycles away from translating the device from being a benchtop wunderkind into being something more like a clinical trial to assess cancer risk,” says LaBarge.

“What is it telling us?”

Mechano-NPS has also proved useful in research related to the diagnosis and treatment of acute promyelocytic leukemia (APL), an aggressive blood cancer. Once a person with APL presents with the acute phase, they need to be given a drug called ATRA (all-trans retinoic acid), or they will likely die within a week. But there is a small set of APL patients who receive ATRA but don’t respond or stop responding to it, and there are no biological assays to test for ATRA resistance.

“That’s where our device came through,” says Sohn. “Brian Li, a [former] graduate student [in my lab], wanted to know if we could detect ATRA resistance in APL cells using mechanical measurements.”

They discovered that ATRA-resistant APL cells are significantly stiffer than ATRA-sensitive APL cells. They also studied the biological reason why cells are soft or stiff and how the internal components, such as the nucleus and cytoskeleton, correspond to whether an APL cell is resistant to ATRA.

For Sohn, the intersection between physical and biological properties is not only fascinating, but also holds a lot of promise. “This mechanical property of cells is making a niche for itself in applications,” says Sohn. “It’s opened our thoughts on what it means for a cell to be soft or stiff. What’s exactly going on inside this cell? What is it telling us?”

These days, you can find Sohn working on new applications for her mechano-NPS device in a range of fields. She recently collaborated with associate professor of mechanical engineering Grace O’Connell, whose research is focused on soft tissue biomechanics and tissue regeneration.

“We set up a platform in her lab, so that they could look at the mechanical properties of her chondrocytes [cells found in cartilage], and whether or not they can use stiffness as a parameter to select the appropriate chondrocytes for potential tissue regeneration,” says Sohn.

Sohn also has been working with Andreas Stahl, professor in the Department of Nutritional Science and Toxicology. His team is studying how drugs applied to adipocytes — fat cells that make up adipose tissue — can change the stiffness of the cells. They would typically use an atomic force microscope for their work, but Sohn’s device is allowing them to increase their productivity.

“Every time I think we’ve done enough with this device, there’s always something new that comes on board,” says Sohn. “It’s very satisfying to just keep going and see what happens. It’s so simple — and that, I think, is really cool.” BE

TAKING UP SPACE

Finding solutions for living on Mars — and a rapidly changing Earth

STORY BY ANDREW FAUGHT

iStockphoto/Getty

Artist's rendering of a human base on a new planet, aerial view.

Every morning at 2:30, Adam Arkin awakens from his short night's slumber. As the rest of the neighborhood sleeps, the director of Berkeley's Center for the Utilization of Biological Engineering in Space (CUBES) looks skyward to motivate himself for the coming day.

There, a pale red speck, millions of miles away in the cosmos, captivates his imagination and informs his work. Our presence on Mars, it turns out, is no longer the stuff of science fiction. With NASA's successful landing of the Perseverance rover in Mars' Jezero Crater in February 2021, the possibility of human colonization on the planet seems even more likely.

Getting there is no easy feat, and neither is sustaining life, given Mars' limited natural resources. The uninviting environs lack oxygen and liquid water, and atmospheric temperatures are an enervating -80 degrees Fahrenheit. A lack of light makes photosynthesis — the process in which plants use light energy for growth — virtually impossible without some form of amplification.

But for national space agency officials — CUBES is a NASA Science Technology Research Institute — the once improbable has become the art of the possible. And they've put Arkin at the apogee of scientific inquiry.

"We want to be able to provide food, pharmaceuticals and materials for astronauts, on demand," says Arkin, the Dean A. Richard Newton Memorial Professor of Bioengineering. "You can start out your trip with a huge truck of everything you need, but it's expensive, and if things go wrong, you've lost your truck and that's the end of it.

"We want you to take something you can grow from seed — plants, bacteria, fungi and viruses — that can start out as small frozen stocks and grow into an entire factory, so we're designing a self-reproducing, integrated biomanufacturing system," he adds. "Amazon doesn't deliver this stuff. Everything has to be easy to operate and use resources hyper-efficiently and cleanly."

For now, the researchers are working with a limited goal: supporting nine astronauts on a 12-month voyage to and back from Mars, with an intervening stay of 550 days. A mission could still be at least a decade away, according to Arkin. But the astronauts will need something akin to an extraterrestrial "starter kit" — one that not only allows for total self-sufficiency, but also uses systems that are self-sustaining, recycling everything that is used.

In the meantime, there's a need to support humans for sustained stays in locations closer to Earth. Current efforts include NASA's Artemis program, which foresees bases on the moon, and Blue Origin's Orbital Reef space station. The longer humans are out there, the more resources they will need to make on site.

At CUBES, Arkin is leading efforts to create zero-waste biomanufacturing systems in "Mars-like conditions" — for travel to the planet as well as continued inhabitation. Synthetic biology, by redesigning organisms for useful purposes and engineering them to have new abilities, could be just the panacea.

"We're concerned about the worlds that we're going to visit, as we're concerned about our current world," says Arkin. "We think of this as designing sustainable manufacturing for the next planet we visit, as well as for Earth, which is rapidly transforming due to the impact of its human population."

WORLDS TRANSFORMED

CUBES' core work is in creating engineered plants and microbes to grow functional foods, medicines and materials using Mars' typically incompatible atmospheric gases and nutrient-free substrate, the planetary surface layer known as regolith. It's hoped that the same organisms could thrive on Earth in contaminated and otherwise marginal lands.

