Forefront

COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA, BERKELEY

fall 2010

Man of a thousand faces

Paul Debevec ('96) makes digital look real

Engineering with broad shoulders

BART NAGEL

A key tenet of Berkeley Engineering is to educate leaders. To us, engineering leadership extends beyond simply creating new technologies and managing technology innovation. Truly transformative engineering leadership calls for a comprehensive understanding of the economic, legal, privacy and environmental implications of novel and emerging technologies and services in societal scale systems.

Now we have a direct path to provide our students with the educational resources to achieve just that. We are proud to announce a bold, new program designed to meet the mounting demand for engineers who can successfully lead projects and organizations in global environments. It is the revitalization of the Berkeley Engineering Professional Master's Program, a one-year, 24-unit course of study culminating in the master of engineering (M.Eng.) degree.

The first major initiative of the Coleman Fung Institute for Engineering Leadership, this program is designed to close the gap between engineering theory and industry practice and groom engineers for top CXO positions in the world's leading technology-dependent enterprises and in the top global centers of innovation.

After months of intensive research, consultation and planning, we are now preparing the curriculum for a fall 2011 launch. Several programs will be offered on campus, taught through the college's departments by top engineering faculty. Coursework is based on the "T-model" for engineering leadership education: vertically supported by deep technical specialization (represented by the vertical portion of a capital "T") and extending outward through broad instruction in key management and leadership concepts (the cross atop the "T").

All of the programs will share the common core curriculum in engineering leadership, an entirely new menu of value-added skill sets including financial and risk management tools, organizational leadership, enterprise strategy and policy and regulatory frameworks. A team-oriented "capstone" project will bring groups of students face-to-face with industry and faculty mentors to develop their learning by applying emerging technologies to solve societal-scale, real-world problems.

Our vision is to continue to evolve the program over time in collaboration with industry partners and expand our undergraduate entrepreneurship courses as well as our executive education offerings. For more, go to **www.funginstitute.berkeley.edu.**

Once again, we thank Coleman Fung (B.S.'87 IEOR) for the generous gift that allows us to broaden the college's offerings and amplify its beneficial impact by educating a new type of engineer, one with broad shoulders, business leadership skills and a culture of global citizenship.

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

—S. SHANKAR SASTRY
Dean, College of Engineering
Roy W. Carlson Professor of EECS, BioE & ME
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 for a broad engineering audience through news and research, profiles and current issues and events.

Published by
UC Berkeley College of Engineering
Office of Marketing & Communications
312 McLaughlin Hall
Phone: 510.643.6898
www.coe.berkeley.edu/news-center/publications/forefront

Karen Rhodes
EXECUTIVE EDITOR

Patti Meagher
MANAGING EDITOR

Rachel Shafer
ASSOCIATE EDITOR

Cathy Cockrell
Carol Ness
Robert Sanders
Justin Sayarath
Sarah Yang
Wally Ye
CONTRIBUTORS

Alissar Rayes
DESIGNER

S. Shankar Sastry
DEAN

Melissa Nidever
ASSISTANT DEAN, COLLEGE RELATIONS

Jayne Anderson
DIRECTOR, EVENTS & PROGRAMS

Dawn Kramer
ASSOCIATE DIRECTOR, EVENTS & PROGRAMS

SEND COMMENTS AND LETTERS TO:
forefront@coe.berkeley.edu

SUBMIT YOUR CLASS NOTE AT:
www.coe.berkeley.edu/alumni/class-notes

SEND CHANGE OF ADDRESS TO:
ffaddresschange@coe.berkeley.edu

SUBMIT ENGINEERING GIFTS ONLINE AT:
www.coe.berkeley.edu/giving
OR MAIL TO:
Berkeley Engineering Annual Fund
208 McLaughlin Hall #1722
Berkeley, CA 94720-1722
Phone: 510.642.2487

Forefront *fall '10* contents

12

18

20

6

features

departments

On the cover
Read the story on page 8.

Paul Debevec (Ph.D.'96 EECS), engineer and movie buff, enveloped by his Light Stage, the scanning system he developed to create authentic-looking and award-winning digital faces for movies like *Avatar, Spider-Man* and *The Curious Case of Benjamin Button*.

Letters
TO THE EDITOR

Girls want science, too

In your story about bioengineering students in Peru (spring 2010, p. 8), I couldn't help but notice that, according to the photos accompanying the article, only male children in Puerto Alegría were eligible to participate. I am surprised the Berkeley graduate students went along with such long outmoded gender attitudes. I did note the one photograph showing women: washing clothes. The more things change, the more they stay the same.

—LUELLA MAST
Silver Spring, Maryland

Future Scientist leader Richard Novak replies:
For our initial project, we worked primarily with a boys' orphanage in Puerto Alegría, but we also engaged a nearby school with more than 100 students split almost equally between the genders. Unfortunately, the photos didn't reflect that. Future Scientist is committed to equality in education, and most of our projects involve relatively even gender distribution, both among our volunteers and the communities within which we work.

Ranting on high-speed rail

Thank you for your balanced examination of California's high-speed rail (spring 2010, p. 12). The long-term benefits in terms of reduced energy, reduced petroleum and better land use are compelling. But the CHSRA's proposal requires tens of billions of investment before any utility is achieved. I suggest we begin by investing in incremental rail capacity improvements aligned with a future HSR network, while also aligning these investments with present transportation demands and current budget constraints. Remember, one definition of a good engineer is one who can do for a dollar what any fool can do for two bucks.

—MIKE MCGINLEY, P.E. (B.S.'66 CEE)
La Crescenta, California

I have to wonder at a rail system that requires 450,000 permanent employees to support 800 miles of track. That is 562 employees per mile of track! Assuming salary and benefits total $50,000 per year per employee, at $105 per trip, it will require 214,285,000 one-way trips to pay the annual labor costs. Another concern is 24 stations spread over 800 miles of track. That results in an average of 33 miles between stations. The time spent at each stop will reduce the travel time advantage over driving, hardly a viable alternative to air travel.

—KARL ERIKSEN (M.S.'87 CEE)
Edmonds, Washington
Hydraulic engineer, U.S. Army Corps of Engineers

Thanks for the balanced article on high-speed rail. Really interesting stuff . . . but it sounds like a lot more "reality" should have been cranked into the concept before urging the voters to approve the $10 billion. It would have been wiser, given the state of California's financial affairs, to start with a much smaller sum for the study and evaluation phase. Ah well, let's hear it for politics, and hindsight.

—FRANCIS P. DIANI (B.S.'61 EECS)
Goleta, California

Your story on high-speed rail is not the first time I have heard Southwest mentioned as its greatest source of competition. However, as the recent Kevin Smith incident revealed, there are individuals for whom the architecture of air travel is a very mixed bag. Very tall, highly adipose and wheelchair-using individuals emerge both frustrated and sniped at by their fellow passengers, as if they were to blame for the design. An all-domestic high-speed rail system could target this demographic by considering a roomier and more navigable internal architecture.

