College of Engineering
University of California, Berkeley
Spring 2015
Volume 7

SPECIAL DESIGN ISSUE

Welcoming makers to Jacobs Hall

The many frontiers of synthetic biology

Berkeley ENGINEER

IN THE DOMAIN OF DESIGN

Constructing a new approach to engineering

At the intersection of design and entrepreneurship

As we anticipate the fall opening of Jacobs Hall, home to the Jacobs Institute for Design Innovation, we look forward to the expanded opportunities the new building will bring to our students. Twenty-four thousand square feet of studio space with modern prototyping and fabricating equipment will be the foundation of an undergraduate curriculum newly focused on project-based, team-oriented, hands-on learning.

While design and innovation are interrelated, the linkage between the two is not always linear. At Berkeley Engineering, we are committed to building an extensive innovation ecosystem that ensures that our students not only learn how to design, but also how to translate ideas and designs into sustainable, high-impact ventures.

That's where the Center for Entrepreneurship & Technology comes in. In 10 years, CET has grown from a single course to a model of technical innovation in an entrepreneurial environment. With their unique pedagogy, the Berkeley Method of Entrepreneurship, faculty leads Phil Kaminsky, Ikhlaq Sidhu and Ken Singer use game-based learning to develop an entrepreneurial mindset and hone networking skills.

Along the way, the team has demonstrated that entrepreneurship is not something that belongs to a talented few, but can, in fact, be taught. And, as we can now say, scaled as well!

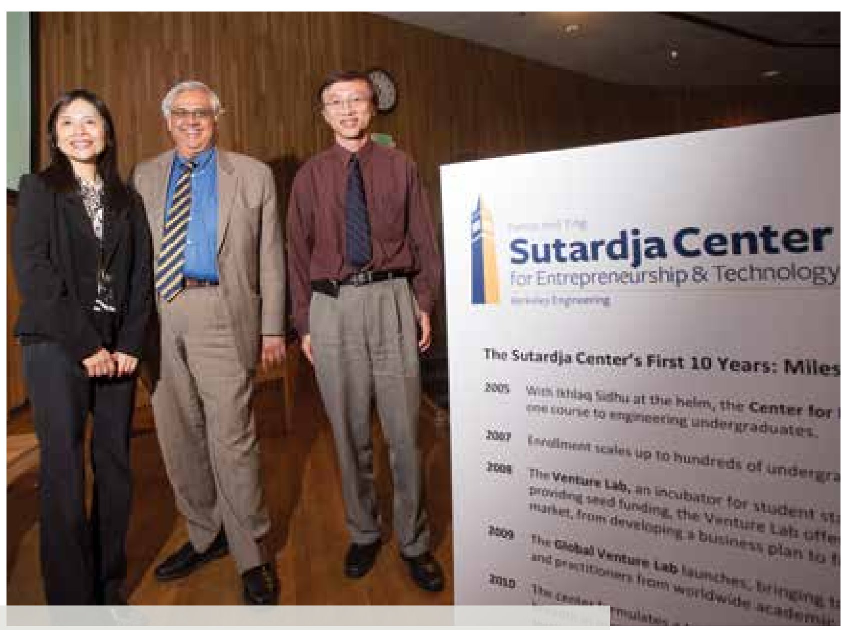
A generous gift from Pantas Sutardja and Ting Chuk, both Berkeley Engineering graduates, is enabling the center to fulfill its vision as a catalyst for technology innovation and to propel many more students and faculty into entrepreneurial careers in both new ventures and established companies.

As Pantas says, "Berkeley has such a strong academic reputation — it will be wonderful for more students to take what they learn here and create a culture of innovation wherever they go."

We are tremendously grateful to our entire community, and especially to our generous benefactors, for making possible at Berkeley Engineering this exciting new era of engineering education combining design innovation and entrepreneurship.

Design is the first step in an extensive innovation ecosystem here at the college.

—*S. Shankar Sastry*
DEAN AND ROY W. CARLSON PROFESSOR OF ENGINEERING
DIRECTOR, BLUM CENTER FOR DEVELOPING ECONOMIES



Noah Berger

At a celebration on campus on April 21, Dean Sastry announced the expansion of the newly renamed Pantas and Ting Sutardja Center for Entrepreneurship & Technology, which will move to new headquarters in Memorial Stadium this summer.

in this issue

BerkeleyENGINEER SPRING 2015

MORE >

> COVER PHOTO NOAH BERGER

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Manny Fernandez

STILL IN FASHION: EECS professors David Patterson and Carlo Séquin, pictured in 1981, were recently honored, along with other Berkeley computer scientists, for their role in developing the Reduced Instruction Set Computer (RISC) — technology that revolutionized the way microprocessors function.

Seismic song

To mark the achievement of 100 years vertical, the campus has planned several celebrations throughout the year for the iconic Sather Tower, also known as the Campanile.

One such event, which made local and national news, happened on a moonlit night in February. Industrial engineering and operations research professor **Ken Goldberg** and art practice professor Greg Niemeyer, working with the support of the Berkeley Center for New Media, devised a live performance based on real-time seismological data.

The piece, called "Natural Frequencies," linked data from sensors recording the shifting of the Hayward Fault underground to a light show and the Campanile's 61-bell carillon — creating a symphony in three movements. Other equally daring festivities are planned for a full year of celebration.

> campanile.berkeley.edu

MILESTONES

Simplify: The RISC story

It was a time when Blondie, Pink Floyd and Olivia Newton-John topped the Billboard music chart. "Let's go back to 1980," said **David Patterson** recently, addressing a group gathered to mark the unveiling of a milestone award. "It's a year before the IBM PC. Four years before Macintosh." Computing, as we know it now, was still over the horizon.

The crowd, consisting of circa-1980 alumni, faculty members and industry representatives, joined Patterson in remembering how a group of Berkeley computer scientists first started working on a better way of designing microprocessors, a change that would eventually enable personal workstations and then mobile computing.

The Berkeley project became known as the Reduced Instruction Set Computer (RISC), and the result was the development of single-chip microprocessors. The technology — novel, even counter-intuitive at the time — was led by Patterson and fellow computer science professor **Carlo Séquin.**

"Throughout the 1970s, the prevailing wisdom was that the best way to exploit the increasing capabilities of semiconductor technology was to similarly increase the complexity of computer architecture," said Howard Michel, president of the Institute of Electrical and Electronics Engineers (IEEE), during his remarks at the celebration.

The RISC team took the opposite approach and stripped down semiconductor technology to its bare bones, realizing that unnecessary complexity came at the cost of overall computing power. Processing and memory were put on the same chip, performance increased, and soon RISC chips were outperforming other systems. The RISC research was made open-source, spun off into a variety of related projects and later widely commercialized.

Today, RISC roots are used in ARM-based microprocessors, which are the foundation of most smartphones. "The 'R' in ARM stands for RISC," said Patterson. "They shipped 10 billion ARM processors last year, more than one for every person on the planet."

In February, Patterson, Séquin and other members of the original RISC team were awarded an IEEE technology milestone for their landmark efforts. A plaque honoring the achievement hangs in the plaza entryway of Soda Hall.

"It was a remarkable moment in time when a dozen Berkeley graduate students could build a better microprocessor than Intel could build," said Patterson.

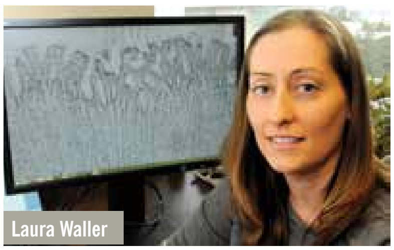
"...!" SEND THE EDITORS YOUR COMMENTS, CLASS NOTES AND UPDATES: **berkeleyengineer@berkeley.edu.**

FACULTY RESEARCH

Fostering disruptive technologies

Customized models of brain and heart vasculature; making visible the phase change of cells on low resolution optics; a wearable device to improve pediatric imaging; and finding alternatives to dyeing denim — all are engineering projects spawned by the 2015 Bakar Fellows program. Started in 2012 by Berkeley's vice chancellor for research, the campuswide program aims to translate novel applied research into commercially viable properties.

Selected from a pool of early career faculty in engineering sciences, Bakar Fellows receive $75,000 a year for five years to support research that could potentially impact California's economy. The faculty members featured below are among the 16 Bakar Fellows who currently receive support from the program.


Laura Waller


Shawn Shadden (right)


John Dueber (right)


Ana Claudia Arias

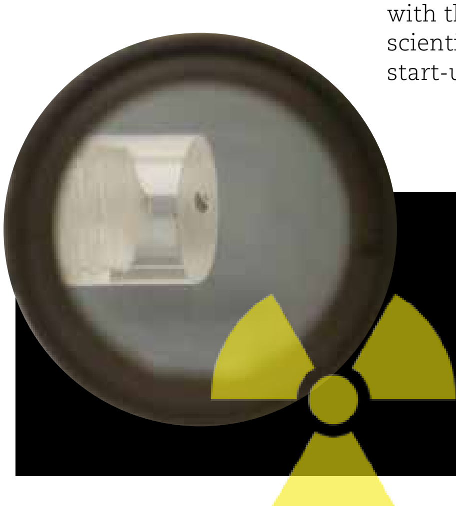
Peg Skorpinski photos

Laura Waller, assistant professor of electrical engineering and computer sciences (EECS), builds software to serve as the equivalent of Photoshop for the microscopic world. Waller's algorithms convert large amounts of visual data into high-resolution images critical for medical diagnostics. "We use 'cheap and dirty' optics to achieve the results of expensive, highly corrected microscopes," she says. "Imaging labs probably already have the needed hardware, so they would only need the software."