Further, CUBES scientists are working to create nutrient-giving plants that could grow in areas with restricted space, light, water and soil fecundity. The work also is considering biologically produced pharmaceuticals, cell-based treatments and therapeutics, and developing processes for new manufacturing technologies. Manufacturing would be done in a "closed-loop" system, in which all waste is reused and regenerated.

On Mars, manufacturing food and pharmaceuticals would involve harvesting carbon and nitrogen from the Martian atmosphere and gathering oxygen and hydrogen from frozen water sources. "From these, you fix them into molecules that can be used by other microbes and plants to grow," Arkin says, noting that they are also using this technology to create recyclable bioplastics.

The work feeds Arkin's innate sense of wonder. He enjoyed reading the works of Kim Stanley Robinson, whose fiction included the Mars trilogy, which imagined scientific advances made on Mars, as Earth suffered the consequences of overpopulation and ecological disaster.

"It's about how worlds get transformed, and how technology allows us to create the world around us," Arkin says. "I love that, the idea that we have control of and responsibility for the world, for better or for worse."

It's been five years since Arkin — along with others, including Doug Clark, professor and dean at UC Berkeley's College of Chemistry, and postdoctoral researcher Aaron Berliner — first proposed CUBES to NASA. Agency funding will continue for at least three more years.

Currently, CUBES comprises scientists from Berkeley, Stanford, UC Davis, Utah State University and the University of Florida. Researchers include Karen McDonald, a chemical engineering professor at UC Davis who is researching transgenic plants. Transgenic crops are known for their high quality and ample yield. As importantly, they also are considered "factories" for protein production necessary for making pharmaceuticals.

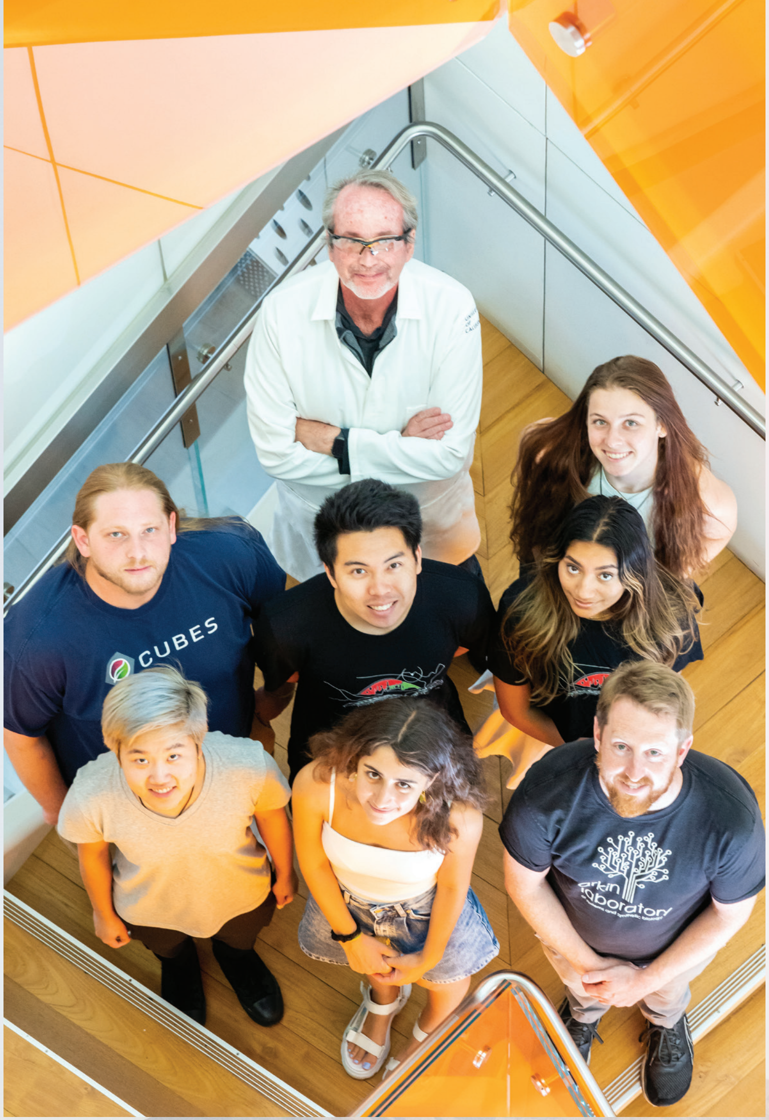
Specifically, McDonald and her team are creating genetically modified lettuce in which a gene-coded protein has been inserted into the plant's genome. This can help reduce bone loss in astronauts during spaceflight. Transgenic lettuce seeds could be grown during flight, or on Mars, and the lettuce could be created to include pharmaceutical properties.

"CUBES has really motivated all of us to think outside the box, in my case making a human therapeutic and delivering it in a nontraditional way with minimal resources," McDonald says. "Adam has been a great leader and advocate. He has a way of asking provocative questions to get the group thinking and brainstorming. It's been a great experience."

Other team members include the noted plant scientist Bruce Bugbee of Utah State University. He's also working with genetically engineered plants — in his case, rice — whose photosynthetic apparatus has been modified to capture light more efficiently.

For his part, Clark, a biochemical engineer by training, is researching the potential to create reusable bioplastics from raw materials such as sugar, methane or carbon dioxide, unlike today's unrecyclable petroleum-based plastics blamed for choking the world's oceans and waterways. Bioplastics could be used to make whatever objects astronauts might need to lead their lives in a distant space outpost.

