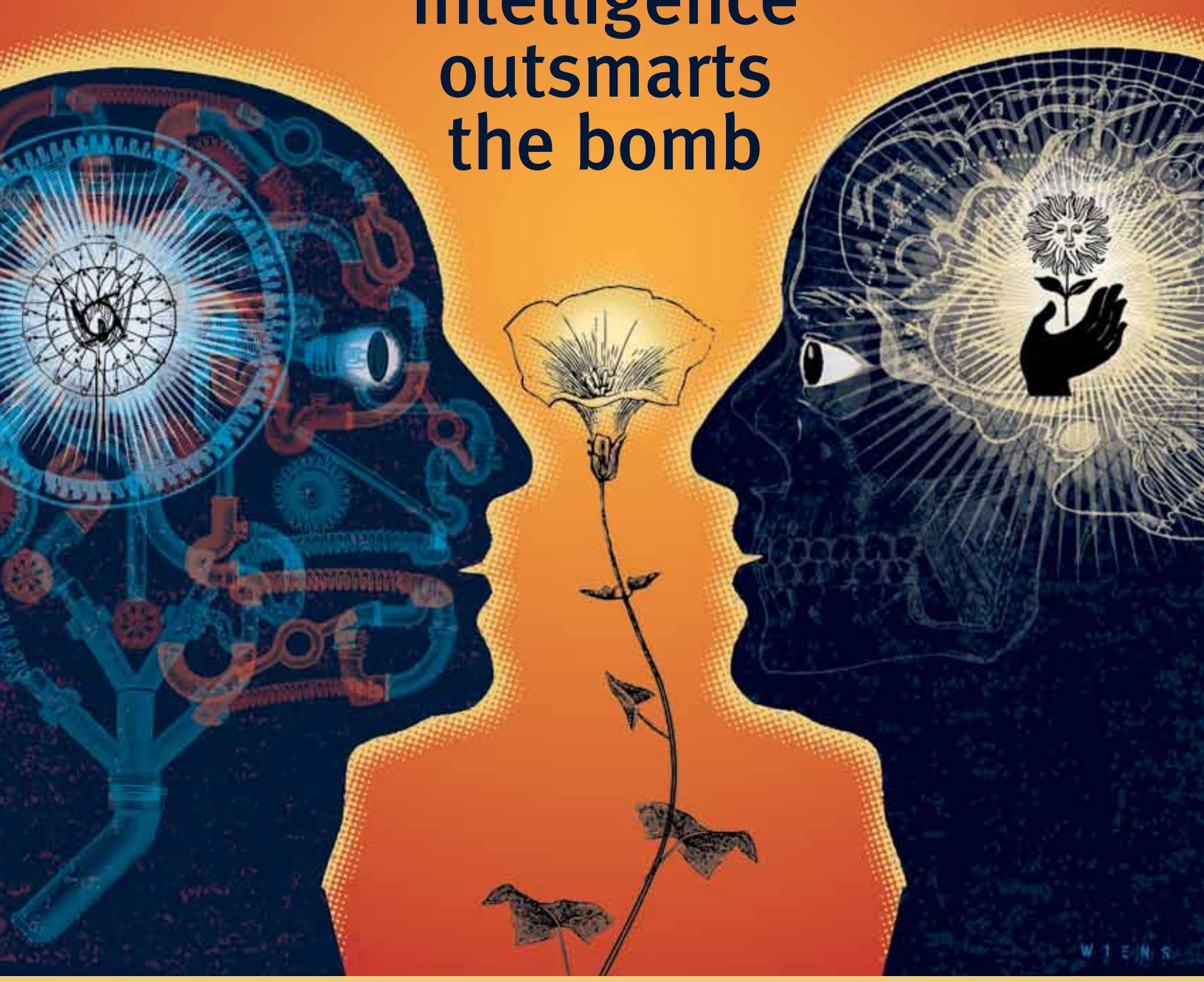
Forefront

COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA, BERKELEY

fall 2011

Artificial intelligence outsmarts the bomb



Dean's message

Learning by doing

BART NAGEL

Universities often draw a sharp distinction between pure and applied disciplines—the real world, not so much. Berkeley's approach, what I call its West Coast style of engineering, is not only to educate engineers as superb technologists but also to instill in them an urgent sense of the societal implications of their work. They understand which technologies can make a real difference in the broader world.

This issue of *Forefront* tells the story of our new master's program in translational medicine, which is designed to accelerate the delivery of a medical treatment or device to market. In the case of our featured students, the pioneering treatment is a synthetic scaffold to encourage cardiac stem cells to form healthy vascular cells. Students spend 14 months investigating not only the technology, but also the regulatory and industrial framework to propel their particular advance forward as quickly as is safely possible.

Our new college-wide professional master's of engineering program (M.Eng.) announced in the spring issue also focuses on a capstone project. Rather than writing a traditional thesis, students combine leadership skills with technical knowledge to solve pressing societal-scale problems, in consultation with industry sponsors. As our first cohort of M.Eng. students took its place this fall, we were excited to see the students choose from almost 50 capstone projects that the faculty and industry sponsors had to offer them. They are already well on their way with these projects, with mid-project reviews in early December.

"That's the type of integrative, hands-on experience critical for graduate students stepping into industry," says Paul E. Jacobs, chief executive of Qualcomm and chair of the college's advisory board. "And exactly what companies like ours are looking for."

This fall, we are looking at integrating more of this exciting pedagogical approach into our undergraduate curriculum as well. As the Internet has totally transformed how students learn, we need to shift further away from supplying information towards more experiential and team-based learning, along with an early opportunity to practice innovative approaches to engineering design.

In the words of alum Cary Opel (B.S.'04 BioE), who became an R&D engineer at Genentech and is now pursuing a doctorate in chemical engineering, "I can't overestimate the importance of undergraduate research. It helped me get my job, and the publication I co-authored as an undergrad definitely helped me get into a top grad school. It was a launching point for all of the things that I was able to do later."

I welcome your thoughts and ideas at **dean_sastry@coe.berkeley.edu**.

—**S. SHANKAR SASTRY**
Dean and Roy W. Carlson Professor of Engineering
Director, Blum Center for Developing Economies

Forefront is published twice yearly to showcase the excellence of Berkeley Engineering faculty, alumni and students and bring their work to life through news and research, profiles and current issues and events.

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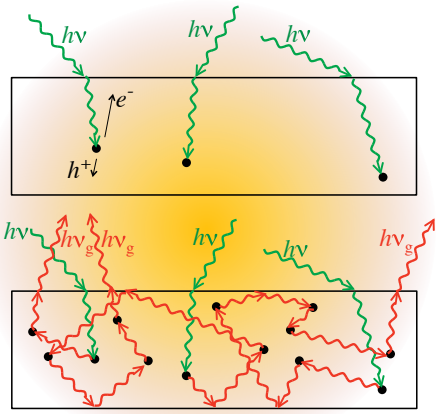

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Featured in this issue

On the cover

Computers think and reason their way through one of the United Nations' biggest problems: how to detect clandestine nuclear weapons explosions. *Read more on page 8.*

COVER ILLUSTRATION BY CARL WIENS

Comments

STEVE MCCONNELL

Walking at graduation

The spring *Forefront* told the remarkable story of Austin Whitney, the paralyzed 22-year-old Berkeley student who was outfitted with an exoskeleton designed by mechanical engineering professor Homayoon Kazerooni and his team. In May, with the help of the "Austin" exoskeleton, Whitney rose from his wheelchair and walked across the stage at graduation to shake Chancellor Robert Birgeneau's hand. The crowd went wild. A video of the event can be seen at newscenter.berkeley.edu/2011/05/14/paraplegic-student-stands-walks-at-graduation; a few of the posted comments follow.

Amazing work! As a mechanical engineer I am so proud of your accomplishments; you put the human in our profession. Congratulations to you and the entire team at UCB (and this from a Carnegie Mellon grad! None the less!). All the best and God bless all of you.

—SIXAXLE

In many ways I believe that I was part of this machinery. I was wearing a pacemaker at age 12; I am now in a power wheelchair. It would be mind-blowing if I could get a suit like Austin to go one more step into a power suit as Iron Man.

—RCVOLUNTEER1978

I'm cheering for everyone there with each passing second. Congratulations to Austin and the engineering department for this amazing feat! Go Cal!

—XXBIUCRUSHXX

I am a cancer survivor. I battled back from complete neuropathy in my legs for a year to being able to walk to getting my second degree black belt. I know what this guy is going through. And I am just glad to see that life isn't going to hold him back!

—MUD91DUCK

I teared up. This is truly wonderful. So proud to be a Berkeley student.

—YEEBRADA

Those Berkeley guys are so smart! May they continue to work on that prototype! Coolio!

—KWMKC13

Epic man. All I can say is epic.

—SLY3571

WE LOVE YOUR COMMENTS!

Write to us at **forefront@coe.berkeley.edu**; post to **facebook.com/berkeleyengineering**; or send letters to *Forefront*, 312 McLaughlin Hall #1704, University of California, Berkeley, CA 94720-1704. Please note that we may edit for length and clarity.

Napolitano on cyberspace security

U.S. Secretary of Homeland Security Janet Napolitano addressed some 250 students, faculty and staff during a visit to campus in April as part of a national university tour looking for cybersecurity innovation and a few good engineers.

Speaking at Sibley Auditorium, Napolitano said government must partner with academia and business to make cyberspace safe from hacking, spamming and other threats.

In ordinary times, "what we were doing in the homeland security area might be good enough to say we are safe enough," she said. "But these are not ordinary times."

Napolitano told the assembled students that her cybersecurity department is looking for more tech- and policy-savvy people like themselves.

"We, on the public policy side, we know what we don't know," she said. "We know we need technology-savvy people in the government."

