College of Engineering
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Burning questions
How wildfires spread

In sickness and in health
The promise of nuclear medicine

Berkeley ENGINEER

Unequal burden

Addressing air quality disparities through data and policy

Innovation with impact

The ascendance of artificial intelligence, recognized by last month's Nobel Prize in Physics, has led me to reflect on the many technological innovations — including key contributions by Berkeley engineers — that have led to this historic era of transformation.

The seamless integration of electrical engineering and computer sciences at UC Berkeley has enabled our world-class faculty, students and alumni to make pioneering contributions that helped form the hardware backbone of AI. Examples include computer operating system Berkeley Unix, industry-standard chip simulation program SPICE, Reduced Instruction Set Computing (RISC) architecture for more energy-efficient microprocessors, and the Apache Spark framework that supports big data processing. Those Berkeley innovations were all open source, accelerating widespread adoption in the tech industry.

Such advances enabled dramatic improvements in computational speed, ushering in the Age of AI. Today, electricity demands are increasing exponentially with the proliferation of AI applications. Among the initiatives funded through the CHIPS and Science Act are research programs that address the need for more energy-efficiency in AI hardware. These include the California-Pacific-Northwest AI Hardware Hub, co-led by UC Berkeley and Stanford University, that was recently awarded $16.3 million.

CHIPS and Science Act programs are also creating more demand for a trained workforce, which Berkeley Engineering is addressing with a new undergraduate major in electrical and computer engineering; this, along with a new environmental engineering major, will be one of two new baccalaureate programs launched next year.

But UC Berkeley alone cannot meet the nation's need for engineering talent. All engineering schools across the country should be empowered to help fill the talent gap, which is why I have volunteered to serve as president of the National Academy of Engineering (NAE). As the sole candidate for NAE president, I expect to start a six-year term in July 2025 and therefore plan to step down as dean at the end of this academic year. An interim dean will be named for the 2025–26 academic year, during which a search will be conducted for a new dean, who will start in July 2026.

The future of Berkeley Engineering is bright, particularly under the leadership of Chancellor Rich Lyons. Our college will no doubt continue to serve as a motor of innovation and entrepreneurship. I look forward to seeing a healthier, more equitable and sustainable world shaped by Berkeley engineers in the years ahead.

Fiat Lux — and Go Bears!

—Tsu-Jae King Liu

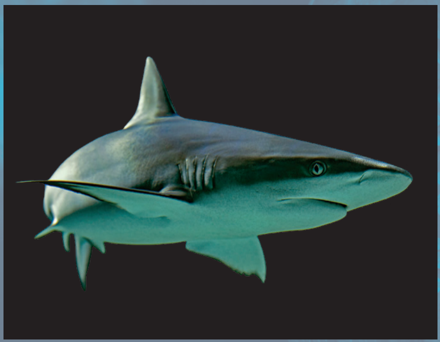
DEAN AND ROY W. CARLSON PROFESSOR OF ENGINEERING

Our faculty, students and alumni have made pioneering contributions that helped form the hardware backbone of AI.

Dean Tsu-Jae King Liu welcomes UC Berkeley Chancellor Rich Lyons at this fall's Dean's Society event.

Adam Lau

in this issue



> COVER: PROFESSOR JOSHUA APTE AND POSTDOCTORAL RESEARCHER SAMUEL CLIFF, FROM LEFT, MEASURE AIR QUALITY AT THE SAN FRANCISCO CALTRAIN STATION. PHOTO BY ADAM LAU

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MATERIALS

New glues

Berkeley engineers have discovered a new chemical strategy that opens the door to high-performance, recyclable adhesives for a wide variety of applications — including a surgical superglue, a pressure-sensitive adhesive and an epoxy-like structural adhesive.

To develop these new adhesives, the researchers looked to polymers derived from alpha-lipoic acid (αLA), a small molecule that aids in cell metabolism. The instability of αLA polymers has long been a barrier to their use in practical settings, but the team was able to stabilize the αLA polymer, then make small modifications to the underlying monomer composition.

"Most commercially available polymer adhesives are tailored for specific, sometimes narrow uses," said **Phillip Messersmith,** professor of bioengineering and of materials science and engineering. "But these αLA polymers have shown that they translate well across a range of applications and may be the start of a new industry paradigm, one built around multipurpose adhesives."

After developing the surgical superglue, the researchers investigated its use in fetal surgery, in which an incision is made in the amniotic sac. The process can cause the sac to rupture, leak fluid or get infected, increasing the risk of pre-term delivery and fetal death. Typically, the incision is sealed by applying the adhesive at the conclusion, with limited success.

Using their surgical superglue, the researchers developed a new "presealing" approach that involves placing the αLA polymer adhesive on the tissue before puncturing with a needle — and is believed to be the first procedure of its kind in a preclinical study. The surgical superglue successfully sealed murine (mouse) amniotic sac ruptures, increasing the fetal survival rate from 0% to 100%.

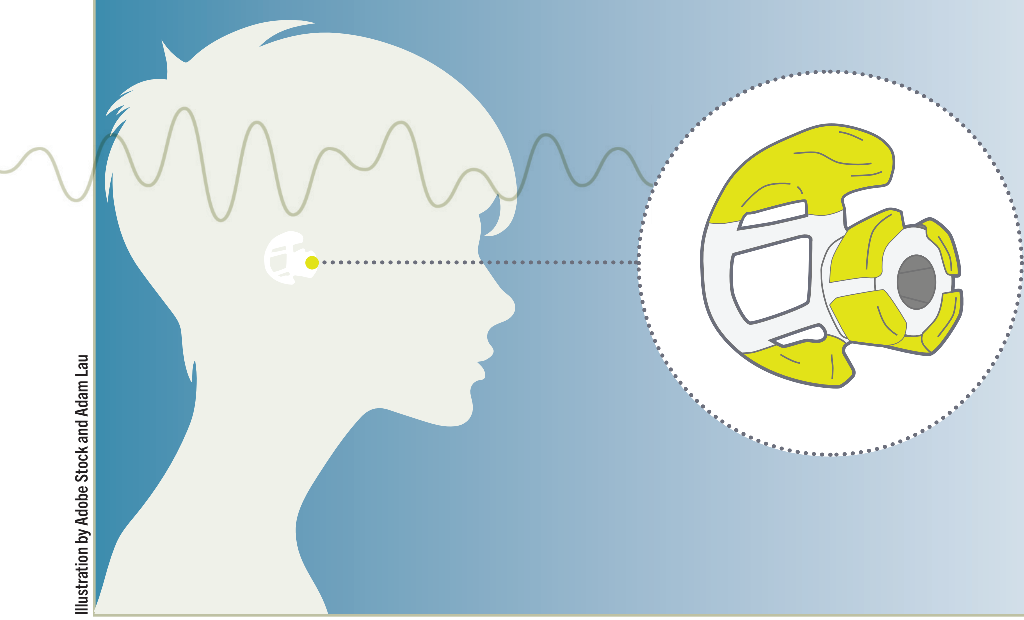
The researchers also created a pressure-sensitive adhesive and an epoxy-like structural adhesive, and they found that both surpassed the performance of conventional adhesives. These new adhesives are also environmentally friendly, in contrast to most on the market, which tend to be petroleum-based.

"These αLA polymer adhesives can be sustainably sourced — as αLA can be biomanufactured," said researcher **Subhajit Pal.** "Also, they can be recycled in a closed loop system or left to degrade to non-toxic substances."

DEVICES

Staying alert

For people whose jobs involve driving or working with heavy machinery, drowsiness can be extremely dangerous — if not outright deadly. To help people who may be drifting off, engineers led by **Rikky Muller,** associate professor of electrical engineering and computer sciences, have created earbuds that can detect signs of drowsiness in the brain. Postdoctoral scholar **Ryan Kaveh** (Ph.D.'22 EECS) and graduate student **Carolyn Schwendeman** (B.S.'20, M.S.'21, Ph.D.'26) collaborated with the lab of electrical engineering and computer sciences professor **Ana Arias** to design the final earpiece.



- The earbuds use **built-in electrodes** that make contact with the ear canal, similar to how an electroencephalogram (EEG) measures electrical activity in the brain.
- To fit **multiple electrodes in a cantilevered design** the earpiece incorporates multiple electrodes in a cantilevered design that applies gentle outward pressure to the ear canal.
- The signals are read out through a **custom, low-power, wireless electronic interface.**
- The platform **detects alpha waves,** brain activity that increases when you close your eyes or start to fall asleep.
- The earpieces can also detect **eye blinks and the auditory steady-state response,** which is the brain's response to hearing a steady pitch.

Illustration by Adobe Stock and Adam Lau

PHYSICS

In a twist

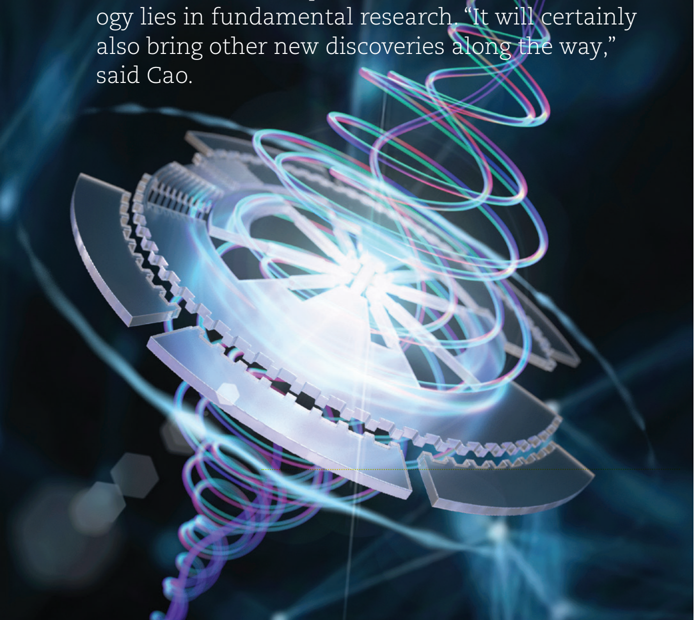
Just a few years ago, researchers discovered that changing the angle between two layers of graphene, an atom-thick sheet of carbon, also changed the material's electronic and optical properties. They then learned that a "twist" of 1.1 degrees — dubbed the "magic" angle — could transform this metallic material into an insulator or a superconductor, a finding that ignited excitement about a possible pathway to new quantum technologies.

To study the physics underlying this phenomenon, "twistronics" researchers had to produce tens to hundreds of different configurations of the twisted graphene structures — a costly and labor-intensive process. But a team of researchers led by **Yuan Cao,** the leading discoverer of the magic angle in 2018 and now an assistant professor of electrical engineering and computer sciences, has created a device that can twist a single structure in countless ways.