"The primary carbon source on Mars will be carbon dioxide," he says. "So, using microorganisms is at least in theory the ideal



Adam Lau

Bioengineering professor Adam Arkin, top, postdoctoral researcher Aaron Berliner, top-left, and other Arkin Lab members.

solution because they'll just continue to grow and utilize CO_2 as their primary feedstock. That's the whole premise of CUBES: to be able to use biology and biotechnology to generate the necessary materials to sustain a group of astronauts on Mars, using the limited resources that are naturally available."

CUBES researchers are hoping that their work for Mars could also be used to address challenges on Earth, where climate change is hastening desertification, making some locations similarly inhospitable to life.

"The technologies that we're working on developing are very relevant to the situation we find ourselves in here on Earth," Clark says. "It's extremely important for the future of the planet and the future of the human race."

"THINGS WE COULDN'T DO BEFORE"

In the lab, Arkin oversees several research scientists, six graduate students and 10 postdocs, including Berliner, who, like Arkin, shares a wacky circadian rhythm. While Arkin is awakening, the night owl Berliner is preparing to go to sleep. During the short overlap between sleep and wakefulness, the pair occasionally "confabulate" about their latest CUBES work, Arkin says.

Berliner is a self-proclaimed majordomo at CUBES, having earned both his doctorate in bioengineering and a master's degree in nuclear engineering from Berkeley in 2022. He's also an avowed "troublemaker," touting the virtues of space and sustainability to those who don't see the connections.

"Nowadays, in this climate in which we live, we've actually taken a good step toward trying to merge interest in space with an interest in sustainability," Berliner says, adding that CUBES even coined the term "space bio process engineering," to give the team's efforts credibility outside laboratory walls.

"It specifically addresses a number of the United Nations sustainability grant challenges," he says of the moniker. "The constraints of space are, in a way, inherently part of what we need to work on for constraints on Earth."

The efforts being put forth at CUBES could pay dividends at home, leading to innovative ways to help with the looming food crisis, such as novel plant- and microbe-based foods that take fewer resources to grow and create less waste and environmental impact. The World Resources Institute reports that close to 10 billion people will inhabit Earth in 2050, adding 3 billion more mouths to feed than in 2010.

The challenge is daunting. But Arkin feels an urgent need to press on, characterizing the intensity and scope of his work as "massive." For inspiration and clarity, he looks to the bevy of metal puzzles that populate his office.

"The puzzles seemed impossible at first, but once you see the solution, they're simple," he says. "You'll see through the complexity to that very simple solution. Those puzzles give me a sense of hope — as does the skill and dedication of the teams I am part of."

Much of Arkin's work on behalf of Earth is looking decades ahead, when perils to the planet take on a new complexion. In 20 years, as certain regions desertify and others become wetter and more saline, scientists expect to see large changes in the quality and quantity of arable lands and potable water.

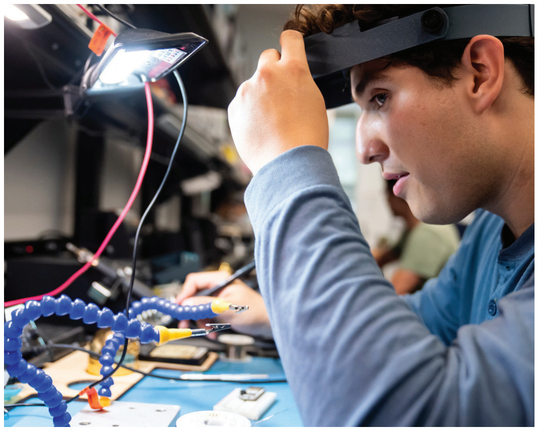
Many of the technologies developed in CUBES address more sustainable means of carbon and nitrogen fixation. This includes more resilient plants, as well as new processes for food and materials production, using plants and microbes that aren't so land and resource intensive and that use waste-streams effectively. Some of these processes could actually be restorative to impacted environments.

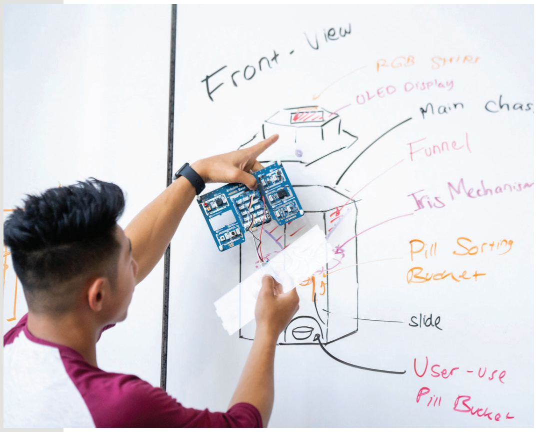
"Our ability to measure and engineer organisms has been transformed even over the past two decades as our ability to read and write the DNA of plants and microbes — and predict the outcomes — has vastly improved," Arkin says, recognizing the impact of Berkeley professor and Nobel laureate Jennifer Doudna's pioneering work in CRISPR gene editing. "And our understanding of the interplay between environmental resources and organismal physiology and productivity has deepened enormously."

Innovation, it is showing thus far, will be critical to solving Earth's most pressing and existential questions. Looking beyond humankind's tiny patch of the universe could bring transformational solutions.