BY KAP STANN

KAT WADE

Secretary of Homeland Security Janet Napolitano

What's new
AT BERKELEY ENGINEERING

Field report from Nicaragua

David Olmos (B.S.'11 ME) spent his summer working with the nonprofit organization blueEnergy in Central America as part of an internship with Cal Energy Corps, a program launched in spring 2011 to help develop sustainable energy and climate solutions around the world. The ME graduate student sent this report from the field:

BLUEFIELDS, NICARAGUA—My primary objective is to design and build a 17-foot wind turbine prototype. Although blueEnergy has fabricated 12- and 14-foot turbines, I am responsible for creating a new prototype capable of harvesting more energy. I already had a strong background in aerodynamics and integration of wind energy into the grid; however, these turbines are for remote villages without an electrical grid, and efficiency is not as much of a concern as reliability. The obstacles in this environment require me to apply engineering techniques in new ways.

The first step in building the blades was to scale up the dimensions of current blade designs. Sawing and fitting the 2x4s together was like a jigsaw puzzle, trying to match the concavity so that they are flush without excessive strains on the epoxy resin. After planing the wood and tapering the blade, remaining chunks were chipped away with a machete and sanded down with a grinder. (This is where the privilege of having a bandsaw would have been useful.) Carving the pitch on the front of the blade was more of a challenge, as the angle of the blade changes along the length, but the change in pitch is necessary to optimize power harvesting. I have also been designing an alternative way to assemble and disassemble the blades to facilitate easier transport and repair of this larger turbine.

I have come to realize how much of a difference a few watts of power can make in people's lives—by providing light for medical operations and access to refrigerated vaccines and radio communication. I also realize that there is a great opportunity to introduce renewable energy into the developing world because there is no existing infrastructure to overcome. If a sustainable infrastructure can be implemented from the start, these communities are likely to have a much more successful future.

See more at **http://vcresearch.berkeley.edu/energy/welcome-cal-energy-corps**

BY DAVID OLMOS

THE ENGINEER'S ADVANTAGE

As the economy struggles to regain its footing, more engineers can drive innovation and growth. Yet as Intel CEO Paul Otellini, who serves on President Obama's Council on Jobs and Competitiveness, notes, the number of engineers graduating from U.S. colleges and universities has stagnated at about 120,000 a year during the last decade.

"By contrast, roughly one million engineers a year graduate from universities in India and China," Otellini says. He co-leads an education task force, an offshoot of the jobs council, which aims to yield 10,000 more engineering graduates in the U.S. each year. Otellini sought out Dean Shankar Sastry, along with engineering deans at Purdue, Georgia Tech and Michigan, to help design mentoring programs, internships and other ways to connect engineering students to industry employment.

Berkeley Engineering stands out among its peers as a major source of top-notch engineering talent. The college awarded 958 engineering bachelor's degrees in 2010, compared to Stanford's 379.

Of particular concern to Otellini's task force is the poor retention of students entering college programs in science, technology, engineering and mathematics (the so-called STEM fields). According to the American Society for Engineering Education, 40 percent of these students leave after one year. Berkeley Engineering, on the other hand, consistently graduates well over 80 percent of its entering freshmen.

And the earnings outlook for engineering graduates is strong. In a report released May 2011, researchers at the Georgetown University Center on Education and the Workforce analyzed earnings based on 171 college degrees. For workers whose highest degree is a bachelor's, those in STEM fields outperform all other occupations, with lifetime earnings averaging more than $3 million. Graduate degrees deliver additional payoff.

BY KAREN RHODES

TR35 ROBOTICS EXPERT NAMED TOP YOUNG INNOVATOR

Pieter Abbeel, known for his novel work in the field of machine learning in robotics, has been named to the 2011 list of 35 of the world's top young innovators by *Technology Review* magazine.

Published by the Massachusetts Institute of Technology (MIT), *Technology Review* annually recognizes innovators under the age of 35 selected from hundreds of nominees from a wide range of research fields, and awards winners at TR's emerging technologies conference at MIT each fall.

Abbeel, 33, assistant professor of electrical engineering and computer sciences, is being recognized for his research in algorithms that enable robots to learn new tasks. As a Ph.D. student, he developed the concept of "apprenticeship learning," in which machines learn by first observing humans demonstrate the task. With his algorithms, autonomous helicopters have learned how to perform complex aerobatic maneuvers, such as flips and auto-rotation landings.

ELENA ZHUKOVA

Robotics pioneer Pieter Abbeel, caught by one of his creations above, has been recognized with a prestigious award from Technology Review *for his work on algorithms that enable robots to learn new tasks.*

More recently, Abbeel has focused on applying his machine-learning research to surgical and personal robotics. His team has enabled robots to perform such skills as tying surgical knots or folding towels and socks. To complete those tasks, robots must be able to view irregular objects—such as a crumpled pile of laundry—identify and pick out the target items and then determine how to correctly manipulate them.

That's easy enough for humans, but tough for a robot. Advancing the field of machine learning could have far-reaching benefits for society.

"Personal robots that can perform everyday chores will enable elderly and disabled people to live more independent lives," says Abbeel. "My research could also be used to enhance surgical efficiency and consistency, improving the quality of healthcare."

See more at **http://www.technologyreview.com/tr35/profile.aspx?trid=1082**

BY SARAH YANG

RACHEL SHAFER

Recent nuclear engineering graduate Vladimir Mozin is launching his career at Lawrence Livermore National Laboratory.

More like Mozin

Vladimir Mozin is just the kind of scientist the U.S. wants to replicate. Mozin, a recent Ph.D. graduate in nuclear engineering, specializes in nuclear safeguards. Now he's working at Lawrence Livermore National Laboratory, advancing American initiatives in that area.

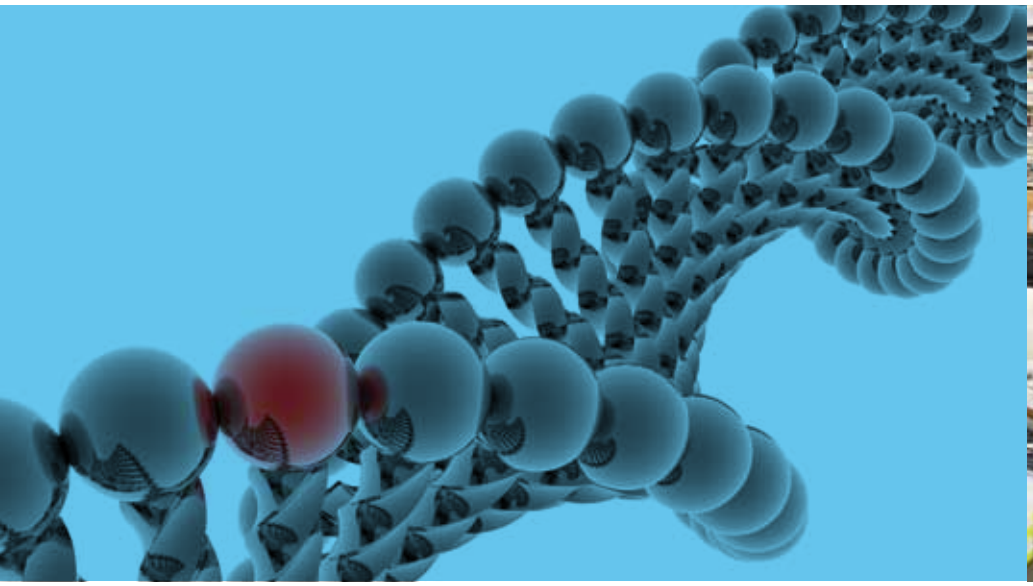
In June, a consortium of seven universities led by Berkeley won a $25 million, five-year Department of Energy National Nuclear Security Administration contract to help supply the government with nuclear security experts—and create more national lab scientists like Mozin.

To grow the pipeline, the consortium (dubbed Nuclear Science and Security Consortium 7) will use the award to expand recruitment of the best and brightest high school students into the nuclear science field. At the undergraduate level, students will gain extra exposure to research and government programs through expanded research opportunities, mentorships, summer schools and seminars. Finally, graduate students will receive assistance in job placement and early career development with a focus on the national labs. The award will also support growth of the consortium's nuclear departments and academic programs and recruitment of underrepresented minorities.

"There is a compelling need to reinvigorate the U.S. nuclear science and technology base," says Jasmina Vujic, nuclear engineering professor and the consortium's principal investigator. "The University of California, together with participating universities and national labs, can uniquely address all safety, security, nonproliferation and economic issues, which must be solved to ensure a sustainable nuclear energy and technology enterprise."

The consortium comprises four UC campuses (Berkeley, Davis, Irvine and San Diego), Michigan State University, University of Nevada, Las Vegas and Washington University in St. Louis. It will closely collaborate with Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory and Sandia National Laboratories.

BY RACHEL SHAFER



LAWRENCE BERKELEY NATIONAL LABORATORY/PHOTOGRAPHER: ROY KALTSCHMIDT

Adam Arkin

REVOLUTIONIZING SYNTHETIC BIOLOGY

Chris Anderson and Adam Arkin hope to train tiny cellular assassins. That is, the bioengineering faculty members and their research teams have joined forces to search for the best way to engineer complex microbes that will hunt down cancer-causing tumors and eventually kill them—one example of Berkeley's pioneering work in the hot new field of synthetic biology. By manipulating and building biological systems, synthetic biologists promise to transform health and medicine, energy sources, the environment, food production and global security.

In April, bioengineering professor Arkin and other top investigators formed an alliance to move Berkeley's research in synthetic biology into an industrial pipeline, while also developing standards and scrutinizing social and ethical pitfalls.

