College of Engineering
University of California, Berkeley
Fall 2021
Volume 20

Right off the bats
Insights into the brain

Block by block
Measuring air pollution disparities

Berkeley ENGINEER

Back down to earth

Re-engineering plastics for sustainability

Engineering better health

This fall, our college community — largely vaccinated and masked — welcomed the return of in-person classes with a mix of excitement, joy, relief and a bit of apprehension. While we keep our guards up against a threat that continues to persist, we are determined to move forward, applying lessons we've learned during this health crisis and innovating new ways to improve health.

Throughout the pandemic, we saw the need for rapid diagnostic tests to contain outbreaks and facilitate contact tracing. We felt the strain of medical facilities as doctors made wrenching life-and-death decisions due to limited resources. And although telemedicine existed before COVID-19, the pandemic highlighted the importance of mobile health technologies for safe and efficient patient care.

The stressors placed on our healthcare system clearly illustrate the need for new strategies to deliver quality care that is sustainable and accessible. That is why I am pleased to announce our Engineering Better Health initiative to engage students, faculty and collaborators to help lead the transformation of traditional healthcare through the invention of novel technologies.

> Our Engineering Better Health initiative will help transform traditional healthcare through the invention of novel technologies.

The first pillar of the Engineering Better Health initiative is the Health Technologies Collaborative Laboratory (the Health Tech CoLab) that we launched this September to accelerate the development of devices and systems to transform the way healthcare is managed and delivered. This new space in Blum Hall will provide a hub for students and researchers from engineering, public health, data science, national laboratories, local clinics and industry to collaborate on innovative solutions for improving the quality, accessibility and cost of healthcare. At the CoLab, student teams and researchers can develop and test their medical device prototypes, exploiting the latest advances in sensors, mobile devices and algorithms.

A prime example of the kind of work facilitated by the CoLab is the adaptation of a cellphone-based microscope for fast, accurate COVID-19 mobile diagnostics. It is a project that came out of a collaboration between Nobel biochemist Jennifer Doudna, virologist Melanie Ott at the Gladstone Institutes/UCSF and bioengineer Daniel Fletcher, who is on my leadership team as a special advisor for health initiatives and the founding director of the Health Tech CoLab.

The Health Tech CoLab is the latest addition to the constellation of collaboration spaces across the Berkeley campus, and I am excited to see it foster innovation toward engineering better health for all.

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

Dean Tsu-Jae King Liu with Oski and students during the Wozniak Terrace ribbon-cutting ceremony at Soda Hall in October 2021.

Adam Lau

in this issue

> COVER PHOTO ILLUSTRATION: **COMPOSTABLE PLASTIC**

PHOTO BY **LAURA VOGT**

DEAN
Tsu-Jae King Liu

ASSISTANT DEAN, MARKETING & COMMUNICATIONS
Sarah Yang

MANAGING EDITOR
Julianna Fleming

ASSOCIATE EDITOR, ART & PHOTOGRAPHY
Adam Lau

CONTRIBUTORS
Ann Brody Guy
Ashleen Knutsen
Kara Manke
Kirsten Mickelwait
William Schulz

DESIGN
Alissar Rayes

WEB MAGAZINE
Steve McConnell

Berkeley Engineer is published twice yearly to showcase the excellence of Berkeley Engineering faculty, alumni and students.

Published by: UC Berkeley College of Engineering, Office of Marketing & Communications, 201 McLaughlin Hall #1704, Berkeley, CA 94720-1704, website: engineering.berkeley.edu/magazine

Reach editors: berkeleyengineer@berkeley.edu

Change of address? Send to: engineerupdates@berkeley.edu **or submit at:** engineering.berkeley.edu/update

Donate online: engineering.berkeley.edu/give, **or mail to:** Berkeley Engineering Fund, 308 McLaughlin Hall #1722, Berkeley, CA 94720-1722, phone: 510-642-2487

© 2021 Regents of the University of California / Not printed at state expense.

♻ Please recycle.
This magazine was produced from eco-responsible material.

ENVIRONMENT

Block by block

The amount of air pollution in a community depends greatly on its proximity to emission sources, such as automobiles, factories and power plants. Now, a group of researchers — led by **Joshua Apte,** assistant professor of civil and environmental engineering and of public health — has shown that levels of air pollution vary not only by region, such as between urban and rural areas, but by city block.

Unlike other air quality studies, where only a few measurements were taken per city, the researchers used Google Street View cars equipped with air monitoring devices operated by Aclima to continuously measure air pollutants street by street. As the cars drove around, the monitoring devices took measurements every second, translating to a measurement about every 10 meters. Over 32 months, the cars covered every street of 13 cities, towns and urban districts in four counties in the San Francisco Bay Area. The researchers found that most variation occurs at the hyperlocal level — from one city block to the next — due to the presence of a pollution source.

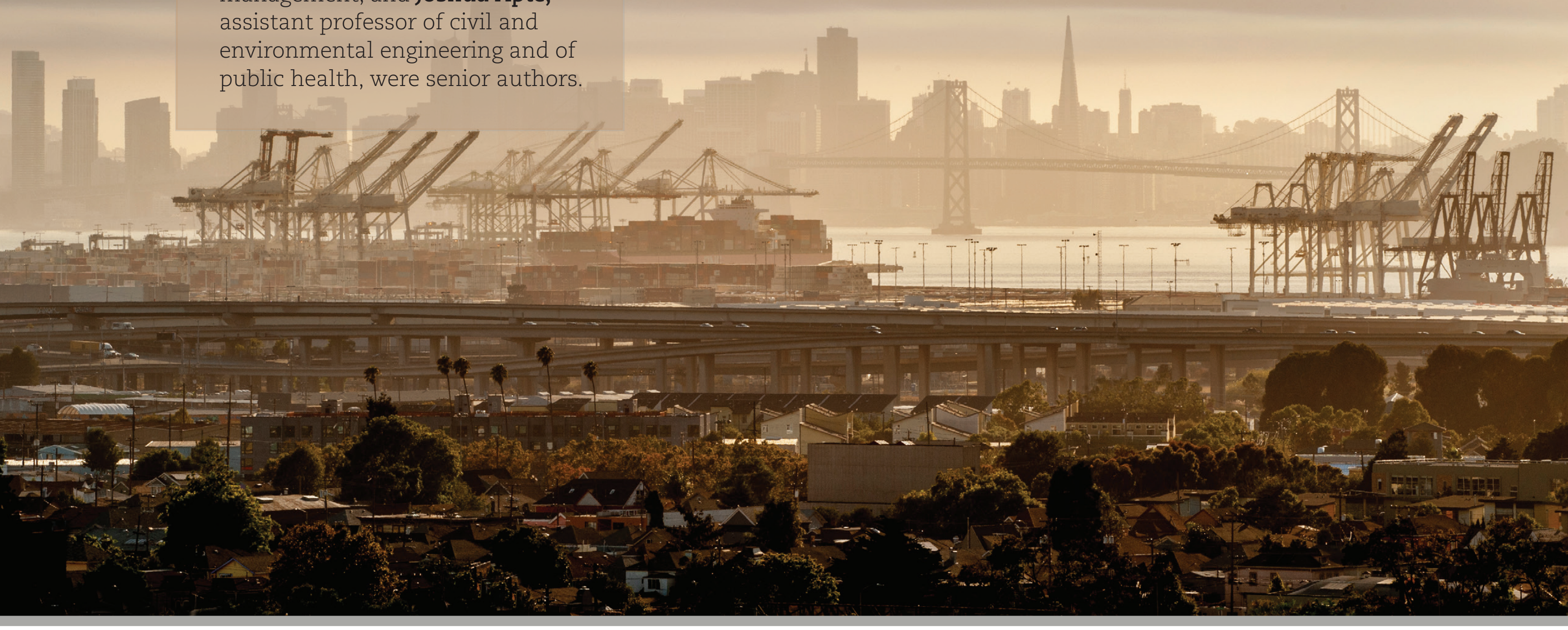
White populations had 9–14% less exposure to these pollutants than the population average, while Black and Hispanic populations had 8–30% higher exposure than the average.

Their results expanded on the authors' previous research, published earlier this year, which showed that fine particulate matter ($PM_{2.5}$), the most deadly air pollutant, disproportionately impacts Americans of color, regardless of income level, state of residence, or urban and rural communities. The findings from that study showed that Black Americans are exposed to greater amounts of air pollution from every source, and that Black, Hispanic and Asian Americans are exposed to higher levels than average from nearly all sources.

"Even as air quality in the U.S. is dramatically cleaner than it was 50 years ago when the Clean Air Act was written, one thing has remained true: although we've made this incredible progress with cleaner air, there is a big racial and ethnic disparity in air pollution that still exists," said Apte.