—AVERY R. COLTER (B.S.'90 MSE)
Bay Point, California
Energy efficiency analyst, Fard Engineers

Speaking of engineering

I thoroughly enjoyed Acting Dean Pisano's message in your last issue (spring 2010, p. i). The term "rocket science" outrages me. That's "rocket engineering," Pal, and don't you forget it! I can tell you about an actual conversation that took place during the Apollo 13 adventure. The next-to-last statement in this conversation was, "Don't worry, George, the engineers got them out there, and the engineers will get them back!" I suggest that, as an additional path to increased recognition for engineering, you advise your students and faculty to become licensed as professional engineers. Salaries in colleges where the majority of the faculty is licensed are considerably higher than those without professional licenses.

—ANGUS N. MCDONALD, P.E. (M.S.'64 IEOR)
Oakland, California

Elevating the perception of engineering is a longstanding problem in the UK, where virtually all engineering fields have been lost to outsourcing and multinational corporations. As a civil engineer, I no longer recommend engineering as a career. Problems range from licensing to the lack of training/apprenticeship programs to the fact that companies now are run mostly by non-engineers who haven't a clue about engineering. But here's the number one issue: jobs. Where are they? You are asking people to consider spending a fortune getting educated in a field where they probably won't get a job, will be treated like rubbish and eventually be replaced 10 years into their career. I don't see a lot of senior engineers who've had rewarding careers and made a lifetime of money training up the next generation. What I do see are a lot of graduates working at McDonald's.

—IVAN THOMSON
Palm Springs, California

WE LOVE YOUR LETTERS!

Write to us at **forefront@coe.berkeley.edu** or send letters to *Forefront* letters, 312 McLaughlin Hall #1704, University of California, Berkeley, CA 94720-1704. Please write a maximum of 250 words and include your name. We cannot include all letters and may edit for length and clarity.

What's new
AT BERKELEY ENGINEERING

Artificial photosynthesis gets real

The task: simulate photosynthesis to develop carbon-neutral transportation fuel. The funding: up to $122 million over five years from the U.S. Department of Energy (DOE). The plan: Nine Berkeley Engineering faculty and researchers at six other labs and institutions have formed a new initiative called the Joint Center for Artificial Photosynthesis (JCAP), led by the California Institute of Technology in partnership with Lawrence Berkeley National Laboratory.

JCAP is one of three DOE Energy Innovation Hubs—large, multidisciplinary teams of scientists and engineers developing clean energy solutions to reduce our national dependence on oil and enhance our energy security.

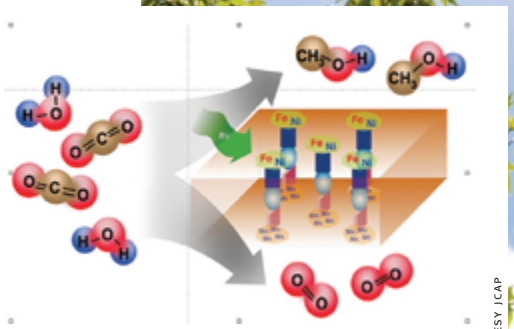
Bold and potentially game-changing, JCAP aims to replace fossil fuels by generating fuels directly from sunlight using sustainable processes. Drawing on the simple ingredients of atmospheric carbon dioxide, water and sunlight, researchers will construct nano-sized artificial photosynthesis generators that will convert solar energy directly into a chemical fuel, a process somewhat analogous to the chemistry that occurs within a leaf.

Researchers will then scale up the generator prototypes to kilometer-sized photosynthetic membranes that can be rolled out over large areas to catch light and produce large amounts of fuel to run our cars and homes. JCAP's mandate is to move basic laboratory research into working applications that will spark a new direct solar fuels industry.

"It's revolutionary," says Berkeley mechanical engineering professor David Dornfeld. "The technology could be put in places where there is no feasible source of biofuels but plenty of sunlight."

See more at **http://solarfuelshub.org**

BY RACHEL SHAFER



Artificial Photosynthesis

COURTESY JCAP

Young women faculty win prestigious awards

Two of Berkeley Engineering's up-and-coming young professors earned prominent awards this fall in recognition of their innovative work.

COURTESY MACARTHUR FOUNDATION

Dawn Song of electrical engineering and computer sciences was named a 2010 MacArthur "genius" Fellow by the John D. and Catherine T. MacArthur Foundation. One of 23 MacArthur Fellows to receive $500,000 in unrestricted funding over five years, Song was singled out for her work protecting computer systems from malicious software, or malware.

www.macfound.org/site/c.lkLXJ8MQKrH/b.6239749/k.1427/Meet_the_2010_Fellows.htm

PEG SKORPINSKI

Amy Herr of bioengineering received a National Institutes of Health 2010 New Innovator Award. The early career award comes with $1.5 million in funding over five years. Herr's project will employ a new measurement technique that harnesses microfluidics to design fast and automated assays for mapping protein signaling and better utilizing proteins as disease markers.

http://nihroadmap.nih.gov/newinnovator/recipients10.asp

BART NAGEL

In Jay Keasling's synthetic biology lab, researchers artificially manipulate the natural chemical processes of E. coli *and yeast to create microscopic factories capable of producing key ingredients for semisynthetic artemisinin.*

Lab to factory:
Malaria treatment realized

Malaria beware. By 2012, a European factory will be churning out artemisinin—a key ingredient in first-line malaria treatment—using a new, semisynthetic technology developed by Berkeley's Jay Keasling and his research team. The low-cost breakthrough (along with artemisinin derived from the sweet wormwood plant) promises to significantly reduce fatalities from malaria. The parasitic blood disease now claims nearly one million lives per year, mostly among African children.

"It's incredibly gratifying to know that something you conceived and worked on in the lab will get out and benefit the people who really need it," says Keasling, professor of bioengineering and chemical engineering and director of SynBERC, the Synthetic Biology Engineering Research Center.

Keasling launched the artemisinin project in 2004, funded by a $42.6 million grant from the Bill and Melinda Gates Foundation, with the goal of making malaria treatments affordable in the poorest and sickest regions of the world. (See *Forefront*, spring 2005, cover story.) Using yeast, *E. coli* and sweet wormwood genes, the researchers constructed bacterial factories that chemically produce two microbes of artemisinic acid.

Amyris Biotechnologies, a startup founded by Keasling and his former postdocs, optimized the microbes and their production for commercialization and licensed it to global pharmaceutical company Sanofi-aventis. In July, Sanofi-aventis received a new Gates grant of $10.7 million to build a production facility in Europe.

Keasling says the semisynthetic artemisinin will be priced comparably with its naturally derived version to support farmers growing wormwood and to stabilize the crop's market swings. The two versions work together, he dds, to increase availability and drive down prices.