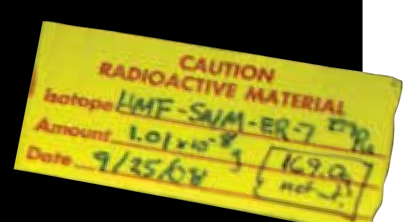
"Science is one thing, but when you talk about making clinical advances, there are so many steps you need to take," says mechanical engineering assistant professor **Shawn Shadden,** who develops computational tools to model how blood flows through the vascular system — research that could one day lead to modeling treatment options following a stroke or heart attack. "Besides working with regulatory agencies, you need to know how to identify and protect the core intellectual property, and connect with the investors and other scientists who have created start-ups," he says.

Assistant professor of bioengineering **John Dueber** aims to reform a dirty $66 billion industry by scaling a better way to produce the indigo dye commonly used in the manufacture of denim. Dueber and his team of students have used lab-based methods to convert indigo from plants to a blue dye to replace petroleum-based synthetic dyeing techniques. "Students want to make a difference with their research," Dueber says. "We're still going to focus our research on academically interesting questions, but when there are industrial applications, we want to be aware of that. We'd all like to see our indigo research lead to greener blue jeans."

Associate EECS professor **Ana Claudia Arias** is addressing the shortcomings of imaging techniques for children too small or wiggly to obtain good results. With EECS colleague **Miki Lustig,** Arias embeds radio frequency coils needed to get an MRI signal into flexible materials to be worn by the smallest patients. The technology is able to produce results as good as conventional methods. Arias eventually wants to develop image sensors to be sewn into blankets. "When you see kids in the hospital, it's scary for them — when they're in a blanket, it's a much more comforting experience," she says. "We want to swaddle them."



LOST AND FOUND: During the tranquil winter break, news broke of an interesting campus discovery, or re-discovery. Locked in a windowless closet in the university's hazardous materials storage area was a fleck of early plutonium developed through the Manhattan Project. The late Berkeley chemist Glenn Seaborg and a team of scientists were the first to figure out how to synthesize plutonium, for which Seaborg was awarded the 1951 Nobel Prize in chemistry. "This is the first sample of plutonium large enough to be weighed and its mass determined," says professor of nuclear engineering **Eric Norman,** who led the analysis verifying the find.



CEE lecturer Susan Amrose develops electrochemical remediation technology to remove arsenic from drinking water.

DEVELOPMENT ENGINEERING

For clean water

Ten years ago, physics major **Susan Amrose** was passing a classroom where civil and environmental engineering professor **Ashok Gadgil** was teaching the course Design for Sustainable Communities. She sat in on the first class and wound up staying the semester. Today, she teaches the course.

The Gadgil Lab, known for its revolutionary Berkeley Darfur cookstoves, was also working on a modular and scalable way of removing arsenic from groundwater in South Asia.

"I realized this is where I wanted to be," says Amrose, now a lecturer in civil and environmental engineering, "doing science that could be immediately applied to development challenges."

As many as 200 million people drink water with varying levels of arsenic, which, though naturally occurring, can cause cancer and other illnesses with high or chronic exposure. "It has been called the largest mass poisoning in human history," says Amrose.

By 2009, Amrose and Gadgil had teamed up with Berkeley Lab staff scientist **Robert Kostecki** and built an electrochemical arsenic remediation (ECAR) prototype. Steel plates submerged in a large tank of water are electrified via a small voltage to accelerate rusting. The iron oxides bind to arsenic, causing it to sink to the bottom.

Luminous Water Technologies now uses the team's technology in schools and villages in India and Bangladesh. Closer to home, Amrose and Berkeley alum **John Pujol** started SimpleWater, a company to distribute the technology to small rural communities in the U.S. — including California's Central Valley, which contains the nation's highest arsenic levels.

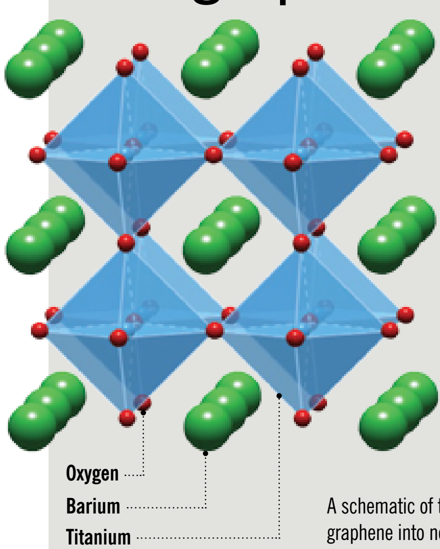
In all cases, Amrose remains loyal to her biggest idea of all: bridging the gap between research and real-world applications. "A lot of great technology and research doesn't end up making an impact because it doesn't cross that chasm," she says. "We can do better. We can really have more of a hand in making these things create impact in the world."

MATERIALS

The graphene switch

Studies presented this spring at the International Solid-State Circuits Conference estimate that Moore's Law — the observation that the number of transistors on a square inch of integrated circuits doubles every two years — will continue to hold true until transistor size reaches seven nanometers. At the current rate of size reduction, this means that around 2018, the material boundaries of silicon might be met. Further reductions in transistor size will become difficult without alternative manufacturing methods.

That's why graphene, a one-atom-thick layer of crystalized carbon, holds so much promise. So far, it is the heir apparent for integrated circuit design — its material properties could allow for even smaller, more powerful transistor design. While the inability to control polarity in graphene has limited its applications, research conducted by associate professor of materials science and engineering **Lane Martin** has demonstrated a way to manipulate the polarity of graphene (essentially emulating the devices in silicon that make up our computers today) by controlling the nature of its electrons. The research, published in *Nature Communications,* was done in partnership with material scientists from the University of Pennsylvania and the University of Illinois at Urbana-Champaign.



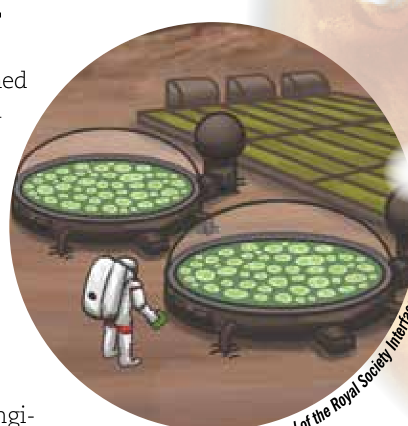
A schematic of the atomic crystal structure like the ones used to turn graphene into next-generation devices.

BIOENGINEERING

The many frontiers of synthetic biology

From the astronomical. . .

Aerospace engineers working for NASA estimate that it will take 916 days for a manned spacecraft to get safely to Mars, complete a mission and then make the return trip, if launched from Earth with today's technology. Most of the journey's complexity stems from crew support. In order to decrease the load and propel a heavy, provision-laden craft across millions of miles, engineers are developing various Mars-based chemical and mechanical manufacturing techniques.



Courtesy of the Journal of the Royal Society Interface

Syn bio on Mars? Researchers say that manufacturing needed resources during missions will make deep space exploration feasible.

Synthetic biology, specifically genetically engineered microbes that can act like the matter-converting replicators in *Star Trek,* offers much promise. Using basic biological processes to create material goods would enable space missions to become self-sufficient and reduce the mass of equipment and supplies compared to proposed abiotic techniques. On a mission to Mars, biology-based space manufacturing can lower payload by 26 to 85 percent, according to recent research published jointly by Berkeley engineers and NASA researchers.

"One goal of our paper is to advocate for an expanded role for synthetic biology in space science, with a view toward future mission deployment," says **Amor Menezes,** a postdoctoral researcher at QB3, the UCSF-based California Institute for Quantitative Biosciences. Menezes is the lead author of a recent *Journal of the Royal Society Interface* article that featured space-made biologically produced fuel, food, plastics and medicine. **Adam Arkin,** professor of bioengineering and division director of physical biosciences at Berkeley Lab, along with two scientists from NASA Ames Research Center, co-authored the paper.

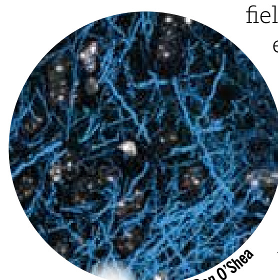
The researchers identified microbes that can be engineered to convert gases from the Martian atmosphere or a spacecraft's waste stream into useful supplies. A methane-oxygen fuel blend can be produced by harnessing *Methanobacterium thermoautotrophicum,* a single-celled organism common in sewage treatment plants and hot springs; cyanobacteria, such as *Arthrospira* or *Synechocystis,* can make spirulina food or the painkiller acetaminophen; and construction-grade biopolymers needed for 3-D printing replacement parts can be engineered from a soil bacteria, *Cupriavidus necator.*

"Space synthetic biology is truly groundbreaking. Abiotic technologies were developed for many, many decades before they were successfully utilized in space, and biological technologies like synthetic biology are only now seeing development efforts," Menezes says. "So, of course these technologies have some catching-up to do when utilized in space. But it turns out that this catching-up may not be that much, and in some cases, the technologies may already be superior to their abiotic counterparts."

. . .to the anatomical

Rather than gazing out across the heavens, bioengineering professor **Sanjay Kumar** has focused his attention inward. By engineering proteins inspired by the structural components of nerve cells, Kumar and a team of postdoc researchers are creating a smart coating that can be used in biological sensors, valves, drug delivery systems and medical diagnostic equipment.

"This work represents a unique convergence of the fields of biomimetic materials, biomolecular engineering and synthetic biology," Kumar says. "We created a new class of smart, protein-based materials whose structural principles are inspired by networks found in living cells."



Dan O'Shea

Back on earth, researchers are building syn bio versions of neurofilaments.

Kumar and his team sought to create the biological equivalent of synthetic polymer brushes that are used in a variety of products, such as paint and cosmetics, to keep small particles from glomming together. They were inspired by neurofilaments, proteins that form the main structural networks within certain nerve cells.