In a study, the researchers demonstrated the world's first micromachine that can twist 2D materials at will. The fingernail-sized, on-chip platform, called MEGA2D, uses microelectro-mechanical systems (MEMS) to conduct voltage-controlled manipulation of 2D materials — which are only nanometers thick — with unprecedented flexibility and precision.

"Our work extends the capabilities of existing technologies in manipulating low-dimensional quantum materials," said Cao. "It also paves the way for novel hybrid 2D and 3D structures, with promising implications in condensed-matter physics, quantum optics and related fields."

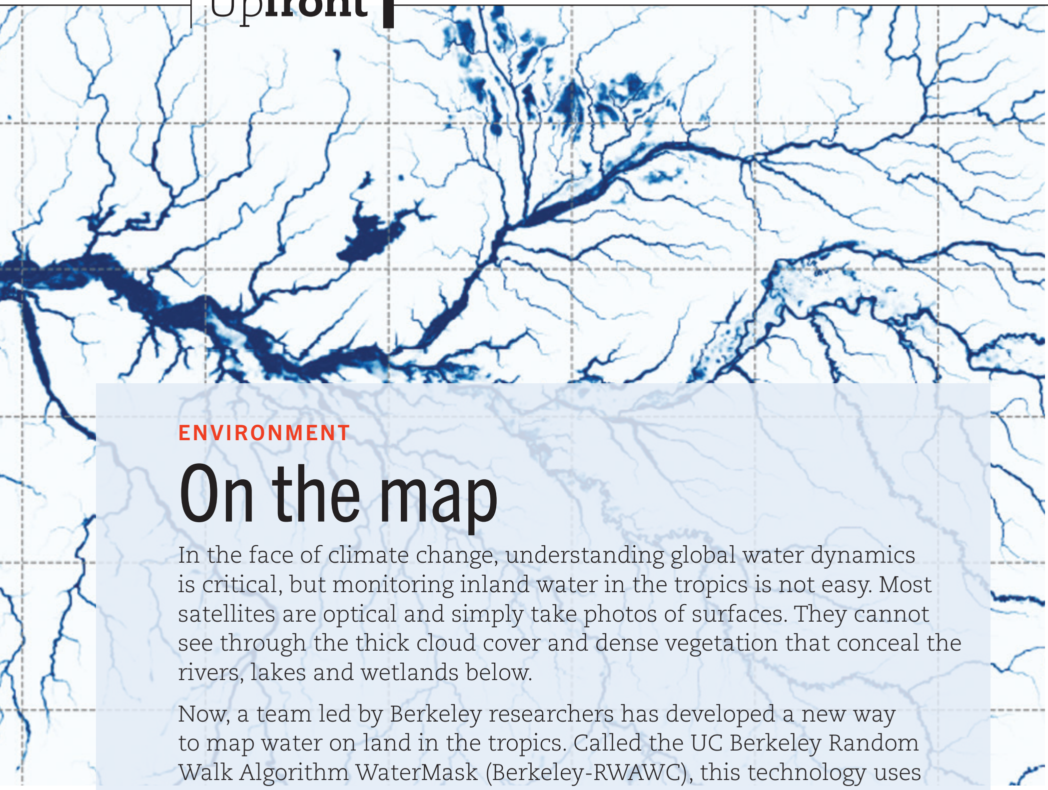
According to the researchers, the MEGA2D platform has several potential applications beyond twistronics, including use as a tunable light source for classic, or standard, light bulbs as well as for quantum versions. For now, the team believes that the true power of the MEGA2D technology lies in fundamental research. "It will certainly also bring other new discoveries along the way," said Cao.



Courtesy the researchers

Adam Lau

THE ENGINEERING CENTER continues to take shape on campus, as progress on its construction remains on target. The building has obtained LEED Gold certification and is now on track to be LEED Platinum certified. Scheduled to open in spring 2025, the center will house an array of student services and programs, student organizations, entrepreneurship activities and more. For updates and timelapse videos of the construction, visit the Berkeley Engineering website.



Courtesy the researchers

ENVIRONMENT

On the map

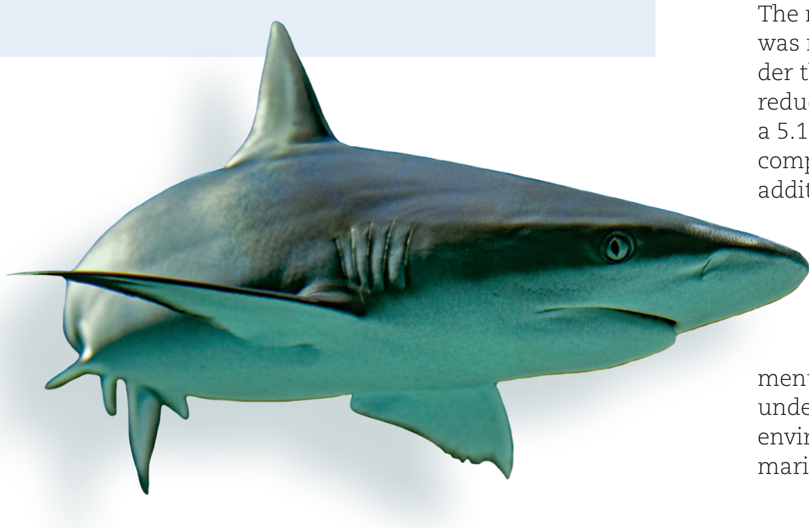
In the face of climate change, understanding global water dynamics is critical, but monitoring inland water in the tropics is not easy. Most satellites are optical and simply take photos of surfaces. They cannot see through the thick cloud cover and dense vegetation that conceal the rivers, lakes and wetlands below.

Now, a team led by Berkeley researchers has developed a new way to map water on land in the tropics. Called the UC Berkeley Random Walk Algorithm WaterMask (Berkeley-RWAWC), this technology uses L-band microwaves from the Cyclone Global Navigation Satellite System (CYGNSS) to “see” water hidden beneath visual barriers, like tree canopies and clouds. It also incorporates a computer vision algorithm that works with CYGNSS data to differentiate between land and water.

According to Ph.D. student **Tianjiao Pu,** this data is particularly critical for communities in the tropics, which are heavily impacted by climate change and need help preparing for and responding to floods and droughts. For example, Berkeley-RWAWC can be used to track floods to improve hydrologic models.

“The Sudd wetlands in South Sudan have been experiencing catastrophic floods for multiple years in a row, displacing over a million people and adding to an already dire situation on the region,” said **Cynthia Gerlein-Safdi,** assistant professor of civil and environmental engineering. “Improved maps of flooding in the area can provide new tools for humanitarian aid to be released ahead of the next flood event.”

Berkeley-RWAWC also can be used to model greenhouse gas emissions in tropical wetlands, which are natural emitters of methane. “Berkeley-RWAWC improves the mapping of where and how big these wetlands are, allowing other scientists to then predict the trajectory of these wetlands and their methane emission as the climate warms,” she said.



DESIGN

A shark of inspiration

Submarines and ships rely on towed sonar arrays (TSAs) for underwater exploration and security operations, but dragging these sensors through water, especially at high cruising speeds, creates excess noise that can mask target signals and compromise the sonar’s detection capabilities. Now, engineers are attempting to solve this problem with a little inspiration from Mother Nature.

Berkeley researchers, in a collaboration with MIT Lincoln Laboratory, demonstrated how a textured surface designed to mimic patterns on shark skin, known as riblets, can reduce drag and mitigate flow-based noise on TSAs. **Grace Gu,** assistant professor of mechanical engineering, said the idea of using riblets was inspired by serrations, which help owls achieve silent flight and are used on surfaces to mitigate noise in aeronautic systems.

To test their theory, the researchers — including Berkeley graduate students **Zilan Zhang** and **Dahyun Daniel Lim,** along with MIT Lincoln Laboratory’s **Justin Rey** and **Matthew Jones** — used computational modeling to simulate riblet surfaces with different shapes and patterns and then simulated the movement of water around them. Of the designs tested, the rectangular riblet design was most effective at both diminishing noise generated by water flow and decreasing hydrodynamic drag.

The magnitude of these improvements was most evident for turbulent flows. Under these conditions, rectangular riblets reduced noise by up to 14.3%, along with a 5.1% decrease in hydrodynamic drag, in comparison to a smooth array surface. In addition, riblets with finer, more closely spaced geometries further reduced drag by another 25.7%.

According to Gu, this research could lead to key advancements for underwater vehicles and instruments. And the quieter operation of these underwater devices also benefits the environment by reducing the impact on marine life.

Q+A on AI and traffic management

Could environmentally friendly, energy-efficient high-occupancy vehicles (HOVs) become the preferred and quickest mode of transportation? Berkeley Engineering researchers think so. Using a simulated environment, a team — including Smart Cities Research Center director **Jane Macfarlane** and civil and environmental engineering professor **Scott Moura** — has created a traffic signal control algorithm that maximizes the throughput of people, rather than vehicles, at intersections. Dubbed HumanLight, the novel technology uses AI to prioritize and reward passengers of HOVs with more green lights.

What led you to HumanLight?

JM: I helped launch OnStar, and we had seat sensors, much like those used with air bags, that would tell us how many people were in the car in the event of an emergency or accident. [I thought] if we have a way of knowing how many people are sitting in those vehicles waiting at a traffic signal, we can develop a traffic signal control system, like HumanLight, that gives priority to those with higher occupancy.

SM: We had this seven-year project called NEXTCAR, where we looked at ways to optimize the speed of the vehicle to reduce energy consumption based on the traffic light timing. As I got deeper into it, I started to wonder, what if we could control traffic light timing? Transportation engineers, meanwhile, were thinking, but how do you control traffic light timing if the vehicle flow is uncontrollable? But what if we could control both?

How does HumanLight fit into the traffic puzzle?

JM: HumanLight is part of the next step in the evolution of transit signal priority and emergency vehicle preemption. Its goal is to optimize traffic signal control for maximum people throughput, not car throughput. Rather than using standard control theory, HumanLight uses an AI technique, reinforcement learning, to manage the dynamic behavior of complex traffic environments.

SM: If you want to move people from point A to point B quickest, it might make sense to actually prioritize the direction that has more people going through. That's the core idea: to somehow make the traffic light timing intelligent, where it understands the occupancy of the incoming vehicles.

How does this differ from other approaches?

JM: Current transit signal priority systems will prioritize an empty bus because they don't know how many people are on the bus. They just know the bus is coming. Still, that bus might pick up 50 people on the other side of the light. But HumanLight could potentially provide a clearer picture of vehicle occupancy for multiple modes of transportation, from cars to shuttles and buses, and get more people where they want to go faster.