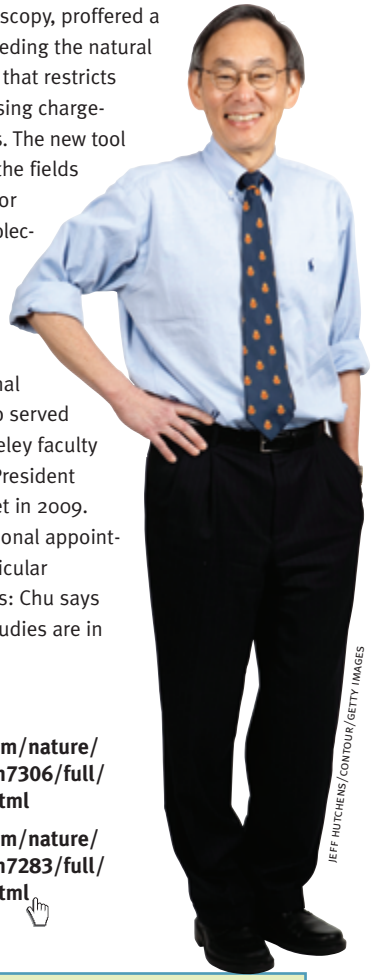
Relax! It's research

What do you do in your spare time?

U.S. Energy Secretary Steven Chu (Ph.D.'76 Physics) writes, but it's not introspective journaling. Most recently, he coauthored the paper "Subnanometre single-molecule localization, registration and distance measurements," published in July by the scientific journal *Nature*. It came on the heels of another *Nature* paper he coauthored earlier this year.

"I just consider it my equivalent of . . . vegging out in front of the TV," Chu told The Associated Press. When not managing oil spills, grappling with global warming or advising the president, Chu conducts research—often while flying to meetings, AP reported.

Chu's paper, on the nano-boundaries of optical microscopy, proffered a method of exceeding the natural diffraction limit that restricts resolution by using charge-coupled devices. The new tool could advance the fields of semiconductor research and molecular biology. Chu, former director of Lawrence Berkeley National Laboratory, also served on the UC Berkeley faculty before joining President Obama's cabinet in 2009. Despite his national appointment, extracurricular science beckons: Chu says several more studies are in the works.



JEFF HUTCHENS/CONTOUR/GETTY IMAGES

See more at
www.nature.com/nature/journal/v466/n7306/full/nature09163.html

www.nature.com/nature/journal/v463/n7283/full/nature08776.html

Grad school, employment trends in flux: The stagnant economy may be pushing more engineering graduates out of the job market and into graduate school, according to several media reports and Bay Area university officials. Preliminary data from Berkeley Engineering's class of 2010, which are consistent with students across the board, suggest that the number going on to graduate school is up about 15 percent, said UC Berkeley Career Center Director Tom Devlin.

But a September Berkeley Career Center report indicates that the employment picture is brightening. Of 267 employers that typically recruit at UC Berkeley, more than 85 percent say they plan to hire at the same level as last year or better; and nearly half those employers plan to increase their recruitment efforts on the Berkeley campus as well as their number of internships.

A Shackleton finally reaches the South Pole

Scott Shackleton, the college's assistant dean of facilities and capital projects, fulfilled a childhood dream by visiting the South Pole on Feb. 9, becoming the first Shackleton to reach the legendary spot after distant relative Sir Ernest Shackleton made his famous attempt in 1907–09. (Norwegian explorer Roald Amundsen first achieved the goal in 1911.)

Scott Shackleton's own journey had a military, not exploratory, mission. A reservist and commander in the U.S. Navy, he served as one of two officers in charge of the annual resupply of McMurdo Station, an outpost on Antarctica dedicated to scientific research.

COURTESY SCOTT SHACKLETON

AT THE AXIS: Scott Shackleton visited the South Pole in February. His distant relative, Sir Ernest Shackleton, attempted to reach the elusive spot in the early 1900s.

With the resupply complete, Shackleton took a five-hour Air Force flight to the pole. He stepped off the plane into an air temperature of minus 56 with poor visibility. Trained in ice survival and wearing subzero gear, Shackleton trekked a half mile across 9,000-foot-thick ice to the official South Pole location. At 9,306 feet above sea level, he unfurled family flags and took pictures.

"Standing there, I felt an incredible respect for Ernest and the others whose own journeys there were unbelievable—true testaments to the will of man," he said. "It was emotional."

Sir Ernest Shackleton, Scott's long-deceased cousin five times removed, achieved mythical status for his later attempt to cross Antarctica by foot in 1914. When his ship, the Endurance, sank in pack ice, Sir Ernest led his crew to safety in one of the most gripping survival stories of the twentieth century. (Read the full account in *Endurance: Shackleton's Incredible Voyage*, by Alfred Lansing.)

Berkeley's own Shackleton, long back from his two-and-a-half week assignment to the icy land, inherited the same adventurous spirit. He and his wife are next planning an ascent of Mount Kilimanjaro.

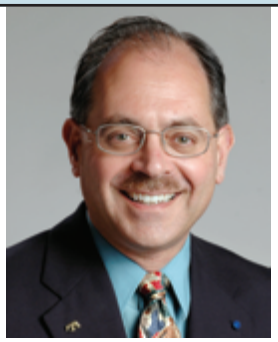
BY RACHEL SHAFER

Pisano leads campus Operational Excellence effort

Albert P. Pisano, professor and former chair of mechanical engineering and, most recently, acting dean of engineering, was appointed June 1 to serve as program office head for Operational Excellence, Chancellor Robert Birgeneau's campuswide initiative to improve efficiency and reduce by $75 million annually the cost of doing business at UC Berkeley.

A drop in state funding last year resulted in a nearly $150 million deficit and permanent cuts of $67 million. Ramped-up fundraising efforts and temporary measures like staff layoffs and student fee increases made up some of the shortfall but are not sustainable in the long term, Birgeneau said. He launched Operational Excellence to maintain momentum in cutting costs and streamlining operations while still upholding Berkeley's excellence in teaching and research.

Despite the budget woes, *U.S. News & World Report*'s 2010 "Best Colleges" issue still ranks Berkeley as the top U.S. public university. And, according to the National Research Council's September 2010 survey, the first issued since 1995, Berkeley continues to have the largest number of highly ranked graduate programs in the nation.



PEG SKORPINSKI

Specifically, Pisano's new post will involve coordinating specialized teams to design and implement cost-saving measures in procurement, organizational simplification, information technology, energy consumption, student services and financial management.

Pisano joined the mechanical engineering faculty in 1983 and was named chair in 2004. He has twice won the department's Excellence in Teaching Award and was elected to the National Academy of Engineering in 2001. He will keep a 25 percent faculty appointment and return full time to mechanical engineering in 2013.