The surfaces of individual neurofilaments are coated with protein "bristles" that act like polymer brushes. The bristles can form a stable network, which can prop open the nerve cell and allow electrical signal conduction.

Kumar's team engineered a version of these bristles that could be bacterially synthesized in large quantities, purified and assembled with precise orientation on surfaces. The bristles expanded and collapsed dramatically if the salinity or acidity of the surrounding solution was changed, making them a sort of "smart" material. They are now actively exploring the properties and applications of the new biological materials.

"We showed that our 'protein brush' had all of the key properties of synthetic brushes, plus a number of advantages," Kumar says.

HOW DO I FIND OUT MORE?

Find links to source articles, news details and expanded coverage at **engineering.berkeley.edu.**

IN THE DOMAIN OF DESIGN

STORY BY PAUL PREUSS
PHOTOS BY NOAH BERGER

BJÖRN HARTMANN is always on the move, but one good place to find him is at the CITRIS Invention Lab, which he co-founded with mechanical engineering professor Paul Wright and co-directs with fellow electrical engineering and computer sciences professor Eric Paulos. In the big, open workspace in Sutardja Dai Hall, students are constantly rearranging benches, tool racks, parts cabinets and other paraphernalia. Everything needed for a design team to plan and prototype — and prototype again and again — is close at hand.

"The vision of the Invention Lab is to have high-value digital fabrication tools and to make them available to anyone," says Hartmann — one reason why the Invention Lab is available to all Berkeley students and staff. "The most interesting work happens in collaborations."

Hartmann grew up a native of the digital age. Born near Heidelberg in 1978, when personal computers were being introduced, he has used computers in everything he has done, especially music.

"There was a small annex in our house used by a music school, where I learned to play the piano in jazz combos," he says. "Before there was an Internet, we used bulletin board systems, and people would dial in and leave messages. I became part of a music group that existed only virtually; it probably took us a year before we met in person."

While still a teenager, he gained a reputation as an avant-garde composer and DJ, using PCs to create music. These dual enthusiasms made for a winding path to an academic career. Even after receiving bachelor's and master's degrees in digital media and computer science from the University of Pennsylvania and studying human-computer interaction in Paris and Rome, Hartmann was undecided between a career in research or music.

Music won the first round. He moved to Amsterdam in 2002 and co-founded Contexterrior Media, managing a clutch of record labels and performing as a recording artist and DJ on tours of Europe and Japan. The experience was creatively fulfilling, but he ran into an unexpected problem: success.

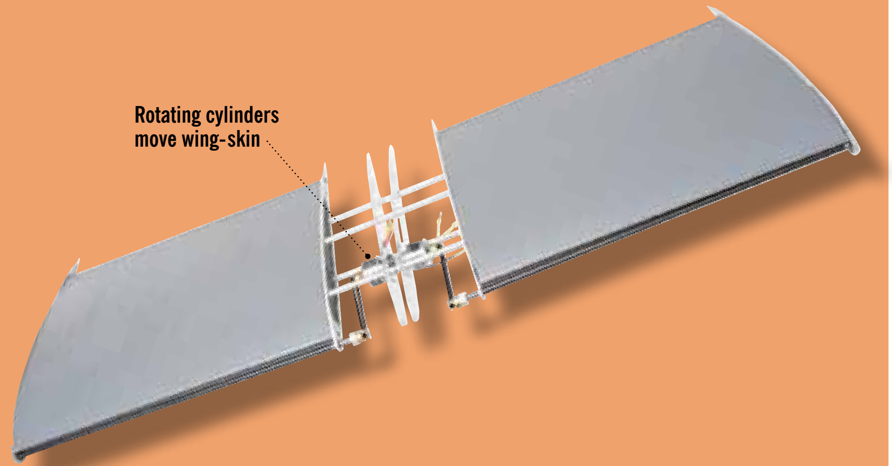
"If you're successful in business, the incentives are to do more of the same," he says. By contrast, "At a university, the freedom to explore is part of the job description."

Hartmann returned to research, putting all of his experience to use. "Running a startup company, and believing that with tenaciousness you can see it through, was immensely helpful for my research afterwards." He received his Ph.D. in computer science at Stanford in 2009 with work on user interface design, and joined the Berkeley Engineering faculty shortly thereafter.

Last spring, the college named Hartmann chief technology officer for the Jacobs Institute for Design Innovation, launched in 2013; anticipating the fall 2015 opening of the institute's new headquarters, Jacobs Hall, Hartmann is poised to help drive the next stage of the digital revolution.

As the institute's name suggests, it's all about design. Ask Hartmann what design means, and he quotes Herbert Simon, the polymath and Nobel Prize-winner in economics: "Everyone designs who devises courses of action aimed at changing existing situations into preferred ones."

Simon made the remark in 1968, when design education at even the best engineering schools was under threat from a nationwide shift favoring the natural sciences. Design is the core of all professional training, Simon argued, whether the subject is medical treatment, a business sales plan or the social policies of government. Radical at the time, his view gained traction in the late '70s. Now business, government, the arts and education have all embraced "design thinking."



DESIGN TEAM | Harshil Goel / Zachary Hargreaves / Jordan Greene

PROTOTYPE | Vires Aero

Summer jobs are as much a part of Berkeley's undergraduate experience as dorm rooms and Tele-BEARS. For Harshil Goel (pictured below), now a graduate student in mechanical engineering, the summer job he landed a few years ago changed his life — and maybe even the future of flight.

As an undergraduate math major at Berkeley, Goel got a summer job at a wind tunnel in Kanpur, India. Often too hot to sleep at night, he pored over technical texts on aerodynamics on loan from his supervisor. One footnote, claiming that a certain type of aerodynamic control was not possible due to complexity, caught his attention, and he took it as a challenge. With his mathematics background and expertise in fluid dynamics, he developed an experiment to disrupt the boundary conditions and to prove this type of control was achievable. When he came up with a solution, he first thought, "This should make things better," and then, "Has anyone ever done this?"

He built a proof of concept with strategically embedded rotating cylinders tangent to the surface of the wing. When he tested it in the wind tunnel, wing lift and stall characteristics improved dramatically. When he returned to campus, he joined up with EECS student Zachary Hargreaves and business major Jordan Greene; the team planted themselves in the machine shop in Etcheverry Hall to build more wings and unmanned aerial vehicles (UAVs) to further test the technology. They crashed a lot of models before finding the right set-up for a moveable wing-skin, which they call active circulation control.

Once deployed, the technology allows slower moving aircraft with shorter wings, like UAVs, to carry bigger payloads. If used on other vehicles, active circulation control could improve fuel efficiency.

Goel is now co-founder and CEO of Vires Aeronautics Inc. The company has attracted the attention of venture capitalists, enabling the team to purchase time at a University of Washington wind tunnel to further refine the technology.

Momentum balance
$$u\frac{\partial u}{\partial s} = -\frac{1}{\rho}\frac{dp}{ds} + \nu\frac{\partial^2 u}{\partial y^2}$$

DESIGN FOR THE INTERNET OF THINGS

Engineers wearing their design hats have always sought to match technology and human needs, Hartmann says, because "the domain of design — what can be designed and what should be designed — changes when the technology landscape changes."

He cites two classic furniture designs. In the 1920s, Marcel Breuer's Bauhaus chairs were inspired by the introduction of seamless tubular steel; in the 1940s, Charles and Ray Eames used their own plywood molding process to make a revolutionary wooden lounge chair. Exploring the aesthetics of novel technologies, both chairs achieved surprising beauty.

Motivated by the Breuer and Eames chairs, this spring the Jacobs Institute offered a class on Interactive Seating, taught by an interdisciplinary team headed by Hartmann and including professor of art practice Greg Niemeyer (also director of the Berkeley Center for New Media) and Robert Full, professor of integrative biology. Student designs for "smart chairs," with built-in new technologies to provide benefits such as feedback on posture, will be presented at the opening of Jacobs Hall.

It's no longer surprising to find computers built into something to sit on (or possibly fall asleep in). "Sensors and actuators and computation are moving everywhere into objects in the environment," says Hartmann, "into the age of ubiquitous computing, the Internet of Things."

The prospect, reaching far beyond furniture, sparks both excitement and fear. Devices vacuum up information to keep track of your keys and money, monitor your health — or steal your identity. With do-it-yourself tools, you can make everything from smart toys to automatic weapons. "As the technology landscape changes, it changes how we live our lives,"

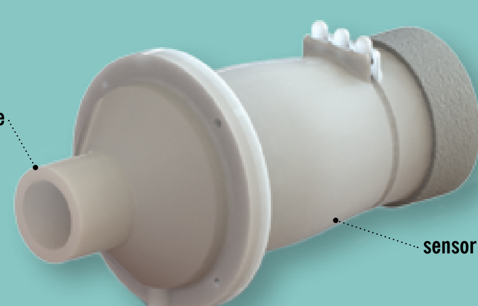
> "What's essential is to step back and ask, 'What does society need?' You have to stay decoupled from the solution until you've figured out the problem."
>
> —Amy Herr

DESIGN TEAM | Charvi Shetty / Huyson Lam / Inderjit Jutla

PROTOTYPE | KNOX Diagnostics

Spirometers measure airflow in and out of the lungs. Charvi Shetty (pictured above right), who has a B.S. in bioengineering from Berkeley and an M.S. in biomedical imaging from UCSF, says they're indispensable for an asthma diagnosis but can be quite expensive: desktop models in pediatricians' offices can cost $2,000 or more. Shetty is founder and CEO of KNOX Medical Diagnostics, which soon plans to introduce a spirometer-based monitoring device for around $100. The idea was hatched in bioengineering professor Amy Herr's capstone design class and immediately produced a sensing device with a mobile app for data analysis that provides feedback asthmatics can put to immediate use. The original plan included a nitrogen oxide (NOx) sensor, thus the name KNOX — now something of an inside joke, since "nitrogen oxide as an asthma biomarker hasn't been validated in the U.S.," Shetty says, and isn't part of the final design.