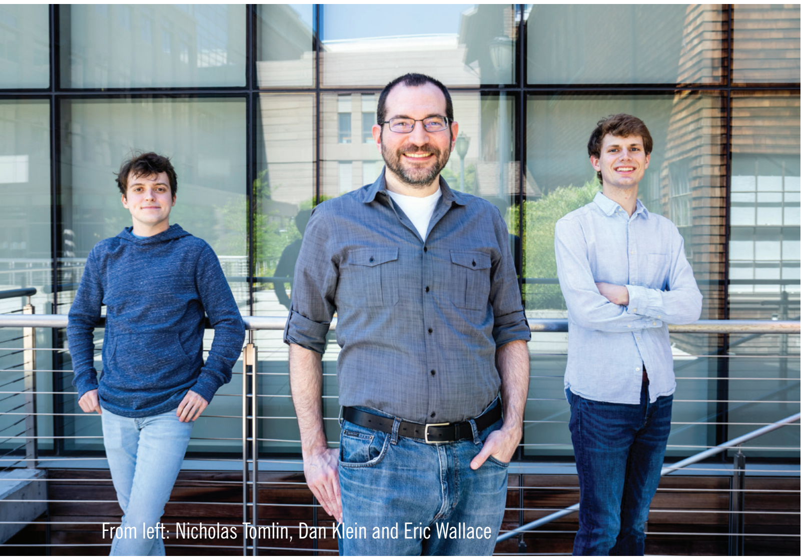
Where there's smoke

When there is wildfire smoke in the air, local residents are told to stay inside. But how much does this actually protect people from hazardous air? In a study that used air sensor data from the crowdsourced PurpleAir network, Berkeley engineers found that by taking steps like closing up their houses and using indoor filtration, residents of the San Francisco and Los Angeles areas cut the infiltration of $PM_{2.5}$ particulate matter to their homes by half on wildfire days. The researchers also used the real estate website Zillow to estimate the characteristics, age and types of buildings in the sensor network, as well as the socioeconomic status of the neighborhood, and found that newer homes and those with central air conditioning were significantly better at keeping wildfire smoke out. Current graduate student **Yutong Liang** (M.S.'15 CEE) was the study's first author; **Allen Goldstein,** professor of environmental engineering and of environmental science, policy and management, and **Joshua Apte,** assistant professor of civil and environmental engineering and of public health, were senior authors.



MACHINE LEARNING

The language of probabilities


From left: Nicholas Tomlin, Dan Klein and Eric Wallace

Adam Lau

Organized by New York Times crossword editor Will Shortz, the American Crossword Puzzle Tournament (ACPT) is the oldest and biggest tournament of its kind. This year, the event moved to a virtual format, attracting more than 1,100 contestants. And for the first time, the top scorer was not a human but an artificial intelligence system known as Dr.Fill. This unprecedented victory was born of a last-minute collaboration between the original system's inventor, **Matthew Ginsberg**, and a team of engineers from the Berkeley Natural Language Processing (NLP) Group.

Ginsberg first developed the Dr.Fill program in 2012, when it finished 141st at the ACPT. Using techniques from machine learning and classic AI, Dr.Fill gradually improved its tournament performance, with its best ranking at 11th place in 2017. This year, its core AI was augmented by a state-of-the-art neural question-answering technology — called the Berkeley Crossword Solver (BCS) — from the NLP Group, led by computer science professor **Dan Klein.**

The partnership began with Ph.D. student **Nicholas Tomlin,** who had been re-implementing Dr.Fill as a fun side project since summer 2020. In February, Klein, Ph.D. students **Eric Wallace** and **Kevin Yang,** and undergrads **Albert Xu** and **Eshaan Pathak** joined the effort. The team reached out to Ginsberg just two weeks before the competition. "It was natural to join forces," said Klein. "Our systems were designed in a way that made it very easy to interoperate because they both speak the language of probabilities."

According to Klein, there are two parts to solving the puzzle: first to come up with answers to the clues and then, from the answers that might work, to find which ones fit together. "The first part is really a game of language understanding, and the second is about search and reasoning."

The BCS is a machine-learning based system that takes enormous amounts of data, both from past puzzles and more generally, to learn a neural network model. The team built a new question-answering system that learned how to combine general language understanding with the kinds of creative clues that show up in crosswords. Like a human, the system knows a good deal about language before it plays its first crossword, and then gets better as it trains on each puzzle. Compared to a human, the system has less world knowledge, but it's been trained on 6.5 million past crossword clues. The BCS' hypotheses on each clue were then given to Dr.Fill, which had expertise on crossword structure, such as how to weigh alternatives within the grid and how clever themes modify the rules for any given puzzle.

Ultimately, Dr.Fill bested humans throughout the competition, which ranks contestants on accuracy and speed. In the qualifying phase, Dr.Fill beat the highest human score. For the final playoff puzzle, multiple contestants — including Dr.Fill — completed it with no errors, but Dr.Fill finished in just 49 seconds, which was two minutes and 11 seconds faster than the human winner.

DIAGNOSTICS

Put to the test

Detecting cancer early can be difficult, and current screening methods can be invasive or expensive. But now, a group of medical researchers — including a team led by **Xin Guo,** professor of industrial engineering and operations research — has developed a method that can help detect cancer from a simple blood test, well before the first symptoms are present.

Blood contains degraded fragments of DNA called cell-free DNA. In individuals who have cancer, some of this cell-free DNA — called circulating tumor DNA (ctDNA) — comes from tumors. Typically, to detect ctDNA in blood, scientists use a genetic analysis method called deep methylation sequencing. But this method produces a lot of data, in part because ctDNA isn't the only DNA present. Weeding through large amounts of data for signs of ctDNA is already a challenge, but the data from deep methylation sequencing is further complicated by limitations of the technique that cause damage to the DNA and errors in the signal.

Because of this, scientists have struggled to find analysis methods sensitive enough to detect low concentrations of ctDNA. But Guo had the perfect solution. She and graduate student researcher **Chengju Wu** fine-tuned a common machine learning algorithm until it was able to sift through thousands of data points and locate the ones they needed. The researchers then applied it to a sequencing method they developed — called enhanced linear-splinter amplification sequencing or ELSA-seq — that boosts the data signal. The results showed that their method outperformed all others, detecting nearly twice as many patients with cancer than another common sequencing method, and was able to detect ctDNA at concentrations as low as 1 in 10,000. They accurately detected cancer in 52% of the patients with early-stage cancer and 81% of those with late-stage cancer, with a 96% specificity.

Courtesy Jenya Pryadkin/STAR

Space Technologies and Rocketry (STAR) team members

UNDERGRADUATE EDUCATION

New aerospace major launched

In response to a growing demand for researchers and developers in the fields of aviation, defense and space exploration, Berkeley Engineering has added a new aerospace engineering major to its portfolio of academic disciplines. Building on the existing undergraduate minor, the new program will include a bachelor of science degree in aerospace engineering.

Launching in fall 2022, the program will have an inaugural cohort of 40 students and could expand to 200 students within four years. Student interest in the subject is already high, with at least 300 actively involved in aerospace-related clubs on campus. Even without a formal program, Berkeley Engineering currently ranks at #14 in U.S. News & World Report's ratings of aerospace and aeronautical programs nationwide.

The new major is designed for students who aspire to become leaders in an emerging era of aerospace technologies that include sustainable aviation, autonomous flight and space exploration. The program will be built around a dual focus of space exploration and low-altitude air mobility. "Our students will benefit from a cutting-edge UC Berkeley education at a time when interest in aerospace engineering rivals that of the Apollo era," said **Panos Papadopoulos,** professor of mechanical engineering and faculty lead of the aerospace engineering baccalaureate program.

BIO-PRESERVATION

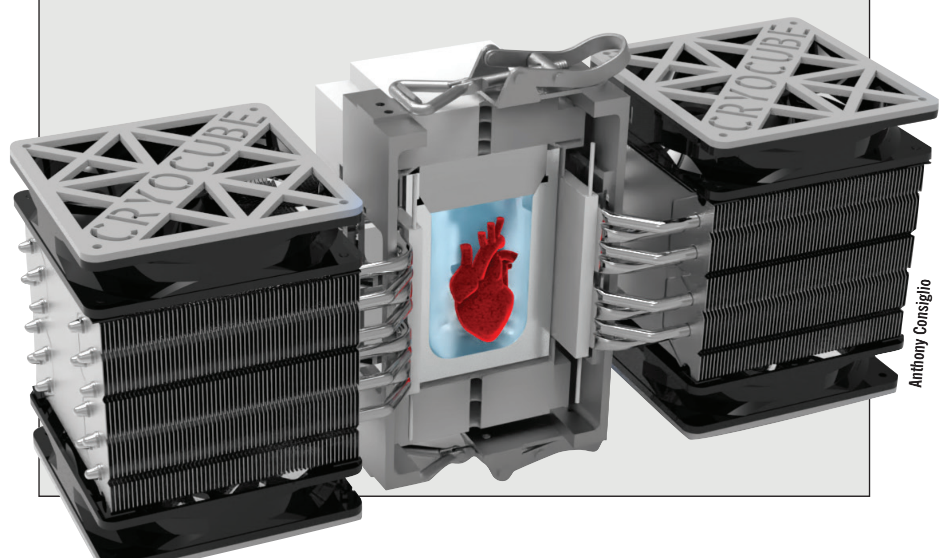
Super cool

Preserving donor tissue and organs is a daunting challenge facing the medical field. The viability of a donor heart, for instance, is measured in hours, greatly limiting the recipients who could benefit from a lifesaving transplant. But Berkeley researchers have now revived human heart tissue after it had been preserved in a subfreezing, supercooled state for 1 to 3 days. The method they used, called isochoric supercooling, was pioneered in the lab of **Boris Rubinsky,** professor of mechanical engineering and of bioengineering. These results also have near-term implications for the preservation and transport of organ-on-a-chip platforms, expanding access beyond the select few labs that can manufacture them for research and industry.