SM: In the past, there was a technology called adaptive traffic light signal timing. It consists of a network of cameras or magnetic detectors placed along a corridor to detect traffic. But these devices just detect metal boxes, not people. A bus or a shuttle containing 12 people is viewed the same as a Suburban SUV with one person. And so that approach doesn't make sense when we're trying to move people. HumanLight not only puts the focus on moving people, but it also provides a framework for bringing together two enabling technologies: connected vehicles and AI.

What has surprised you most about this work?

JM: I didn't expect to see such good results for people who aren't in HOVs. After all, you don't want to design a solution in which people who can't take a shuttle, for whatever reason, are penalized or must wait an extra half hour to get where they need to go. With HumanLight, we were able to design a democratic solution.

SM: [Lead researcher] **Dimitris Vlachogiannis** (M.S.'19, Ph.D.'23 CEE) helped us realize another important outcome: incentivizing people to carpool. Initially, I thought of HumanLight as just an infrastructure control solution. But because we're prioritizing humans, it's also incentivizing human behavior to carpool and use shuttles and buses.

HOW DO I FIND OUT MORE? Find links to source articles and expanded coverage at **engineering.berkeley.edu/magazine.**

Burning questions

California has recorded more than 6,000 wildfires this year, underscoring the need for better mitigation strategies to reduce their devastating impact. Now, researchers have created a wildfire simulation model that may shed light on how these fires spread through communities in the wildland-urban interface (WUI), enabling us to better assess the wildfire risks and build more resilient communities.

The model is the first of its kind to fully integrate wildland and urban fire spread processes, filling a major gap in current tools by introducing data such as structural construction materials, surrounding vegetation and the intensity of approaching flames. The model also addresses the three primary pathways for WUI fires to spread: direct flame contact; radiation, or the intense heat emitted by flames; and firebrand ignition, when flammable vegetation or structural materials break off and travel ahead of the advancing fire, as seen with embers.

The researchers seamlessly integrated their WUI model with ELMFIRE, an existing tool that simulates wildland fire spread and is used by power companies and counties across the state for risk assessment.

To test it, the researchers simulated the Tubbs and Thomas fires, two historical and devastating WUI fires that occurred in 2017. Even accounting for a certain level of built-in uncertainty, the model's predictions achieved an accuracy exceeding 85% for fire perimeters and around 70% for the damaged houses, with over 30% of the houses ignited by firebrands. In addition to validating the role that urban structures play in spreading fires, the model outputs provided new insights into how fire behaves in these settings.

"Fire does spread slower in the community than through the forest and the trees, but it's also very destructive. The behavior is different," said **Michael Gollner,** associate professor of mechanical engineering. "The way a house burns is different, and by including that data in our model, we now see the influence of each process — of the houses burning, of their arrangement side-by-side, of the weather — and how all those processes and factors play together."

Dwi M.J. Purnomo, postdoctoral scholar, was the study's lead author. **Maria Theodori,** Ph.D. student, and **Maryam Zamanialaei,** postdoctoral scholar, were co-authors, along with researchers from the University of Maryland, College Park and CloudFire Inc.

STORY BY MARNI ELLERY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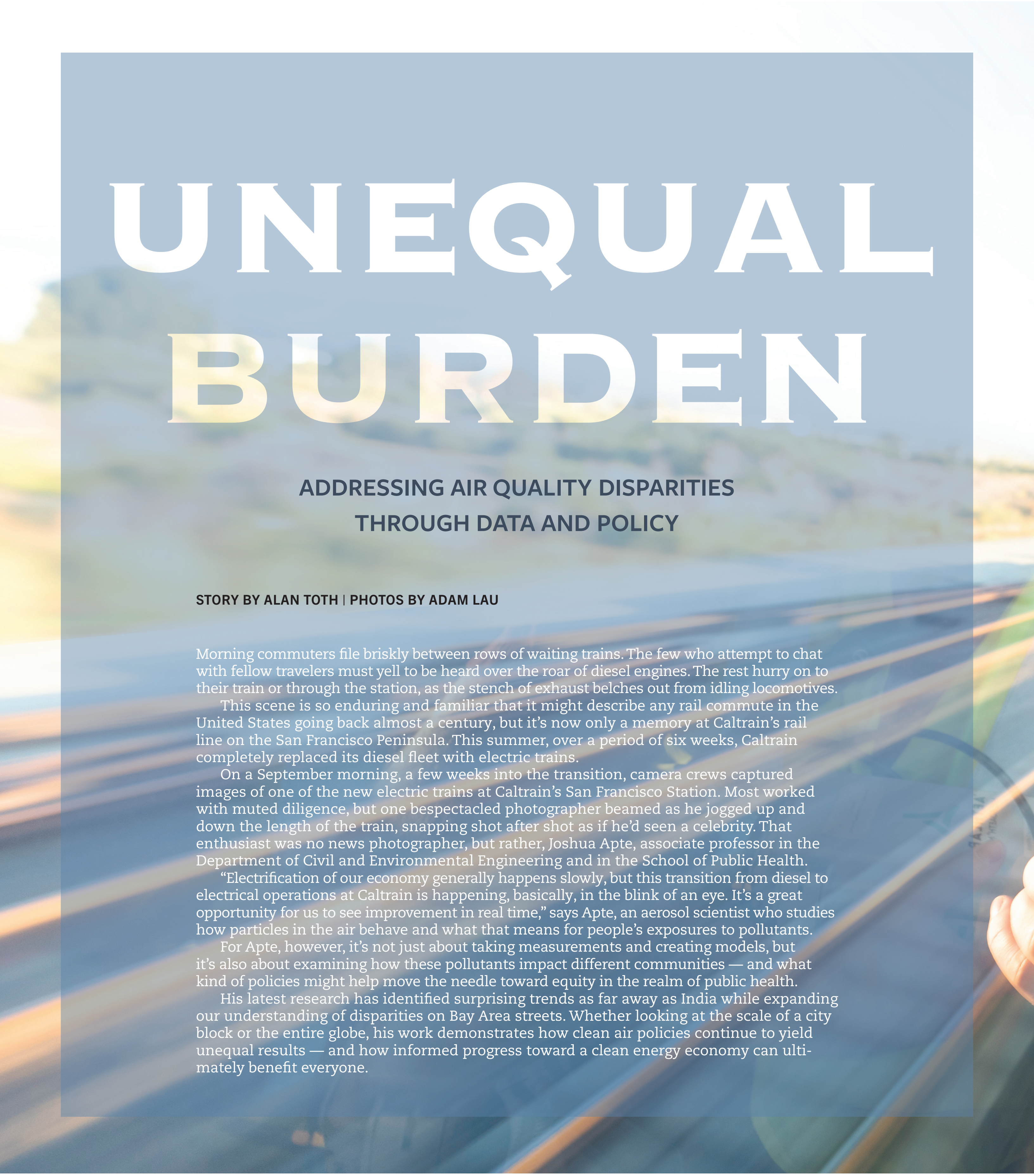


UNEQUAL BURDEN

ADDRESSING AIR QUALITY DISPARITIES THROUGH DATA AND POLICY

STORY BY ALAN TOTH | PHOTOS BY ADAM LAU

Morning commuters file briskly between rows of waiting trains. The few who attempt to chat with fellow travelers must yell to be heard over the roar of diesel engines. The rest hurry on to their train or through the station, as the stench of exhaust belches out from idling locomotives.

This scene is so enduring and familiar that it might describe any rail commute in the United States going back almost a century, but it's now only a memory at Caltrain's rail line on the San Francisco Peninsula. This summer, over a period of six weeks, Caltrain completely replaced its diesel fleet with electric trains.

On a September morning, a few weeks into the transition, camera crews captured images of one of the new electric trains at Caltrain's San Francisco Station. Most worked with muted diligence, but one bespectacled photographer beamed as he jogged up and down the length of the train, snapping shot after shot as if he'd seen a celebrity. That enthusiast was no news photographer, but rather, Joshua Apte, associate professor in the Department of Civil and Environmental Engineering and in the School of Public Health.

"Electrification of our economy generally happens slowly, but this transition from diesel to electrical operations at Caltrain is happening, basically, in the blink of an eye. It's a great opportunity for us to see improvement in real time," says Apte, an aerosol scientist who studies how particles in the air behave and what that means for people's exposures to pollutants.

For Apte, however, it's not just about taking measurements and creating models, but it's also about examining how these pollutants impact different communities — and what kind of policies might help move the needle toward equity in the realm of public health.

His latest research has identified surprising trends as far away as India while expanding our understanding of disparities on Bay Area streets. Whether looking at the scale of a city block or the entire globe, his work demonstrates how clean air policies continue to yield unequal results — and how informed progress toward a clean energy economy can ultimately benefit everyone.

Professor Joshua Apte measures air quality aboard a diesel train bound for San Jose from San Francisco.

UNEQUAL EMISSIONS REDUCTION POLICIES

Much of Apte's research has been aimed at understanding what specifically needs to be done to address systemic air quality disparities in the United States. Apte and his collaborators previously affixed particulate monitoring devices on Google Street View cars to develop block-by-block assessments of pollutant levels in 13 cities. Their work found that neighborhoods with a higher proportion of residents of color have elevated concentrations of pollutants in comparison to neighborhoods with primarily white residents.

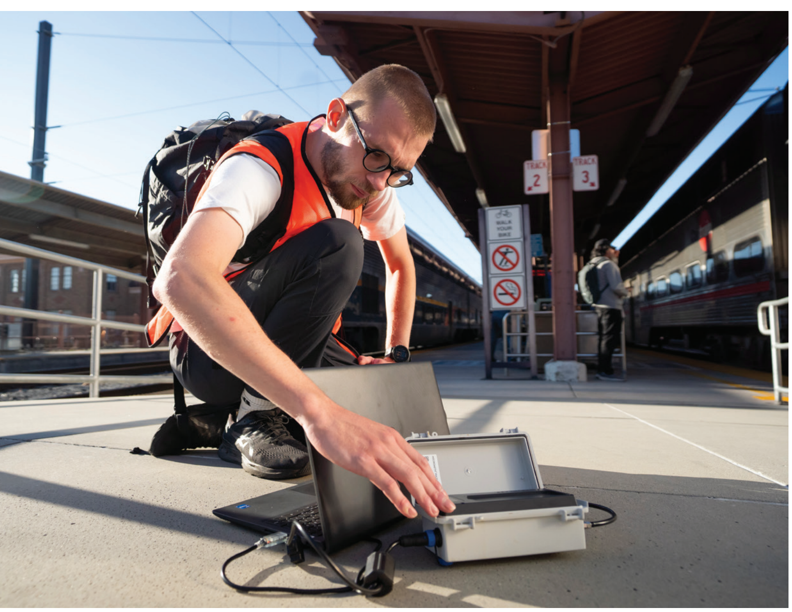
These hyperlocal pollution maps allowed Apte to later demonstrate how historic "redlining" policies (discriminatory property appraisals in areas largely populated by people of color) led to the concentration of pollution sources like freeways, railroads and refineries in Black, Asian and Latinx majority neighborhoods. While segregation is no longer official policy anywhere in the United States, the racial composition of many neighborhoods has not shifted much. As a result, people of color are still exposed to more sources and types of pollution than white populations.