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

Breakthroughs

BERKELEY RESEARCH AT THE ENGINEERING FOREFRONT

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

WASTE NOT

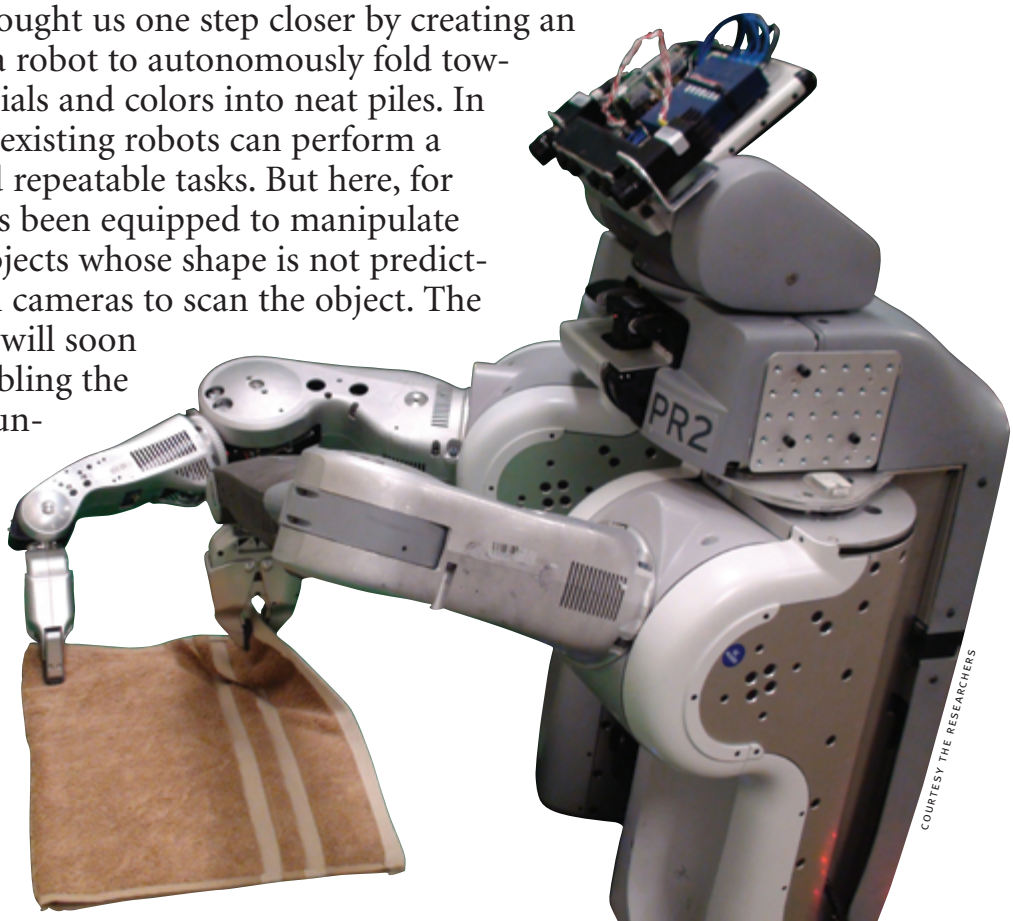
As we search for greener sources of energy, we are forgetting to look in our own backyard. Combustion is an inefficient process that wastes as much as 60 percent of the fuel it burns in power plants and industry, as well as in powering our own computers and automobiles. Junqiao Wu of materials science and engineering and colleagues are using zinc selenide and zinc oxide, two elements that strongly oppose each other atomically, to make a highly mismatched alloy with extremely efficient thermoelectric properties. Further improvement of thermoelectric performance is expected by extending the high mismatch effect from alloys to composites and heterostructures. Wu is working on synthesizing the materials to ultimately produce a cheaper substance that could limit the amount of waste heat that ends up vanishing in thin air.

www.mse.berkeley.edu/~jwu/publications/Lee-PRL-10.pdf

Just call him Jeeves

Robots have long been used to assemble cars and computers, but imagine a robot that could make your bed or do your laundry. Ph.D. candidate Jeremy Maitin-Shepard and Professor Pieter Abbeel of electrical engineering and computer sciences have brought us one step closer by creating an algorithm that empowers a robot to autonomously fold towels of different sizes, materials and colors into neat piles. In highly structured settings, existing robots can perform a wide variety of precise and repeatable tasks. But here, for the first time, the robot has been equipped to manipulate flexible and deformable objects whose shape is not predictable, using high-resolution cameras to scan the object. The next step? The researchers will soon tackle the challenge of enabling the robot to actually do the laundry, from dirty piles to folded stacks, and other tasks like hierarchical planning and furniture assembly.

www.youtube.com/watch?v=gy5g33S0Gzo

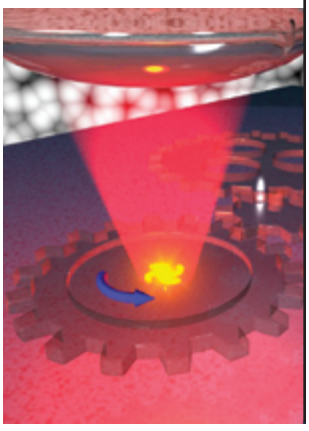


COURTESY THE RESEARCHERS

Putting light in a tailspin

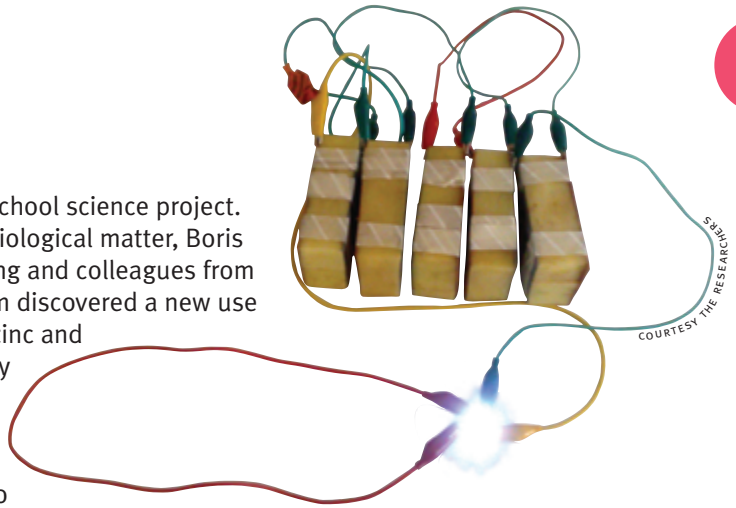
Powerful things come in tiny packages. Mechanical engineer Xiang Zhang and team have developed a 100-nanometer plasmonic motor that, when illuminated, can generate enough torque to power a disc 4,000 times larger in size. While these devices, known as light mills, are not new, Zhang's gem can be rotated and its speed and direction controlled by tuning the frequency of light waves used to power it. Possible applications include a new generation of nanoelectromechanical systems (NEMS), nanoscale solar light harvesters and bots that can perform *in vivo* manipulations of DNA and other biological molecules.