For the study, researchers used cardiac tissue grown from adult stem cells — a heart-on-a-chip system that was developed in the lab of **Kevin Healy,** professor of bioengineering and of materials science and engineering. The heart-on-a-chip was submerged in a rigid chamber filled with a common organ preservation solution that had been chilled to minus 3 degrees Celsius. Researchers then removed the heart cells from the solution after durations of 24, 48 or 72 hours, and returned them to a warm 37 degrees Celsius. Examination of the heart tissue confirmed that isochoric supercooling had not altered the structural integrity of the heart tissue, nor did it significantly affect the beat rate or beat waveform.

They found that spontaneous beating resumed for 65% to 80% of the cells that had been supercooled for up to three days. Moreover, they found no significant difference resulting from the duration of supercooled preservation.

The researchers — including first author **Matt Powell-Palm** (Ph.D.'20 ME), **Berenice Charrez** (Ph.D.'20 BioE), **Verena Charwat,** and **Brian Siemons** — emphasized that further work is needed to scale up these results to full organs.



Anthony Consiglio

HEALTH

Dream on


Anne Hansen

Hypothermia is one of the greatest factors in preventable infant mortality — particularly in low- and middle-income countries — contributing to the deaths of about one million newborns each year. Ideally, infants have skin-to-skin contact with their mother, but in some cases, that's just not feasible. To help address this issue, civil and environmental engineering professor **Ashok Gadgil** and Berkeley lab scientist **Vi Rapp** (Ph.D.'11 ME) have developed technology for a low-cost, non-electric, reusable warming device that has been shown to reduce infant mortality rates from hypothermia.

The Dream Warmer — a wraparound pad that can maintain a temperature of 37 degrees Celsius for approximately six hours — contains a phase-change material that can absorb and steadily release large amounts of heat. Based on an initial design by Berkeley Lab researchers **Jonathan Slack, Mike Elam, Roger Sathre** and **Howdy Goudey** (B.S.'97 Eng. Sci.), the newest model uses a wax-based warming indicator developed by Gadgil and Rapp that changes from a liquid to a solid just above body temperature. To use the pad, the warmer is simply immersed in very hot water for about 5 minutes and then cooled for about 15 more minutes before use.

The Berkeley researchers collaborated with a Harvard Medical School team, led by **Anne Hansen,** and a Rwandan medical research team for a randomized field trial in Rwandan hospitals. In the trial, the Dream Warmer reduced "all-cause mortality" — not just mortality from hypothermia — in infants by a factor of 3, from 2.8% to 0.9%; the trial's large sample size gives the researchers high confidence in the result. Last year, the technology was selected for an honorable mention in the Patents for Humanity Awards by the United States Patent and Trademark Office.

ROBOTICS

Awesome agility

Delivery services may be able to overcome snow, rain, heat and the gloom of night, but a new class of legged robots is not far behind. Artificial intelligence algorithms developed by a Berkeley team — working with researchers from Facebook and Carnegie Mellon University — are equipping legged robots with an enhanced ability to adapt to and navigate unfamiliar terrain in real time.

Their test robot successfully traversed sand, mud, hiking trails, tall grass and dirt piles without falling. It also outperformed alternative systems in adapting to a weighted backpack thrown onto its top or to slippery, oily slopes. When walking down steps and scrambling over piles of cement and pebbles, it achieved 70% and 80% success rates, respectively. Not only could the robot adjust to novel circumstances, but it could also do so in fractions of a second rather than in minutes or more.

The new AI system, called Rapid Motor Adaptation (RMA), combines a base policy — the algorithm by which the robot determines how to move — with an adaptation module. The base policy uses reinforcement learning to develop controls for sets of extrinsic variables in the environment. Because the robot's onboard sensors cannot directly measure all possible variables in the environment, the adaptation module directs the robot to teach itself about its surroundings using information based on its own body movements. For example, if a robot senses that its feet are extending farther, it may surmise that the surface is soft and will adapt its next movements accordingly.

"Our insight is that change is ubiquitous, so from day one, the RMA policy assumes that the environment will be new," said **Jitendra Malik,** professor of electrical engineering and computer sciences. "It's not an afterthought, but a forethought. That's our secret sauce."


Courtesy the researchers

Leaps and bounds

Hundreds of free-range fox squirrels have made the Berkeley campus their home, where they impress students and visitors alike with their bold athletic feats. To better understand how the squirrels' agility is tied to the split-second decisions they make while navigating tree canopies, a research team including **Robert Full,** professor of electrical engineering and computer sciences and of integrative biology, took to a eucalyptus grove on the west side of campus, where they set up an outdoor apparatus complete with branchlike perches. Using peanuts to entice the wild squirrels to leap from perch to perch, the researchers were able to observe how these mammals alter their movements to make successful landings, time and again.

The researchers found that the squirrels could consistently leap from unfamiliar types of simulated branches, regardless of the flexibility, without ever falling. After launching from a starting point, the squirrels adjusted their bodies midair, and then again as they landed, adapting their maneuvers to the stability of the individual branch.

The researchers also observed the squirrels utilizing parkour-type maneuvers in which they bounced off nearby walls in order to cross the largest gaps between perches, using those vertical surfaces to modify their speed. When they didn't land squarely on a perch, the squirrels used special moves — such as rolling over or under the branch, or grasping the branch with their sharp claws — to stabilize their bodies before pulling themselves up. When navigating the same bendy branch multiple times, the squirrels' landings became increasingly steadier with each successive leap.

The researchers plan to conduct further study into the relationship between the squirrels' decision-making processes and biomechanical abilities, with possible applications in robotics. The interdisciplinary team included integrative biology researcher **Nathanial Hunt,** psychology professor **Lucia Jacobs** and psychology graduate student **Judy Jinn.**

COMPOSITE PHOTO BY LAWRENCE WANG, DOMINIC PANG, SEBASTIAN LEE, JEREMY SNOWDEN, TINA KUANG, FRANK ALIAGA AUQUI

Back down to earth

Materials science professor Ting Xu is re-engineering plastics for the age of sustainability

STORY BY ANN BRODY GUY
ILLUSTRATION AND PHOTOS BY ADAM LAU

The humdrum task of garbage-sorting can elicit confusion or even suspicion. Compost? Recycle? Are those corn-based disposable forks truly compostable or are they just feel-good trash? Many recyclable plastics never even make it into the right bin, and while products with terms like "eco" and "plant-derived" in their brand names can let us feel like we are making Earth-friendly choices, scientists say their benefits may be oversold.

"To be compostable, everything has to be gone in about 60 days," says materials science and engineering professor Ting Xu. Plant-based plastics will biodegrade in composting conditions, meaning they'll eventually break down completely, she says, but most won't do it within the typical compost cycle, which forces municipal and industrial composting facilities to pull them from the mix. And when they end up in landfills, as they often do, they last as long as conventional plastics — forever.

Waste disposal is a problem the plastics industry only recently took on.

"Sustainability was never a design criterion," says Xu, who is also a professor of chemistry. The industry, a relatively young one, did a great job of providing affordable, durable consumer products, she says. It's only recently, with the emergence of a waste crisis — plastic bags, straws and tiny pellets ubiquitous in the environment — that the end of the plastic life cycle has moved to the design fore.

Xu's lab has been working on that life cycle-based design, most recently addressing an urgent need for affordable, sustainable plastics made from renewable resources that can easily and safely compost, materials called bioplastics. In an April 2021 issue of Nature, her lab demonstrated a new bioplastic that completely composts within weeks because of the unique way that enzymes they implanted in the material digest the plastic from within. The process is a breakthrough that could make all single-use consumer plastics truly compostable, solving an entrenched environmental and human health problem.

Disposal of single-use plastics has confounded scientists because to be effective consumer products, they need to be stable, but to be good garbage, they need to break down. It's a sticky materials science problem. When conventional plastics break down, they don't go away; they just form smaller, ever tinier plastic — visible pellets called microplastics and, eventually, tiny particulate matter called mini-microplastics. This detritus is everywhere — in the ocean, the soil, the digestive systems of marine life — so much so that some scientists have called our current era the "Plasticene."