"It really is a racial issue, not an income issue," says Apte.

In his latest paper, Apte and co-author Libby H. Koolik, a Ph.D. student in environmental engineering, examined how effectively the existing air quality standards for on-road mobile vehicles address disparities. Previous research aimed at reducing disparities in emissions exposure has proceeded from two different approaches. The first assumes that disparities are best addressed by reducing emissions from specific economic sectors — transportation, for instance. The second assumes that targeting emissions reductions within geographic areas already overburdened by pollution will be more effective.

The California Air Resources Board (CARB) regulates vehicle emissions more stringently than the federal Clean Air Act requires and has aggressively enforced policies aimed at reducing emissions for every on-road vehicle in the state. These regulations provided Apte and Koolik an excellent means of testing the approach that focuses on reducing emissions from specific economic sectors.

Using data collected by CARB, they modeled exposure concentrations of inhalable particles 2.5 micrometers and smaller in diameter ($PM_{2.5}$) in California from the years 2000 through 2019. They found that, overall, exposure to $PM_{2.5}$ emissions dropped 65% throughout the state, a finding that likely translates to more than 10,000 lives saved over the past two decades.



Postdoctoral researcher Samuel Cliff measures air particulates on a Caltrain platform.

This overall finding is undoubtedly good news, but it does little to improve racial disparities because, though their total exposure dropped, people of color still live closer to emissions sources than white Californians. The vehicles are cleaner, but the freeways haven't moved. This study suggests that targeting emissions from specific economic sectors will yield broad societal benefits but will not achieve the goal of ameliorating racial disparities.

"Despite the huge drop in emissions, we found that the relative inequality was constant through time. This suggests that a location-based approach would be more efficient at reducing disparities," says Koolik.

Koolik plans to study what specific features of environmental policymaking are best suited to decrease disparities, and she's created a tool that will help. ECHO-AIR is the modeling program Apte and Koolik used in the disparities study. It's built and validated with California-specific data, but with substitute geographic data, it could potentially be used for any area. The tool was designed for non-scientists. Regulators, community activists, journalists and others can use ECHO-AIR to estimate the exposure, equity and health impacts associated with a variety of emissions scenarios — for instance, the effect of removing a freeway.

"If you have a laptop and some way of estimating emissions, you can use ECHO-AIR to do your own air pollution modeling," says Koolik.

MORE DETAILED POLLUTION MAPPING

Many emissions policies are aimed only at reducing the carbon dioxide emissions that contribute to climate change. For example, the Inflation Reduction Act of 2022 provides tax credits to homeowners who replace natural gas appliances with all-electric models. Though it provided additional credits for low-income communities, homeowners who want to replace their gas-powered appliances still need to be able to pay the full cost upfront before receiving the rebates, and not everyone can afford to do that.

By demonstrating the additional health benefits of replacing gas-powered appliances, Apte hopes that governments will be empowered to create more substantial and inclusive emissions control policies. The Bay Area Air Quality Management District, which regulates air pollution in the counties surrounding San Francisco Bay, has mandated restrictions on the sale and installation of new gas-powered water heaters and furnaces beginning in 2027 and 2029, respectively. Apte wants to track the reduced emissions that will likely result from this policy.

The primary health concern related to natural gas-burning appliances is from nitrogen oxides (NO_x) created as a byproduct. Regular exposure to NO_x has been linked to asthma and increased risk of heart attacks and death. Apte has recently acquired a van that he's planning to pack with specialized pollution sensing equipment. Once complete, Apte will take his tricked-out ride to Bay Area streets and measure levels of NOx, as well as diesel soot (black carbon), ultrafine particles, ethane, methane, volatile organic compounds and other pollutants.

Visualizations created with this kind of multi-pollutant data provide insights into how pollution varies in both space and time — the weather conditions and economic activities that affect air quality — and also how the interaction of different pollutants can compound deleterious effects. Apte says the results are often surprising.

The most polluted region of the planet is South Asia, according to the 2023 IQAir World Air Quality Report. Apte estimates that people living in parts of Pakistan, Bangladesh and the Indo-Gangetic Plain in North India lose nearly two years of life expectancy due to exposure to $PM_{2.5}$.

Apte has been studying pollution in South Asia for 15 years. With his network of pollution monitors installed throughout South Asia, Apte was able to show that rural areas are often more polluted than urban areas because rural populations still

A Caltrain worker crosses the tracks between an old diesel train (left) and a new zero-emission, electric train (right) at the San Francisco Caltrain Station.

burn wood for fuel. Even in summer, when wood is only used for cooking and not heating, Apte found that air quality levels in rural areas are often similar to those recorded near wildfires.

TRACKING RAPID IMPROVEMENT

Back at home, Apte is working with Caltrain to track the changing emissions associated with the transition to electric operations. This summer, Apte rode a diesel-powered train from San Francisco to San Jose and back again, measuring black carbon and nitrogen dioxide (NO_2) levels inside the passenger cars. Both pollutants are associated with a variety of detrimental cardiopulmonary conditions. On returning to the San Francisco station, Apte turned to a Caltrain employee to share his results.

"You were not wrong about the first car behind the locomotive being bad. It was worse-than-New Delhi-traffic-jam bad," said Apte.

Apte recorded between 20 and 40 micrograms per cubic meter of $PM_{2.5}$ black carbon in the first passenger car behind a diesel locomotive. Those numbers are similar to concentrations Apte measured while sitting in a three-wheeled rickshaw in New Delhi, which has one of the most polluted traffic environments in the world. Notably, Apte did not record similarly high levels on northbound trains because the locomotive's smoke trailed behind the train and did not enter the passenger cars.

After the round trip to San Jose, Apte and postdoctoral researcher Samuel Cliff visited a disused switch tower southwest of the station. They climbed into a long-abandoned interior and checked results from two devices they'd installed several weeks before. Two small tubes sniffed the air outside the tower and delivered it to a spectrometer that measured NO_2 and a filter device that measured black carbon. Levels of the two pollutants were relatively low because the tower was upwind of the diesel engines, so the location provided good control data.

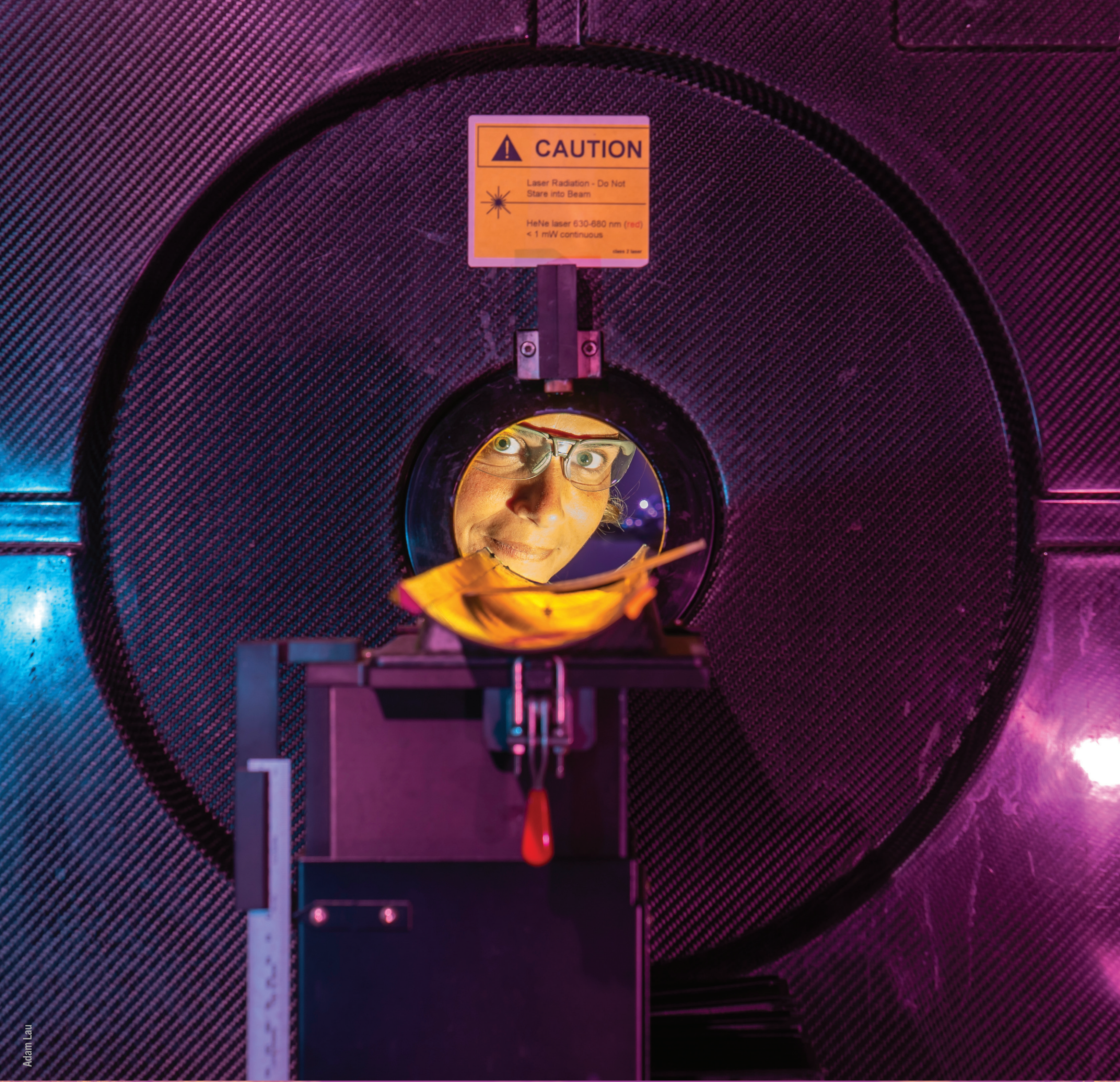
Next, they made some modifications to sensors they'd installed on the train platform and then visited an office that had been temporarily converted into a third monitoring area. Levels of pollutants were, unfortunately, quite high inside the station. Cliff explained that they record spikes in the two pollutants they're monitoring whenever the platform doors open. Exhaust from the locomotives likely gusts in through open doors and gets trapped there.