Led by the College of Engineering and the College of Chemistry, the UC Berkeley Synthetic Biology Institute (SBI) encompasses 33 faculty and scientists from Berkeley's engineering, chemistry and biology departments and four divisions at Lawrence Berkeley National Laboratory.

"We want to make SBI a place for all these people to communicate with each other and the larger Berkeley community, train students and translate their work out into the world," explains Arkin, the institute's director. "We hope to build a vibrant community of Berkeley researchers and external partners to realize the promise of this emerging field."

One such partner is Agilent Technologies Inc., SBI's founding industry member. Agilent helped launch SBI's initiatives with a multimillion-dollar commitment, including early access to Agilent research and active participation of the company's scientists and engineers.

The long-term goal? An industrial revolution, say SBI scientists. Inspired by the amalgamation of chemistry, physics and engineering that produced the semiconductor revolution, the institute hopes to follow a similar multidisciplinary model to produce a groundswell of innovation and manufacturing in biological engineering.

See more at **http://synbio.berkeley.edu/**

BY RACHEL SHAFER

Class of '15 welcomed in true Berkeley style

More than 800 incoming students received a rousing college welcome at fall orientation, which included team-building exercises, lab tours, and electric go-cart and Formula SAE race car demonstrations. They also got their first taste of Top Dog, the popular northside eatery that has fed generations of Berkeley engineers.

Fiona Doyle, professor of materials science and engineering and the college's newly appointed executive associate dean, welcomed the class. Hailing from 35 states and 25 countries, the 641 first-year students and 210 transfer students help make up a combined undergraduate engineering enrollment of more than 3,100, aiming to join a community of more than 56,000 Berkeley Engineering alumni around the world.

BY KAP STANN

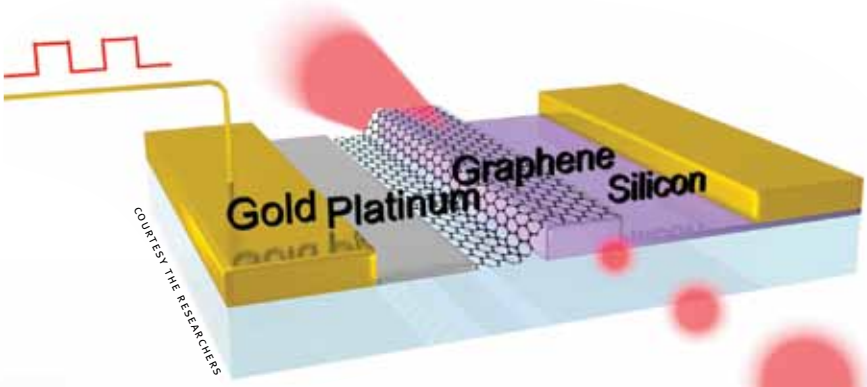
NOAH BERGER

LeeAnn Patrick was among hundreds of students taking part in New Student Orientation at Memorial Glade.

Breakthroughs

BERKELEY RESEARCH AT THE ENGINEERING FOREFRONT

MORE BREAKTHROUGHS **www.coe.berkeley.edu/news-center**



COURTESY THE RESEARCHERS

BREAKING THE SPEED LIMIT

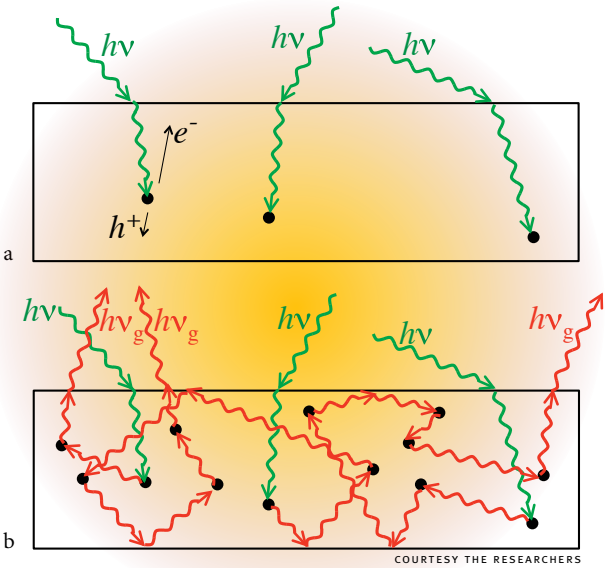
Hold your pencils. Graphene—first extracted from graphite, the same element in pencil lead—may be a wonder material that could help break current speed limits in digital communications. Led by mechanical engineering professor Xiang Zhang, a team of researchers has successfully used graphene to build the world's smallest optical modulator, a device that changes electrical signals into optical form, which can then be carried by optical fiber at a much higher speed—up to 10 times faster than current technology allows. Researchers said that graphene-based modulators may soon allow consumers to stream full-length, high-definition, 3-D movies onto a smartphone in a matter of seconds.

http://newscenter.berkeley.edu/2011/05/08/graphene-optical-modulators-ultrafast-communications/

On the safe side

This year's Fukushima Daiichi nuclear plant disaster has drawn scrutiny to the safety of nuclear power plants throughout the world. Recently, researchers at Berkeley, Lawrence Berkeley National Laboratory, Los Alamos National Laboratory and Montanuniversitaet Leoben in Austria have developed a groundbreaking technique for testing irradiated materials that could lead to more advanced and safer nuclear technologies. By showing that this nanoscale testing technique can provide relevant strength values, researchers hope to design materials that are more resistant to radiation damage and to extend the lifetime of existing nuclear reactors. Andrew Minor, associate professor of materials science and engineering, and Peter Hosemann, assistant professor of nuclear engineering, co-authored the study.

http://www.nature.com/nmat/journal/vaop/ncurrent/full/nmat3055.html



COURTESY THE RESEARCHERS

SOMETHING NEW UNDER THE SUN

The forecast for solar cells will be cloudy until they can convert energy to electricity as efficiently as fossil fuels. But research by electrical engineering and computer sciences professor Eli Yablonovitch has led to the development of more efficient solar cells that appear poised to become the least expensive source of primary energy. Scientists at Alta Devices, a start-up Yablonovitch co-founded, have created thin-film photovoltaics that are reaching efficiency levels of 28.2 percent, breaking the previous record of 26.4 percent. To achieve this, the team worked with a single layer of cells using gallium arsenide. They also developed techniques that will significantly reduce manufacturing costs. Owen Miller, a graduate student of Yablonovitch, first set the stage for this advance by showing these efficiency levels were theoretically possible. As shown above, a conventional solar cell up top (a), compared to the new solar cell concept below, which promotes the emission of fluorescent photons $h\nu_g$ (b).

http://arxiv.org/abs/1106.1603

WATER WORKS

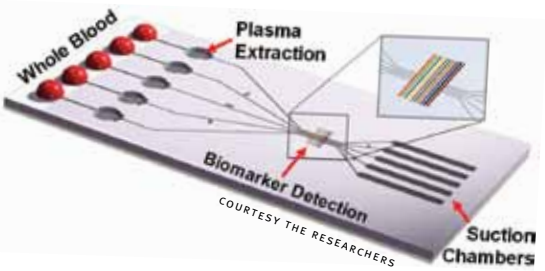
Many communities use regional wetlands to treat their wastewater. Sometimes, this works; other times, it doesn't. Civil and environmental engineering professor David Sedlak, co-director of the Berkeley Water Center, has built a wastewater treatment testbed on several acres of wetland in the Sacramento River Delta. Not only does the model show promise in removing chemicals and pathogens more effectively; it's also a low-energy system that creates wildlife habitat. Sedlak is deputy director of a new, multi-university Engineering Research Center on urban water infrastructure, funded by the National Science Foundation.

http://innovations.coe.berkeley.edu/vol5-issue7-sept11/sedlak

OUT FOR BLOOD

Working with an international team of researchers, bioengineering professor Luke Lee and other Berkeley engineers have developed a device that can process whole blood samples without the use of external tubing and extra components. Their biochip uses gravity—via narrow trenches patterned underneath microfluidic channels—to selectively separate blood components for analysis.

"This is a very important development for global healthcare diagnostics," says Lee. "Field workers would be able to use this device to detect diseases such as HIV or tuberculosis in a matter of minutes. Our goal is to address global health care needs with diagnostic devices that are functional, cheap and truly portable."