Considering the ubiquity of microplastics, not much is known about their effects on human and environmental health — so little that both the National Institutes of Health and the National Science Foundation (NSF) have called for more research in the area. What we do know, Xu says, is that plastics, which contain all kinds of chemical additives, are everywhere in the environment and can be taken up by the body like any other particulate matter.

The plastic disposal problem has created an urgent demand for biodegradable plastics. That's why Xu's research includes funding from the Departments of Energy and Defense, and this August she was awarded a $2 million NSF grant to lead a group of sustainable plastics researchers from across the United States. A start-up company commercializing her lab's discoveries has received early financial backing.

LESS IS MORE

The new material self-digests because researchers implant it with polymer-eating enzymes, which suggests an image of the classic video game hero Pac-Man gobbling up glowing dots. That's not too far off from what's happening, Xu says, except that polymers, strings of molecules that form plastics, are more like long noodles that Pac-Man must slurp up from one end to the other to digest. Chomp them in the middle, she explains, "and you still have noodles — they're just going to be shorter." In other words, they'll be microplastics. That's why Xu mainly chooses to insert enzymes that have processive depolymerization characteristics — they slurp — and she can use a highly precise process to convert some enzymes from a chomping to a slurping action.

To implant enzymes in a material, researchers add water to the enzymes and the coating, both solids, then combine the two resulting liquids at high speed. Since water isn't needed for plastic production, it is extracted through vaporization. The material can then be synthesized into a film or shape.

Researchers left their enzyme-charged polylactic acid, a common so-called compostable plastic, in two test situations: warm water and soil. In both cases, the plastic quickly broke all the way down to lactic acid, an organic compound that can feed soil microbes.

In addition to the enzymes' slurping action, two other innovations make Xu's process both affordable and scalable for manufacturing.

One of the lab's biggest innovations is preserving the power of the enzymes by encasing them in a special protective coating called random hetero polymers, or RHP, an earlier breakthrough that was 10 years in the making. Xu, with two co-inventors, patented the work in 2018.

Professor Ting Xu with a sample of a biodegradable polymer, right, and a completely dissolved filament, left.

Aaron Hall (M.S.'18, Ph.D.'20 MSE), who co-authored both the bioplastic and enzyme-coating publications, likens the encasement to personal protective equipment. Just as firefighters need protective gear to enter a burning building, he explains, enzymes — proteins that live inside a cell — need protection from the unnatural environments of synthetic materials. "We want them to be able to go into a chemically diverse environment they wouldn't normally like to be in," he says, "and still have them retain their shape and function so they can do the job that we're hoping to get out of them."

The researchers also developed a mechanism for making enzymes disperse evenly and efficiently when added to the plastic.

The combined result of all these advances is that using only a tiny bit of enzyme — just 0.02% of the material — produces a highly efficient reaction, making their bioplastic inexpensive to produce. To achieve the same reaction without protecting the enzymatic activity, Xu says, the material would need to use a vastly higher percentage of enzymes — at least 10% — to achieve comparable results. She likens the economics to bread baking. "Dough only uses a little yeast," she says. "If 10% of the dough is yeast, the price is going to skyrocket."

But, she adds, a material that was 10% unprotected enzymes wouldn't even be functional because the enzymatic activity wouldn't be retained. "The mechanical properties are going to be terrible; it'll crumble before you use it," she says. That's why she calls enzyme stabilization "the foundational technology that makes us different."

Keeping the amount of additives low means it can easily plug into the existing manufacturing structure. "Manufacturing is set up to make plastics a certain way," Xu says. "You have to come into the existing infrastructure — you can't expect that everything's going to change for you because it would be too expensive."

GETTING TO CONSUMERS

Hall founded the startup Intropic Materials to focus on the formidable task of getting the lab's self-digesting bioplastic to market. As a 2021 fellow of Activate, a nonprofit that supports entrepreneurial researchers who are building technologies that can benefit society, he's receiving two years of support that includes instruction, mentorship and significant funding for salary and research.

As CEO, he's also allowing time to explore the enormous possibilities of RHP. From vegan burgers to makeup that uses artificial collagen, synthetic biology relies on enzymes, and RHP could allow these processes to scale up. With RHP, a whole breadth of enzymes could be utilized for all kinds of sensors, Hall says, such as tests for specific biomarkers or toxins in the body, or labels on food storage containers that indicate food spoilage. Stabilized enzymes could also preclude the need to refrigerate insulin, vaccines and protein-based therapeutics for diseases like cancer.

"We're able to use enzymes in a wider variety of conditions than current manufacturing can, and still get the same efficiency, the same clean reaction," Hall says. "I think it's almost our obligation to try to bring as much of that to the world as possible because we're able to create more effective, more efficient, cleaner and faster ways of producing materials and, hopefully, making new types of devices."

Hall expects the company to eventually roll out other products. But for now, he is focused on getting the Xu lab's composting-plastic breakthrough to an eager marketplace; one estimate projects the bioplastics market will grow to $27 billion by 2027. “Maybe some of it was prescience and some of it was luck, but the core technology we were developing turned out to be solving a problem that people care about,” he says.

ONE SIZE DOES NOT FIT ALL

As a science adviser to Intropic Materials, Xu shares Hall’s vision that all single-use consumer packaging can and should be compostable to protect the environment. However, that’s only one small subset of plastics, she says; not every plastic needs to be broken down.

In the U.S., she says, processes for recycling and upcycling properly sorted plastics are mature — a milk container might become a chair and then part of cement, for example. Other plastics, like those inside cars, airplanes and spacecraft, need to be as durable as possible and should not degrade at all.

Xu's point is a fundamental engineering principle: Decisions about materials depend on their intended use. How a plastic is made, including additives like enzymes, controls how long it will take to degrade and under what types of conditions — hot, cold, wet, dry. “Manufacturing decisions depend on the setting and the purpose for the material,” she says.

Manufacturing decisions also need to be governed by environmental responsibility, she adds. She made a careful choice to work with enzymes, which are just molecules that break down; they can’t replicate, like viruses. Other chemical agents may create harm, known and unknown, once they are released into the environment. Her Nature study doesn’t offer a specific solution, but instead issues a warning to “put a leash on” any additives so they don’t end up like microplastics — running wild in ecosystems.

The suite of benefits and concerns that plastics carry with them — the environment, human health, business and manufacturing — is why Xu’s lab takes a team approach. Researchers include partners in public health, environmental science, civil engineering and chemistry, studying issues like ingredient toxicity and upcycling waste into building materials. Business and nonprofits partners, including Hall’s startup, look at scaling up and following Environmental Protection Agency guidelines.

Xu thinks her team will be working on plastics for a long time — her lab is also looking at ways enzymes can improve the upcycling of conventional plastics. The disposal problem is not going away, she says, so she’s committed to designing them responsibly.

“Plastics aren’t evil — they just need to be engineered correctly for each specific use,” she says, which means striking a balance between biodegradable and non-biodegradable. “Any future materials and devices, any products — you just have to add sustainability into the design criteria.” The philosophy should apply to everything people make, she adds, from electric car batteries to solar panels. “If we do that, I think we have the technology to make sure we live in harmony with nature.”

Top to bottom: Graduate student Ivan Jayapurna prepares a sample film of polylactic acid plastic; an undegraded film of polylactic acid plastic; biodegraded fragments of polylactic acid plastic.

Right Off the Bats

What the only flying mammal can teach us about the brain

STORY BY WILLIAM SCHULZ
ILLUSTRATION AND PHOTOS BY ADAM LAU

Among the many devastating impacts of Alzheimer's disease and other types of dementia is the risk that patients will wander and become lost. Indeed, according to the Alzheimer's Association, six in 10 people with the disease will wander at least once over the course of their illness — and many do so repeatedly.

For researchers who study and treat people with neurodegenerative disorders, understanding the human neural circuitry that leads to such behavior is among the highest-priority goals. But to better study these and other neurological conditions, the work needs to begin with effective, accessible animal models.

That's where researchers at the NeuroBat lab — led by Michael Yartsev, assistant professor of bioengineering and of neurobiology — come in. Their studies of the neural circuitry of navigation in Egyptian fruit bats are yielding insights that might one day help explain and prevent dangerous situations for humans.

Egyptian fruit bats are "one of the most superior navigators that exist on our planet," Yartsev says. He describes how these diminutive, highly social creatures in the wild will travel tens of kilometers, even through dark and stormy nights, seldom if ever getting lost in their search for food. The bats' complex travel through 3D space, he says, could shed light on the complexity of human behavior in navigating from place to place.

But understanding the neuronal processes at the root of behavior in appropriate animal models goes well beyond studies of navigation. "We have a huge number of questions that we want to understand about the brain," Yartsev says. And one of his goals as a neuroscientist is to advocate for an expansion of the diversity of animal models researchers have available for their work.

In the current landscape of neuroscience research, Yartsev says, 75% or more of the work focuses on a handful of "standard" organisms, such as rats and mice. The reasons often come down to accessibility of tools and ease of maintenance in laboratory environments. But this overwhelming convergence is not without cost, as it limits the type of questions asked, the discoveries made and the degree to which scientific findings can be generalized beyond those species.