http://newscenter.lbl.gov/feature-stories/2010/07/05/nano-sized-light-mill



COURTESY THE RESEARCHERS

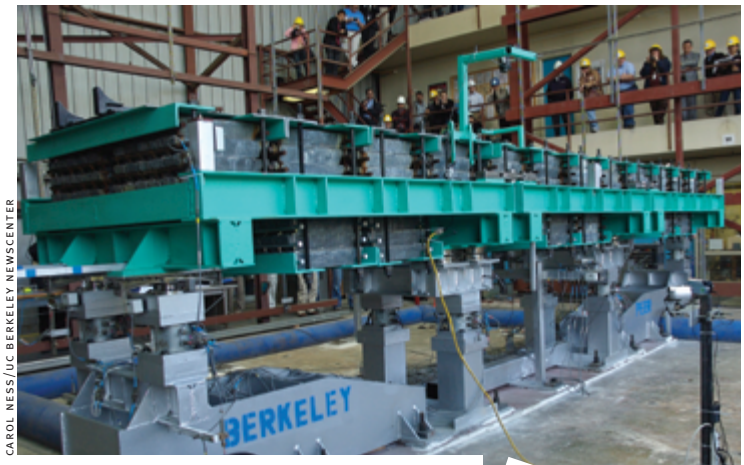
POTATO POWER



COURTESY THE RESEARCHERS

No, it's not just your typical high school science project. While researching electrolysis in biological matter, Boris Rubinsky of mechanical engineering and colleagues from the Hebrew University of Jerusalem discovered a new use for the humble spud. Connecting zinc and copper electrodes to a potato, they were able to efficiently generate electric energy; boiling the potatoes increases that capacity as much as tenfold. The boiled potato batteries, 1/50th the cost of conventional batteries, generate enough power for lighting, telecommunication and information transfer. They are an inexpensive alternative that could improve quality of life for the world's 1.6 billion people living in developing countries without an electrical infrastructure.

http://english.ntdtv.com/ntdtv_en/ns_me/2010-07-29/232054203973.html



CAROL NESS/UC BERKELEY NEWSCENTER

SHAKE IT, DON'T BREAK IT

As the new Bay Bridge goes up before our eyes, engineers are designing technology that may keep future bridges not only standing but also operational during earthquakes. Steve Mahin, civil and environmental engineering professor and director of Berkeley's Pacific Earthquake Engineering Research Center, demonstrated a 30-foot scale-model bridge outfitted with two types of isolators and a new "lockup guide." These features are designed to keep bridge segments moving together during shaking but still allow enough play to keep the bridge intact and passable to traffic. At the demonstration, the Richmond Field Station shake table was set in motion, simulating major historic quakes like California's 1989 Loma Prieta (6.9) and Chile's 1985 temblor (7.8). Rail cars lowered onto the bridge pitched and rolled but still stayed on track.

www.berkeley.edu/news/media/releases/2010/05/27_shake.shtml

Seeing-eye backpack

What's that in your backpack? A team of researchers led by Avideh Zakhor of electrical engineering and computer sciences is working on a backpack studded with laser scanners and cameras that generate a photorealistic 3-D map of any building after the wearer walks through it and data have been collected. While working on the technology that generates Google Earth maps, the team got the idea of developing something that, like GPS outdoors, could autonomously scope out building interiors. With sponsorship from the Army Research Office, the team built a prototype of the device, which has potential applications in the civilian world like making video games more lifelike and buildings more energy efficient.

http://abclocal.go.com/kgo/story?section=news/drive_to_discover&id=7599245

COURTESY THE RESEARCHERS

The secret behind Hollywood's authentic digital countenances

Man of a thousand faces

BY RACHEL SHAFER

At the movies, your popcorn is real, yet what you see onscreen may not be; special effects have long been part of the magic and allure of film. Over the last decade, the line between real and virtual in motion pictures has grown even blurrier with the rise of computer-generated imagery (CGI). If CGI is done well, you could be looking at a pixel painting of Brad Pitt, not the hunky star himself, and you'd be none the wiser.

Any visual effects supervisor will tell you that one of CGI's biggest challenges is replicating faces. Humans look at faces every day and expertly distinguish fact from fiction. But technology is catching up.

SONY PICTURES IMAGEWORKS

Take, for example, the two images at the left. Can you identify the digital replica? (It's the one on the left.) The CGI twin of Alfred Molina, who played the multi-tentacled villain Doc Ock in the 2004 film *Spider-Man 2*, fooled audiences with visually realistic appearances battling Spider-Man in midair, then sinking into the Hudson River in a dramatic full-screen facial close-up.

The unlikely hero behind this CGI breakthrough? Paul Debevec (Ph.D.'96 EECS), a friendly, congenial academic with a love of movies who has engineered an ingenious system to make digital animation, in particular human faces, more realistic. His specialty? Light.

Because of its complex geometry, the human face casts shadows around the nose yet bounces light into the concave bowl of the eye sockets, explains Debevec, a research associate professor of computer science at the University of Southern California (USC). "We needed a way to not only accurately map facial geometry down to the smallest scale but also capture how the face reflects light."

As director of the Graphics Lab at USC's Institute for Creative Technologies, Debevec has pioneered a number of techniques in computer graphics and visual effects. Among the most notable are a scanning device called Light Stage and its accompanying modeling software that together help make animated faces photo realistic.

In February, Debevec and several colleagues stepped out smartly in black tie to accept a Scientific and Engineering Award. Given by the Academy of Motion Picture Arts and Sciences, this honor—the techie version of an Oscar—recognized the group's latest Light Stage work in the groundbreaking blockbuster *Avatar*, the highest grossing film of all time in the United States and Canada.

STAR LIGHT: *Actor Will Smith in Light Stage 5 for the movie* Hancock. *Animation of live actors affords several advantages. Directors can create scenes that may be dangerous or impossible for a human being to enact. They can also digitally age or de-age a character fairly quickly without sending an actor to makeup for hours at a time.*

COURTESY USC ICT

Illuminating the stars

In *Avatar*, the main human characters have CGI avatars in the form of blue-skinned creatures called the Na'vi. Director James Cameron wanted the digital avatars to closely reflect the detailed shapes of the real actors, and faces were particularly important. So, working with Cameron's CGI team at Weta Digital, Debevec and his researchers invited the leading actors—Sigourney Weaver, Sam Worthington, Zoe Saldana, Joel Moore and Stephen Lang—to their lab.

Each actor spent a couple hours in the Light Stage, acting out various facial expressions needed for their avatar. The Light Stage is a sphere-shaped icosahedron two meters in diameter that almost entirely surrounds the subject. Attached to the sphere are 468 white Luxeon V LED lights. Over the course of three seconds, an eight-bit microprocessor flashes the lights in arbitrary pattern sequences and simultaneously triggers the shutters of two cinema-grade digital cameras. The cameras can record up to 4,800 frames per second at a resolution of 800 by 600 pixels.

The resulting scans display the actor's face in every possible lighting condition and in such detail that skin pores and wrinkles can be seen at the sub-millimeter level. Light is captured as it reflects and refracts below the skin's surface; direct and indirect light are separated out in a breakthrough technique that, during subsequent steps in the process, gives digital artists much greater control as they animate.