COURTESY THE RESEARCHERS

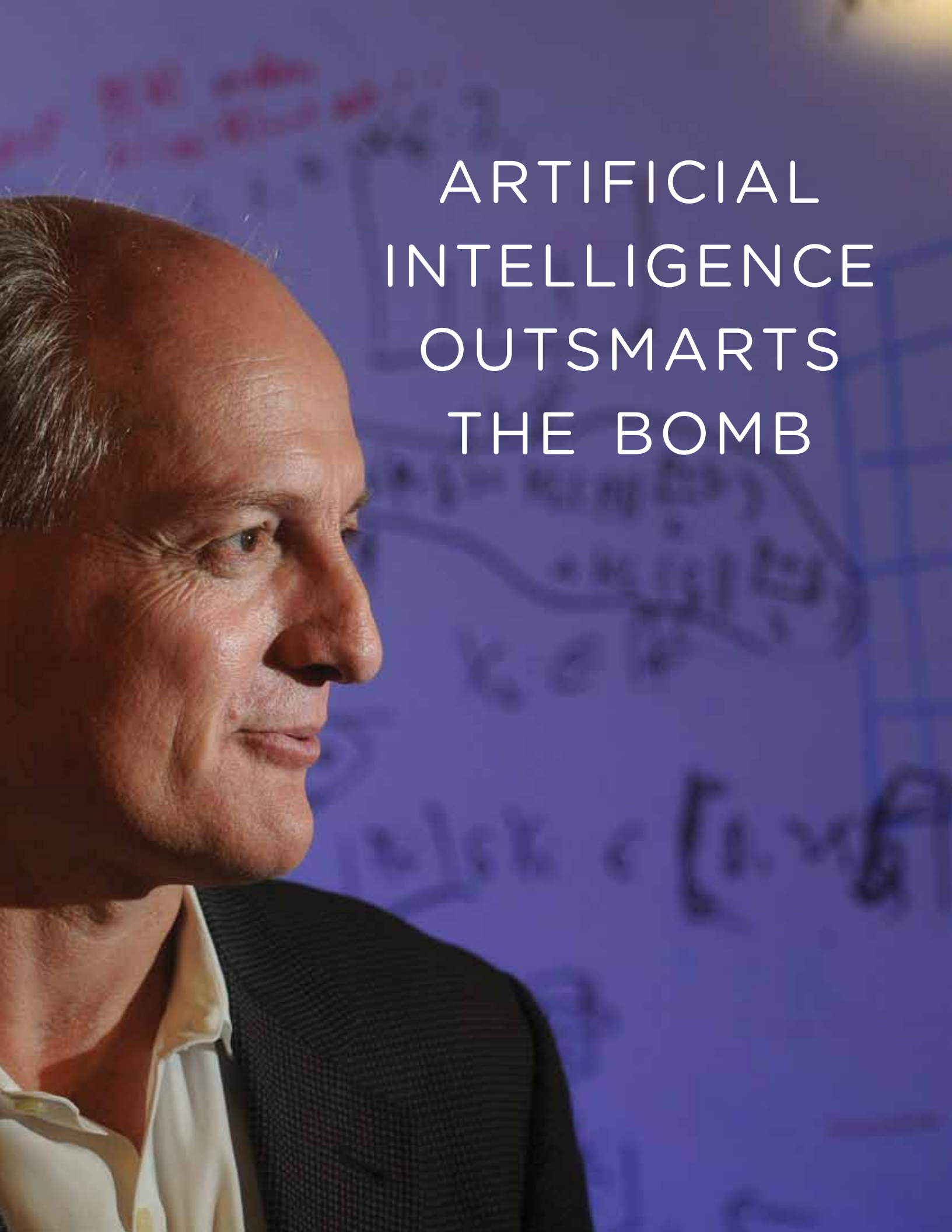
As shown above, the tether-free chip features a blood loading area, plasma separation microtrenches, detection sites and suction flow structures.

http://newscenter.berkeley.edu/2011/03/16/standalone-lab-on-a-chip/

Gut check

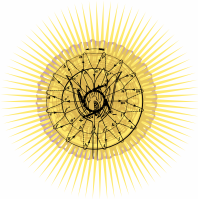
Most premature infants spend anywhere from two weeks to six months in intensive care before they're deemed healthy enough to go home. Hoping to learn more about the illnesses that afflict preemies, scientists for the first time have sequenced and reconstructed the genomes of most of the microbes in the gut of a premature newborn. Working with researchers from Berkeley, Stanford and the University of Pittsburgh, Jill Banfield, whose three faculty appointments at Berkeley include one in materials science and engineering, followed a single premature infant during the first month of the infant's life and documented how the microbe populations changed over time. Further studies involving more infants could eventually help researchers understand the causes of various preemie intestinal problems and learn if these illnesses are caused by strains of bacteria or an imbalance of microbe populations in the gut.

http://newscenter.berkeley.edu/2011/01/13/scientists-sequence-gut-microbes-of-premature-infant/



ARTIFICIAL INTELLIGENCE OUTSMARTS THE BOMB

A.I. pioneer Stuart Russell and the science of nuke hunting



BY RACHEL SHAFER | PHOTO BY NOAH BERGER
ILLUSTRATIONS BY CARL WIENS

In June 2009, Stuart Russell found himself at a science and technology conference in Vienna's royal Hofburg Palace. It was not your run-of-the-mill academic symposium, the computer science professor thought wryly: Security was tight. Hundreds of scientists, journalists and diplomats mingled beneath glittering chandeliers. In the main meeting room, an 18th-century ballroom, Beethoven once premiered his Symphony No. 8 and President Kennedy met with Premier Nikita Khrushchev in the summer of 1961.

The conference topic was no less weighty. North Korea had recently detonated a nuclear weapon underground, its second nuclear test. The conference host, the United Nations (UN) Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) found the timing impeccable. The palace buzzed with purpose.

The UN test ban treaty, not yet in force but ratified by 154 nations (the United States, North Korea, China, Egypt, India, Indonesia, Iran, Israel and Pakistan not among them), monitors for compliance. Its system detects and verifies signs of clandestine nuclear explosions and reports them to member states—sifting through 10 gigabytes of data per day (the rough equivalent of 50,000 emails without attachments). The recent North Korean test poured urgency into the conference: how to improve the system's accuracy, particularly for difficult-to-detect underground tests.

Russell and his graduate student Nimar Arora were at the palace to present preliminary results on a pilot project that applied artificial intelligence (A.I.) methodologies to the CTBTO's data problem. If it showed promise, Russell's project might significantly improve the verification process, save the UN money and potentially influence global security. It would also be the kind of success story the A.I. field craves, a field with big aspirations and even bigger hurdles.

UNCERTAIN ABOUT UNCERTAINTY

John McCarthy, who coined the term "artificial intelligence" in 1956, defines A.I. as "the science and engineering of making intelligent machines, especially intelligent computer programs." But what is intelligent?

In computing, most tasks today comprise an execution of orders. You tell the computer what to do in a language it understands (Java, Perl, Python, etc.), in sentences it understands (algorithms that mathematically instruct the computer how to complete a function), and it executes the order. An intelligent machine, therefore, needs to think, not just do. And it needs to think independently without human intervention and take rational action, the best

possible action, to achieve a goal, says Russell. It needs to acquire knowledge about the world, understand its environment, reason, make correct decisions and develop plans. Sometimes that means simulating human intelligence, sometimes not. An intelligent machine might also see the world, touch the world and speak and understand us.

Russell is especially interested in those aspects of cognition that are well developed in humans: learning, reasoning and knowledge representation. "My interest in A.I. probably came from reading science fiction, but as a young person I was also trying to understand human intelligence and ways of thinking," he says.

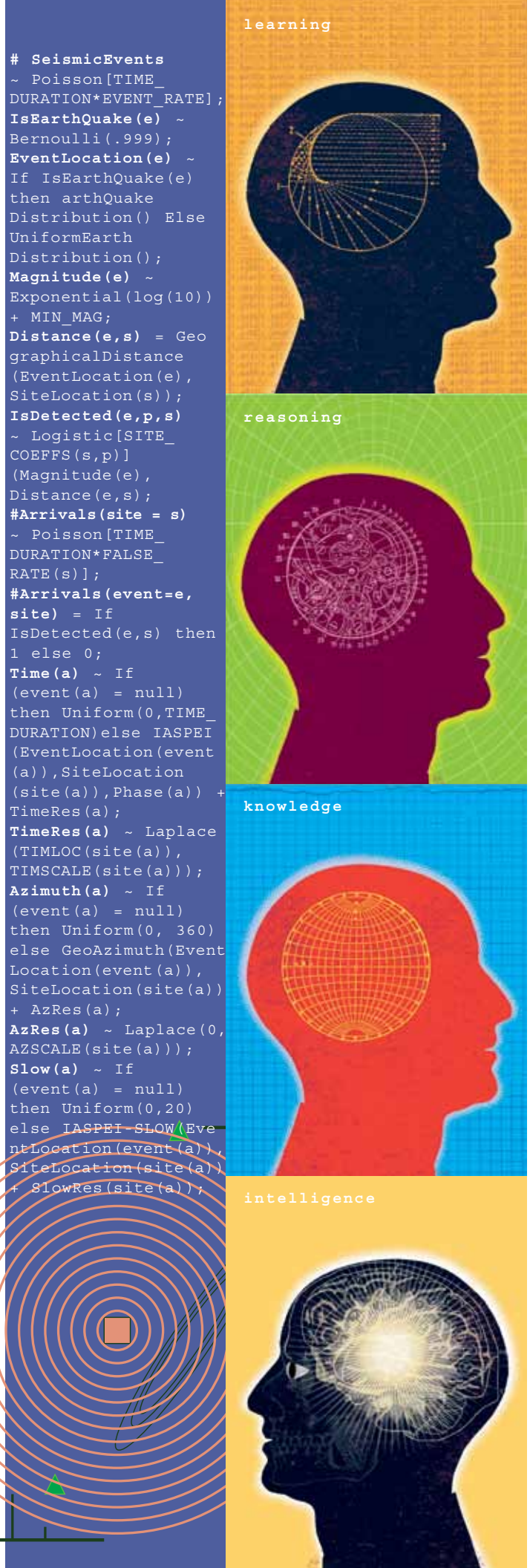
When Russell joined Berkeley in 1986, A.I. was 30 years old, but progress had stalled. Scientists knew they could get computers to reason using first-order logic: by employing formal mathematics, a programmer could represent the world by mapping out relationships between known objects and input that knowledge. A computer could then deduce answers on its own. Any given sentence in first-order logic can have one of three values: true, false or unknown.

There are no likely or not-so-likely answers, degrees of probability that humans successfully navigate all the time. So while first-order logic answered some questions, don't-knows abounded, along with frustrations. Many scientists working in A.I. subfields such as automated vision and robotics moved their research to more promising areas such as mathematics, statistics and control theory.

"We're always uncertain about the state of the world and how it works," says Russell. "That is inescapable. So with first-order logic, we could never give a computer enough knowledge in enough detail and with enough definiteness to actually deal with the real world. Building faster computers or better algorithms will not solve it." A.I. researchers had to find a new approach.