With bats, Yartsev says, their ability to fly, complex social behaviors, patterns of vocalization, long lives and more set them apart as animal models for studying a specific set of basic research problems in neuroscience — such as how the brain processes skills like navigation, sociality and language.

The ultimate flight room

Yartsev's first encounter with bats as a subject for neuroscience took place some 15 years ago during his Ph.D. studies at the Weizmann Institute of Science in Israel. Yartsev says it was a risky move, then, to pursue a Ph.D. in neuroscience by studying a non-traditional animal. But this work helped establish bats as an important model system for a variety of new research topics.

As befits Yartsev's biomedical engineering background, the work has included the opportunity to develop new research tools for neuroscience — for example, the first wireless electrophysiology system for recording and studying a bat's brain activity during flight.

"This was the first single-cell neural recording from a freely flying animal," Yartsev says, referring to experimental work behind a 2013 Science paper on navigation-related bat neural activity. Bats obviously cannot fly around freely with a cable attached, "so we had to develop the tools needed to do this work — we still do," he adds, citing, as another example, a piezoelectric device for recording vocalizations that is lightweight enough for the bats to wear as a necklace while communicating with one another.

In 2015, Yartsev brought his pioneering research with Egyptian fruit bats to UC Berkeley, where he has established his own group, the NeuroBat Lab. Studying the neural circuitry of these diminutive creatures, the group continues to build and publish a rich trove of basic research data and neuroscience insight with more to come.

In a continuation of his research work on navigation using bats, the NeuroBat Lab has recently focused on neural mechanisms that could underlie goal-directed navigation, which Alzheimer patients often struggle with. To carry out the study, the Yartsev team used a specialized facility they created called the fully automated flight room. It is a human-free space used to obtain detailed, quantitative understanding of bat navigation and flight behavior by recording activity in relevant neural circuits.

Bioengineering graduate student Madeleine Snyder, one of Yartsev's team members who also studies the neural mechanisms of navigation in bats, says bats make a good research subject because "they're both highly social and highly navigationally adept, and that's very similar to humans in many ways. They will go kilometers and kilometers to forage in a specific tree and then come home together."

She describes the flight room as "about the size of a large living room" that is outfitted with cameras and other recording devices. Researchers can situate perches for the bats at various places in the room. The perches might be outfitted with beam breakers that, when triggered by a bat alighting on the perch, will trigger some action like the introduction of food. Lights can be programmed to turn on and off, sounds can be introduced — and researchers can simply step back, watch and record how the bats interact with their environment.

In comparison to studies with other animal models, she says, "with bats in the human-free flight room, we're not constraining the animal but just letting them do what they want to do and seeing what happens."

As with many animal-model studies, Yartsev says, subtracting humans from the study environment can heighten fidelity of results. That's because the presence of human investigators may introduce experimental biases, reduce reproducibility of the experiment, prevent the animals from engaging freely in self-paced navigational behavior and limit the complexity of tasks that could be utilized to study neural circuits.

For the navigation study, the team looked at the activity of place cells, specialized cells in the brain that act as a sort of internal global positioning system. Studies of place cells in rats had indicated that the cells primarily encode the animals' location at the time the cell is firing.

"What we are showing in this paper is that if you align all the place cells that you are recording as they are firing in the hippocampus, there is a continuum of space and time," Yartsev says, referring to their paper published in Science earlier this year. "The cells are representing where the animal has been, where it will be a half a second into the future, a second into the future and so on."

One of the hallmarks of Alzheimer's disease, Yartsev notes, "is that people get lost all the time, even in their own neighborhoods." Understanding how the brain represents the environment, how a person knows the route to take to get from one place to another remains unknown, he says. The NeuroBat Lab study suggests that the reason a person might get lost is that their brain somehow loses that continuum of space and time — the ability to hold and follow a planned trajectory.

He says the data from their fast-moving bat animal model reveals dynamics of neuronal activity that would be difficult to observe so cleanly by only studying, for example, a slower-moving rodent in a 2D maze.

"We can sometimes make very significant progress with just one experiment with bats, no matter that it can at times be very difficult," Yartsev says. That's because the animals can be a highly relevant model system for a specific scientific question that could also be important for humans. For example, bats are specialized for communication at the group level. "They have developed behavioral capacities for group living and the underlying neural circuits that serve those capacities."

On the same wavelength

In another recent study from the lab, the team became the first to observe synchronized brain activity in a nonhuman species engaging in natural social interactions like grooming, fighting or sniffing each other.

For the study, published in the journal Cell, Yartsev and postdoctoral fellow Wujie Zhang used simultaneous wireless neural recording devices to measure brain activity while multiple bats freely interacted. The specialized recording devices allowed them to capture what modalities like functional MRI and EEG cannot — the full scope of neural activity from brain oscillations to the firing of individual neurons, all at the same time.

Flight paths indicated by light trails encircle professor Michael Yartsev and lab manager Yuka Minton, from right, in their fully automated bat flight room. A 16-camera array mounted on the ceiling monitors the bats' position in 3D space as they explore a room covered in black foam to minimize acoustic reverberations.

The researchers found surprisingly strong correlations between the bats' brains. That is, as they engaged with one another in social behaviors in the same environment, their brain wave and neuronal electrical activity began to look the same in each bat, even when the bats performed very different actions. The correlations were present whenever the bats shared a social environment and increased before and during their social interactions, Yartsev says.

Their detailed analysis of social interactions allowed them to rule out other possible explanations for the synced-up brain activity, such as that bats were simply reacting to the same environment or engaging in the same activity. For example, bats placed in identical but separate chambers and that were both busy grooming did not show the same synchronization.

"This study is really laying the groundwork for studying inter-brain correlation in animals," Zhang says. "We didn't know if this is something that's only observed in humans. If we have the same phenomenon in animals, then there's a lot more experimental techniques we can use to really understand the mechanisms of this phenomenon, including its function."

"This is a very core phenomenon that, for two decades, people have been excited about in humans," Yartsev says. "Now that we've observed it in an animal model, it opens the door to very detailed research of it." Importantly, this phenomenon also relates to how humans socialize with one another in social groups and is impacted during diseases such as autism and other neurological disorders. Understanding the neural mechanisms behind it and how it mediates natural group social behavior could lead to future therapeutics in humans.

"And this is exactly where we are going with this," Yartsev says. In another paper, published in Science this fall, the lab studied social communication among groups of bats for the first time. Led by graduate student Maimon Rose and postdoctoral fellow Boaz Styr, the researchers discovered a rich repertoire of neural signals that represent key components in group communication, findings that could also have significant implications for understanding aspects of human mental health.

"The crown jewel"

Another future area of research interest, Yartsev says, is language — "the crown jewel of humanity." Humans are the only mammals capable of learning and using language, but they are joined by bats, elephants and cetaceans (whales, dolphins) — out of some 5,400 species of mammals — in the ability to learn new sounds. This process, also known as vocal learning, is the basis for language learning.

"First of all, just understanding that fact about learning language is really important," he says. "How does our brain allow us to learn a language? It becomes even more important when we think that about 10 percent of the people in the world suffer from language disorders. And this affects them dramatically. These disorders relate to autism, dyslexia and a whole variety of problems related to brain functioning."

Unfortunately, in the world of neuroscience today, Yartsev says, "we still do not understand the detailed neurobiological mechanisms that allow us to learn a language."

And beyond biology and human health, the research into complex neurobiological processes in bats might also power new technology development, Yartsev says. For example, insights from the bats might aid development of new machine learning algorithms and sensing technologies critical to the development of fully self-driving cars. Such autonomous vehicles must be able to safely maneuver roadways by sensing and reacting to other moving vehicles, random obstacles and constantly changing environmental conditions.

"For some questions, the bats provide us very unique advantages that you simply can't find in other animal model system — and these are the questions we focus on," Yartsev says. BE

Pieter Abbeel, professor of electrical engineering and computer sciences, is the recipient of the IEEE Kiyo Tomiyasu Award for his contributions to deep learning for robotics.

Civil engineering undergraduates **Arupa Adhikary, Cole Benner, Chee Weng Michael Leong, Alejandro Sannia** and **Karilin Yiu** took first place at the 2020–21 Airport Cooperative Research Program's University Design Competition for Addressing Airport Needs. Their proposal to help solve airfield congestion utilizes methods from high occupancy vehicles.

Zakaria Al Balushi, assistant professor of materials science and engineering, was among Nanotechnology's young researcher awardees, recognized for his contributions on electronic and photonic materials synthesis.

Bioengineering graduate student **Kwasi Amofa** was named to the 2021 class of Gilliam Fellows by the Howard Hughes Medical Institute.

Two early career engineering faculty have been named 2021 Rose Hill Innovators: **Gopala Anumanchipalli,** assistant professor of electrical engineering and computer sciences, and **Liana Lareau,** assistant professor of bioengineering.