Debevec's team then plugs the data into specialized algorithms that churn out highly complex facial models. Weta Digital used the models to help faithfully reproduce the detailed skin structure and texture of the *Avatar* actors. The Light Stage system also helped Weta artists light the CGI faces postproduction to accurately match the lighting of real scenes that had already been filmed.

"These are very famous faces, and you don't want the digital version to look stilted and wooden or it will immediately throw a viewer out of the story," Debevec explains. "As with real actors, the way you light digital characters is extremely important."

The team used a similar scanning process in *Superman Returns, Spider-Man 2* and *3, Hancock, King Kong* and *The Curious Case of Benjamin Button.*

COURTESY USC ICT

HIGH-TECH CLOSEUP: *From left, Weta Digital visual effects supervisor Stephen Rosenbaum,* Avatar *actress Zoe Saldana, and ICT researchers Paul Debevec, Tim Hawkins and Alex Ma in front of Light Stage 5. Saldana had just been scanned in the device, which provided microscopic facial data for digitally creating her Na'vi character, Neytiri.*

Real and digital blended seamlessly, helping *Avatar* win this year's Oscar for Best Visual Effects in addition to giving Debevec his own red carpet moment with the Academy's Scientific and Engineering Award. It was the culmination of more than a decade of work, work that began at Berkeley Engineering.

Fiat lux

Debevec first became interested in computer graphics when, as a young kid, he saw *Star Wars*, followed by a PBS documentary about digital effects in movies. "The result was all this magic, and in a way, it reminded me of my father's physics laboratory," where math and science intersected to produce significant, sometimes artful results. (Paul T. Debevec is professor emeritus of nuclear physics at the University of Illinois at Urbana-Champaign.)

At Berkeley, Debevec joined the Computer Graphics Group, studying computer vision under EECS professor Jitendra Malik. Then, as now, Berkeley offered a creative environment for computer graphics with a rather anti-establishment attitude conducive to exploration. "We were always trying to rethink or change our approach to a problem," Debevec recalls. "We said to ourselves, 'Let's do it a better way.'"

The Midwest native became fascinated with how different objects reflect light—how wood might reflect light differently than, say, metal. He photographed campus buildings, created algorithms to generate light and rendered 3-D scenes in different lighting scenarios. The result was *The Campanile Movie,* based on his and others' Ph.D. work. Debevec premiered it at the 1997 SIGGRAPH conference.

One person in the audience that day was John Gaeta, the visual effects supervisor for the 1999 movie *The Matrix*. Gaeta was trying to solve the complexities of the movie's now-famous "bullet time" shots, where time appears to stand still as characters fire bullets at each other and the camera circles them. Gaeta had to successfully mesh real actors with virtual environments.

"When he saw my film, he realized this was the path to solving some of the key problems," Debevec told *The Chronicle of Higher Education* earlier this year. Gaeta didn't hesitate to contact the twenty-something from Cal.

Hollywood was beckoning, but academia ran in Debevec's blood. He stayed on as a postdoctoral researcher at Berkeley, where he developed a prototype for the first Light Stage apparatus and continued his research into graphical illumination, doing pioneering work in high dynamic range imaging (HDRI) and radiance maps.

(HDRI is a method of digitally capturing and editing the full range of radiant light present in a real world scene, which can't be captured either by film or digital cameras alone but is achieved by combining multiple shots. Debevec would later develop HDRI Shop, the editing software for this process.)

He also made *Fiat Lux*, a short movie that created waves in the graphics community when it was screened at the 1999 SIGGRAPH conference. "I thought it was the best computer-generated lighting I had ever seen," says Mark Sagar, now a special projects supervisor at Weta Digital. Sagar phoned Debevec, and the two became close collaborators in facial rendering techniques and future iterations of Light Stage. In fact, Sagar would become instrumental in adapting Light Stage for use in moviemaking.

A couple years later, Debevec joined the faculty at USC and, in 2002, at age 31, he was named one of *Technology Review*'s Top Young Innovators Under 35.

Now 39, Debevec says that working with Sigourney Weaver, Will Smith and other famous faces gives him plenty of thrills, but it's only part of what he does. (When asked, Debevec will tell you that Will Smith is one of the funniest guys he's ever met.)

A consummate researcher, Debevec and his team publish six or so papers a year and, at any given time, are working on five different research projects in addition to several industry collaborations. At the moment, one of their biggest projects is the next iteration of Light Stage, Light Stage 6, a 26-foot sphere with more than 6,000 LED lights that will scan a full body in motion.

The lab is also delving into next-generation virtual reality, creating prototypes for 3-D imaging, video teleconferencing and, most recently, lighting for interactive virtual people. One application, Debevec says, might be a virtual mentor. Another is a virtual museum guide, now being tested at the Museum of Science in Boston with funding from the National Science Foundation, capable of responding to questions from visitors. Not as heart-stopping as Brad Pitt, but another way Paul Debevec is illuminating our future world.

AUTHENTIC AVATARS: *Debevec's scanning system helped these computer-generated Na'vi closely resemble their human counterparts in the breakthrough film* Avatar.

Berkeley Engineers at the movies:
alumni and selective filmographies

Oren Jacob
(B.S.'92, M.S.'95 ME)

Studio tools group director/chief technical officer, Pixar Animation Studios

- Toy Story 3
- Up
- WALL-E
- Ratatouille
- Cars

Eliot Smyrl
(B.S.'87, M.S.'89 EECS)

Senior animation scientist, Pixar Animation Studios

- Cars
- Finding Nemo
- Monsters, Inc.
- Toy Story 2
- A Bug's Life
- Toy Story

Doug Smythe
(B.S.'87 EECS)

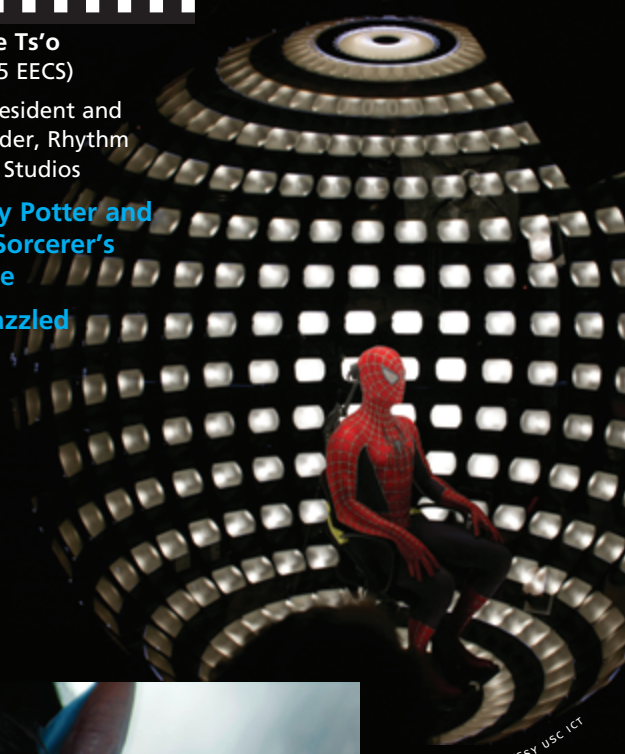
Associate visual effects supervisor, Industrial Light and Magic

- Iron Man 2
- Terminator Salvation
- Iron Man
- Harry Potter and the Half-Blood Prince
- Pirates of the Caribbean: At World's End

Pauline Ts'o
(M.S.'85 EECS)

Vice president and cofounder, Rhythm + Hues Studios

- Harry Potter and the Sorcerer's Stone
- Bedazzled



COURTESY USC ICT

TWENTIETH CENTURY FOX

BLOOMBERG/ GETTY IMAGES

Disaster prone

One engineer's effort to tame a dangerous world

BY PATTI MEAGHER

Robert Bea's got a problem. In fact, he's got several: The Deepwater Horizon. Hurricane Katrina. California's fragile 100-year-old levees.