Probability often goes hand in hand with statistics, and A.I. researchers looked next to statistical tools. But no formal mathematical language existed to write out large-scale probability models until UCLA computer science professor Judea Pearl, in conjunction with others, developed something called Bayesian networks in the late 1980s. Based on a theorem by 18th-century mathematician Thomas Bayes, Bayesian networks could concisely describe—even with small amounts of inputted knowledge—the likelihood of a given world. The models produced reams of possibilities, and by applying special algorithms, inferred the most likely answer. Now A.I. scientists could manage uncertainty, and automated reasoning leapt forward.

On the heels of the breakthrough, scientists labored over the next decade or so to unify first-order logic and probabilistic reasoning—a difficult conundrum first identified in the 1850s—and create formal computer languages that exploited the best of each. By 2005, Russell's team had developed one such A.I. supertool, a language called BLOG (short for Bayesian Logic). "BLOG allows you to reason about unknown objects and deal with open universe cases where you don't even know what's out there, let alone how objects relate to one another," Russell explained at a symposium honoring Judea Pearl in 2010. "Now you can install effective machine learning on a very small amount of data." In more good news, robotics and vision researchers returned to the A.I. fold. "We are now rapidly moving towards truly intelligent systems," Russell told the symposium.



NUCLEAR INTELLIGENCE

A thoughtful, cerebral man with a British accent, Russell favors suit jackets without the tie and lightens conversation with a dry wit. When he discusses A.I., it's usually not from the perspective of a research pioneer—which he is—but of a longtime teacher—which he also is. He coauthored the field's leading textbook, *Artificial Intelligence: A Modern Approach*, with Peter Norvig (Ph.D. '86 EECS), Google's director of research. When you talk to him, Russell wants you to know A.I.'s context, and most important, its open questions. Yet, for however much he's a professor's professor, in a field known for being *out there*, Russell is a firm believer in the real world. A.I. must solve real world problems. Artificial must "get" real.

After developing BLOG, Russell was hunting for a project that would test out the tool. One day in the fall of 2008, he heard from long-time friend James Rector, a Berkeley civil and environmental engineering professor who specializes in exploration geophysics and applied seismology. Rector knew scientists at Lawrence Livermore National Laboratory working on CTBTO initiatives, and thought Russell might know how to help the CTBTO exploit its rapidly growing library of data. This was just the project Russell had been looking for: Infer events and their locations from raw data—in this case seismic waveform signals—and confer meaning on an unknown world.

Russell attended a CTBTO meeting in March 2009 to learn more about the seismology and geophysics involved. Then he spent his lunch hour writing a probability model in BLOG. It was a half-page long. That afternoon, Russell demonstrated the model during a short presentation.

For more than 100 years, seismologists have been analyzing seismic data. The CTBTO employs human analysts and a sophisticated, multimillion-dollar software system that uses a well-known, bottom-up methodology to analyze each signal separately to determine if it is of sufficient size to be caused by an earthquake or nuclear explosion. Russell dumped all that on its head by empowering a small computer program to look at groups of signals and the relationships between them and determine the most probable explanation given the evidence—intelligence writ large.

"Initially, they were surprised and a little shocked," Russell remembers. "I think they thought, 'Shut up, you computer scientist, you don't know what you're talking about.' Then they realized I could be right, actually. It took less than five minutes."

Back at Berkeley, Russell and graduate student Arora refined the model using CTBTO data. Then, at the Hofburg Palace during the CTBTO's annual science and technology conference that year, the pair demonstrated that their model, with its A.I.-driven automated reasoning, could better infer seismic events than the CTBTO's existing system.

Now, two years later, Russell and Arora have improved the model further, reducing missed events by a factor of three. That has CTBTO scientists enthusiastic. "There is a very good chance that this work will lead to a major operational upgrade for us within the next two years or so, once it's sufficiently adapted, tested and proven," says Ronan Le Bras, head of the software integration unit at CTBTO's International Data Centre in Vienna.

Russell is happy to see A.I. demonstrating its chops and hopes the project might, just might, influence geopolitics. "The U.S. hasn't ratified the treaty, in part, because it claims that it's too hard to verify events," says Russell. "If we can remove that excuse, then maybe we can make it easier for the U.S. to ratify."

Sheila Vaidya, deputy director of defense programs at Lawrence Livermore National Laboratory, collaborates with Russell on the project. She won't predict whether the model will encourage the U.S. or other nations to ratify, but, she says, "The more information you have, the more likely it is you can make the right decision. Stuart is moving the envelope forward so we can make better educated judgments."

OUR FIGHT FOR IMMORTALITY

What's certain is that artificial intelligence is getting smart. You see it every day in Google's search algorithms, Amazon.com's personal shopping recommendations and Microsoft's Kinect technology. Yet for however intelligent computers have become, they're far from being the Swiss Army knife of problem-solving, and they still rely on human intelligence.

How do we know when the goal has been achieved? One of the most famous ways to measure machine intelligence is the Turing test. A human judge converses with two participants, one human and one computer both hidden behind a curtain. If the judge can't distinguish between human and computer, the computer is crowned intelligent. Russell believes in another test: failure. "To me, how a machine reacts to error is what makes it seem intelligent," he says. "Can it recover? Can it move on and achieve its goal? In that way, I'll know A.I. when I see it."

Recognizing A.I. is one thing; whether it's a good thing, is another. Judea Pearl, the UCLA professor who set modern A.I. on its present course, believes our quest for machine intelligence is simply an ancient fight against mortality, a way of extending ourselves through computer code instead of genetic code, cheating death through machine children instead of biological ones. "If we can create the superhuman, why not?" he says.

Nimar Arora agrees. "My friends always joke, 'You're basically making yourself antiquated, right?'" he says, laughing. "But it's never going to happen. Humans will always use computers as a tool. If we're making them smarter, then we're becoming smarter in the process. The gap between human and artificial intelligence will never close."

There will come a time for closer introspection, Russell and others acknowledge, as A.I. inevitably matures. Scientists will have to confront ethical conundrums as well as grapple with more basic engineering problems such as designing intelligent systems to ensure their behaviors aren't unexpected. But it's more than a decade away, Russell predicts.

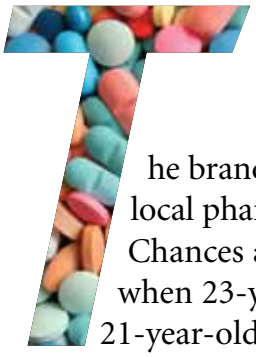
"If you could see the robot Pieter Abbeel [see story on page 4] has developed trying to fold a pair of socks, you wouldn't be too worried about it taking over the world any time soon, even though it's getting pretty good at folding socks," says Russell. "Right now, we have much better ways of destroying ourselves—with technology we know works—than with robots and Terminator."

At that, Russell returns to his computer and the world of rogue nations, BLOG and the task of hunting nukes.

Found in translation

Degree by degree, bioengineers learn the patient's world

BY ABBY COHN | PHOTOS BY NOAH BERGER



The brand-new drug arriving on your local pharmacy's shelves isn't all that new. Chances are, it was discovered back when 23-year-old Derek Dashti and 21-year-old Ramya Chitters were still in grade school. The average time span from a drug's detection in the lab to its formal approval stretches 13 years.

Amid growing concern about the sluggish pace—and soaring costs—of such medical innovation, Dashti (B.S.'09, M.S.'11 BioE) and Chitters (M.S.'11 BioE) spent the past year learning how to speed the rollout of new drugs, devices and therapies.

The two freshly minted bioengineers were among the inaugural participants in a new master of translational medicine (MTM) degree program jointly launched by Berkeley's Department of Bioengineering and UCSF's Department of Bioengineering and Therapeutic Sciences. This pioneering venture trains young engineers, scientists and clinicians in the complex steps between scientific discovery and the actual delivery of advances in patient care. Collaboration and creativity are encouraged to hasten the bench-to-bedside journey—and ensure that new technologies address real medical needs.

"Scientists are focused so much on research. Understanding how to get research out is another process in itself," says Dashti, who hopes to become an inventor in the field of regenerative medicine.

One of the first programs of its kind, the MTM is the brainchild of former Intel Corporation chief executive and technology visionary Andy Grove (Ph.D.'63 ChemE). Faculty on the UC Berkeley and UCSF campuses embraced and advanced the concept.

"When you have a problem, look to technology for a solution," says Grove, who has challenged medicine to adopt Silicon Valley's "better, faster, cheaper" approach to product development. Grove proposed the translational program at a Berkeley Engineering-UCSF conference, "Translating Technology into Cost-Effective Healthcare," in November 2009. He then donated $1.5 million to get the effort up and running.

A joint degree program was unveiled in August 2010 and graduated its first class of 14 students this summer. An equal number recently began their yearlong training. Selected from nearly 200 applicants, the new contingent includes a medical student, an international student and participants with industry experience. In time, program leaders want to grow the number of students to 30.

Dashti jumped at the chance to enroll. Trained in bioengineering and working as a Stanley Hall lab manager, he wanted to learn about clinical, regulatory and business processes. "If we're in a biotech revolution, the scientist needs to understand the whole pathway to get research from a lab to application in the real world," he says.

Chitters was conducting basic research as a UC San Diego bioengineering undergraduate when she realized she had no clue how promising ideas become marketplace products. "Everyone is working on something amazing, but not everything is turned into direct patient use," she says.

Effectively translating research is, in fact, a widespread problem. Despite an inflation-adjusted doubling of federal research funds from 1995 to 2005, approvals of new drugs have not increased, according to S. Claiborne "Clay" Johnston, associate vice chancellor of research at UCSF and director of the Clinical and Translational Science Institute (CTSI). CTSI, along with Berkeley Engineering, has been a close partner in the program's development.