"In human history, we've had climate change events that have led to times of plague and famine. We've been through things like this, but not at this rate and not at this scale. The predictions of environmental change and impact that we were making in the '60s, based on what we were observing back then, are essentially becoming true and are moving faster than we were predicting, not slower."

Bioengineering, Arkin says, is the ideal discipline to take on such tough challenges: "Bioengineering asks, 'How do we harness knowledge to cause change? How do we engineer ourselves and organisms to do new things for us?' That's what it ultimately takes to build a human society elsewhere." BE





Berkeley Engineering's Transfer Pre-Engineering Program (T-PREP) has won the 2022 Inspiring Programs in STEM Award from INSIGHT Into Diversity magazine. Founded in 2012 with initial funding from Lockheed Martin, Recare Foundation and General Motors, T-PREP serves incoming, underrepresented Berkeley Engineering transfer students for whom the transition from a community college to a major research university can be challenging. T-PREP begins with a three-week summer session and continues throughout the year with workshops and events. These include academic seminars, professional development workshops and even a design studio with civil and environmental engineering associate professor **Scott Moura** — himself an alumnus of PREP, the companion program for incoming freshmen — at the Jacobs Institute for Design Innovation. The program serves up to 60 students each year, totaling nearly 500 students in its nine years on the Berkeley campus.

STORY BY KIRSTEN MICKELWAIT | PHOTOS BY ADAM LAU

Electrical engineering and computer sciences professor **Pieter Abbeel** has received the Association for Computing Machinery Prize in Computing, which recognizes an early- to mid-career computer scientist who has made a fundamental innovative contribution in computing.

Rediet Abebe, assistant professor of electrical engineering and computer sciences, has been named to the 2022 class of Andrew Carnegie Fellows.

Zakaria Al Balushi, assistant professor of materials science and engineering, has been named a CIFAR Azrieli Global Scholar. He has also been recognized as a "rising star of nanoscience" by Nature for his work in devising ways to produce next-generation nanomaterials.

Electrical engineering and computer sciences professor **Ana Claudia Arias** has been conferred an honorary doctorate from Tampere University in Finland.

Ruzena Bajcsy, electrical engineering and computer sciences professor emerita, and her daughter, **Klara Nahrstedt,** are the first mother-daughter pair to be elected to the National Academy of Engineering. Bajcsy was also awarded the Slovak Medal of Honor in recognition for her scientific achievements, leading by example and setting a positive image of the Slovak Republic abroad.

Siva Bandaru (Ph.D.'20 CEE), civil and environmental engineering postdoctoral researcher, is this year's recipient of the Rien van Genuchten Early-Career Award of Porous Media for a Green World for his contributions to the development and implementation of electrochemical arsenic remediation in rural South Asia.

Roderick Bayliss III and **Vivek Nair,** graduate students in electrical engineering and computer sciences, have been selected to receive Hertz Fellowships.

Civil and environmental engineering professor **Jonathan Bray** (Ph.D.'90 CEE) is the recipient of the American Society of Civil Engineers' 2022 H. Bolton Seed Medal in honor of his advancements in geotechnical earthquake engineering.

Maya Carrasquillo, assistant professor of civil and environmental engineering, was named to the Georgia Tech Alumni Association's "40 Under 40" list.

Jeffrey Cawlfield (M.S.'84, Ph.D.'87 CE) has been named chair of the Department of Geosciences and Geological and Petroleum Engineering at Missouri University of Science and Technology.

Materials science and engineering professor **Gerbrand Ceder** (Ph.D.'91 MSE) was elected to the American Academy of Arts and Sciences. He was also named a fellow of the Electrochemical Society.

Electrical engineering and computer sciences professor emerita **Constance Chang-Hasnain** (Ph.D.'87 EECS) has won the 2022 Welker Award at Compound Semiconductor Week.

Jennifer Chayes, associate provost of the Division of Computing, Data Science and Society and professor of electrical engineering and computer sciences, was awarded an honorary doctorate from Bard College.

A paper co-authored by electrical engineering and computer sciences professor **Alvin Cheung** has won the ACM SIGPLAN Distinguished Paper at the Conference on

Programming Language Design and Implementation.

Kaichen Dong, materials science and engineering postdoctoral researcher, has been named to MIT Technology Review's "35 Innovators Under 35" list for his invention of a smart roof coating that has both insulating and radiating properties. **Magi Richani** (M.S.'12 CEE), CEO of Nobell Foods, and **Rui Wang** (M.S.'16 MSE), assistant professor at Westlake University, were also named to the list.

Leslie Field (M.S.'88, Ph.D.'91 EECS) has won the inaugural 2022 Mark Shannon Grand Challenges Award, which recognizes "long-term contributions of members of our technical community with a vision to address humanity's pressing issues."

Bioengineering professor **Daniel Fletcher** has been named the new faculty director for the Blum Center for Developing Economies.

Electrical engineering and computer sciences professors **Armando Fox** (Ph.D.'98 EECS) and **Dan Garcia** (M.S.'95, Ph.D.'00 EECS) — based on their proposal in partnership with El Camino College and California State University, Long Beach — have been selected to receive a California Education Learning Lab Award.

Ashok Gadgil, professor of civil and environmental engineering, has been named the inaugural winner of the 2022 Zuckerberg Water Prize by the Zuckerberg Institute of Water Research at Ben-Gurion University of the Negev in Israel.