These are just three open cases in a portfolio of more than 600 disasters or disasters-in-waiting Bea has investigated in his 57-year career as a flood protection engineer, oil and ocean engineer, risk management specialist, UC Berkeley professor of civil and environmental engineering and one of the nation's foremost authorities on disaster mitigation.

His busy schedule got even busier after the Deepwater Horizon offshore oil rig exploded on April 20, causing the worst accidental marine oil spill in history. In response, Bea formed the Deepwater Horizon Study Group, which has been asked to provide results from its work to the Graham-Reilly Commission, appointed in May by President Obama to investigate the catastrophe.

The 73-year-old Texan has been traveling from coast to coast, investigating the site, serving on advisory panels, writing reports, and giving abundant media interviews for major outlets like CBS-TV's *60 Minutes* and the *New York Times*, hoping to make sure nothing like this ever happens again.

"There's a problem to solve here: let's solve it," Bea says. "I tell my students, don't focus on the personalities, or on your behind, or why you did this or that. Just work the problem. That helps you get focused on the right things."

Robert Bea, UC Berkeley professor of civil and environmental engineering, has investigated more than 600 disasters, including the 1989 Exxon Valdez tanker spill, the 2003 Columbia Space Shuttle disintegration and the 2005 failure of flood control systems in New Orleans following Hurricane Katrina.

A day in the life

In a Davis Hall conference room on the Berkeley campus, 15 members of Bea's Deepwater Horizon Study Group (DHSG) are in attendance at their regular biweekly meeting, some by speakerphone from Louisiana. Bea has assembled 55 participants in all, from oil rig workers to distinguished academics. As yet unfunded, the group works under the auspices of UC Berkeley's Center for Catastrophic Risk Management (CCRM), which evolved from Bea's work on Hurricane Katrina with fellow Berkeley professor Ray Seed.

In two preliminary reports already submitted to the presidential commission, the group concludes that the gulf accident was caused by a combination of system failure, lack of regulatory oversight and "organizational malfunction." At this particular meeting, Bea is trying to assign sections of the team's final report, barely disguising his impatience when disagreements or interruptions arise. Bea is focused on the report, and he wants it done, as promised, by December 1.

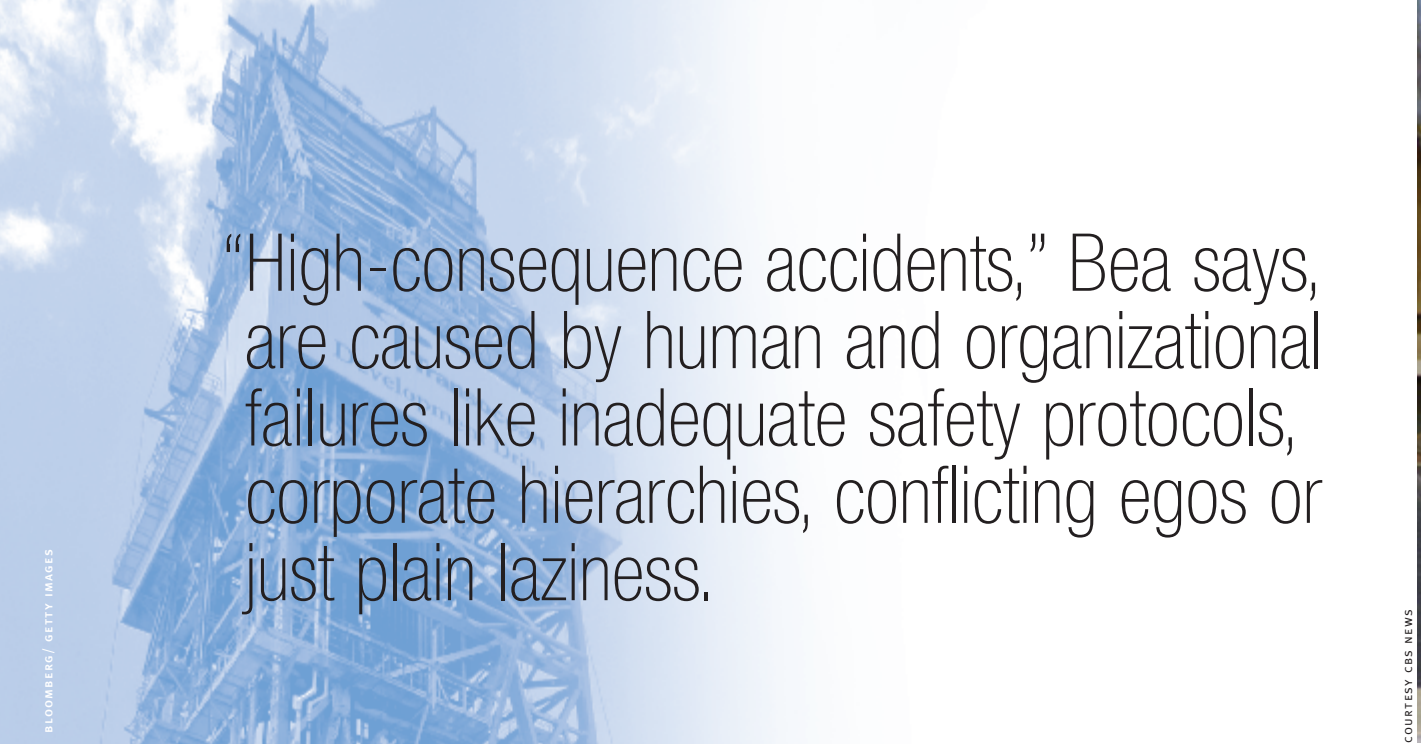
News from the gulf that week had been positive, with the well capped and remaining oil dissipating more quickly than anticipated. But meeting attendees were soberly listening to a report from Thomas Azwell, a DHSG member and UC Berkeley doctoral student in environmental science, policy and management who had just returned from a week-long visit to the gulf.

Among Azwell's observations? Chemical dispersants, by breaking up the oil, make it impossible to recover; and, although they have made the oil less visible, they make it more bioavailable, hence more toxic, to marine life. Azwell also saw polypropylene-filled booms being left in place to contain what oil remains. But since oil is coming to shore in an emulsified state (altering its specific gravity), it can easily enter the water column and pass beneath the booms to reach marshes and shorelines.