"The air in the station and on the platform is much worse than the surrounding area, but we're seeing quite a big reduction in emissions, particularly on the weekends when they're already running a fully electrified fleet," said Cliff.

The transition to electric operations at Caltrain delivers huge benefits for commuters and neighbors in the form of emissions and noise reductions, but it likely won't be noticed by traditional emissions tracking efforts. That's because monitors used by official regulating bodies are very expensive, sparsely distributed and sample the air less frequently. They're best suited to monitoring broad trends over long periods.

To address this limitation, Apte is bringing all of his research together. Along with co-author Chirag Manchanda, a Ph.D. student in environmental engineering, Apte has developed a method to combine data from expensive regulatory monitors, commercial-quality monitors and mobile monitors like those he installed on Google Street View cars. This high-resolution air quality mapping could provide a hyperlocal picture of emissions that can help identify unknown pollution sources and see the immediate benefit of emissions mitigation efforts.

"We want to measure how changes are happening so we can quantify the benefits," says Apte. "People will be able to see just how much better things can be for everyone."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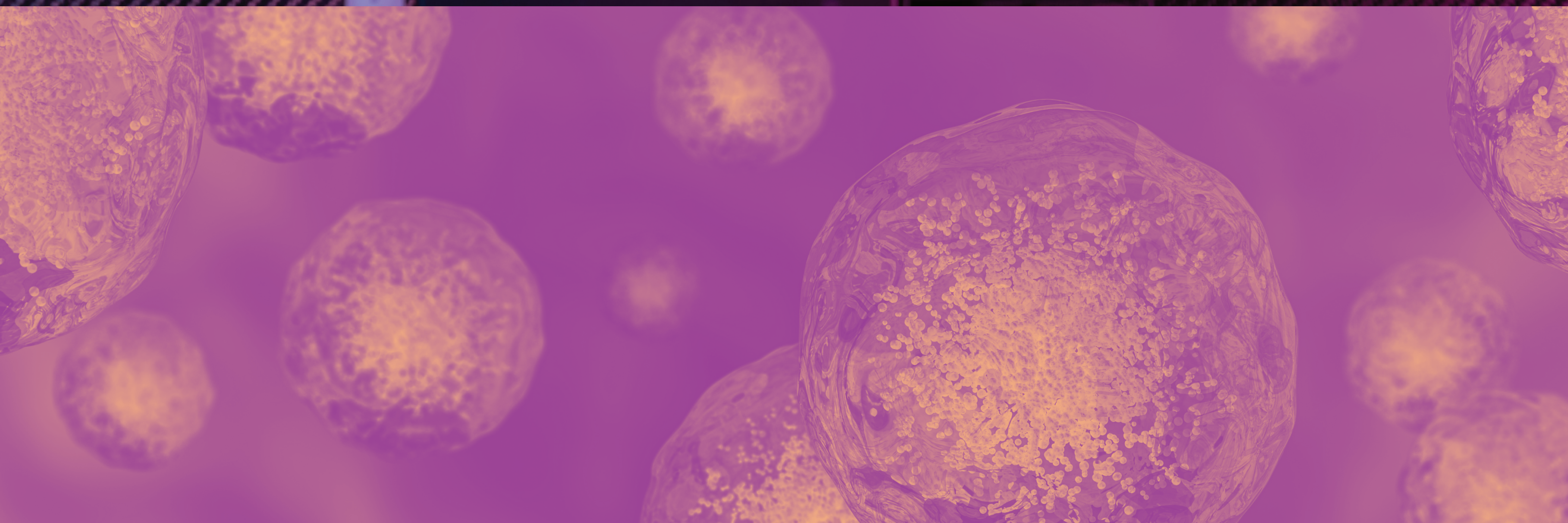


In sickness & in health

THE PROMISE OF NUCLEAR MEDICINE

STORY BY C

The dawn of the nuclear age nearly 80 years ago heralded a new era in energy — as well as in medicine. Today, radioactive metals have become an integral part of modern life, but they can be a double-edged sword when it comes to human health. At their worst, they are deadly, but when radioactive metals can be precisely controlled, their unique properties can be harnessed to deliver life-sustaining medical treatments.

Rebecca Abergel's research bridges these extremes. A decade ago, the associate professor of nuclear engineering and of chemistry developed an anti-nuclear contamination pill that can remove radioactive metals like uranium and plutonium from the body, potentially saving thousands of lives in the event of a nuclear incident. Now, she is working on other novel applications, like delivering highly potent alpha radiation directly to cancer cells and removing other heavy metal contaminants from the body.

Abergel's research centers on lanthanides and actinides — the two rows of heavy metals at the very bottom of the periodic table. Set aside from the table's otherwise neat rows and columns, many of these elements have familiar names like berkelium and californium. But because they are rare and are often unstable, the properties of lanthanides and actinides are much less familiar than those of other elements.

By deepening our understanding of the fundamental properties of these unusual elements and leveraging these properties with synthetic molecules, Abergel is building on the Berkeley legacy in this arena. The molecules she synthesizes bond to heavy metals through a chemical process called chelation, affording her a degree of control that can enable the removal of harmful metals from the body, while delivering helpful ones to the places they are needed the most.

Cancer research has been a key interest for Abergel, as she works to advance promising therapeutic options. The first known attempts to treat cancer date back to ancient Egypt, where a medical text described how to surgically remove a breast cancer tumor. The text also noted that the disease had no cure, and thousands of years later, that's still the case. But one day soon, Abergel hopes that could change.

Professor Rebecca Abergel peers through a positron emission tomography (PET) scanner at Berkeley Lab.

Targeted alpha-particle therapy (TAT) is an emerging treatment that can deliver powerful doses of radiation directly to cancer cells while causing minimal damage to surrounding tissue. In clinical trials, the approach has shown promise for the treatment of metastatic prostate cancer, and now, Abergel is exploring how it could be used to treat other forms of the disease.

"TAT could be a very versatile, universal type of therapy. It could treat almost any type of cancer, but we don't have all the tools we need to do that yet," she says.

Abergel compares TAT to attacking a tumor with a tiny nuclear missile. Her work in this field centers on the molecular scaffold that bonds to a radioactive element, transporting it to the site of the cancer. There, a protein bonded to the molecular scaffold attaches to the cancer cells, bombarding them with radiation from alpha particles.

Alpha particles are produced by the radioactive decay of some heavy elements. They consist of two protons and two neutrons — the same composition as the nucleus of a helium atom. Because alpha particles are large and heavy, they can't go very far from their source. In biological tissue, they travel about a tenth of a centimeter, which maximizes the impact of the radiation in the immediate area of a tumor, while minimizing damage to everything else. But for this type of treatment to work, you need to deliver radioactive material to the site of the cancer and keep it there. That's easier said than done.

"It is not a new concept — diagnosing and treating cancer with radiation is what nuclear medicine is all about," says Abergel. "But alpha particles are the most energetic type of ionizing radiation, so they can deposit a lot of energy very locally and do a lot of damage to cancer cells. It could enable treatments that are less toxic to patients, but if you can't target the radioactivity precisely, you could damage healthy tissues and induce secondary cancers."

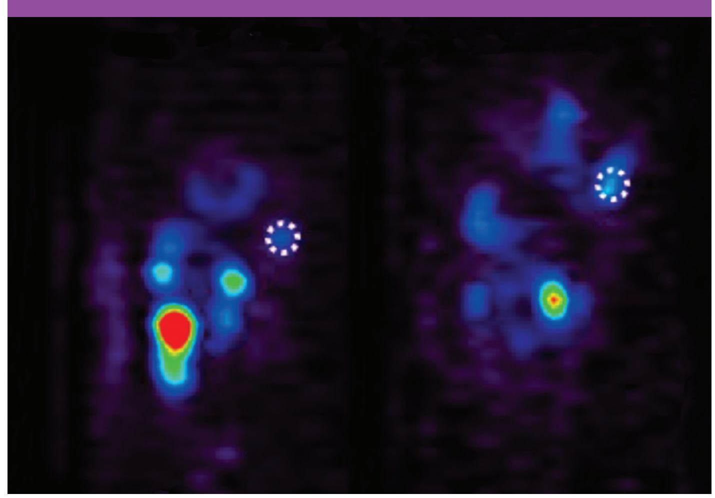
TAT has three main steps. First, you need to create the radioactive isotope. Then, you need to identify a material that can bond to it and transport it to the site of a tumor — the molecular scaffold. Finally, you need a peptide or a protein that can bond to the molecular scaffold and attach itself to cancer cells once it reaches them.

Actinium, one of the metals used in TAT, is a soft, heavy metal that was first identified in 1902 by Friedrich Oskar Giesel, working with the residues of an experiment conducted by Marie and Pierre Curie. The metal is unstable and highly radioactive. Some of its isotopes have a half-life of only a few hours; because it decays so quickly, actinium is almost never found in nature. The material used clinically, actinium-225, can only be synthesized at a few specialized facilities, one of which is Berkeley Lab's 88-inch cyclotron, a type of particle accelerator that can induce nuclear reactions to produce new isotopes. Chemical manipulations are then needed to separate the metallic products of radioactive decay from the elements that produced them.

Actinium-227, the isotope of actinium that Abergel uses in her research, is derived from uranium-233, a radioactive isotope first identified at Berkeley in 1940. At Berkeley Lab's Heavy Element Research Facilities, small amounts of the metal can be obtained from decaying uranium-233 in a process that

Elena Zhukova

"If we could produce as much of an isotope as we wanted and solve the challenge of reliably attaching it to a protein, we could treat pretty much anything."



Courtesy the researchers

Rebecca Abergel (top); coronal PET images (bottom)

Abergel compares to milking a cow. It is only possible to extract tiny amounts of actinium, but luckily, only vanishingly small amounts are needed to conduct the research, which is still in the pre-clinical stage. There are just 5 micrograms of the stuff available for these experiments — an amount so miniscule you'd need an electron microscope to even see it.

Abergel has created a scaffold that bonds to actinium. It starts with a synthetically produced molecule called a ligand. It is composed of carbon, oxygen and nitrogen atoms, and is large enough to fully surround the actinium. The ligand has free electrons that form chelating bonds with the positively charged actinium. The resulting small molecule is held together tightly.

The molecular scaffold needs to have a high affinity for the metal — it has to *want* to form a chelating bond with it. Inside the body, many naturally-occurring metals are present, including calcium, iron and zinc. So, the scaffold needs to maintain its bond with the actinium, even when other metals are available to bond with.