Michael Garcia (M.S.'80 ME) recently retired from Los Alamos National Laboratory after a 40-year career — including employment at Sandia National Laboratories and Lawrence Livermore National Laboratory — performing research and development on several national security programs. He was awarded an individual Distinguished Performance Award and two Department of Energy and National Nuclear Security Agency Defense Program Awards of Excellence during his career.

Rakesh Goel (M.S.'85, Ph.D.'90 CE) has been selected as the next dean of the School of Engineering at UC Merced.

A research team led by **Ken Goldberg,** professor of industrial engineering and operations research and of electrical engineering and computer sciences, was recently honored with the Best Paper Award by the IEEE Conference on Automation Science and Engineering.

A student team mentored by civil and environmental engineering associate professor **Marta Gonzalez** and lecturer **Jasenka Rakas** was awarded the Professor Joseph M. Sussman Best Paper Prize 2021 for its paper about COVID-19's impact on U.S. aviation. Gonzalez also received a top paper award from IEEE Transactions on Intelligent Transportation Systems for her research on advancements in smartphone applications for drivers.

Kosa Goucher-Lambert, assistant professor of mechanical engineering, has received the 2022 Young Investigator Award in Design Theory and Methodology from the American Society of Mechanical Engineers.

Bioengineering professor **Amy Herr** has been named the inaugural chief technology officer of the Chan Zuckerberg Biohub Network, an effort to develop the science and technologies to observe, measure and analyze human biology in action.

Civil and environmental engineering professor **Arpad Horvath** has been elected to the National Academy of Construction for his work as "an academic leader in the area of infrastructure sustainability, including resiliency."

Peter Hosemann, nuclear engineering professor and department chair, was chosen as the winner of the 2022 TMS Brimacombe Medalist Award for his contribution to micro- and macroscale mechanical testing.

Computer science professor **Michael Jordan** has been selected as the inaugural WLA Prize Laureate in Computer Science or Mathematics by the World Laureates Association.

Lighting up Hollywood

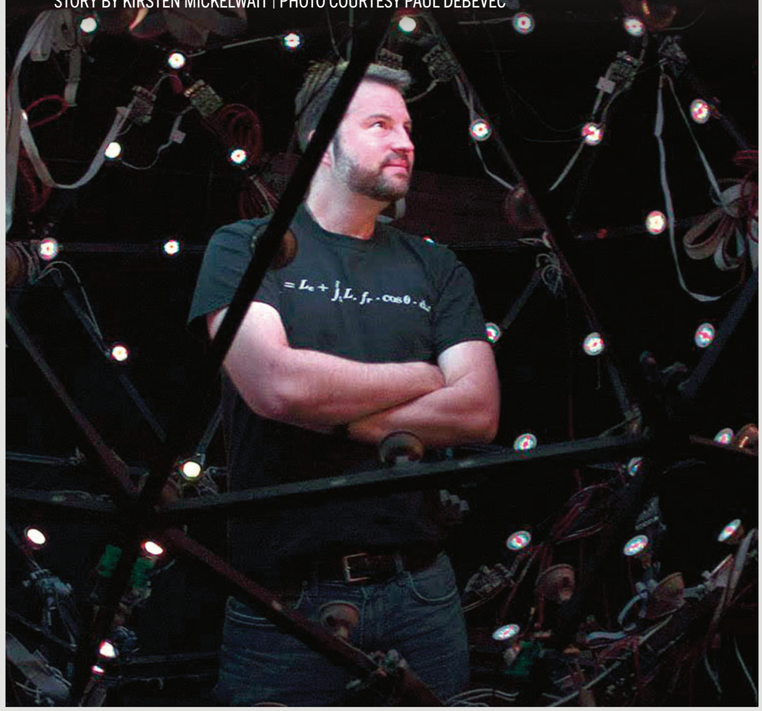
Paul E. Debevec (Ph.D.'96 EECS) received the Charles F. Jenkins Lifetime Achievement Award at the Television Academy's 74th Engineering, Science & Technology Emmy Awards in September. The honor is given to a living individual whose ongoing contributions have significantly affected the state of television technology and engineering.

The award recognizes Debevec's groundbreaking work in high-dynamic-range imaging, image-based lighting and photogrammetry — techniques used in computer graphics for visual effects and virtual production. His work enables engineers to record and reproduce the light of real scenes to illuminate virtual scenes, a technology that is ubiquitous on today's cellphone cameras.

High-dynamic-range imaging, the subject of a 1997 paper by Debevec and **Jitendra Malik,** professor of electrical engineering and computer sciences, is considered a linchpin of computer graphics and — combined with techniques stemming from Debevec's 1998 paper on image-based lighting — has enabled realistic integration of existing live-action lighting in computer-generated imagery. These tools and concepts are now standard within the visual effects industry. He also pioneered a virtual production technique called Light Stage, which uses lighting simulation software that allows a computer-generated image or live actor in the studio to be illuminated by the light of the scene in which it's supposed to occur.

"I'm incredibly fortunate to have had UC Berkeley's amazing faculty, students, environment and traditions of excellence to influence my work," said Debevec, now the director of research, creative algorithms and technology for Netflix.

STORY BY KIRSTEN MICKELWAIT | PHOTO COURTESY PAUL DEBEVEC



NASA astronaut candidates Warren "Woody" Hoburg, Kayla Barron, Frank Rubio and Zena Cardman.