Paige Balcom (M.S.'18 ME) has won the 2021 "Use It!" Lemelson-MIT Student Prize for her invention of a locally made, manually powered recycling system to transform PET plastic waste into desirable household products such as wall tiles. She plans to use the prize money to finance grants in Uganda to support local innovators.

Industrial engineering and operations research undergrads **Duncan Barcelona, Alexandra Novales, Maya Sprouse** and **Samantha Tito** earned first place at the IISE Industry Advisory Board's YouTube Video Contest. Their winning video will be used to promote the industrial and systems engineering profession to high school students, teachers and college counselors.

Leyla Kabuli (B.S.'21 EECS and Music) was this year's winner of the University Medal, Berkeley's highest honor for a graduating senior. While an undergrad, she earned a Jacobs Institute Innovation Catalysts Ignite Grant, Outstanding Graduate Student Instructor Award, Samuel Silver Memorial Scholarship Award, Edward Frank Kraft Award for Freshmen and a California Seal of Biliteracy in French and Turkish — and a perfect 4.0 GPA. A classically trained musician, she has held solo and ensemble performances at Hertz Hall on campus, as well as at concert venues across the country. She also served as a teaching assistant for six semesters and has organized outreach activities for local middle and high school students. This fall, she returned to Berkeley for graduate studies in electrical engineering and computer sciences, where she will pursue research in diagnostic imaging.

PHOTO BY BRITTANY HOSEA-SMALL

Bolt Threads, co-founded by **David Breslauer** (Ph.D.'10 BioE), has been named one of the 10 most innovative fashion and style companies of 2021 by Fast Company. They were recognized for their Mylo product, a leather substitute made from fungal mycelium.

The **Cal Seismic Design Team** took second place in this year's Earthquake Engineering Research Institute's Seismic Design Competition. Meanwhile, the **Cal Steel Bridge Team** won second place in this year's American Institute of Steel Construction's Student Steel Bridge Supplemental Competition; the team was also recognized for its great enthusiasm and support among teammates by winning the Robert E. Shaw Jr. Spirit of the Competition Award.

Jennifer Chayes, associate provost of the Division of Computing, Data Science and Society and professor in the Department of Electrical Engineering and Computer Sciences, has been honored with the Distinguished Service Award from the Association for Computing Machinery.

Electrical engineering and computer sciences assistant professors **Alvin Cheung** and **Somayeh Sojoudi** and mechanical engineering assistant professor **Grace Gu** (B.S.'16, M.S.'17 IEOR) have each received Office of Naval Research 2021 Young Investigator Program Awards, which recognize new career faculty for prior academic achievement and their potential to make significant scientific contributions.

David Culler, professor emeritus of electrical engineering and computer sciences, is a 2021 recipient of the Berkeley Citation, one of UC Berkeley's highest awards that honors individuals whose achievements exceed the standard of excellence.

Abigail De Kosnik, director of the Berkeley Center for New Media, has been selected as a recipient of UC Berkeley's American Cultures Excellence in Teaching Award.

E-commerce startup Drapr — founded by **Will Drevno** (B.S.'13 IEOR), along with Haas alums **Richard Berwick** and **David Pastewka** — has just been acquired by Gap Inc.

Ioannis Emiris (M.S.'91, Ph.D.'94 CS) professor of informatics at the University of Athens in Greece, has been elected president and general director of the ATHENA Research Center, a nationwide institution focusing on information and communication technologies.

Andrea Goldsmith (B.S.'86, M.S.'91, Ph.D.'94 EECS), dean of the School of Engineering and Applied Science and professor of electrical engineering at Princeton University, has been appointed to the President's Council of Advisors on Science and Technology.

Anjali Gopal (B.S.'15, Ph.D.'21 BioE) has been named to the Council on Strategic Risks' 2021–22 class of the Fellowship for Ending Bioweapons Programs. A member of bioengineering professor Amy Herr's lab, she aims to leverage her scientific training for pandemic preparedness and bioweapons prevention initiatives.

Paul Hagouel (Ph.D.'76 EECS) will be the 2022 chair of the Committee on the Genocide of the Roma. He is also a member of the Greek delegation to the International Holocaust Remembrance Alliance and the Academic Working Group.

Computer science professor **Joseph Hellerstein** (M.S.'92 CS) has been named a Datanami 2021 Person to Watch. He is the chief strategy officer and co-founder of Trifacta, a company that markets data preparation and interaction technology based on Data Wrangler, a data transformation and discovery tool that he co-developed at the RISELab.

Bioengineering professor **Amy Herr** has been appointed to the Schmidt Science Fellows Program Academic Council, where she will mentor groups of fellows and advise the entire fellowship community in her specific area of expertise.

Civil and environmental engineering professor emeritus **Alex Horne** received the Odum Award from the American Ecological Engineering Society.

Jill Hruby (M.S.'82 ME) was confirmed as the next Under Secretary for Nuclear Security and Administrator of the National Nuclear Security Administration, which manages the Department of Energy's nuclear weapons and nuclear nonproliferation work.

Timothy Hsieh (B.S.'04 EECS) has joined the faculty of the Oklahoma City University School of Law as an assistant professor. He was also elected editor-in-chief of the Journal of the Patent and Trademark Office Society — the first Asian American editor-in-chief in its 100-year history.

Tammy Hsu (Ph.D.'19 BioE), founder and chief scientific officer of the synthetic biology startup Huue, has been named to the MIT Technology Review's "35 Under 35" list for developing an environmentally friendly process to create indigo dye using microbes.

Kohei Itoh (M.S.'92, Ph.D.'94 MSE), professor of science and technology at Keio University in Tokyo, Japan, was named the university's next president. He is research supervisor for the quantum state control and functionalization research area of the Japan Science and Technology Agency's Precursory Research for Embryonic Science and Technology program and the quantum information technology program director for MEXT Q-LEAP.

Cesunica Ivey, assistant professor of civil and environmental engineering, has been named to Chemical and Engineering News' "Talented 12" list, which recognizes young stars in the chemical sciences who are working to solve some of the world's most challenging problems.

The Royal Society has selected **Michael Jordan,** professor of electrical engineering and computer sciences and of statistics, as a foreign fellow. Membership in the Royal Society is considered one of the world's most prestigious honors in science.

Daniel Kammen — professor of nuclear engineering, of public policy and of energy — has been selected to serve as senior adviser

High school named in honor of alum

In May, the trustees of the Tamalpais Union High School District voted unanimously to change the name of Sir Francis Drake High School in San Anselmo, California, to Archie Williams High School. "Archie Williams is inarguably an individual who made tremendous contributions to our school, our community and to our nation," said Leslie Harlander, board president.

Born and raised in Oakland, **Archie Williams** (B.S.'39 ME) came to Berkeley in 1935 to study mechanical engineering and run track. At the NCAA track and field championships in 1936, he set a new world record for the 400-meter race with a time of 46.1 seconds. He went on to compete in the 1936 Summer Olympics in Berlin, winning a gold medal in the 400-meter race. After a welcome back to campus that included a noon rally on the steps of Wheeler Hall, Williams continued with his engineering studies and became the first Black student to run for the university's student council.

After graduation, Williams earned his pilot's license and was hired as a civilian flying instructor at the famed Tuskegee Army Flying School. He eventually enlisted in the Air Force — working as an instructor, weather officer and pilot — flying missions during World War II and the Korean War. After his retirement at the rank of lieutenant colonel, Williams taught high school math and computer science for over 20 years at Sir Francis Drake High School, where he was a revered educator and mentor.

PHOTO COURTESY OF THE LIBRARY OF CONGRESS, LCCN-46045246

The art of engineering

Is engineering an art or a science? Most of us would place it firmly in the latter camp: with the careful application of specific rules and factors, it's a broad discipline based on scientific and mathematic principles.

"BABA YAGA'S HOUSE" by Jessi Sprocket. Installed first at Burning Man and then at Fly Ranch, Nevada.

But at least one Berkeley Engineering alumnus sees it differently. **Alireza Lahijanian** (B.S.'09, M.S.'10 ME) is the co-founder of Rbhu, a Bay Area engineering company that specializes in large-scale artwork and entertainment structures. There, his work blurs the lines between art and science. "Art sculptures are not cookie-cutter buildings," Lahijanian said. "They're designed outside the box and are aesthetically complex. As engineers, we must find ways to make the aesthetic work while applying principles of physics."

Lahijanian and **Selinda Martinez,** a former classmate at Diablo Valley College, founded Rbhu in 2014. The two dreamed about "engineering things with purpose, things that provide joy for people and things that change the world," he said.

Since then, the firm has completed more than 150 sculptures; four in-house engineers are currently working on about 40 projects in various stages of development. The company provides structural and dynamic analysis, 3D modeling and rendering, and structural drawings — mechanical skills applied to the idea that "monumental sculpture can lift the human spirit, ignite our imagination, help us process and express feelings, and bring people together."