Making the device was straightforward; understanding the market wasn't. In Herr's course and a follow-up course at UCSF, Shetty and her colleagues interviewed over 200 patients, clinicians and insurance executives. To their surprise, major insurance companies regarded potential savings as too trivial. Supported by the Foundry@CITRIS and Founder.org, KNOX decided to go directly to consumers, targeting not just severe asthmatics but all those, even with milder symptoms, who can benefit from the device.



Prototype AKA "Spiritus" = Latin for "breathing"

$60,000 from UCSF to fund clinical trials starting in June 2015.

says Hartmann. "How should one design applications and products for a future where everyday objects have computing power built in?" The question is at the heart of human-centered design.

In his Interactive Device Design course, co-taught with Wright in the Invention Lab, Hartmann poses the question directly to students from engineering, business, art, cognitive science and other disciplines. They team up to create devices specifically designed to respond to their users.

Well-stocked with components like Arduino microcontrollers and Raspberry Pi microcomputers, the lab is equipped with advanced machinery. "More and more fabrication tools are now entirely software-driven, for example 3-D printers and laser cutters," Hartmann says. "So if you have the right machines and put in the time to create a 3-D representation of the object you want to build, the machine does the rest."

Students hone their skills by examining the design process from consumer research to finished prototype. Teams who want to try starting a business with a promising new gadget are eligible for fellowships, grants and workspace.

The Invention Lab, along with other facilities like the Cal Design Lab in the College of Environmental Design and the Haas School of Business Innovation Lab, exemplifies a new teaching style, with professors as "guides on the side" to help students as needed; in the Invention Lab, professional technicians are on hand with supplies and useful advice.

Hartmann calls this kind of facility and the education it makes possible a "workable model to grow in the Jacobs Institute" when Jacobs Hall opens. "But the Jacobs Institute has a larger mission, to which the fantastic faculty will bring their own expertise."

'WICKED PROBLEMS'

One faculty member is professor of mechanical engineering Alice Agogino, who will teach her classic course in Introduction to Product Development to a hundred students this fall in Jacobs Hall's largest studio. Agogino introduced the concept of design thinking to the College of Engineering shortly after she came to Berkeley in 1984 — years before the term itself had entered the language.

She recalls being asked to create a seminar in design theory and methods and reaching out to "the inquiry disciplines, the creative arts, rhetoric," and many other departments across the campus. "It was the intellectual foundations of how they framed design that I wanted to understand, where they intersected. What could we learn from each other?"

Among those whose ideas impressed her was Horst Rittel, a professor in the

continued on page 12

DESIGN TEAM | David Lu / Deepak Talwar / Hannah Hagen / Baljot Singh

PROTOTYPE | Clarity

Atmospheric science major David Lu (pictured above) returned from a trip to air-polluted Beijing in 2013 with a sore throat and an idea. He shared the latter with his organic chemistry study partner Hannah Hagen, from the College of Natural Resources. "Wouldn't it be great to have something you could plug into a phone and read off pollution levels?" he asked. He'd come to the right person: "My vision was to start a business to protect the environment," says Hagen. Joining forces at the beginning of 2014 with mechanical engineering major Deepak Talwar — Hagen jokes that "we're from the U.S., China and India, so we have all the world's pollution covered" — they created Clarity, a key-chain-sized monitor that sends data on fine particulates to the user's phone and can combine with other users' data to map an entire city's pollution picture in real time. With help from the Foundry@ CITRIS, including Invention Lab access, plus backing from U.S. and China-based startup accelerator HAXLR8R, Clarity will launch the system in Beijing this October with a thousand users — a hundred or more of them go-everywhere bicycle messengers to establish a baseline.

Jacobs Hall: New home for design innovation

Starting in fall 2015, future engineers, artists and game-changers from many fields will have an inspiring new environment for advancing visionary ideas into designs to help improve the world.

The 24,000 square feet of the newly constructed Jacobs Hall, at the northeast corner of campus next to Soda Hall, serves as a hub for the Jacobs Institute for Design Innovation. Five design studios with access to the latest equipment for rapid prototyping and fabrication provide enough space to let ideas loose.

JACOBS INSTITUTE FOR
DESIGN INNOVATION
COLLEGE OF ENGINEERING, UC BERKELEY

To learn more about the Jacobs Institute for Design Innovation and its new home, see **jacobsinstitute.berkeley.edu.**

DESIGN

At its core, the Jacobs Institute for Design Innovation is about education. The primary focus is preparing undergraduate students to combine technical skills with design theory to develop original solutions and technologies, based on human-centered design principles.

> "It's so cool to make something yourself, to know that it came from your head and that you can make something tangible, like a building, like a device — literally anything you can think of, and that you can change the world with that."
>
> — **PAUL JACOBS,** QUALCOMM EXECUTIVE CHAIRMAN, AT THE JACOBS HALL TOPPING-OUT CELEBRATION IN FEBRUARY 2015

BUILD

Students from a wide variety of academic disciplines with varying levels of technical experience will collaborate to complete project-based assignments using state-of-the-art facilities. Jacobs Hall will offer:

- CAD/CAM lab, electronics lab, A/V equipment and maker space
- Laser cutters, 3-D printers and other rapid prototyping equipment
- CNC router, waterjet cutter, shop and hand tools

LAUNCH

At the Jacobs Institute for Design Innovation, ideas and prototypes will lead to solutions for all sorts of social problems, and will be an integral part of Berkeley's expanding innovation ecosystem of technology translators, entrepreneurial ventures and start-up incubators.

DESIGN COURSE | CE 186: Design of Cyber-Physical Systems

PROTOTYPE |

Smart scooter

Scott Moura (pictured below) had a breakthrough while watching kids ride scooters in the streets of Paris a few years ago. He had recently been invited to join the Berkeley civil and environmental engineering faculty, and was asked by fellow professors Steven Glaser and Raja Sengupta to help design a cyber-physical course and relate it to the smart energy grid, one of Moura's research areas.

"We wanted students to have some kind of hands-on activity," says Moura, "but when we talk about electric vehicles, it's not feasible to give students their own electric vehicle. At the time, I was studying in France and watching kids ride these Razor-like scooters and thought: why not design the course around these scooters? That was the genesis of the hands-on portion of the class."

CE 186: Design of Cyber-Physical Systems was taught for the first time last spring. In addition to riding the scooters to collect data, students modified open-source hardware platforms to measure voltage, state-of-charge and current. Their final step was to write software that controlled the charging infrastructure via a cloud-based web app.

College of Environmental Design. In 1973, Rittel had introduced the term "wicked" to describe certain problems, the very nature of which makes them hard to define, much less to solve creatively and effectively.

Some design problems are tame (tame problems have rules and unambiguous resolutions, like a game of checkers); Agogino says they're routine and can often be handled by automation. "Designers should be working on the hardest problems, the wicked problems."

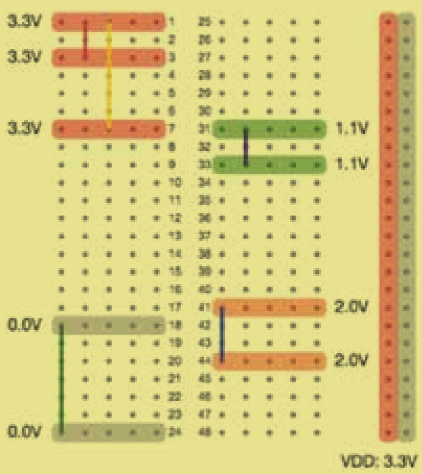
> "We're doing our best to create a little test bed in which the students can iterate. They learn to program an Arduino microcontroller on an electric scooter and ride around campus and collect data on their own mobility patterns."
> —Scott Moura

Rittel called design "an argumentative process," says Agogino. "He said that when you talk to your customers and other designers and different stakeholders, you're always making tradeoffs, and you have to understand what they are. To do this you need a deep, empathetic understanding of customers' and users' needs." She adds, "It looks like what today we call design thinking."

Another design thinker Agogino met early on was Sara Beckman, a senior lecturer at the Haas School of Business and an industrial engineer by training and experience. The two of them created a course in developing new products that is still going strong 20 years later. The course led to an emerging awareness of an underappreciated component of successful design: team diversity.

DESIGN TEAM | Filip Maksimovic / Julie Newcomb / Daniel Drew / Dominic Cincione

PROTOTYPE | ToastBoard



When graduate students Filip Maksimovic, Julie Newcomb, Daniel Drew and Dominic Cincione (pictured above) teamed up for a course in interactive device design, they had plenty of expertise among them: Drew and Maksimovic in electrical engineering; Cincione in mechanical engineering; Newcomb in computer sciences. They were all do-it-yourselfers and had plenty of ideas. However, no idea was simple enough to execute in less than a semester, which became particularly evident during the frustrating process of breadboarding: the painstaking wiring and rewiring of circuitry, again and again, until things finally work. Aha! Their frustration became opportunity.

How about a pluggable board that could instantly reveal everything wrong and right with a circuit, with columns of LEDs beside the plug boards to show what was connected to what? With basic data on an LCD screen and detailed information, via web client, on a nearby computer? The team split up to write the software, assemble the hardware and build the package, and inveterate punster Drew called the result a ToastBoard, "the Breader Breadboard" — a name, he says, "they all hated." Nevertheless, it stuck. "There's nothing like it," says Newcomb. "It's pretty cool." Lessons learned? "There wasn't enough time to dig into the areas of others' expertise. It became apparent how little we knew about each other's fields."