To infinity and beyond

When the SpaceX Crew-6 mission heads to the International Space Station (ISS) in spring 2023, Berkeley Engineering alum **Warren "Woody" Hoburg** (M.S.'11, Ph.D.'13 EECS) will be, quite literally, launching a new career. A NASA astronaut since 2017, Hoburg will be taking on the role of pilot on the spacecraft Dragon for the first time, applying years of intensive training.

"I always thought being an astronaut would be the coolest job ever, but I had no knowledge of how to get there," he said. "It was only in hindsight that my skills and background made sense."

After receiving his bachelor's degree from MIT in aeronautics and astronautics, Hoburg came to Berkeley to earn his master's and Ph.D. degrees under adviser **Pieter Abbeel,** professor of electrical engineering and computer sciences. But after two years, his original plan to research machine learning for robotics changed direction. "While studying convex optimization, I realized that a special type of optimization, geometric programming, was well-suited for aircraft design," he said.

"The first time I met Woody, he already had an exceptionally clear vision: he wanted to become an astronaut, and his Berkeley Ph.D. was one step toward that," said Abbeel. "His thesis demonstrated that sizing all the parts and subsystems of an aircraft can be formulated in a way that's mathematically reliable and efficient to solve, enabling each design cycle to take seconds or minutes instead of hours or days."

Much of Hoburg's doctoral study was completed from a staging area in Yosemite National Park, where he worked during the summers of 2010 and 2011 on the Yosemite Search and Rescue Team. He trained as an EMT and learned to hang off ropes to save stranded rock climbers. It exposed him to high-stakes decision-making — the kind you'd need when encountering unexpected situations on a space mission.

Having earned his Ph.D., Hoburg spent a year at Boeing Commercial Airplanes and then joined the MIT faculty, leading a research group that developed software for aircraft design. But when Hoburg heard through a friend that NASA was accepting applications, he took a shot and applied. "Somehow I was lucky enough to get that once-in-a-lifetime phone call," he said.

Hoburg joined NASA as a member of the 2017 astronaut class. Five years later, he is in the thick of mission training, focused on two separate functions: first, preparing to fly Dragon to the ISS and back; and second, training for six months of living and working in space.

To train for the launch and return phases of flight, he's spending time at SpaceX, learning how to handle emergencies and malfunctions with the Dragon spacecraft's many systems. Hoburg and his crew mates are also training for spacewalking at NASA's neutral-buoyancy facility: a 40-foot-deep tank that holds 16.2 million gallons of water and a full-scale mock-up of the space station.

Hoburg has now found the right balance between his technical, engineering side and his operational side. "I was always seeking ways to combine these two passions, but they never aligned perfectly until I got to NASA," he said. "This is a place that needs highly technical people who love math and problem-solving, but who also want to do operations. I finally feel truly at home."

Clearly, for Woody Hoburg, the sky's the limit.

STORY BY KIRSTEN MICKELWAIT | PHOTO NASA/ROBERT MARKOWITZ

Jessica Kahn (B.S.'07 NE) is the new public works director for the city of Capitola, California.

Angjoo Kanazawa, assistant professor of electrical engineering and computer sciences, was named to the 2022 Society of Hellman Fellows.

Bioengineering professor **Sanjay Kumar** stepped down as chair of the Department of Bioengineering to become director of Berkeley's California Institute for Quantitative Biosciences (QB3).

Kam Lau, electrical engineering and computer sciences professor emeritus, has received the 2022 California Institute of Technology's Distinguished Alumni Award, the institute's highest honor.

Elizabeth Lun (B.S.'06 CE) has been named to the "Rising Stars of 2022" list by Progressive Railroading. She is the assistant director of design at Metrolink Southern California Regional Rail Authority.

Arun Majumdar (Ph.D.'89 ME), an internationally recognized expert in advanced energy systems and renewable energy, has been named the inaugural dean of Stanford University's Doerr School of Sustainability.

Benjamin Mildenhall (Ph.D.'20 CS) and **Pratul Srinivasan** (Ph.D.'20 EECS) jointly received an honorable mention for the 2021 Association for Computing Machinery's Doctoral Dissertation Award.

La Academia De Ingenieria of Mexico has inducted **Khalid M. Mosalam,** professor of civil and environmental engineering and director of the Pacific Earthquake Engineering Research Center, as corresponding member for his lifetime contributions to earthquake engineering. Mosalam also received the 2021 Hojjat Adeli Award for Innovation in Computing for a paper co-written with **Yuqing Gao.**

Jelani Nelson, electrical engineering and computer sciences professor, has won the Best Paper Award at the 2022 ACM Symposium on Principles of Database for his paper "Optimal Bounds for Approximate Counting," co-written with **Huacheng Yu.**

Janeen Obeid (B.S.'12 CE) has been named one of the awardees of the Arab America Foundation's 40 Under 40 initiative.

UC Berkeley has selected **Oliver O'Reilly,** professor of mechanical engineering, as the vice provost for undergraduate education, supporting "diversity, equity, inclusion, belonging and justice efforts."

Vern Paxson (M.S.'91, Ph.D.'97 EECS), professor of electrical engineering and computer sciences, has won the USENIX Security Test of Time Award for his 1998 paper, "Bro: A System for Detecting Network Intruders in Real-Time," which has been cited 3,852 times, according to Google Scholar.

Nuclear engineering professor **Per Peterson** (M.S.'86, Ph.D.'88 ME) has been awarded the 2022 American Nuclear Society's Walter H. Zinn Medal in recognition of "his contributions to the development of technologies for passive safety in nuclear reactors, and his leadership to develop and commercialize fluoride salt-cooled high-temperature reactors."