The team has also served as the engineering firm and design consultant for the annual Burning Man event in Black Rock Desert, Nevada, as well as for many public art installations across the U.S. Some of those projects have kept Lahijanian awake at night. He remembers one in particular: an enormous teeter-totter, 80 yards long and four stories high, with two live human beings positioned on each end. But every single project comes with its own unique challenge and perfect solution, he said.

Most recently, Rbhu began providing pro bono services for artists in support of projects that raise awareness for an issue of the artists' choosing. "It's an important way for us to give back," he said. "We believe that public art is a way to inspire, to ignite creativity and have a positive impact on people's health and well-being."

STORY BY KIRSTEN MICKELWAIT • PHOTO COURTESY RBHU for energy, climate and innovation for the U.S. Agency for International Development.

Jay Keasling, professor of bioengineering and of chemical and biomolecular engineering, has been named a Distinguished Scientist Fellow by the U.S. Department of Energy's Office of Science.

Michelle Khine (B.S.'99, M.S.'01 ME, Ph.D.'05 BioE) was appointed associate dean for undergraduate education at UC Irvine, where she is also the director of faculty innovation.

Albert Ko (B.S.'93 CEE) was appointed city engineer and deputy director for the infrastructure design and construction division of San Francisco's public works department.

Sharjeel Laeeq (B.S.'21 ME) was awarded the 2021 Jengyee Prize, Leadership for a Better World scholarship. Using his own funds, he helped a town in Pakistan install a reverse osmosis system to provide more clean drinking water to residents.

A former capstone project by **Jay Lin** (MEng'19 ME), published last year as a paper, is now being developed as a product to hold spent fuel rods for 3D tomography investigations at the Los Alamos Neutron Science Center accelerator.

James Malley (B.S.'80, MEng'83 CEE) was recently elected to the National Academy of Engineering for his contributions to advancements in seismic design over a 38-year career at Degenkolb Engineers, a west coast structural and earthquake engineering firm where he is a senior principal and the group director for three Northern California offices.

Materials science and engineering professors **Lane Martin** and **Kristin Persson** have been elected fellows of the American Physical Society in recognition of their outstanding contributions to the advancement of physics.

Professor emeritus of electrical engineering and computer sciences **Nelson Morgan** (B.S.'77, M.S.'79, Ph.D.'80 EECS) won the 2022 James L. Flanagan Speech and Audio Processing Award, a prestigious IEEE Technical Field Award, for his "contributions to neural networks for statistical speech recognition."

Grace O'Connell has been honored with a Chancellor's Award for Research in the Public Interest, which recognizes faculty research that addresses critical needs in local and global communities.

Mechanical engineering professor **Oliver O'Reilly** was appointed to serve as interim vice provost for undergraduate education.

The INFORMS Section on Energy, Natural Resources and the Environment has awarded **Shmuel Oren,** professor of industrial engineering and operations research, the 2021 Harold Hotelling Medal. He also received the 2021 IEEE PES Outstanding Power Engineering Educator Award for his contributions to mentorship and education on the design and operation of electricity markets.

Andrea Palomo Saavedra, a bioengineering and materials science undergrad, was awarded the Society of Women Engineers' Outstanding Collegiate Member Award, given to 10 students who are making significant contributions to the STEM community and the advancement of women in engineering.

Anthony Papavasiliou (M.S.'07, Ph.D.'11 IEOR), associate professor at Belgium's Université Catholique de Louvain, was one of six people awarded the prestigious Bodossaki Distinguished Young Scientist Award for 2021. He was recognized for his contribution to the rational use of energy resources and the large-scale penetration of renewable energy sources in electricity systems.

Per Peterson (M.S.'86, Ph.D.'88 ME), professor of nuclear engineering, has been appointed a member of the Nuclear and Radiation Studies Board at the National Academies of Sciences, Engineering and Medicine.

Electrical engineering and computer sciences assistant professor **Jonathan Ragan-Kelley** is the recipient of the Association for Computing Machinery Special Interest Group on Computer Graphics and Interactive Techniques' 2021 Significant New Researcher Award.

Robert Ritchie, professor of materials science and engineering and of mechanical engineering, has published his first book, Introduction to Fracture Mechanics.

Kathryn Rosenbluth (Ph.D.'09 BioE) is the founder of Cala Health, which was named to Forbes' list of "52 Women-Led Startups Driving the Future of HealthTech and FemTech." Cala Health creates noninvasive wearable neuromodulation therapies for patients living with chronic diseases.

Computer science professor **Stuart Russell** has been named a 2021 Officer of the Most Excellent Order of the British Empire for services to artificial intelligence research. He was also selected for the 2021 BBC Reith Lectures, one of the most prestigious public lectures in Britain, where he will speak on the impact of AI on humanity.

S. Shankar Sastry (M.S.'79, Ph.D.'81 EECS) — professor of electrical engineering and computer sciences, of mechanical engineering and of bioengineering — is the recipient of the American Society of Mechanical Engineers' 2021 Rufus Oldenburger Medal, which honors a lifetime of achievement in the field of automatic control.

Raluca Scarlat (Ph.D.'12 NE), assistant professor of nuclear engineering, is the winner of the American Nuclear Society's 2021 Mary Jane Oestmann Professional Women's Achievement Award.

Electrical engineering and computer sciences professor **Sanjit Seshia** was a recipient of the CAV Award at the 2021 International Conference on Computer-Aided Verification. This year's award specifically recognizes "pioneering contributions to the foundations of the theory and practice of satisfiability modulo theories."

Aaron Streets, assistant professor of bioengineering, is the winner of the Shu Chien Early Career Lecturer Competition at the UC Systemwide Bioengineering Symposium.

Mechanical engineering assistant professor **Hannah Stuart** received the Women in STEM2D Scholar Award from Johnson & Johnson.

Armando Tiscareño (B.S.'93, M.S.'94 CEE) has been named executive vice president, east region, for Stacy and Witbeck Inc., a leading heavy civil contractor specializing in the rail transit market.

Ernst Valfer (B.S.'50, M.S.'52, Ph.D.'65 IEOR) is finally enjoying full retirement at the age of 96. He retired from his position as director of a large management sciences staff for the U.S. Department of Agriculture in 1990, as the director of a community mental health center in 2010 and as a consultant and clinical supervisor in 2019.

Joshua Yang (MTM'16 BioE), co-founder of Nephrosant, was featured in Poets & Quants as one of the "2021 Best and Brightest MBAs." He graduated from Stanford Business School and also founded another startup, Glyphic Biotechnologies.

Candace Yee (B.S.'21 CEE) was selected by the American Society of Civil Engineers' Committee on Student Members as a national finalist for the 2021 Daniel W. Mead Prize for Students. This year, students submitted papers about the responsibilities of civil engineers in the face of a global pandemic

Electrical engineering and computer sciences professor **Kathy Yelick** has been named UC Berkeley's next vice chancellor for research as of January, when she will take the helm from the current vice chancellor, computer sciences professor **Randy Katz.**

Yang You (Ph.D.'20 CS) received one of two honorable mentions for the 2020 ACM Special Interest Group in High Performance Computing Dissertation Award. A professor of computer science at the National University of Singapore, he also made the 2021 Forbes' "30 Under 30, Asia" list for healthcare and science.

Professor **Bin Yu,** professor of electrical engineering and computer sciences and of statistics, has been awarded an honorary doctorate from the University of Lausanne, Switzerland. She was cited as "one of the most influential researchers of her time" for the breadth and importance of her contributions.

SEND YOUR CLASS NOTES to **berkeleyengineer@berkeley.edu,** submit at **engineering.berkeley.edu/update** or mail to:
Berkeley Engineer magazine, Berkeley Engineering, 201 McLaughlin Hall #1704, Berkeley, CA 94720-1704

Aristotle Arapostathis (M.S.'78, Ph.D.'82 EECS) died in May at the age of 67. He was on the faculty of the electrical and computer engineering department at the University of Texas at Austin, where his research focused on how to optimally steer time in uncertain processes.

Jon Asselanis (M.S.'93 CE) died in April at the age of 62. His career as a materials scientist included positions at Consolidated Engineering Laboratories, the International Cement Microscopy Association, Berkeley's Department of Civil and Environmental Engineering and Schwein Christensen Labs Inc.

Patrick Creegan (M.S.'87, D.Eng.'91 CE) died in July at the age of 96. He worked around the world as a civil, structural, geotechnical and dam engineer, including projects in Nicaragua, Dubai and India. A lifelong learner, he received his doctorate in engineering from Berkeley at the age of 67.

William H. Crim III (B.S.'64 EECS) died in December 2020 at the age of 83. He was the owner of SAS Engineering.

Leonard Daley (B.S.'54 ME) died in July at the age of 96. He served in the U.S. Merchant Marines during World War II and later in the U.S. Navy Reserves, achieving the rank of commander. He was also the chief administrative officer for the Philadelphia Naval Shipyard during the Vietnam War and had a 40-year career with General Electric.