"A chelator is a little like a claw machine that clamps on to the radioactive material in a chemical reaction," she says. "The hurdle is to design a molecule that has enough coordinating atoms that can arrange in space in a way that will fully surround the metal ion and get it to stay there."

The metals already in the body are present in far greater amounts than the actinium, and the molecular scaffold can't release the actinium and bond with, say, iron instead. It needs to stay bonded to the actinium until it reaches the cancer cells, then attach to them. Identifying which molecules will work together is a process that leans on a chemist's intuition.

"When you work with a certain section of elements on the periodic table long enough, you get a feel for what shapes of molecules might interact with that system," says Trevor Arino, a Ph.D. student in Abergel's lab. "You get a feel for which elements could be good electron donors and would form the ideal kind of bond with the molecules you're working with.

To deliver the molecular scaffolds to the site of a tumor, Abergel's group has partnered with researchers at the Fred Hutchinson Cancer Center in Seattle, who have developed a protein that will attach to blood cancer cells. The protein's amino acids carry a positive charge, which leads to an electrostatic interaction with the negatively charged molecular scaffold, causing them to bond into a larger molecule that will attach to cancer cells. Incidentally, this molecule was also shown to slowly crystallize over the course of about a week, which led to the first ever single crystal structure known to incorporate actinium.

The protein, ligand and a purified version of actinium are combined in a solution to form a single large molecule that serves as a vessel to transport the material through the bloodstream. That step — like all the others — must be executed seamlessly to ensure the treatment is safe and effective. But the potential for this type of therapy extends far beyond blood cancer.

"If we could produce as much of an isotope as we wanted and solve the challenge of reliably attaching it to a protein, we could treat pretty much anything," says Abergel. "We could target any cancer, because cancer cells have no real protection against internal contamination with radioactivity. If all the parts come together, and we learn to target these therapies precisely, we can adapt them to whatever we hope to accomplish."

In France, Marie Curie is a national hero. Curie's groundbreaking research with radioactive metals earned her a Nobel Prize in 1903 — the first time the award was given to a woman. And when Abergel was growing up in Paris, Curie was more than just an intellectual giant, she was a role model.

In the 1990s, there were fewer women scientists than there are today, but Curie's accomplishments were proof of the possibilities. As an undergraduate student, Abergel began following in Curie's footsteps. She found herself drawn to the complicated chemistry of heavy metals, elements so rare that understanding their fundamental properties has been challenging. Moreover, slightly different isotopes can exhibit wildly diverging properties.

"I like that heavy metals are challenging to work with and to understand," she says. "The chemistry is tuned to each individual element, and there are properties you just don't see anywhere else."

Today, Abergel leads the Heavy Element Chemistry Group at Berkeley Lab, where she seeks to understand the radiological and chemical behavior of heavy elements in biological systems. Back in 2014, Abergel developed an anti-radiation pill that uses a chelating molecule to remove radioactive materials from the body, and that molecule continues to play a role in her research today.

"If a nuclear attack ever occurred, it would immediately cause some acute radiation poisoning, but the longer-term concern is radioactive contamination of water and soils," says Abergel. "This can increase the incidence of cancers, killing thousands more. People will ingest or inhale the radionuclides dispersed after a blast. Plutonium or uranium can deposit in the skeleton or organs like the liver and the kidneys, but this pill allows us to target them and remove them, reducing the risk of developing those cancers."

But the chelating molecule in that pill will bond to any lanthanide or actinide metal, not only plutonium or uranium. That could enable a wide range of applications unrelated to nuclear accidents. One of them is removing gadolinium from the body.

Gadolinium is a contrast agent used in about one-third of patients undergoing magnetic resonance imaging (MRI) scans. It enhances the quality of the signal and is used to image tumors and blood flow. But gadolinium-based contrast agents can have side effects like brain fog and joint pain. They can even cause life-threatening kidney complications.

The chelating molecule used in Abergel's anti-radiation pill can bond to gadolinium and remove it from the body once a scan has been completed. To accomplish this, Abergel needed to recalibrate the dosing regimen — the duration and frequency of treatment. The first heavy metal-removing version of the pill is currently in phase 1 clinical trials, which assess safety for human consumption. There could be even more applications for that same chelating product. Because it will bond with any lanthanide or actinide metal, it could potentially be used to treat people exposed to fumes at mine sites for rare earth metals, which are lanthanides. And in 2018, Abergel published data indicating it could also be effective at removing lead or cadmium from the body.

The potential applications for these metals and the chelators that bond to them are wide-ranging, and we are still learning about all they can do. But Abergel hopes her research is filling in the gaps in our knowledge and unlocking innovative applications that leverage the unique properties of these metals.

"The search for heavy elements and the search to understand their behavior is a legacy of Berkeley," she says. "We have a long-standing program dating back to the Manhattan Project. I couldn't do this work anywhere else."

The Seismological Society of America presented its highest honor, the 2024 Harry Fielding Reid Medal, to **Norman Abrahamson,** adjunct professor of civil and environmental engineering, for his global leadership in the field of probabilistic seismic hazard assessment.

Alexis Abramson (Ph.D.'02 ME) was appointed as the next dean of the Columbia Climate School. An expert in sustainable energy technology and advanced energy research, she is currently dean of the Thayer School of Engineering at Dartmouth.

Five Berkeley Engineering professors are among the 2024 Spark Award winners from the Bakar Fellows program: **Zakaria Al Balushi,** assistant professor of materials science and engineering; **Liana Lareau,** assistant professor of bioengineering; **Jennifer Listgarten,** professor of electrical engineering and computer sciences; **Robert Pilawa-Podgurski,** professor of electrical engineering and computer sciences; and **Adam Yala,** assistant professor of electrical engineering and computer sciences.

Researchers from three multi-institutional teams have won major awards from the Advanced Research Projects Agency for Health to fund pioneering biomedical research. A research team led by **Mekhail Anwar** (M.S.'01 EECS), professor of electrical engineering and computer sciences as well as of radiation oncology at UCSF, was awarded up to $15 million to develop a next-gen miniature scanner to detect individual cancer cells during surgery. Projects in microbiome engineering, led by bioengineering professor **Adam Arkin,** and in implantable biologic drug delivery, including work by associate professor of electrical engineering and computer sciences **Rikky Muller** (Ph.D.'13 EECS), will receive up to $22.7 million and $34.9 million, respectively.

Alexandre Bayen, CITRIS director and professor of electrical engineering and computer sciences and of civil and environmental engineering, has been honored with the following 2024 IEEE awards: ITS Institutional Lead Award, ITS Outstanding Research Award and CSS Transition to Practice Award.

Electrical engineering and computer sciences assistant professor **Jessica Boles** has won an ARPA-E Inspiring Generations of New Innovators to Impact Technologies in Energy 2024 (IGNIITE) Early Career Award, as well as the 2023 Power Electronics Prize Letter Award.

This fall, Berkeley Engineering welcomed six new tenure-track and teaching professors: **Yuan Cao,** assistant professor of electrical engineering and computer sciences; **Huiwen Jia,** assistant professor of industrial engineering and operations research; **Ken Kamrin** (B.S.'03 Eng. Physics), associate professor of mechanical engineering; **Phillip Kerger,** assistant teaching professor of industrial engineering and operations research; **Pierluigi Nuzzo,** associate professor of electrical engineering and computer sciences; and **Eleanor Tubman,** assistant professor of nuclear engineering.

Suraj Cheema (Ph.D.'21 MSE) joined MIT's Department of Materials Science and Engineering as an assistant professor, with a joint appointment in the Department of Electrical Engineering and Computer Science.

Electrical engineering and computer sciences assistant professor **Irene Chen** is the recipient of a Google Research Scholar Award.

Electrical engineering and computer sciences associate professor **Alvin Cheung** has been awarded the Dahl-Nygaard Junior Prize for his groundbreaking work on "verified lifting," applying ideas from program synthesis to dramatically improve the end-to-end performance of database-backed applications.

Jack Dennerlein (Ph.D.'96 ME) was named the dean of the College of Health and Rehabilitation Sciences: Sargent College at Boston University.

Electrical engineering and computer sciences associate professor **Anca Dragan** was named the head of AI safety and alignment at Google DeepMind.

Massimiliano Fratoni, associate professor of nuclear engineering, has been awarded the 2024 ANS Untermyer and Cisler Reactor Technology Medal for his outstanding contributions to the advancement of nuclear technology.

Fast Company highlighted **Tomas Garcia** (MDes '23) for his "[tech]tonic toolkit," a device developed for his 2023 master's thesis that makes emergency preparedness more accessible by relying on long-range, low-power mesh networks for post-disaster communication rather than on cell towers or satellites. The innovation is a winner of the magazine's 2024 Innovation by Design Awards.

The Arizona Board of Regents has appointed **Suresh Garimella** (Ph.D.'89 ME) as the next president of the University of Arizona. He is currently the president of the University of Vermont. Previously, he served as executive vice president for research and partnerships at Purdue University.

Civil and environmental engineering professor **Allen Goldstein** received the Carol D. Soc Distinguished Graduate Student Mentoring Award for Late Career Faculty, which recognizes faculty for outstanding mentorship of graduate students at UC Berkeley.

Andrés Gómez (M.S.'14, Ph.D.'17 IEOR), assistant professor of industrial and systems engineering at USC, received a Young Investigator Award from the Air Force Office of Scientific Research.

Six graduate students were honored as Siebel Scholars Foundation's class of 2025 and will be awarded $35,000 grants to advance their research: **Cade Gordon, Claire Hilburger** and **Sakshi Shah** of bioengineering, and **Jessica Lin, Eric Markley** and **Oliver Yu** of electrical engineering and computer sciences.

Vivek K. Goyal (M.S.'95, Ph.D.'98 EECS), professor in the Department of Electrical and Computer Engineering at Boston University, has been named a 2024 Guggenheim Fellow. The award recognizes his groundbreaking work in computational imaging, including research to photograph objects hidden by walls and around corners.

Electrical engineering and computer sciences professor emeritus **Paul Gray** has won the National Academy of Engineering's Simon Ramo Founders Award, one of the academy's highest honors. He was cited "for contributions to modern analog integrated circuit design through research and education, and for leadership of academic, philanthropic and corporate enterprises."

D. Vaughan Griffiths (M.S.'75 CE) was named head of the Department of Civil and Environmental Engineering at Colorado School of Mines.