Amy Pickering (M.S.'04 CEE), civil and environmental engineering assistant professor, has received a National Science Foundation CAREER Award.

Raluca Ada Popa, associate professor of electrical engineering and computer sciences, has received the Association for Computing Machinery's Grace Murray Hopper Award, recognizing an outstanding young computer professional who has made a single recent major technical or service contribution to the field of computer science before the age of 35.

Brown University's School of Engineering awarded **Lisa Pruitt,** professor of mechanical engineering, with a Brown Engineering Alumni Medal.

Materials science and engineering professor **Ramamoorthy Ramesh** (Ph.D.'87 MSE) has been named as Rice University's vice president for research. Ramesh was also elected to the American Academy of Arts and Sciences and, with colleagues, was named the Europhysics Prize 2022 winner.

Robert Ritchie, professor of materials science and engineering and of mechanical engineering, received the 2022 Robert Henry Thurston Award from the American Society of Mechanical Engineers.

Computer science professor **Stuart Russell** has won the International Joint Conferences on Artificial Intelligence 2022 Award for Research Excellence.

Alberto Sangiovanni-Vincentelli, electrical engineering and computer sciences professor, received an honorary doctorate from AGH University of Science and Technology in Krakow, Poland.

Nuclear engineering assistant professor **Raluca Scarlat** (Ph.D.'12 NE) is among 11 new members named to the Department of Energy's Nuclear Energy Advisory Committee.

Electrical engineering and computer sciences assistant professor **Sophia Shao** has won the IEEE Technical Committee on Computer Architecture Young Computer Architect Award. She is also among the 15 recipients of this year's Intel Rising Star Award.

Timothy Shea (M.S.'63, Ph.D.'68 CE) received the Stanley E. Kappe Award of the American Academy of Environmental Engineering and Science for his contributions to advancement of the environmental engineering profession, including his service as president of the academy in 2005.

Scott Shenker, professor emeritus of electrical engineering and computer sciences, has won the Fiat Lux Faculty Award from the UC Berkeley Foundation and Cal Alumni Association, honoring a faculty member who has advanced the university's philanthropic mission and transformed its research, teaching and programs.

Emily Stednitz (B.S.'18 ME) is now one of the 777X flight-test directors at the Boeing Company.

Ion Stoica, electrical engineering and computer sciences professor, has won the 2023 IEEE Koji Kobayashi Computers and Communications Award "for contributions to the design of cloud and computer network services."

The Phi Beta Kappa Northern California Association has recognized **Clancy Wilmott,** faculty member of the Berkeley Center for New Media, with a 2022 Teaching Excellence Award. She was also named to the 2022 Society of Hellman Fellows.

Junqiao Wu, materials science and engineering professor, has been named the recipient of the 2023 Functional Materials Division John Bardeen Award from The Minerals, Metals & Materials Society.

Ting Xu, professor of materials science and engineering and of chemistry, was recognized with a Science Breakthrough of the Year award from the Falling Walls Foundation for her work on biodegradable plastics. She is also the recipient of UC Berkeley's 2022 Faculty Excellence in Postdoctoral Mentoring Award.

The University of Lausanne Business School (HEC Lausanne) has selected industrial engineering and operations research professor **Candace Yano** as the new laureate of its Female Career Award in recognition of her pioneering research in operations management, as well as her efforts to educate the next generation of scholars.

Electrical engineering and computer sciences professor **Katherine Yelick** has won the 2022 CRA Distinguished Service Award, which recognizes a person or organization that has made an outstanding service contribution with a major impact to the computing research community.

Zeyu Zheng, industrial engineering and operations research assistant professor, has received the prestigious Hellman Fellowship with his team of students — **Natalie Andersson, Sophea Bonne** and **Lucie Chen** — for their proposal to enhance housing subsidy programs to aid low-income families.

Samuel Aroni (M.S.’66, Ph.D.’66 CE) died in April at the age of 94. A professor in the UCLA Department of Architecture and Urban Design, he served as chair of the UCLA Academic Senate and acting dean of the Graduate School of Architecture and Urban Planning, among other leadership positions.

Joseph Barkley Jr. (B.S.’49 EECS) died in May at the age of 96. During his career at Ampex, he developed magnetic recorders and developed the first instant-replay device for sports.

Richard Carlson (B.S.’52 IEOR) died in August 2021 at the age of 92. His civil engineering career included structural design work on many buildings in the Bay Area after the Loma Prieta earthquake.

Carlos España (B.S.’68, M.S.’69 CE) died in April at the age of 74. He worked for Earth Technology as president of its North American headquarters before starting his own firm in the geotechnical engineering field. He also served on the Berkeley Engineering Alumni Society board.

Mark Hetherington (B.S.’75 CE) died in June at the age of 71. He founded the geotechnical engineering firm Hetherington Engineering Inc., where he served as president and principal engineer for 37 years.

Lester Hoel (Ph.D.’63 MSE) died in April at the age of 87. He was a professor of engineering and the director of transportation studies at the University of Virginia.

Richard Johnson (B.S.’66 EECS) died in January at the age of 78. He was the vice president of advanced development at EchoStar.

Eugene Kovalenko (B.S.’60 CE) died in April at the age of 89. During the Korean War, he was trained as a Russian interpreter, working in the top-secret Berlin Tunnel. His subsequent career included positions at Brunswick Defense and Los Alamos National Laboratory.