The MTM is intended to better prepare graduates to become industry leaders and innovators.

Program directors liken the educational experience to an MBA in medical technology. "Hopefully what we can do is train a new generation who can work at this interface of engineering and medicine," says Song Li, a Berkeley professor of bioengineering and the MTM's co-faculty director.

Students divide their time between Berkeley Engineering, the Haas School of Business and a number of UCSF departments. They take classes in topics ranging from medical device innovation and clinical trials to cost-effectiveness analysis, patent applications and entrepreneurship. Physicians, industry executives, venture capitalists and others share their expertise and advice.

LEARN, THEN DO

Everything comes together in a "capstone" research project. Working in small teams, the students apply their knowledge to navigate the translational path for an actual device, drug or treatment. The hands-on exercise exposes them to basic research, business development and the complex regulatory landscape for new advances in patient care.

Dashti and Chitters devoted months to their high-stakes project—a concept for regenerating seriously diseased hearts. Joining the Stanley Hall lab of bioengineering professor and department chair Kevin Healy, the students monitored the growth of cardiac stem cells and their potential to rejuvenate. Eventually, the interdisciplinary team, which includes UCSF clinical collaborator Yerem Yeghiazarians, hopes to inject the cells into a patient's damaged cardiac tissue via a synthetic scaffold. That scaffold is intended to keep stem cells in place and provide a "pro-survival" environment to prompt them to grow into healthy vascular cells.

If successful, the concept could lead to a far cheaper, less invasive and more accessible alternative to the 1,800 heart transplants performed each year in the United States. Though still in the early stages, "it looks quite promising," says Dashti.

Beyond that cutting-edge bench research, Dashti and Chitters explored their project from a variety of clinical and financial angles. They evaluated the need for treatment, looked at competing

approaches, planned a clinical trial, prepared a business proposal and performed a cost analysis. "I think it goes a lot faster if you understand all the different aspects of it," says Chitters, a Cupertino native interested in the crossroads of medical practice and technology.

In studying the complexities of FDA requirements and the procedures for filing patents to protect intellectual property, Dashti found that "there's a plethora of regulatory pathways."

The MTM program offers a roadmap of that uneven terrain. "We're bioengineers by training but educated in a way we can understand what happens when you go to a patent lawyer or a businessman," Dashti says.

Since graduating in July, Dashti, who grew up in Southern California's Santa Clarita Valley, continues to pursue his research at Berkeley. Eventually, he would like to enroll in a joint M.D./Ph.D. program to become a physician-scientist.

Fellow classmate Philip Chung (B.S.'10, M.S.'11 BioE) entered the MTM program because as a young bioengineer, "I felt too detached from the clinical setting I wanted to be impacting." By combining engineering, clinical medicine and business, the master's training was "pretty much a perfect match for me," says Chung, 23.

Like Dashti, Chung was so inspired by his capstone project that he, too, is staying on as a researcher. Chung is helping to develop a "smart" cervical diaphragm capable of predicting the onset of preterm labor. "Right now, I'm interested in pushing the technology forward and seeing how far we can get," says the Los Angeles-area native. Led by UCSF associate professor Shuvo Roy, the team is exploring the possibility of spinning the technology into a startup.

Roy, who also teaches a class in medical device innovation, has personal experience with the field's steep learning curve. Earlier in his research career, Roy developed medical devices while educating himself on FDA and other regulatory issues. "It was definitely an eye-opener for me," he recalls. "If I had an MTM program before I got started, there's no question about it, I would have accelerated the process."

Translational medicine doesn't translate into skimping on product safety, advocates say.

"I think there are so many inefficiencies," says Tejal Desai (Ph.D.'98 BioE), a UCSF professor of bioengineering and therapeutic sciences and MTM co-faculty director. "Costs keep going up," she says. Without compromising safety, "there are ways we might be able to think about developing technology that aren't the most expensive but actually solve the problem."

Joining in the call for more translational efforts is Francis Collins, director of the National Institutes of Health. Citing "the triple frustrations of long timelines, steep costs and high failure rates" in the medical pathway, he recently proposed the establishment of a National Center for Advancing Translational Sciences. Its mission would be to "catalyze the generation of innovative methods and technologies" to create better responses to human diseases and conditions.

Along with the typical 13-year timeline for drug approval, the failure rate for drugs under development exceeds 95 percent, and the average cost to bring a single drug to market is more than $1 billion, according to Collins.

A CULTURE OF INNOVATION: (below) Derek Dashti (B.S.'09, M.S.'11 BioE) and Ramya Chitters (M.S.'11 BioE) study the growth of cardiac stem cells as part of a novel research project seeking an inexpensive and minimally invasive treatment for serious heart disease. The collaborative effort, housed in the Stanley Hall lab of bioengineering department chair and professor Kevin Healy, could one day address the devastating human and financial costs of congestive heart failure.

the scientist needs to get research

Berkeley's Li hopes that translational efforts will breathe new life into lost creativity. He notes that only a small percentage of patents are ever turned into actual inventions. "There's a gap there," he says. "If someone could be very efficient in translating ideas to technology and products, that would be very big."

For innovation to be more successful, clinicians and scientists must do a better job of communicating and collaborating, according to translational backers. A required MTM course, provocatively called Anti-Medical School, introduces students to physicians and their unmet clinical challenges. "Why would you invent something

BEYOND THE BENCHTOP: (left) Along with their scientific explorations, Dashti and Chitters spent the past year learning how to navigate a concept for regenerating damaged cardiac tissue through a variety of clinical and regulatory hurdles. The master of translational medicine (MTM) program jointly launched by UC Berkeley and UCSF introduces young innovators like Dashti and Chitters to the pathway linking initial research discovery to the actual delivery of new medical technology. In this way, the MTM program aims to accelerate the development of drugs, healthcare devices and therapies.

"If we're in a biotech revolution, to understand the whole pathway from a lab to application in the real world."

not knowing what the needs are?" asks Marc Shuman, clinical director of the California Institute for Quantitative Biosciences, a UCSF professor and the class's originator. "It's that frequent, mutual exchange that's absolutely critical."

Chung shadowed doctors at an OB/GYN clinic affiliated with UCSF to figure out how to better design the obstetric device his team is developing. "Our team in the lab is all engineers," he says. "It's very difficult to understand what happens in a clinical setting."

As it embarks on its second year, the MTM program continues to evolve. The program's first graduates received a master of science degree in bioengineering with an emphasis in translational medicine. In the works is a proposal to designate a new professional degree, a master of translational medicine, which would be jointly awarded by Berkeley and UCSF.

Though the program he spurred is in its infancy, Grove likes the progress he has seen.

The MTM program, he says, is "a starting point to establish that teams of interdisciplinary people can address increasingly complex problems that require interdisciplinary approaches."

Displaying the same restless drive and passion that made him a digital-age legend, Grove is a fierce champion of better, faster, cheaper medicine.

"I'd like to see medicine working like the cell phone industry," he says. "You don't sit around being evaluated for 14 years for the next available iPhone, Android or whatever. The technology flows and it's twice as good and half as expensive. Every cell phone engineer is translational."

Class notes

Keep in touch by mailing your news and photos to *Forefront* Class Notes, UC Berkeley College of Engineering, 312 McLaughlin Hall #1704, Berkeley, CA 94720-1704. Or go to **coe.berkeley.edu/alumni/class-notes** and click on *"Submit a new class note."*

2000s

HEATHER BOWERMAN (B.S.'05 BioE) was recently named by the White House as an associate in the Office of Science and Technology Policy. Her focus is a new science policy initiative for "Startup America," a national campaign to promote high-growth entrepreneurship across the country. In February, she accepted the Technology Award from the Kairos Society on the balcony of the New York Stock Exchange, when the start-up that she co-founded as a graduate student at Harvard was named a top student-run company in the world.

CHRISTOPHER CHERRY (Ph.D.'07 CEE) is an assistant professor of civil and environmental engineering at the University of Tennessee, Knoxville. He was awarded the National Science Foundation's Faculty Early Career Development Award for his work, which includes research on the increased usage of electric two-wheelers in China.

TOBIN FRICKE (B.S.'03 EECS) is currently a Ph.D. student with the Laser Interferometer Gravitational-wave Observatory project. He is excited to report that he just earned his private pilot's license, flying out of Hammond, Louisiana, in a Cessna 152. "Now I just have to get out of grad school and into a real job so that I can actually afford to fly!" he writes.

ELIZABETH HAUSLER (M.S.'98, Ph.D.'02 CEE), who was profiled in the spring 2009 issue of *Forefront*, recently won the 2011 $100,000 Lemelson-MIT Award for Sustainability. The CEO and founder of Build Change, she promotes a low-tech reconstruction method to establish earthquake-resistant housing in the developing world.

COURTESY MISHA LEYBOVICH

Misha Leybovich

MISHA LEYBOVICH (B.S.'05 ES) returns to Atlanta after a year in Shanghai with McKinsey & Company, where he is now a junior engagement manager. Highlights of his time abroad include midwinter nocturnal hiking solo on China's most treacherous mountain; a pilgrimage to his father's birthplace in Uzbekistan; competing in Mongolia's national wrestling tournament; and visiting more than 30 countries. He writes, "I am looking forward to reconnecting with friends and not having to get up at 3 am to watch Cal football."

1990s

GLENN BOOKER (M.S.'90 ME) of Philadelphia, Pennsylvania, completed his Ph.D. in biomedical engineering at Drexel University and was promoted to associate teaching professor at the iSchool there.

ANANTHA CHANDRAKASAN (B.S.'89, M.S.'90, Ph.D.'94 EECS) of Belmont, Massachusetts, has been named head of MIT's department of electrical engineering and computer sciences. He joined the MIT faculty in 1994, with a focus on micro-power digital and mixed-signal circuit design, wireless microsensor system design, portable multimedia devices and energy efficient radios.