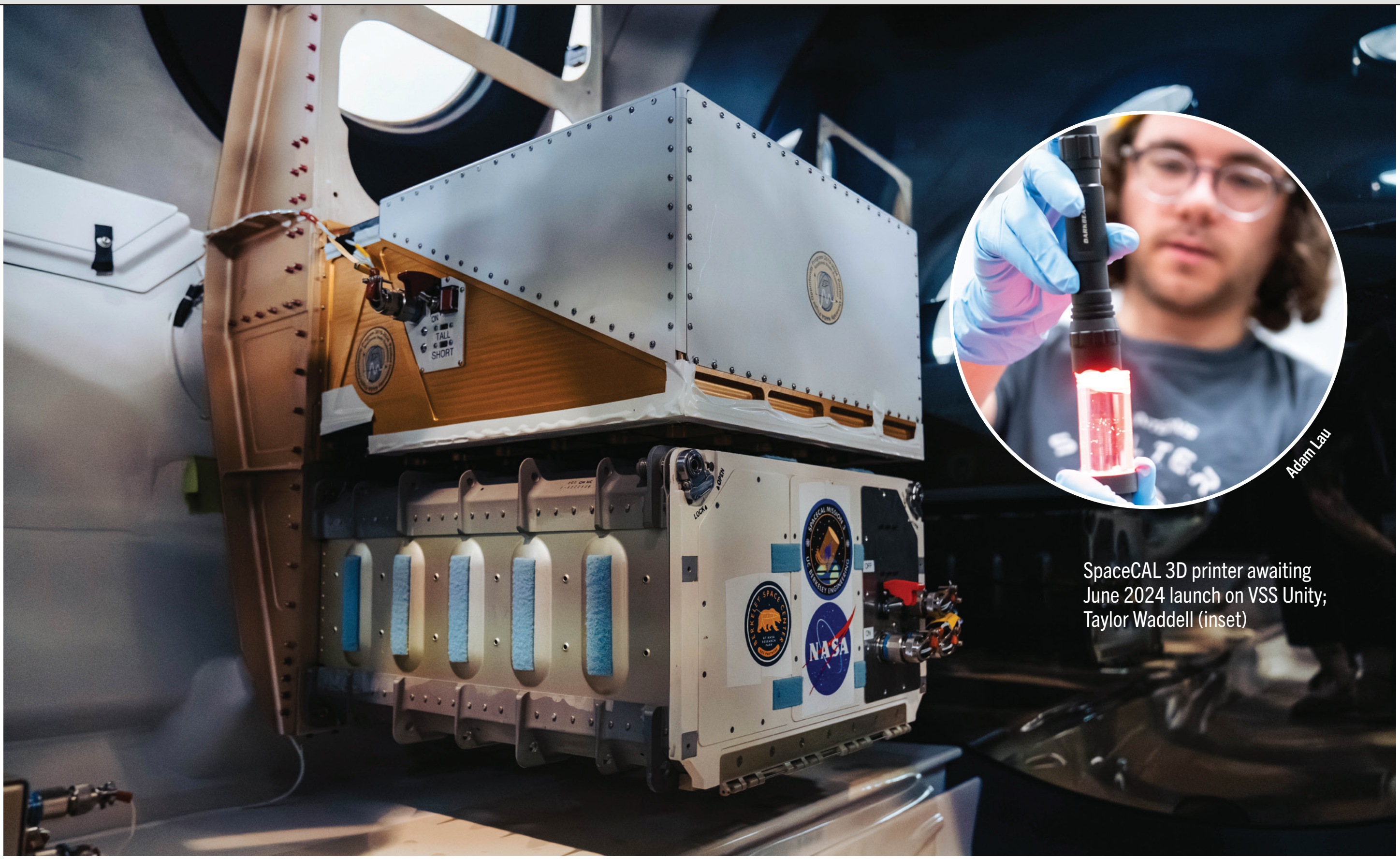
Ashraf Habibullah (M.S.'70 CE), CEO of Computer and Structures Inc., returned to campus in September to deliver a talk on the importance of "human engineering" in education, drawing a crowd of civil and environmental engineering students.

Nuclear engineering undergraduate student **Eric He** was awarded a 2024 fellowship by Tau Beta Pi, the engineering honor society.

Teresa Head-Gordon, professor of bioengineering, of chemistry, and of chemical and biomolecular engineering, has been honored with a research award from the Humboldt Foundation, which fosters collaboration with German scientists.

Dorit Hochbaum, professor of industrial engineering and operations research, has been awarded the 2024 Khachiyan Prize by the INFORMS Optimization Society.

Electrical engineering and computer sciences graduate students **Logan Horowitz, Syed Tahmid Mahbub, Jiarui Zou** and professor **Robert Pilawa-Podgurski**



SpaceCAL 3D printer awaiting June 2024 launch on VSS Unity; Taylor Waddell (inset)

Adam Lau

Courtesy Virgin Galactic

Manufacturing in microgravity

Imagine a crew of astronauts headed to Mars. About 140 million miles away from Earth, they discover their spacecraft has a cracked O-ring. But instead of relying on a dwindling cache of spare parts, what if they could simply fabricate any part they needed on demand?

A team of Berkeley researchers, led by mechanical engineering Ph.D. student **Taylor Waddell,** may have taken a giant leap toward making this option a reality. This summer, they sent their 3D printing technology to space for the first time as part of the Virgin Galactic 07 mission. Their next-generation microgravity printer — dubbed SpaceCAL — spent 140 seconds in suborbital space while aboard the VSS Unity space plane. In that short time span, it autonomously printed and post-processed a total of four test parts, including space shuttles and benchy figurines from a liquid plastic called PEGDA.

“SpaceCAL performed well under microgravity conditions in past tests aboard parabolic flights, but it still had something to prove,” said Waddell. “This latest mission, funded through NASA’s Flight Opportunities program and with support from Berkeley Engineering and the Berkeley Space Center, allowed us to validate the readiness of this 3D printing technology for space travel.”

3D printing has evolved considerably since the 1980s. In 2017, **Hayden Taylor,** associate professor of mechanical engineering, led a team of Berkeley and Lawrence Livermore National Laboratory researchers that invented Computed Axial Lithography (CAL) technology. CAL, which uses light to shape solid objects out of a viscous liquid, expanded the range of printable geometries and functioned well in microgravity conditions, opening the door to applications related to space exploration.

CAL also stands apart from other 3D printing technologies because of its incredible speed — creating parts in as little as 20 seconds — and efficiency. By enabling astronauts to print parts on demand, CAL potentially eliminates the need to bring thousands of spare parts on long-duration space missions.

In addition, CAL’s unique ability to print well in microgravity conditions allows engineers to explore the limits of 3D printing from space. To date, CAL has shown that it can successfully print with more than 60 different materials on Earth, such as silicones, glass composites and biomaterials. According to Waddell, this versatility could come in handy for both the cabin and the crew.

“So, with the cabin, if your spacecraft is breaking down, you can print O-rings or mechanical mounts or even tools,” he said. “But CAL is also capable of repairing the crew. We can print dental replacements, skin grafts or lenses, or things personalized in emergency medicine for astronauts, which is very important in these missions, too.”

Next, Waddell and his colleagues hope to begin work with NASA on developing and validating a single object that could support crew health and wellness, like a dental crown for an astronaut or a surgical wound closure tool.

“These experiments are really focused on pushing technology for the betterment of everyone,” said Waddell. “Even though it’s for space, there are always tons of ways it can benefit people back here on Earth.”

STORY BY MARNI ELLERY

have received a Best Showcase Award at the 2024 ARPA-E Energy Innovation Summit. In collaboration with researchers from the University of Illinois Urbana-Champaign and other academic and industry partners, the Berkeley team developed technology that aims to drastically improve the efficiency of future data centers.

Cesunica Ivey, assistant professor of civil and environmental engineering, has won the Sloan Scholars Mentoring Network's Early Career Alumnus Award in recognition of her past and future contributions to research, teaching, professional service and community service.

Maryam Kamgarpour (M.S.'07, Ph.D.'11 ME) won the European Control Award for her research in the SYCAMORE lab.

Electrical engineering and computer sciences assistant professor **Angjoo Kanazawa** has won the IEEE/CVF Computer Vision and Pattern Recognition Conference Young Researcher Award, which recognizes researchers who have made distinguished contributions to computer vision within seven years of receiving their Ph.D.

Yasser Khan (Ph.D.'18 EECS) has been honored by the David and Lucile Packard Foundation as one of the 2024 Packard Fellows

Precision under pressure

It was in the early morning of October 5 when ESPN set up on Memorial Glade for College GameDay. This was the first time the sports channel brought its hugely popular pre-game show — running since 1987 — to Bear Territory. A few hours into the broadcast, thousands of Cal fans trained their eyes on **Daniel Villasenor,** a sophomore in civil engineering who'd been on-site since 11 p.m. the night before, as he took on the program's field goal challenge.

Wearing a pair of weathered Vans slip-on shoes, Villasenor strode up to the football and missed his first attempt. Host **Pat McAfee** then made an offer: if Villasenor successfully made his next try, not only would he up the prize from $75,000 to $100,000, but he'd add in an extra $100,000 to College Game Day's hurricane relief donation.

As Oski, Cal cheerleaders and sign-waving fans intently watched, Villasenor took his second 33-yard shot, which easily cleared the goal posts. The crowd erupted into a frenzy of cheers and wild celebration. The kick quickly went viral across social media — and Villasenor, a soccer player who'd only attempted just a few field goals in his life, became a new and surprising legend in Cal football lore.

Phil Ellsworth/ESPN

for Science and Engineering. An assistant professor of electrical and computer engineering at USC, he was recognized for his ground-breaking research on neurochemical dynamics in the brain and gut, exploring their connections to physiological processes and disease mechanisms.

Electrical engineering and computer sciences assistant professor **Preeya Khanna** (Ph.D.'17 BioE) has received the New Innovator Award from the U.S. National Institutes of Health. She will study how different parts of the brain collaborate to "control precise movements, like handling objects" and will develop stimulation techniques that aim to boost neural communication across these areas. Khanna is also the recipient of a Google Research Scholar Award.

Materials science and engineering Ph.D. student **Calton Kong** has been named a winner of a prestigious Hertz Foundation Fellowship. His research focuses on sustainable energy conversion.

Kevin Kornegay (M.S.'90, Ph.D.'92 EECS) was elected as a fellow of the American Association for the Advancement of Science. He is currently a professor in the Department of Electrical and Computer Engineering at Morgan State University.

Jason Lee (B.S.'05 ME) joined a team of four volunteers who entered the Human Exploration Research Analog (HERA) to embark on a simulated mission to Mars. Their 45-day stay involved conducting scientific research and operational tasks, including simulated walks on Mars' surface.