Greg DesBrisay (B.S.'83 EECS) died in July 2020 at the age of 60. He was a radio frequency engineer who pioneered wireless technology at several start-ups — including CellNet, Cellular Data Inc. and Clarity Wireless. He also worked as a consultant with Pacific Gas and Electric for the SmartMeter program.

Sigmund Freeman (B.S.'55, M.S.'57 CE) died in April at the age of 88. He was an internationally recognized expert in seismic engineering, known for creating influential technical models and analytical tools. He performed on-site earthquake damage assessments following four major West Coast earthquakes, developed methods to predict earthquake damage and drafted codes for earthquake-resistant construction.

Charles Gillespie (M.S.'61 CE) died in August at the age of 86. He was a public health engineer before joining Gillespie and Powers, where he worked in metal recovery for 57 years.

George Greenwood (B.S.'54 CE) died in July at the age of 93. He attended Berkeley after serving with the U.S. Navy during World War II. After graduating, he worked as an engineer for the San Francisco Bay Bridge and on buildings for Wildman and Morris. He later joined the structural engineering firm H.J. Degenkolb and Associates, where he ultimately became a partner.

Kurt Hess (B.S.'66 CE) died in June 2020 at the age of 76. He was a member of the Office of Coast Survey for the National Oceanic and Atmospheric Administration, where he pioneered many early coastal ocean modeling initiatives. He also co-founded VDatum and was co-developer of the Chesapeake Bay Operational Forecast System.

Robert Keller (Ph.D.'70) died in September 2020 at the age of 76. He was a professor at Harvey Mudd College, where he served as the first chair of the newly formed computer science department. He also created the free open-source software Impro-Visor, which analyzes a user's musical playing in order to advise them as they craft a solo.

William King (B.S.'57 ME) died in April at the age of 85. An expert in the field of fluid mechanics, he built a career of more than 40 years in aerospace engineering at firms such as Rockwell International, Aerospace Corp. and the Rand Corp. He also taught mathematics at Santa Monica Community College and Los Angeles City College.

John Lucas (B.S.'49 Agricultural Eng.) died in June at the age of 98. He joined the Caltech Jet Propulsion Laboratory in 1954, where he participated in the early missions to the moon, Venus and Mars. From 1977 until his retirement in 1985, he was project manager for the development of technology for solar thermal parabolic dish electricity generation. He was also involved with the John W. Lucas Adaptive Wind Tunnel at Caltech.

Cornell Maier (B.S.'49 EECS) died in August at the age of 96. He served as chairman and chief executive officer of Kaiser Aluminum and Chemical Corp. and of its successor company, KaiserTech. During his tenure as CEO, he launched several community service programs, and he was an active East Bay philanthropist in retirement.

John Morton died in January at the age of 75. He built a 23-year career as a machinist working in the mechanical engineering department at Berkeley, designing and building apparati in support of engineering research. He later learned to construct metal resophonic stringed instruments that, after his retirement, became a part-time business.

David Redo (B.S.'59 EECS) died in November 2020 at the age of 83. After receiving his MBA from Santa Clara University, he pursued a career in finance, including roles as president of Sierra Asset Management and CEO and founder of Fremont Investment Advisors.

John Robertson (B.S.'57 EECS) died in June at the age of 89. His career began with jobs at RCA and IBM and led to management positions at Zeltex Inc. and Preco Electronics. His 21 years of leading Preco included the acquisition of Santa Clara Plastics (SCP Global Technologies) and the development of a manufacturing facility.

Martin Wachs, professor emeritus of civil and environmental engineering and of city and regional planning, died in April at the age of 79. An outstanding teacher and mentor, he was a leading researcher on transportation finance and policy, as well as environmental justice. He was also the founder of UCLA's Institute of Transportation Studies (ITS) and the former director of ITS Berkeley.

George Wilson (B.S.'54, M.S.'57, Ph.D.'64 ME) died in July at the age of 87. He began his career at the Boeing Co., where he worked on noise control and vibration isolation related to the B-52 aircraft. He then returned to Berkeley for his Ph.D., teaching mechanical engineering and developing the fundamentals of acoustics course. In 1966, he founded Wilson Ihrig and Associates, an acoustical consulting firm, where he served as president until his retirement.

Howard Winegarden (B.S.'50 IEOR) died in June at the age of 94. He came to Berkeley after serving in the U.S. Navy during World War II. Following graduation, he worked for Owens Illinois Glass Co. for 32 years, retiring as a vice president.

Keegan Houser

With flexibility comes possibility

Working remotely from Indiana during the pandemic, undergrad Dylan Steury struggled to meet his bioengineering class requirements while using public-access computers and WiFi. But thanks to the Berkeley Engineering Fund, our Engineering Student Services (ESS) team was able to provide a personal laptop and WiFi hotspot for Dylan — as well as for 186 other students who needed the technology to work from home.

This initiative was first implemented in ESS's summer preparatory programs, PREP and T-PREP, which last year served 194 incoming first-year and transfer students from across California as well as from out of state.

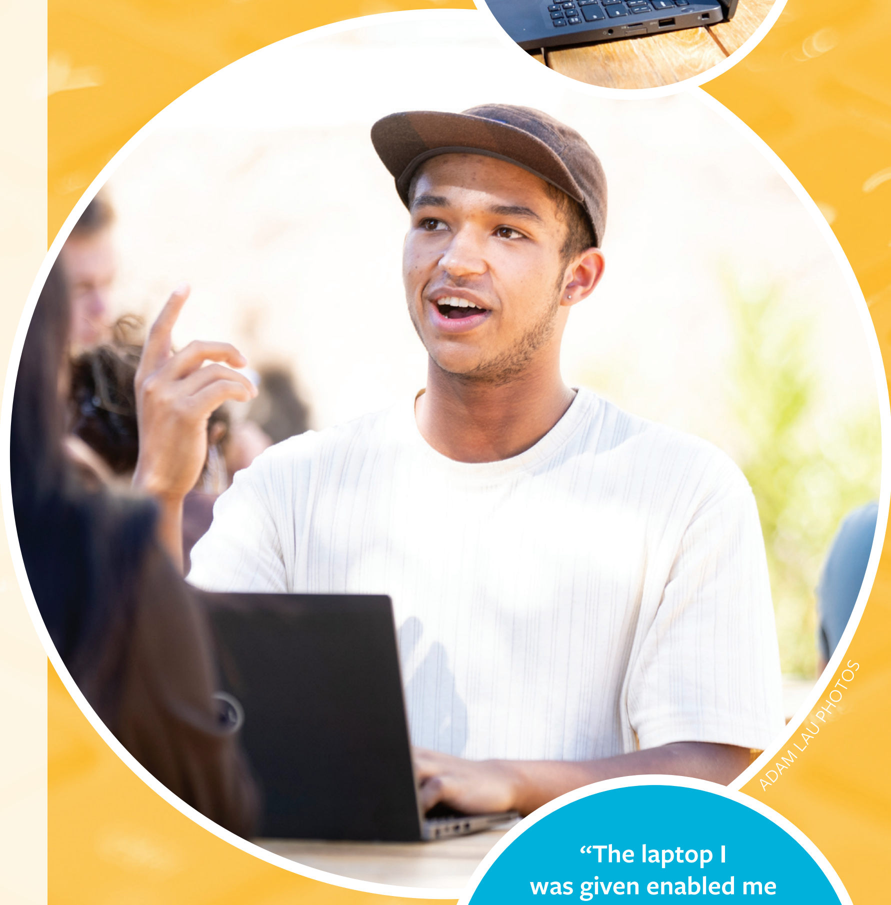
Resources like the Berkeley Engineering Fund give us the flexibility to meet such new challenges quickly. Contributions to this annual fund can be put to use immediately in support of the college's greatest needs. With your support, anything is possible.

To learn more about giving to the Berkeley Engineering Fund, email us at:

bef@berkeley.edu

"We're committed to broadening our reach so that our students have whatever support they need to fully thrive at Berkeley."

- Tiffany Reardon, associate director, engineering excellence programs



ADAM LAU PHOTOS

"The laptop I was given enabled me to study at home instead of a public space, and the hotspot connected me to my Berkeley classes from Indiana."

- Dylan Steury, undergraduate student

Berkeley Engineering

Berkeley**ENGINEER**
University of California, Berkeley
College of Engineering
Office of Marketing & Communications
Berkeley, CA 94720-1704

NONPROFIT ORG.
U.S. POSTAGE
P A I D
UNIVERSITY OF CALIFORNIA,
BERKELEY


ADAM LAU PHOTO

The power of one professor

"I hope to train the next generation of leaders who are not just technically excellent, but who also have the vision, leadership and empathy to enhance society for all," says Scott Moura, the Clare and Hsieh Wen Shen Distinguished Professor in Civil and Environmental Engineering. It's faculty members like Scott Moura who help 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.

To learn more about this and other ways to support our faculty, visit: **engineering.berkeley.edu/give.**

Berkeley
Engineering