SANDEEP CHATTERJEE (B.S.'95 EECS) of Foster City, California, was named a Young Global Leader for 2011 by the World Economic Forum. He is also the co-founder of SourceTrace Systems, a company that produces remote financial transaction software for mobile transactions.

ROBIN COGER (M.S.'90, Ph.D.'93 ME) of Matthews, North Carolina, has been named dean of the College of Engineering at the University of North Carolina, Charlotte. She is also a professor of mechanical engineering and the founder and director of the Center for Biomedical Engineering Systems.

MARIE DES JARDINS

(Ph.D.'92 CS) of Fulton, Maryland, was recently promoted to full professor at the University of Maryland, Baltimore County, where she has been a faculty member since 2001. She writes, "I am only the 11th woman named full professor in STEM areas at UMBC, and one of my goals is to support more women to full professors. I also serve as an honors faculty fellow and the chair of UMBC's faculty affairs committee. Meanwhile, my two daughters are thriving—Caroline in high school, and Heather at Harvard. Please drop me a line, especially if you're going to be in the D.C. area, at mariedj@cs.umbc.edu."

PHU QUANG PHILLIPS HUYNH (B.S.'98 EECS)

of Union City, California, recently joined HP-Palm Global Business Unit as a senior engineering program manager. Previously, he worked at MobiTV and had obtained a Stanford certified program manager certificate.

GARY MAY (M.S.'88, Ph.D.'91 EECS) of Atlanta,

GEORGIA TECH

Georgia, has become the dean of the College of Engineering at the Georgia Institute of Technology. He joined the faculty in 1991 and has worked as a professor as well as chair of the electrical and computer engineering school.

JASON MIKAMI (B.A.'92 East Asian Languages, B.S.'98 EECS), profiled in September 2011 *Innovations*, was promoted to vice president of operations at the cloud computing firm SugarSync. He is also the owner and founder of an artisan winery, Mikami Vineyards, which earned a wine medal at the prestigious *San Francisco Chronicle* wine competition.

VERONICA J. SANTOS

(B.S.'99 ME) of Tempe, Arizona, is an assistant professor of mechanical engineering at Arizona State University. She was recently selected for the National Science Foundation's Faculty Early Career Development Award.

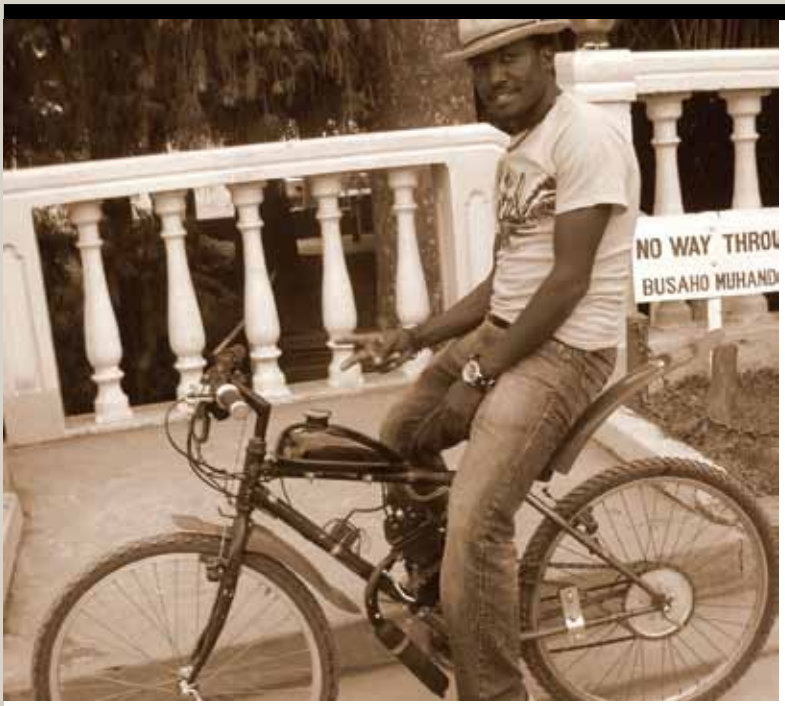
1980s

SURESH GARIMELLA (Ph.D'89 ME) of West Lafayette, Indiana, has been named Purdue University's first associate vice president for engagement. He is currently a Jefferson Science Fellow at the U.S. State Department, as well as a professor of mechanical engineering and director of the NSF Cooling Technologies Research Center at Purdue.

ROALD T. LOKKEN (B.S.'75 ME, Ph.D.'80 Naval Architecture) of Houston, Texas, has been appointed chief offshore engineer for ExxonMobil and is assigned to ExxonMobil Upstream Research Company.

JACKSON NICKERSON (M.S.'86 ME, MBA'90, Ph.D.'97 Business Administration) of St. Louis, Missouri, has written *Leading Change in a Web 2.1 World* (Brookings Institute Press, 2010). He is a professor of organization and strategy at the Olin Business School at Washington University in St. Louis.

HOWARD SCHIRMER JR. (B.S.'65, M.S.'66 CE) retired as president of CH2M Hill International and has started Transnational Associates Inc. to help firms build relationships in international projects. He was also an executive producer of a training film to address corruption in engineering and



COURTESY CHRISTOPHER ATEGEKA

DOUG CODY/BAY AREA EVENT PHOTOGRAPHY

The long road to Berkeley

IT'S ALL ABOUT THE BIKE: Christopher Ategeka's journey from rural Uganda to the 2011 Commencement stage was guided by luck, the support of others and his own motivation to ease global poverty. The bicycle, in particular, provides energy-efficient and affordable access to education, work and improved living conditions.

Speaking at Berkeley Engineering's Commencement in May, Christopher Ategeka (B.S.'11 ME) recounted his formidable journey from a rural Ugandan village to Berkeley. He endured heartbreak and hardship with the help of luck and a positive outlook. One tool, however, played a pivotal role along the way: the bicycle.

"Getting a bike changed my life," he says.

The eldest of six siblings, Ategeka had lost both parents to AIDS by the time he was seven years old. What followed was a turbulent period of shifting from the care of one relative to another. Life was hard, with school and his village located seven miles apart. Not long after his parents died, Ategeka was walking the long road home when a stranger stopped and offered him a ride on his bicycle.

The stranger left him with some memorable words: "Life is like a bicycle," the man said, quoting Albert Einstein. "In order to stay balanced, you have to keep moving."

Ategeka took those words to heart. Every day, he walked barefoot to school. After returning home in the dark, he would feed his siblings and do homework.

"I had to keep this balance of things going," he recalls.

Eventually, a family friend suggested he contact Youth Encouragement Services (YES), an American-run agency in Uganda. Through YES, Ategeka was matched with a sponsor in Oakland, California, who provided him with $25 a month.

One of his first purchases? A bicycle.

"I saw how powerful a bike can be," Ategeka says. "My ride to school was only 30 minutes. I could make it home before dark to find food for my siblings. I spent my time studying, and my grades went up."

After his graduation from high school, his sponsor paid for him to come live in Oakland. He enrolled in Laney College, graduated with highest honors and transferred to Berkeley in 2009. Earning his B.S. in mechanical engineering, Ategeka was one of five Berkeley seniors awarded the 2011 Judith Lee Stronach Baccalaureate Prize, which provides seed money for special projects.

Ategeka returned to Uganda in the summer to launch CA Bikes Uganda, a project to help Ugandans build, refurbish and repair conventional and motorized bicycles. He aims to distribute the bicycles to needy village residents—including schoolchildren, healthcare workers and HIV/AIDS patients. He has already secured nonprofit status for his organization—no small task in Uganda. Eventually, he hopes to sell bikes to those who can afford them.

He plans to return to Berkeley in spring 2012 to begin a doctoral program in mechanical engineering.

For Ategeka, CA Bikes Uganda is an opportunity to return to where his journey started and give back. "There are so many other kids suffering in the world," he says. "People say there is no luck out there, and people say there is no love. I think there is luck and love. That's what is out there."

See more at **www.cabikesuganda.com**

BY KATE RIX

construction, the centerpiece of a program to assist the poor and underprivileged around the world.

1970s

FRANCOIS FOURNIER (M.S.'71 CE) of Neuilly Sur Seine, France, has been "retired" since 2006 from the steel industry, and today serves on the board of directors for steel companies in Morocco, New Caledonia and France.

GRANT ERIC HOAG (B.S.'79 CE, MBA'82) of Irvine,

California, is a registered civil engineer with Camp Dresser & McKee (CDM). He also practiced financial planning for cities and municipal utilities over the last 25 years and is otherwise "living the good life."

GLEN LANGSTAFF (B.S.'77 ME) of Fairfield, California, has returned to campus after a 34-year hiatus to work at Lawrence Berkeley National Lab. Previously, he had worked in the medical, electronics, military vehicle and steel industries, and had run his own equipment design and marketing company in the food industry. "It's good to be back in the middle of some of the best science in the world, not to mention the eclectic environment that Berkeley offers," he writes.

Alert! Shots fired

In 1992, the city of East Palo Alto on the San Francisco Peninsula logged the highest homicide rate per capita in the nation. Robert Showen (B.S.'65 EECS), a specialist in acoustics and radio wave propagation, worked just two miles away, and he wondered: What if technology could locate gunfire and tell police where it came from?

Today, Showen's ShotSpotter systems are located in 70 sites around the world, including East Palo Alto. "We're giving the police a tool to help reduce gun crime," Showen says. "We're proud of what we're doing."