Johanna Mathieu (M.S.'08, Ph.D.'12 ME), associate professor of electrical and computer engineering at the University of Michigan, is a 2024 C3E Fundamental and Applied Research Award winner. Her research focuses on using new operational and control strategies to reduce the environmental impact, cost and inefficiency of electric power systems.

Scott McCarey (M.S.'01 CEE) was named the new director of transportation services at the University of Colorado Boulder.

Donald Mendoza (M.S.'95, Ph.D.'96 ME) has been named the chief engineer for the NASA Engineering and Safety Center at Moffett Field. In addition, he serves on the mathematics and statistics faculty at Menlo College.

Maj Mirmirani (M.S.'71, Ph.D.'77 ME) was named interim dean of the College of Engineering at Lawrence Technological University.

Civil and environmental engineering professor **Kara Nelson** received the 2024 Faculty Award for Outstanding Mentorship of GSIs, which is presented to a UC Berkeley faculty member who has provided outstanding pedagogical mentorship to GSIs in preparation for teaching in future careers.

Civil and environmental engineering assistant professor **Eyitayo Opabola** has been named the 2023 Shah Family Innovation Prize recipient by the Earthquake Engineering Research Institute.

Kristin Persson, professor of materials science and engineering, has been named a 2024 Distinguished Scientist Fellow by the U.S. Department of Energy's Office of Science for "pioneering data-driven approach to accelerate clean energy innovations."

Civil and environmental engineering assistant professor **Amy Pickering** (M.S.'04 CEE) was named a 2023 Rising Star in Environmental Research by ACS Environmental AU. Her research focuses on environmental transmission pathways of enteric pathogens and drug-resistant bacteria in high-disease burden settings.

Rebecca Portnoff (Ph.D.'18 EECS) was selected for MIT Technology Review's "35 under 35 innovators" list for 2024 for her efforts in using AI to fight the sexual abuse of children.

Ravi Prasher, adjunct professor of mechanical engineering, and **Sayeef Salahuddin,** professor of electrical engineering and computer sciences, have been elected as fellows of the American Association for the Advancement of Science. Salahuddin also won the IEEE Andrew S. Grove Award "for pioneering contributions to physics of ferroelectrics and integrated ferroelectric devices."

Ramamoorthy Ramesh (Ph.D.'87 MSE), professor of materials science and engineering, has been elected to the National Academy of Sciences (NAS). He is one of the few scholars who has earned membership in both the NAS and the National Academy of Engineering.

Electrical engineering and computer sciences professor **Alberto L. Sangiovanni-Vincentelli** was elected to the American Academy of Arts and Sciences in recognition for his excellence in developing and improving a variety of modern electronics systems.

Electrical engineering and computer sciences assistant professor **Sophia Shao** has won the Anita Borg Early Career Award from the Computing Research Association's Committee on Widening Participation in Computing Research.

Kendra V. Sharp (MEng '96 ME) has been appointed the next dean of the School of Engineering at Santa Clara University, beginning her term in March 2025. Since 2021, she has headed the National Science Foundation's Office of International Science and Engineering.

Barbara Simons (M.S.'81, Ph.D.'81 EECS) was honored this fall for her years of work on voting integrity and her leadership as board chair of Verified Voting. Nancy Pelosi presented Simons with an award for her unwavering commitment to securing our elections.

Nuclear engineering professor **Kai Vetter** has been named a recipient of the Berkeley Lab's Director's Award for Lifetime Achievement in recognition of his "career-spanning achievements in radiation detection and imaging, his impact on science and society, and his commitment to developing the next generation of scientific leaders."

Electrical engineering and computer sciences professor **Laura Waller** has been awarded a Max Planck-Humboldt Medal, awarded jointly by the Max Planck Society and the Alexander von Humboldt Foundation, for "combining computer science and simple instruments to achieve such things as making more details visible and creating three-dimensional images or videos."

Linnea Warburton (M.S.'22, Ph.D.'24 ME), a postdoctoral researcher in professor Boris Rubinsky's lab, was recognized by the Society of Cryobiology with the Crystal Award for best oral presentation and the Critser Award for highest ranked student abstract.

Hakim Weatherspoon (Ph.D.'06 CS) is a 2024 Diamond Award honoree from the University of Washington's College of Engineering.

Bioengineering professor **Michael Yartsev** was named a Howard Hughes Medical Institute Investigator. In addition, he was given the 2024 Boehringer Ingelheim FENS Research Award by the Federation of European Neuroscience Societies, in recognition of his outstanding and innovative work.

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Forrest Anderson (B.S.'53 CE) died in August at the age of 92. After serving in the Army Corps of Engineers, he founded the engineering construction company Anderson Pacific.

Charles Brazie (B.S.'67 ME) died in August at the age of 81. He had a long career at Booz Allen, Arthur D. Little and Arthur Young & Company, and was president at a St. Louis-based telecom company.

Robert Broze (B.S.'62 EECS) died in March at the age of 88. He held leadership positions at Fairchild Research, Applied Materials, Actel Corporation and Infineon Technologies. He also helped further advance flash memory technology.

Thomas Chan (M.S.'73 EECS) died in June at the age of 76. He had a long career as an electrical engineer in Silicon Valley and was a leader in the semiconductor industry.

Frank Collins (Ph.D.'68 ME) died in September at the age of 86. He worked as an assistant professor at the University of Texas, Austin, then at the University of Tennessee Space Institute, where he served on the faculty for over 30 years as professor of aerospace engineering.

Peter Crosby (B.S.'67 IEOR) died in April at the age of 78. He worked for nearly 40 years as a supply chain management consultant at Kearney, Coopers & Lybrand and CGR Management Consultants LLC, which he founded in 1984.

Steven Greenberg (B.S.'82 ME) died in February at the age of 65. He worked at Berkeley Lab for nearly 40 years, becoming an expert in energy efficiency in laboratories, data centers and clean rooms.

William Halnan (B.S.'60 MSE) died in August at the age of 86. He had a long career as a metallurgical engineer, first at Hexcel, and then at Temescal Metallurgical Corp., where he worked for 26 years.

Dale Harden (B.S.'63 ME) died in May at the age of 83. He joined General Electric's Power Generation division as a field engineer, advancing to senior management during his 32-year career.

James Hoffman (M.S.'67 ME) died in February at the age of 79. He had a long career as a marketing systems manager at computer leasing company Comdisco.

Milton Kodmur (B.S.'48 ME) died in July at the age of 100. A U.S. Air Force veteran, he was a second lieutenant during World War II, and he later embarked on a career in air conditioning equipment.

William Lattin (B.S.'68, M.S.'69 EECS) died in June at the age of 83. A U.S. Navy veteran, he held leadership positions at Motorola, Intel, Logic Modeling and Synopsys.

Ingham Mack (B.S.'67 EECS) died in April at the age of 79. He worked as an engineer at Westinghouse, the Naval Research Lab and the Office of Naval Research, and he was an adjunct engineering professor at the University of Maryland, College Park.

James Masson Jr. (B.S.'42 ME) died in March at the age of 102. A U.S. Navy veteran, he served during World War II, earning a Bronze Star Medal for valor. He went on to have a long career at Chevron.

Alfred Mendoza (B.S.'57 EECS) died in June at the age of 94. A veteran of the U.S. Army, he had a 35-year career at Lockheed Missiles and Space Company.

Ian Mitroff (B.S.'61 Eng. Physics, M.S.'63 CE, Ph.D.'67 IEOR) died in June at the age of 86. Considered the founder of the discipline of crisis management, he served on the faculty at USC and was an adjunct professor in UC Berkeley's College of Environmental Design.

Daniel Mohn (B.S.'58 CE) died in July at the age of 92. After serving in the U.S. Army, he began a 37-year career in bridge engineering and construction.

Fred Offenbach (B.S.'50 EECS) died in July at the age of 97. A veteran of the U.S. Navy, he had a long career as an electrical engineer in the telecommunications industry.

Robert Pettitt Sr. (B.S.'58 EECS) died in July at the age of 88. He began his career at Hughes Aircraft Company, working on Surveyor I and Telstar 1. He later worked at the National Institutes of Health before becoming an ophthalmologist.

Michael Pickering (B.S.'64 CE) died in April at the age of 83. He had a successful career as a traffic engineer for the State of California and the City of Oakland.

Richard Propp (Ph.D.'98 ME) died in December at the age of 54. He completed postdoc work at Berkeley Lab before joining Real Time Solutions. He later worked for PeopleSoft and Workday, writing foundational code.

William Rhoades (M.S.'65 ME) died in March at the age of 86. A U.S. Navy veteran, he had a long career at Northrop Grumman, playing a pivotal role in developing the Northrop B-2 Spirit.

Sigmund Roh (M.S.'72 EECS) died in April at the age of 85. A veteran of the Korean Air Force, he worked as an engineer for Bechtel, the U.S. Army Corps of Engineers and the U.S. Department of State.

William Slivkoff (B.S.'58 EECS) died in June at the age of 92. A U.S. Navy veteran, he pioneered the development of the Global Positioning System (GPS) and held patents for equipment he designed at Ford Aerospace and Stanford Telecommunications.

William Smith (B.S.'53 CE) died in May at the age of 93. A veteran of the U.S. Navy, he served for 21 years as a pilot and engineer. Later, he worked at Lockheed Martin and Northrop Grumman.

Sehat Sutardja (M.S.'85, Ph.D.'88 EECS) died in September at the age of 63. He was known for co-founding Marvell Technology, which became one of the world's largest chipmakers. A long-time supporter of the college, he served on the Berkeley Engineering Advisory Board and, through his donations, made possible the construction of Sutardja Dai Hall and the new Engineering Center.

Kenneth Takeda (B.S.'51 CE) died in April at the age of 94. He spent more than a decade testing aircraft structures at Boeing and Douglas Aircraft Company. Later, he worked for 45 years as an orthodontist.

Tuan Tran (B.S.'91 EECS) died in April at the age of 58. After working as a design engineer at Rockwell International, he spent most of his career as an outpatient internist at Kaiser Permanente Medical Group.

Chung-Yiu Wong (M.S.'62 CE) died in March at the age of 90. He began his career at Bechtel, working on East Bay BART stations. Later, he worked as a civil engineer at Koppers Inc. and R.T. Patterson Company.

Peter Woods (B.S.'56 ME) died in July at the age of 89. His career spanned Lawrence Livermore National Laboratory and several small companies, including RPC Technologies.

James Yuengert (MEng '86 CE) died in May at the age of 67. He served as an engineer in the U.S. Army, earning the rank of major. After retiring, he worked at the U.S. Department of State and the Smithsonian Institution.

Keegan Houser

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