Academic and industrial studies have shown the practical worth of technical expertise, gender, ethnicity, age, socioeconomic status and other kinds of diversity in many kinds of teams. David Kolb of Case Western Reserve identified a different kind of diversity: how people learn. He graphed how we perceive information on a central vertical axis, with abstract thinking at the top and concrete experience at the bottom. How we process information he plotted horizontally from left to right, with reflective observation at one extreme, active experiment at the other.

In a 2007 journal article, Beckman and innovation consultant Michael Barry codified how learning styles affect the design process. Where abstract thinking and thoughtful observation overlap, the learning style is called "assimilation"; on a design team, these thinkers understand users' problems readily and can suggest a variety of solutions.

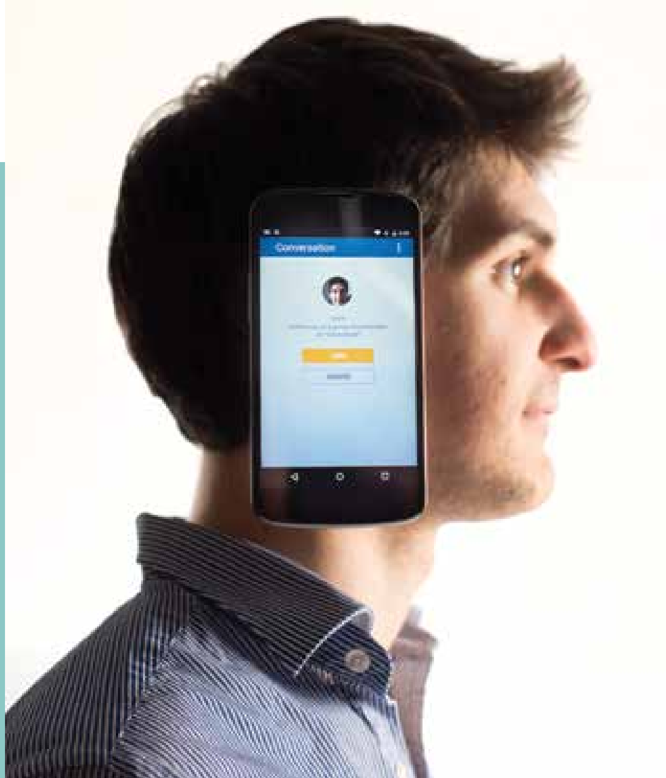
Where abstract thinking combines with active experiment, "convergent" thinkers may take the problem as a given, propose a single solution and go straight to prototype.

In experiential territory, where active experiment overlaps with concrete experience, "accommodators" test prototypes repeatedly and use what they learn to improve the design. Agogino calls these the "makers" of the world.

"It's tempting to think the design process proceeds in steps, but it's a lot messier than that," she says. "It's not linear at all. It involves lots of iterations."

The point becomes clear in the graph's final corner, where concrete experience overlaps thoughtful observation to result in "divergence." It's a rare style of learning about the world that can inform any stage of the design process; divergent thinkers have the off-the-wall ideas and unexpected insights into needs, solutions and even novel prototypes.

To quantify diversity's effect on design team performance, Agogino, Beckman and mechanical engineering doctoral candidate Kimberly Lau studied 33 student teams,



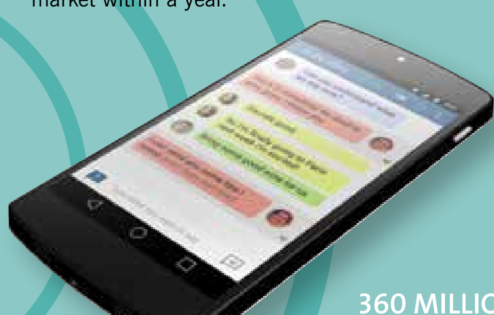
DESIGN TEAM | Thibault Duchemin / Pieter Doevendans

PROTOTYPE | Transcense

At SkyDeck's Kairos Society startup competition in 2013, Thibault Duchemin (pictured above), a graduate student in industrial engineering and operations research and the son of deaf parents, pitched an idea for a smart glove that could translate sign language into words on a screen. Pieter Doevendans, pursuing a master's in innovation sciences at the Haas School of Business, joined Duchemin's team because "Thibault wanted to solve a problem, unlike many ideas presented that weekend, which had no purpose."

At the end of the two-day competition, they presented their prototype, won Overall Best and launched a business. "We thought we knew what we had to build," says Doevendans — until they interviewed a hundred potential users. "The hard-of-hearing all said the glove was not what they wanted. The real problem was following group discussions. That was a big moment for us. We pivoted." Transcense was born when Duchemin and Doevendans recruited Skinner Cheng, a programmer who is deaf, to write the smartphone and web software.

Using the tool, individual speakers in a group conversation are recognized by their cellphones using existing speech recognition technology; in less than a second, the hard-of-hearing user's phone displays a running text of the conversation, colored-coded to each speaker. Crowdsourcing response was dramatic; continuing research involves 50 beta users, and Transcense could be on the market within a year.



360 MILLION: The number of deaf and hard-of-hearing people worldwide

focusing on different learning styles, as well as gender, expertise and other factors.

After the teams were ranked, it was clear that no style is inherently better or worse than another at predicting team success. In fact, when one learning style is overrepresented — or one gender, or one kind of expertise — performance suffers.

The handicap is lack of diversity. For example, none of the four all-male teams or five all-female teams scored in the top quarter. The highest score was won by a team with three women and one man, who represented a range of learning styles: two were assimilators, one a convergent thinker and one an iteration-enthusiastic accommodator.

Agogino sees the Jacobs Institute as highlighting diversity and other key issues in a way never before achieved at Berkeley. "Design is multidisciplinary," she says, "but it's a struggle to cross departmental boundaries. I see the Jacobs Institute as unleashing the creativity that comes from building on and transcending disciplinary strengths."

DENTS IN THE UNIVERSE

The Jacobs Institute is intended for undergraduates, and while many of them will be engineering majors, many others will come from the arts, humanities, business and social sciences. They'll tackle specific projects in teams, ask many questions of potential users, get their hands on modern materials and high-tech machines and prototype their ideas repeatedly.

To enable faculty members to take advantage of what Jacobs Hall will offer, Emily Rice, the institute's director of programs and operations, runs a "mini-grant" program to underwrite new courses or revise existing ones to become more hands-on.

The challenge isn't trivial. Rice taught a class in basic digital fabrication and was surprised to find her students had done little hands-on work. "Half of them had never used a drill before," she says. "It showed me just how far we've gotten, culturally, from being comfortable even with hand tools."

Computers, smartphones, tablets and apps (and television sets before them) may have seduced people into watching the world instead of handling it, but it's a transitional phase that won't last long. The makers are here. Close behind, a generation of do-it-yourselfers is growing up in a world where any device they can program can be fabricated and equipped with its own sensors, controllers, processors and communication. That's why "hands-on" — the *sine qua non* for most Jacobs Institute classes — is only the beginning.

“The myth of art and design is that you have to be born with the trait to be an artist or a designer. I believe it is much more a process and skill that can be learned — and consequently that we can teach, to lots of people.”

—Björn Hartmann

Bioengineering professor Amy Herr’s senior capstone Bioengineering Design Projects class focuses on novel instrumentation in medicine and basic biology. “What’s essential is to step back and ask, ‘What does society need?’ You have to stay decoupled from the solution until you’ve figured out the problem.”

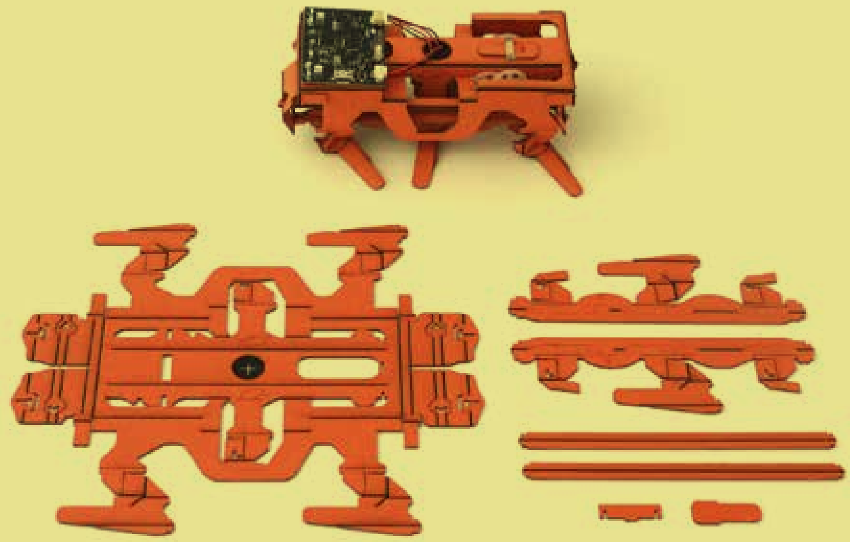
Herr says her design classes start with “the what, not the how” — understanding the need before jumping to a solution. “For us, it’s understanding and quantifying what’s needed, performance-wise,” and that depends on the user. “A test for Lyme disease may need to measure two biomarkers, while a systems biology problem may require hundreds.”

Once there’s a possible solution, prototyping and iteration are vital. “Fail early, fail often, fail cheap,” Herr says. “If it isn’t going to work, we want to know quickly.”

Scott Moura, a professor of civil and environmental engineering, cautions that “in civil engineering, it’s a whole different game,” where full-scale iteration may be impossible.

The capstone course Moura teaches, Design of Cyber-Physical Systems, investigates ways to integrate electric vehicles with the electrical power grid. By 2020, with many more electric vehicles on the road and an accelerating shift toward electricity from renewable sources, the demand on traditional generators will spike dangerously after the sun goes down. “We cannot afford, as a society, to let the grid break,” he says, “and then try to rapidly iterate our way to a solution.”