Robert E. Kunzi (B.S.’51 PE) died in March at the age of 94. He spent 35 years in the petroleum industry, working at large oil-producing companies and offshore oil well drilling contractors.

Armand Langmo (B.S.’60 ME) died in June at the age of 84. He worked for the Bechtel Corporation for 37 years.

Robert Levin (Ph.D.’77 IEOR) died in July at the age of 75. An economic analyst, he worked for 30 years for Pacific Gas and Electric Company, and later, for the California Public Utilities Commission and as a consultant. He advocated for the reduction of dependence on fossil fuels and for the use of renewable energy resources through time-of-use electricity pricing.

Isham Linder (Ph.D.’61 EECS) died in January at the age of 98. A rear admiral in the U.S. Navy, his military career included positions as commander of the cruiser destroyer Flotilla 2 and chief of staff for Admiral Hyman Rickover, the “Father of the Nuclear Navy.”

Noel MacDonald (B.S.’63, M.S.’65, Ph.D.’67 EECS) died in May at the age of 81. An engineering professor at Cornell University and National Academy of Engineering member, he was known for his work on the scanning auger microprobe and micromachined microinstruments.

Jimmie Martin (B.S.’57 CE) died in June at the age of 93. He spent his career working on various construction projects, including the original I-80 interstate through the Sierra Nevada and the Vandenberg Air Force Base launch facility.

Richard Parmelee (Ph.D.’64 CE) died in February at the age of 92. He was a faculty member at Northwestern University and later became vice president at Alfred Benesch and Co., designing structural systems for high-rise buildings.

Doris Pearson Peddy (B.S.’49 ME) died in May at the age of 96. During her long career with North American Aviation, she worked in a high-security area on delta wing aircraft.

Edward Philips (B.S.’48 CE) died in May at the age of 95. For 38 years, he served as public works director for the City of Hayward, overseeing infrastructure development including the trans-bay connection from Hayward to San Mateo.

Karl Pister (B.S.’45, M.S.’48 CE) died in May at the age of 96. A professor emeritus of structural engineering, he served as the dean of the College of Engineering from 1980-90, chancellor of UC Santa Cruz from 1991-96, and the first vice president for educational outreach of the University of California. He was a champion of broad and fair access to the UC system, and he led efforts to improve educational opportunities for underrepresented students in California. He was also an influential voice nationally on engineering education, as well as on science and technology policy. Among his many honors, he was a member of the National Academy of Engineering.

John Rosenbaum (M.S.’80, Ph.D.’81 MSE) died in April at the age of 75. He worked for various Chevron companies and is listed as inventor or co-inventor on roughly 70 U.S. patents.

Ronald “RJ” Skocypec died in June at the age of 33. A Berkeley undergraduate student who was on track to graduate in nuclear engineering in 2023, he maintained a 4.0 average and was awarded the Berkeley Undergraduate Scholarship and the J & B Madden Jr. Scholarship.

Dave Smith (B.S.’71 EECS) died in May at the age of 72. The Grammy-winning engineer known as the “Father of Musical Instrument Digital Interface (MIDI),” he founded Sequential Circuits in 1974 and later designed Prophet-5 — the first polyphonic, fully programmable synthesizer and the first musical instrument with an embedded microprocessor.

Don Suverkrop (B.S.’51 ME) died in January at the age of 96. He worked for Hopper Machine Inc., where he developed solutions for farm machines and had 28 patents. He founded Creative Engineering and developed WinBuildit, a program that created architectural feasibility studies and parameters for design.

Pravin Varaiya died in June at the age of 81. A professor emeritus of electrical engineering and computer sciences, he was a renowned expert in smart transportation systems. He spent 50 years on the Berkeley faculty, where he had a joint appointment with the Department of Economics from 1975-92. He served as director of California PATH, was a leader at the Institute of Transportation Studies, and was a member of the National Academy of Engineering.

Carl Weinberg (B.S.’52, M.S.’53 CE) died in May at the age of 92. He spent 21 years as a bioenvironmental engineer with the U.S. Air Force before joining Pacific Gas and Electric Company, where he built an energy research and development program and led efforts in renewable energy.

Adam Lau

With flexibility comes possibility

This fall, Berkeley Engineering has launched its new major in aerospace engineering, building upon its proven base of research in this area. From aerodynamics to low-altitude flight control, from astrophysics to space biology, our new program will be training the aeronautics professionals of the future. Besides new educational opportunities for our students, it will provide an accelerated focus on aerospace research and exciting new collaborations on campus and beyond.

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Berkeley Engineering

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"It's always been my dream to attend Cal, so I was thrilled when Berkeley Engineering announced its new area of study around my interest in space. I know I belong here."

- Tiffany Batty, first-year undergraduate student

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"NASA Ames is excited to support our growing partnership with UC Berkeley. Together, we can enrich the education of students, as well as research innovation."

- Eugene Tu (B.S.'88 ME), director, NASA Ames Research Center

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The power of one professor

"Among the most rewarding parts of advising, mentoring and teaching students is learning about their individual interests and strengths, and working with them to achieve their goals — whether it's learning course material, working on a master's project or earning their Ph.D.," says Claire Tomlin, professor of electrical engineering and computer sciences and the James and Katherine Lau Chair in Engineering. It's faculty members like Tomlin who are helping aspiring engineers to become inspiring engineers themselves. By creating a faculty endowed chair, you can honor a favorite professor while funding a new generation of inspiration.

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