When a gun is fired, it produces impulsive sound waves, a short blast of energy that creates the *pop* we hear. A network of acoustic ShotSpotter sensors, installed throughout urban communities, listens for the unique sound. When one is detected by multiple sensors, the system's software calculates its point of origin using differences in arrival time at the sensors, explains Showen. Each sensor also records an audio clip of the event.

The system generates "shots fired" alerts that are sent to police dispatchers, 9-1-1 operators and sometimes officers in the field. A specialized computer display marks the location on a map with a red dot, indicates the time and number of rounds fired and includes the audio clip for playback. Officers use all the information to decide their response. The data are logged for use in forensic investigations and trend analysis.

Police credit the technology with reducing gunfire, catching suspects and saving lives. In 2009, the year it installed ShotSpotter, the city of Richmond, California, experienced 47 homicides. In 2010, that number fell to 21. Lieutenant David Harris of the Richmond Police Department attributes the drop to both ShotSpotter and better community policing. "It's amazing technology that has become a normal part of our day-to-day patrol deployment," he says. "It's making a remarkable difference."

BY RACHEL SHAFER

RACHEL SHAFER

***FIRST RESPONDER:** In the control room of his company's headquarters, ShotSpotter co-founder Robert Showen explains how potential gunshot incidents are displayed and logged. Showen, partially retired, is still writing patents and working on improvements to the system's acoustic signal processing.*

1960s

ROBERT A. SHULTZ (B.S.'65 ME) of Los Gatos, California, retired at the end of 2005 and is now actively involved in cycling and woodworking. He worked in engineering sales of commercial air conditioning systems and also in management during his 35-year career with Trane. Prior to joining Trane, he served in the Navy on diesel and nuclear submarines for five years, then served an additional 12 years in naval intelligence. He retired from the Navy with the rank of commander in 1984.

1950s

AMIRAM M. EISENSTEIN (B.S.'51 EE) of Sebastopol, California, retired in 1989 from the aerospace industry

in memoriam

KENNETH BARNHART (B.S.'47, M.S.'49, Ph.D.'55 ME) of Concord, California, died in March. He was a mechanical engineering professor at California State University, Fresno.

PEDRO DE ALBA (M.S.'69, Ph.D.'75 CE) of Dover,

New Hampshire, died in February at age 71. He was a civil engineering professor at the University of New Hampshire. His professional interests were in experimental techniques for measuring the dynamic response of soils, especially the residual strength of liquefied sand. He was also co-editor and founder of the earthquake engineering journal *Sismodinámica.*

LARRY A. ESVELT (M.S.'64, Ph.D. '71 CE) of Spokane, Washington, died in April at age 72. As the owner of Esvelt Environmental Engineering, he designed numerous wastewater treatment facilities throughout the Northwest.

RICHARD E. HALL (B.S.'38 CE), of Berkeley, died

on August 24, four days short of his 94th birthday. A WWII Navy Seabees veteran, Hall joined Underground Construction in 1946 and retired in 1992 as its chairman of the board. He received the college's Distinguished Engineering Alumni Award in 1987. A loyal graduate whose blood "ran blue and gold," according to his obituary, Hall established the Hall Fund for Undergraduate Education and volunteered for the college's Annual Fund.

BRODERICK P. HASKELL (B.S.'50, M.S.'51 CE), of Berkeley, died in February.

EUGENE HERSON (B.S.'65, M.S.'66 CE), founding chair of the Civil and Environmental Engineering Advisory Council in 2006, died in June. The San Francisco resident was CEO of EMCON Associates, an environmental engineering company. In 2003, he received the college's Distinguished Engineering Alumni Award for his engineering achievements and public service.

TIMOTHY T. HUANG (Ph.D.'99 CS) of Middlebury, Vermont, died in June. He was an associate professor of computer science at Middlebury College.

(TRW and Hughes Aircraft) and is now busy restoring antique radios and landscaping his property.

ROGER R. LINDHOLM (B.S.'50 CE) of Sacramento, California, retired in 1987. As a senior civil engineer for the California Department of Water Resources, he managed, investigated and researched projects on water supply, treatment, reclamation and reuse, as well as agricultural drainage.

WALTER B. SWEET (B.S.'50 CE) of Arcata, California, has worked as the owner of a civil engineering, land surveying and geology firm since 1965, where he still does occasional consulting. Previously, he worked in Afghanistan in the 1950s, as well in Arcata as a city engineer.

1940s

HARRY W. FRY (B.S.'40 EE) of Fresno, California, retired from PG&E in 1977. He raised five daughters and a son with his wife, who passed away in 2008. He writes, "I am enjoying the beauty and smell of my flowers and the taste of my veggies. Wow! What a sweet life." He turns 99 in November.

ROBERT W. MEYER (B.S.'47 ME) of Long Beach, California, served in World War II as part of a Navy construction battalion. He is a retired civil and mechanical engineer who worked for the City of Long Beach for 21 years. His California driver's license will expire when he turns 98.

ELMAN F. NIELSEN (B.S.'47 CE) of Orinda, California, recently closed his Sonoma office after 26 years. His career as a civil engineer spanned 63 years, including employment with the California Division of Highways, Kaiser Engineers and his own practice. Some of his major assignments included the Port of Oakland's conversion to containerization, Larkspur's ferry terminal and Canada's New Brunswick marine terminal, as well as work on major wineries and residential projects. Two of his daughters graduated from Berkeley in architecture and landscape architecture, while a third daughter graduated from Chico State in wildlife biology.

ROBERT C. PECK (B.S.'49 EE) of Santa Fe, New Mexico, writes, "From graduation until 1988, I participated in nuclear testing and instrumentation at the Los Alamos National Laboratory. Thanks to Professor Lester Reukema for making known the summer employment program for graduate students at the Los Alamos Lab." Now retired, he volunteers at the New Mexico State Library for the Blind and produces a program of classical music at Santa Fe's public radio station.

ROBERT L. WHITE (B.S.'48 CE) of San Clemente, California, had a 51-year career in public and private practice, which included serving as city engineer for the City of Burbank and as president and CEO of Engineering-Science, Inc. He retired in 1999 after many years of working on the design and construction of major water and sewer projects throughout the world.

Of mice and livers

COURTESY ANDY RYAN

PRIZEWORTHY: Alice A. Chen won this year's prestigious Lemelson-MIT Student Prize for her groundbreaking work in creating a humanized mouse with a tissue-engineered liver.

Humans and mice have more in common than just an affinity for cheese. The two mammals share about 99 percent of their genes, making mice a useful model for studying human health and disease.

There are, however, stark differences between their livers, the organ that removes metabolized drugs from the blood. When it comes to drug trials, this can create problems, as testing on mice often fails to accurately show a drug's toxicity to humans. This can make the drug testing process costly and lengthy, as well as potentially dangerous to human participants in clinical trials.

But Alice A. Chen (B.S.'03 BioE) has devised a technology that could result in faster, safer and more efficient drug development. As a graduate student in biomedical engineering at Harvard and MIT, Chen created a humanized mouse with a tissue-engineered human liver, allowing researchers to predict how a new drug could affect humans at a much earlier point in the development process.

To create a human liver implant, Chen provides human hepatocytes (the cells that make up the main tissue of the liver) and other liver cells and chemistries that mimic the liver's extracellular matrix and embeds them into a synthetic polymer scaffold. She then leaves the mixture to assemble liver-like processes and function on its own.

The resulting implant looks nothing like an actual human liver and is similar in size, shape and appearance to a contact lens. It takes Chen just a few hours to fabricate dozens of implants, then an additional week for each implant to develop fully.

The liver can then be surgically implanted into a healthy mouse. Because the implants can be engineered as small as micrometer-sized, multiple livers can be implanted into one mouse. "Each of these livers could be derived from different patient samples," Chen says, "making [studies of] the mouse more informative and more efficient."

In addition to improving drug testing, Chen's innovation may also lead to new ways of studying human liver biology and diseases, such as malaria and hepatitis C.

BY JULIANNA FLEMING

Not long after joining the faculty in 1997, he received the National Science Foundation's Faculty Early Career Development Award. His research focused on artificial intelligence.

BRUCE MCVEY (B.S.'48, M.S.'50 EE) of Walnut Creek, California, died in February at age 87. A Navy veteran, he worked as an aerospace engineer at Hughes Aircraft Company for 35 years, where he led the development and production of aircraft radars in addition to imaging radars for intelligence gathering.

EVERETT G. NEUMILLER (B.S.'35 EE) of Short Hills, New Jersey, died in April. An Army veteran, he worked for Bell Labs for 48 years.

UN-CHUL PAEK (M.S.'65, Ph.D.'69 ME) of Gwangju, South Korea, died in May. He worked for Bell Labs in New Jersey for 22 years, then returned to South Korea to work as a professor. His research focused on optical fiber technology and laser material interaction phenomena. A lifelong scholar and teacher, he was a member of the U.S. National Academy of Engineering and a recipient of South Korea's Presidential Medal of Honor.

NORMAN E. SORENSEN (B.S.'51 ME) of Saratoga, California, died in May at age 81. He worked for NASA as an aeronautical engineer and was the primary design engineer on multiple patents.

CHARLES S. STONE (B.S.'39 ME) of Albuquerque, New Mexico, died in March, a month short of his 96th birthday.

WILLIAM USIM (B.S.'50 EE) of Sunnyvale, California, died in January at age 84. He worked for 30 years at Lockheed Martin on various projects, including the Hubble Space Telescope. After his retirement in 1986, he enjoyed working on computers as a hobby.

ALEXANDER "BUD" WILSON (B.S.'48 Metallurgy) of Los Altos Hills, California, died in May. He worked for Utah International for 33 years, where he became a leading figure in the mining industry. Over the course of his career, he was instrumental in developing mining projects throughout the world. He was a World War II Army veteran and a big supporter of the University of California and Berkeley Engineering.

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