Any likely fix involves changing people’s behaviors and attitudes toward their cars — an especially wicked problem. Brainstorming on the phone with his colleagues while in Paris, Moura came up with a bit of divergent thinking. “Walking



Courtesy Dash Robotics

DESIGN TEAM | Paul Birkmeyer / Andrew Gillies / Nick Kohut

PROTOTYPE |
Dash Robotics

The Dash Robotics team came together as graduate students in EECS’s Biomimetic Millisystems Lab, creating minirobots inspired by birds that fly; geckos that climb straight up walls and cross ceilings upside down; and fast, agile, nearly unbreakable cockroaches. It was Paul Birkmeyer’s idea to make a cockroach-like — but much cuter — remote-controlled running robot, its structural parts cut from a flat sandwich of flexible plastic and posterboard. Teammate Nick Kohut says that when they put on demonstrations at middle schools, “The kids went nuts.” An educational-toy startup was born, hampered only because “we’re engineers; we could do lots of stuff, but we had no business experience.” The Foundry@CITRIS connected the dots with advice, seed money and access to work space and rapid prototyping. Then it came time to get formal: each member jotted down, in secret, who should do what. They agreed perfectly, says Kohut, who became CEO and handles external relations. Birkmeyer is the CTO, and Andrew Gillies the COO, in charge of product development. Crowdfunding supported the first 1,000 Dashes, which “fold up like origami” from a flat sheet for easy assembly and feature reprogrammable, Arduino-compatible circuitry; they’re fun, sophisticated and, at $50 each, a bargain.

DASH = Dynamic Autonomous Sprawled Hexapod

“What are we designing? Are we designing for those in extreme poverty? Are we designing for the human condition? I hope so, and I hope that becomes part of the Jacobs Institute story.”
—Alice Agogino

around Paris, I'd see kids zipping around on Razor scooters. We couldn't loan all our students a Volt, but maybe a $300 scooter…”

The course aims to test incentives for behavioral change. “We're doing our best to create a little test bed in which the students can iterate. They learn to program an Arduino microcontroller on an electric scooter and ride around campus and collect data on their own mobility patterns,” says Moura. Routes, charge levels and other variables are stored in the cloud and used to calculate how different schemes affect different goals — minimal CO_2 impact versus minimal cost.

“Reframing things creates new understanding,” says Eric Paulos, who looks forward to leading his Critical Making class in Jacobs Hall. “Constraints are your friends,” he says, adding that “design at its best is a critique, a transitional process that starts a debate into the different directions technology should go.”

These are crucial questions, says Alice Agogino. “What are we designing? For whom are we designing it?” Users are many, but “are we designing for those in extreme poverty? Are we designing for the human condition? I hope so, and I hope that becomes part of the Jacobs Institute story.”

For Björn Hartmann, the answers are personal. “Design has to be there from the beginning. The artifacts, the objects, the devices that really succeed in making a dent in the universe, they are what show concern for both technology and questions of human use. They have empathy with their users.” BE

DESIGN TEAM LEADERS | Lee-Huang Chen / Kyunam Kim

PROTOTYPE

NASA Tensegrity robots

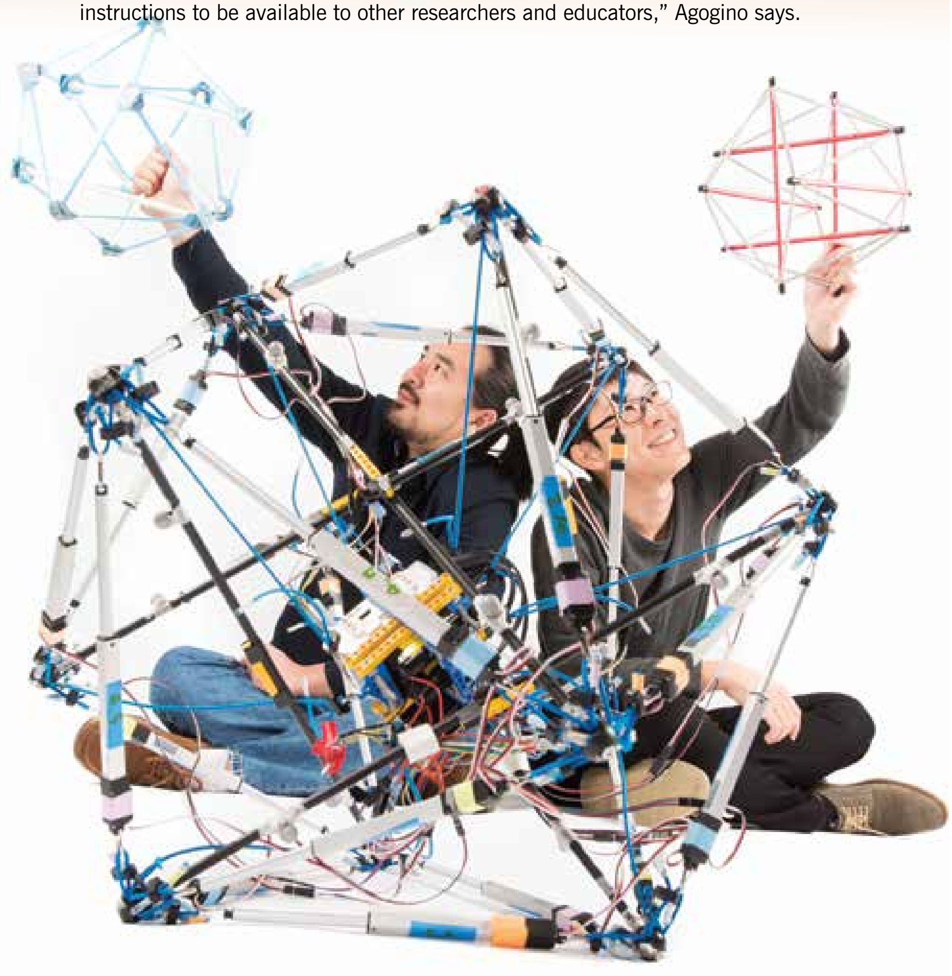
Based on a child's toy and named after an idea first floated in the 1950s by the futurist architect Buckminster Fuller, tensegrity robots are inspiring new ways of thinking about the form and function of automated devices.

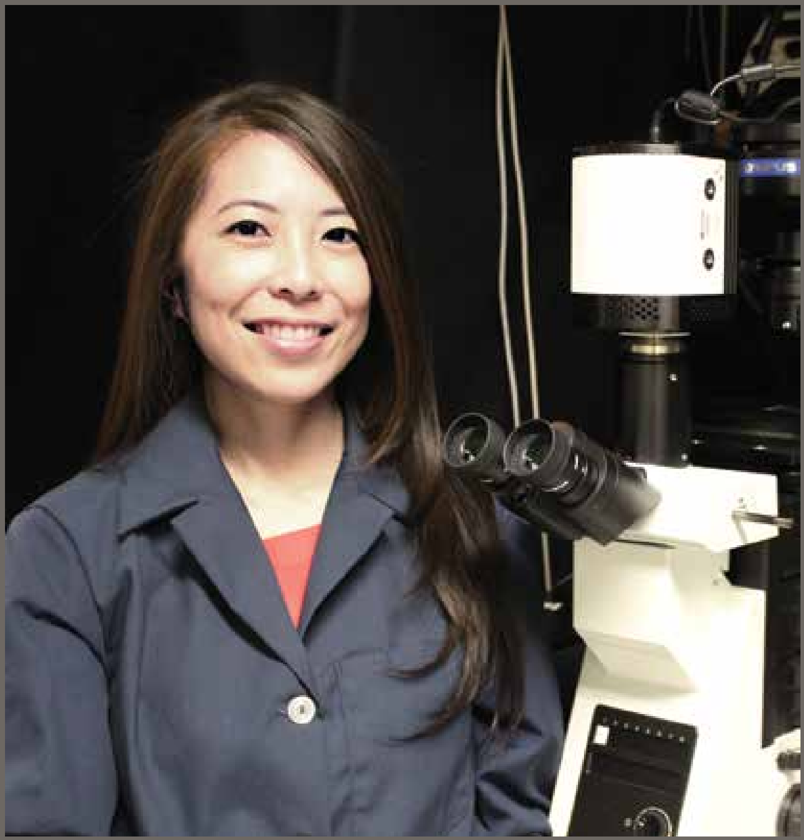
Tensegrity is the concept of finding the sweet spot between compression and tension, so that structures are flexible enough to adaptively respond to constraints and obstacles by changing form, yet maintain enough strength to spring back to a baseline structure once constraints are removed.

Alice Agogino, mechanical engineering professor and director of the Berkeley Emergent Space Tensegrities Robots lab, has partnered with NASA Ames researchers (one of the researchers is her son, Adrian Agogino) to develop applications for tensegrity technology. “The insights that we gain from our prototype testing are being used to inform NASA's larger production system,” Agogino says.

NASA is keenly interested in tensegrity robots because they can be folded, like flat-pack furniture, as payload on a spacecraft. At deployment time, the robots are unfolded and surface-bound cargo is suspended in the middle of the flexible structure. When dropped to the surface, the frame takes the brunt of the impact, cushioning its contents. Both bot and cargo arrive ready to move.

If a ball had bones, the resulting motion would probably resemble what a moving tensegrity robot looks like. Researchers call the motion “controlled punctuated rolling.” Agogino and her students are developing rapid prototyping kits and investigating other ways of deploying tensegrity robots, including for healthcare and education applications. “We are developing an open innovation approach to our rapid prototyping kit because we would like the designs and the do-it-yourself instructions to be available to other researchers and educators,” Agogino says.





Somin E. Lee (Ph.D.'10 BioE), assistant professor in electrical engineering and computer sciences and biomedical engineering at the University of Michigan, received a National Science Foundation CAREER award for her research in engineering plasmonic nanoantenna architectures for efficient nuclear delivery. Lee aims to improve gene therapy by delivering corrected genes directly to the cell nucleus of damaged genes, more efficiently and with greater control than is currently possible.

PHOTO COURTESY UNIVERSITY OF MICHIGAN

2010+

Saurabh Amin (Ph.D.'11 CEE), an assistant professor of civil and environmental engineering at MIT since 2011, researches the design and implementation of resilient network control algorithms for infrastructure systems, along with the effect of security attacks and random faults on the survivability of these systems, to design mechanisms to reduce network risks.

Cynthia Cruz (B.S.'12, M.S.'13 ME) is a clinical specialist for the medical device company Second Sight. She travels the country coordinating trainings and managing the programming of the company's retinal prosthesis. The device restores basic visual perception to those who have lost sight because of a degenerative condition called retinitis pigmentosa. The impact of Second Sight's technology was demonstrated in a video that showed a prosthetic user who sees his wife for the first time in 33 years; the moving clip was widely shared online this past winter.

Johanna L. Mathieu (M.S.'08, Ph.D.'12 ME) is an assistant professor of EECS at the University of Michigan. After graduating from Berkeley, she was a postdoctoral researcher at ETH Zürich, the Swiss Federal Institute of Technology.

Gregory McLaskey (Ph.D.'11 CEE) has received the American Geophysical Union's 2014 Keeiti Aki Young Scientist Award, offered to one scientist in the field of seismology each year. Upon graduating, McLaskey won the USGS Mendenhall Postdoctoral Research Fellowship, and then joined the faculty of Cornell University as an assistant professor of civil and environmental engineering in fall 2014.

Sunny J. Mistry (Ph.D.'14 ME) works at Apple on the product design team for iPhones and the Apple Watch, supporting the design engineering team to make designs more robust by simulating operations on computers.

Jack Reilly (M.S.'13, Ph.D.'14 CEE) received the Council of Universities Transportation Center's Milton Pikarsky Memorial Award for his dissertation, which describes new methods for coordinated, predictive and decentralized freeway traffic control to help create connected corridors and increased traffic flow.

2000+

Kshama Agrawal Mehra (B.S.'06 BioE) married her Cal sweetheart, Ravi Mehra (B.S.'04 Business), in May 2010. Their son was born in July 2014, and "he is looking forward to going to Cal in 18 years," according to his parents. Mehra is also involved with XX in Health, a women-in-health-tech group in Los Angeles.

Christopher Cherry (Ph.D.'07 CEE), an assistant professor of civil and environmental engineering at the University of Tennessee, Knoxville since 2007, received a National Science Foundation CAREER Award for his research in motorization and sustainability in China. He specializes in transportation planning, economics and sustainability.

Richard Din (B.S.'08 EECS and Economics) and **Andy Zhang** (B.S.'14 EECS) are co-founders of Caviar, a food delivery service that originated in San Francisco and has since expanded to Washington D.C., Chicago, New York and Seattle. In 2014, the company was acquired by the credit card and mobile payment company Square. "We started in a small room in our fraternity house, thinking about ideas and trying to build things, and we've been able to grow it into a very large and successful company," says Zhang.

Shanin Farshchi (B.S.'02 EECS) went on to earn his M.S. and Ph.D. degrees in electrical engineering from UCLA, and he has held technical positions at General Motors and several Silicon Valley technology startups. He is now a partner at Lux Capital, specializing in investing in hardware and robotics companies.

Kenneth Kuhn (M.S.'02, Ph.D.'06 CEE), an associate operations researcher at the RAND Corporation and a professor at the Pardee RAND graduate school in Santa Monica, California, specializes in transportation system operations, infrastructure management, the impacts of weather

SEND YOUR CLASS NOTES to **berkeleyengineer@berkeley.edu,** or mail to:
Berkeley Engineer, UC Berkeley College of Engineering, McLaughlin Hall #1704, Berkeley, CA 94720-1704.

and extreme events and logistics. Prior to RAND, he was an assistant professor at the University of Canterbury in Christchurch, New Zealand and an aviation systems researcher at NASA.

Cornelius Nuworsoo (Ph.D.'04 CEE), who earned a master's degree in city planning from Berkeley before completing his doctorate in engineering, joined the faculty of the College of Architecture and Environmental Design at Cal Poly, San Luis Obispo in 2005 and is now an associate professor. He has 22 years of experience in both urban and regional planning and in transportation engineering, and he is a member of the American Institute of Certified Planners.

Elizabeth Vargis (B.S.'04 BioE) joined the Utah State University faculty as an assistant professor of biological engineering in 2013, after earning her master's degree and Ph.D. in biomedical engineering from Vanderbilt University. She completed her postdoctoral training in Knoxville, Tennessee at Oak Ridge National Laboratory.

1990+

Pablo Durango-Cohen (M.S.'97, Ph.D.'02 IEOR) is now an associate professor of civil and environmental engineering at Northwestern University. He joined the faculty in 2001, and in 2006 he received a CAREER Award from the National Science Foundation for his work in transportation infrastructure systems.

Alums make pop, pop

Hooktheory founders **Dave Carlton** (B.S.'06, Ph.D.'12 EECS), **Chris Anderson** (Ph.D.'09 AS&T), and **Ryan Miyakawa** (B.S.'05, Ph.D.'11 Eng. Phys.), pictured left to right, first met on campus in 2005. Beyond engineering, they found they also shared a love of music.

In 2009, the trio considered creating a platform to simplify music education; from that evolved a unique form of music notation devoid of measures and staffs. They envisioned an intuitive platform with colorful bar graphics, like those in the Guitar Hero video games.

They developed a suite of products to bring their ideas to a broader audience. An online platform called Theorytab allows users to easily learn about and play back chord progressions and melodies from popular music. A free, web-based software program called Hookpad helps songwriters choose chords and write melodies for their own music.

"Our approach is great for people who don't have a lot of exposure to music theory, but at the same time, it can be applied to very complicated songs," Miyakawa says. "I was always worried that we were oversimplifying the music-theory side. But the music-theory geeks are the people that are really, really into this."

STORY BY NATE SELTENRICH • PHOTO BY BRUCE COOK

“California, We’re For You”

The Cal Alumni Association (CAA) has selected **Steve Wozniak** (B.S.’86 EECS) as the 2015 Alumnus of the Year and has honored **Yoky Matsuoka** (B.S.’93 EECS) with the Excellence in Achievement Award. Both recipients are credited with important technological innovations; a Silicon Valley icon and philanthropist, Wozniak co-founded Apple Computer Inc. with Steve Jobs in 1976, introducing the Apple I personal computer, while Matsuoka is recognized as having created the modern robotic hand.

Wozniak has demonstrated a strong commitment to education and has focused on computer capabilities in schools, hands-on learning and encouraging student creativity in various business and philanthropic ventures. Wozniak’s many awards include the ACM Grace Murray Hopper Award (1979), the National Medal of Technology from President Ronald Reagan (1985) and multiple honorary doctor of engineering degrees.

Matsuoka arrived in the U.S. at age 16 not knowing a word of English, yet a passion for engineering and technology led her to get a B.S. from Berkeley in EECS and advanced degrees from MIT. In 2009, she became Google’s head of innovation before joining Nest as the smart thermostat company’s vice president of technology, and she recently accepted the position of vice president of technology and analytics at Twitter. In 2007, she was named a MacArthur Fellow, and prior to that she won a Presidential Early Career Award and an IEEE early career award for her work on robotics.

STORY BY MIRANDA KING • WOZNIAK PHOTO BY MICHAEL BULBENKO • MATSUOKO PHOTO COURTESY YOKY MATSUOKO

Charles Manese (B.S.’90 EECS), an infrastructure engineer at Facebook, is part of the team responsible for data center, storage and networking technologies. Earlier, he was at Dell as an architect in the data center solutions group, designing and delivering hyperscale computer products.

1980+

Kevin Dong (M.S.’87, M.Eng.’88 CE) worked with the engineering firm Arup, initially in London and then in their San Francisco office, where he became an associate in 1990. In 2001, he started teaching at Cal Poly, San Luis Obispo, where he is now a professor in the architectural engineering department and associate dean of administration for the College of Architecture and Environmental Design.

Lorraine Fleming (Ph.D.’85 CEE) and **Gary May** (M.S.’87, Ph.D.’91 EECS), along with **Sheila Humphreys,** EECS director emerita of diversity, received the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM). The award is recognition for playing a crucial role in helping science and engineering students develop personally and professionally. “These educators are helping to cultivate America’s future scientists, engineers and mathematicians,” President Obama said of the awardees. “They open new worlds to their students, and give them the encouragement they need to learn, discover and innovate. That’s transforming those students’ futures, and our nation’s future, too.” Fleming is a professor at the College of Engineering, Architecture and Computer Sciences at Howard University, where she has held numerous leadership positions, including department chair and interim dean. Gary May is the dean of the College of Engineering at the Georgia Institute of Technology.

Thomas Holsen (B.A.’83 Env. Sci., M.S.’85, Ph.D.’88 CE) has been named the Jean S. Newell Distinguished Professor of Engineering at Clarkson University in New York. He is also associate director of Clarkson’s air resources engineering and science center, and has served on EPA science advisory board committees and on the board of the International Association of Great Lakes Researchers. With more than 140 journal publications, his research focuses primarily on environmental systems.

Ronald Kaneshiro (M.S.’79, Ph.D.’83 EECS) has been named vice president of engineering at Kaiam Corporation, a leader in hybrid photonic integrated circuit technology. Earlier, he was senior director at Avago Technologies and vice president and chief operating officer of systems and integration at Glo, a venture-backed company that develops advanced LED products using nanotechnology.

1970+

Reza Abbaschian (Ph.D.’71 MSE), dean of the Bourns College of Engineering at UC Riverside for more than 10 years, started his academic career at the University of Florida, where he rose from a materials science professor to department chair, a post he held for 16 years. He has published more than 250 scientific articles, holds five patents and eight disclosure patents and has authored eight books. His research focuses on the role of interfaces on the processing and properties of material. He is a past president of the American Society for Metals International, and has won several awards, including the Minerals, Metals and Materials Society’s Educator and Leadership awards and the Davis Productivity Award of the State of Florida.

George T. Hahn (M.S.’78 ME) has published the second novel in his planned sci-fi trilogy, *Tau Ceti: The New Colonists,* which takes readers through space travel and the building of a new world.

Glen Langstaff (B.S.’77 ME/NE) is general manager at ECS Refining, a leading recycler of electronics in the country, located in Stockton, California. He is working toward ECS’s vision of 100 percent recycling of all electronics in the U.S. (that figure is currently around 25 percent). Previously, he was vice president and chief operating officer at a robotics and contracting firm.

Young P. Oliver (M.S.’70 NE) is a pediatric neurologist in Omaha, Nebraska. His son is following in his father’s footsteps, now studying nuclear engineering at Texas A&M University.

1950+

Amiram M. Eisenstein (B.S.’51 EE), born on a chicken ranch in Petaluma, California in 1928, parlayed his youthful interest in tinkering with clocks, radios and cars to a degree in engineering. Eisenstein began his career in the U.S. Navy Bureau of Aeronautics, testing air-to-air guided missiles — “the best and most enjoyable job I ever had,” he says. In 1958, he joined Thompson Ramo Wooldridge Inc. (now Northrop Grumman), designing interconnecting cabling for the lunar excursion module. He later taught algebra and trigonometry at Cerritos High School, then worked at Litton Data Systems Group. In 1973, he moved to Culver City, where he worked on sensor and spacecraft programs for Hughes Aircraft Company until his retirement in 1989. He and his wife Becky returned to Sonoma County, where he has resumed repairing and restoring old radios — now for collectors and antique stores. He also enjoys making toys for his six-year-old grandson.

Jack Kubota (B.S.’52 CE) has had an engineering career in wastewater and sewage treatment management spanning nearly seven decades — an achievement recently recognized by the American Society of Civil Engineers (ASCE). His daughter Charleen Kubota, a UC Berkeley librarian, says, “The ASCE honor is a fitting tribute to my dad, whose work is exemplified by best engineering practices, exemplary professional conduct and generous mentoring of young engineers.” Kubota joined the U.S. Navy straight out of high school in 1946, and he pursued his education with the help of the G.I. Bill. Kubota began his career in the public sector, then the private; in 1972, he opened his own business. Kubota remains a member of the Independent Rates and Oversight Committee, a citizen’s advisory committee in San Diego.

Ernest Worthington Blee (B.S.'51 CE) died on January 3. Blee left high school early to join the U.S. Coast Guard during World War II, where he served as a radio operator. After Berkeley, he began a long career with Caltrans, where he was senior resident engineer for the Antioch Bridge. He later worked with Sverdrup Corp. and Jacobs.

Robert Anthony Dal Porto (B.S.'49 IEOR) died in January at the age of 89. He took time off during college to volunteer for the Navy Air Corps, serving as a Marine pilot in World War II. In 1946, he returned to school, where he lettered in track and football. He was a member of the Rose Bowl team under coach Pappy Waldorf and graduated at the top of his class. Until 1980, he was a rancher in Oakley, California; he then worked as an engineer for Chevron in Colorado. He remained a loyal Cal Bears fan throughout his life, a season ticket holder for many years and an active member of "Pappy's Boys."

Robert G. Dean (B.S.'54 CE) died in February at the age of 84. He earned a master's degree from Texas A&M in oceanography in 1956 and a Ph.D. from MIT in 1959, and was widely recognized for his expertise in coastal engineering. He directed Florida's Division of Beaches and Shores and was also a prolific teacher, holding faculty positions at several universities on the east and west coasts. He co-authored three technical books and hundreds of technical articles, and was elected to the National Academy of Engineering in 1980. Dean retired from the University of Florida in 2003.

William Louis Garrison, civil and environmental engineering professor emeritus and former director of Berkeley's Institute of Transportation Studies, died in February at age 90. Garrison served in the U.S. Army's meteorology branch during World War II, and later earned a Ph.D. in geography from Northwestern University. On the faculty of the University of Washington, he began using computerized statistical techniques such as multivariate analysis for geographic research. Garrison joined the Berkeley faculty in 1973 and retired in 1991. Of his many enduring contributions to the transportation engineering program, Garrison expanded and strengthened the planning and policy elements of the curriculum.

Irvan F. Mendenhall (B.S.'41 CE) died in July 2014 at age 96. He graduated just before the U.S. entered World War II, and he was commissioned by the U.S. Navy's Civil Engineering Corps in 1942. After the war, he returned to his hometown of Santa Maria, California, where he started his own engineering firm, Daniel, Mann, Johnson and Mendenhall, which eventually became one of the largest engineering firms in the country. He became president of the American Society of Civil Engineers in 1981 and was honored as Engineer of the Year by the Consulting Engineers Association of California and the Los Angeles Council of Engineering Societies.

James McCraney (B.S.'47 EECS) died on January 19. In 1941, McCraney began studying mechanical engineering and played clarinet in the Cal Band. He left school in 1943 to join the Army, seeing duty in India, Burma and the Philippines; when he returned to campus he switched over to study EECS. He worked for the California Public Utilities Commission for three years, until he was drafted during the Korean War. He spent his tour of duty in Spokane, Washington, where he met his wife, Janice. McCraney eventually returned to work for the utilities commission, where he worked for 40 years until his retirement in 1987.

Thorndike Saville (M.S.'49 CE) died in November at the age of 89. Saville attended Harvard for a year before joining the U.S. Army in 1943. During World War II, he served as a weather observer. After the war, he returned to Harvard to complete his degree. He then worked for the War Department, where he conducted studies of sediment and water movement in California. In 1971, he was named technical director of the Coastal Engineering Research Center, a position he held until his retirement in 1981. He was considered to be one of the foremost experts in coastal engineering.

Cravens (Chris) Wanlass (B.S.'50, M.S.'52 EECS) died in January at age 89. At age 17, he joined the U.S. Navy as an electronics technician. He fought in the Battle of Okinawa and was aboard the first ship into Japan after the signing of the armistice. He received many commendations for his service, including the World War II Victory and Asiatic Pacific Campaign medals, with two bronze stars. As a member of the UCLA engineering faculty, he designed the world's first airborne digital and transistorized computer and invented a high-efficiency electric motor. He was awarded 38 UC patents. He also held many important positions in industry, such as vice president and director of engineering and R&D for Packard Bell and director of electronics research for Ford Motor Aerospace division. He was awarded the Robinsons' Design Award for the Wanlass motor in 1977 and received special commendations from both the U.S. Senate and the House of Representatives for his energy-saving work.

Gaetano Borriello (Ph.D.'88 CS) died in February. After graduating from Berkeley, he joined the faculty of the University of Washington, where he was the Jerre D. Noe Chair of Computer Science and Engineering. His career spanned the areas of integrated circuits for networking, automatic synthesis of digital circuits, reconfigurable hardware and embedded systems development tools. In 2001, he founded the Intel Research Laboratory in Seattle, where he launched projects in elder care and in location-aware computing now used by Apple, Google and Microsoft. More recently, he was working on the application of mobile technologies to the challenges in public health and development in low-resource settings. His group's Open Data Kit — open resource mobile data collection tools — is in use worldwide.

PHOTO BY STEPHEN BRASHEAR

Borriello spoke on "Personalizing Public Health" at TEDxSeattle in 2010.

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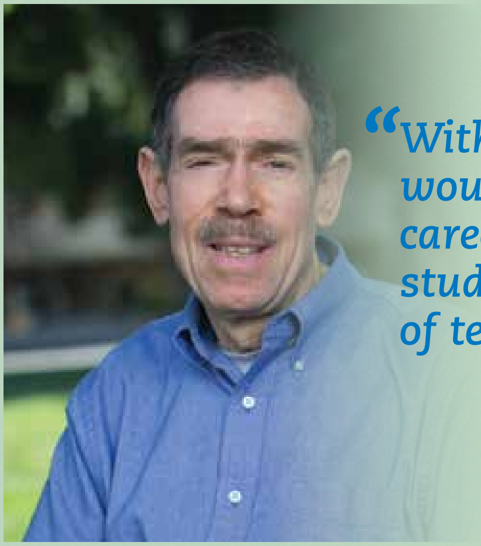
Bruce Cook

"Without my Berkeley education, I would not have had such a rewarding career. Now I want to enable future students to contribute to the advance of technology."

—TED KAMINS (B.S.'63, M.S.'65, PH.D.'68 EE)

Although he currently teaches at a rival institution across the bay, **Ted Kamins** still bleeds blue and gold. "Berkeley Engineering gave me the knowledge — both technical and intellectual — that exposed me to a lot of new ideas and launched me on a fascinating career," he says. With his three Berkeley degrees in hand, Kamins got involved in a technology that was then just emerging in Silicon Valley: semiconductor materials and devices. He is now an electrical engineering professor at Stanford University.

To show his thanks, Kamins regularly contributes to the Berkeley Engineering Fund. He has also developed an estate plan that will endow a faculty chair position in electrical engineering and computer sciences or in materials science and engineering. "It's gratifying," he says, "to be able to support the future of forward-looking research, innovation and teaching that will advance my field."

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Second-year civil and environmental engineering major Emily Stednitz, fabricating parts for the Steel Bridge team in the Davis Hall welding lab.