Azwell is working on a method of converting *bagasse*—an abundant and natural byproduct of Louisiana sugar cane refineries—into a more effective cleanup product that would support local industry and replace plastic booms with natural, compostable ones.

"This catastrophe is actually two sets of failures," Bea later explains. "One is the failure of the drilling exploration; the other is the failure of the cleanup." Of what he calls "high-consequence accidents," Bea says 80 percent are caused by human and organizational failures like inadequate safety protocols, corporate hierarchies, conflicting egos or just plain laziness.

Bea says he had already seen organizational problems in 2001 when he was invited by BP to address some culture-clash issues arising from a series of acquisitions; he spent two years developing a report that, apparently, he says, was not taken seriously. But the problem goes even deeper.



BLOOMBERG/ GETTY IMAGES

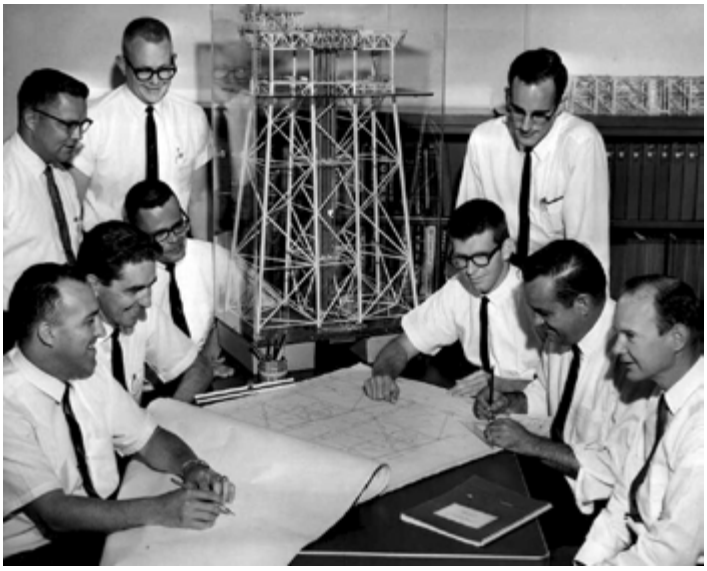
"High-consequence accidents," Bea says, are caused by human and organizational failures like inadequate safety protocols, corporate hierarchies, conflicting egos or just plain laziness.

COURTESY CBS NEWS

"Some of this is happening in Washington, D.C., too," Bea adds. He served on a National Academy of Engineering advisory panel that prepared a report for the Interior Department recommending, among other measures, a six-month ban on any *new* deepwater oil drilling permits. But the Obama Administration used that report to justify declaring a six-month moratorium on *all* drilling operations, which the panel opposed. The ban has since been modified but, Bea told the *Wall Street Journal*, it has shut down many safe rigs, which could cause safety and manpower problems when those rigs resume operations.

Comfortable with catastrophe

Bea calls it dumb luck, but his life has taken some surprising turns. He had his first close encounter with a hurricane in 1965 as a resident of New Orleans, where he would later return to investigate Hurricane Katrina. He came to Berkeley after more than three decades in industry to apply for the Ph.D. program; instead he landed a tenure-track job on the faculty.



COURTESY ROBERT BEA

Bea (top row, right), with colleagues at Shell Oil in the 1960s. Following six years with the U.S. Army Corps of Engineers and a construction company in Texas, Bea spent 17 years with Shell Oil, which introduced him to his first disaster: a military radar platform that collapsed off the coast of New York City in 1961, killing 28.

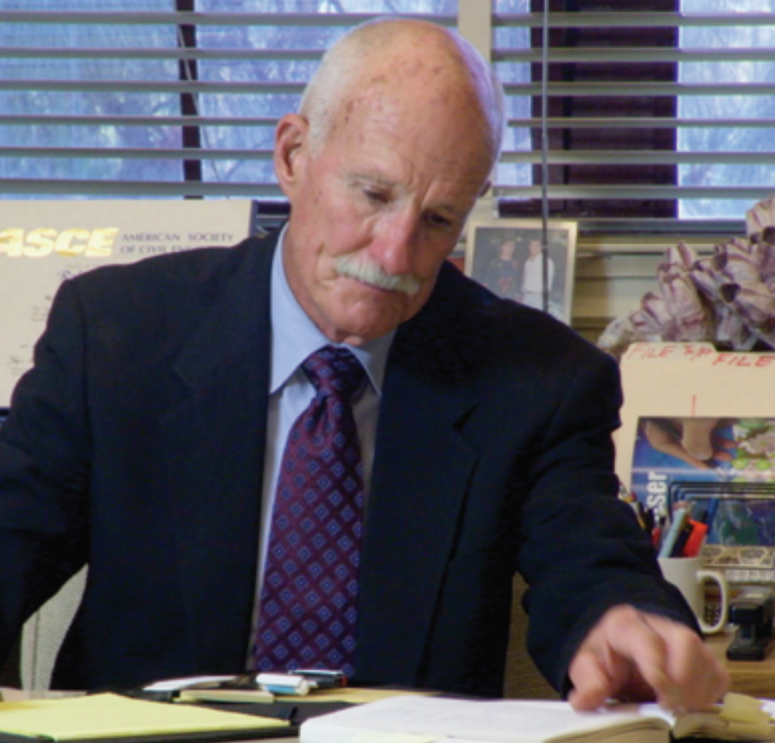
"My coming here was totally unpredictable," Bea says. "I had no plan in my life ever to end up in a university, much less teach." After 17 years with Shell Oil and 20 more with several construction and engineering firms, there was no doubt he had all the engineering chops; all he needed was a Ph.D.

Just after Berkeley hired him in 1988, the Piper Alpha oil platform exploded in the North Sea, killing 167 and causing $3 billion in damage. Because of his oil experience, Bea was called in and ended up working on that problem for three years. By the time the Exxon Valdez slammed aground the following year, he had a topic for his doctoral dissertation (earned in 2000 from the University of Western Australia) and found himself firmly situated in the study and mitigation of disasters.

Around the same time he met two colleagues whose thinking would profoundly influence his work: Haas School of Business professor Karlene Roberts, who introduced him to human psychology and organizational behavior; and University of Washington professor Ed Wenk Jr., who introduced him to the "technology delivery system," a concept that defines engineering infrastructures as only one part of a network involving the public, government, commerce and industry, and the environment.

Taking this big-picture approach, Bea believes, is essential to implementing complex engineering systems that—like the Deepwater Horizon—have powerful impacts, designed to be beneficial but potentially destructive. Through Berkeley's Center for Catastrophic Risk Management (CCRM), he uses the non-engineering tools he has learned from his colleagues to connect teams of social scientists, economists, CEOs, attorneys and public officials with engineers.

"If you're going to deliver the best technology," Bea explains, "you've got to get all these groups working together." The Deepwater Horizon Study Group, for example, is now consulting directly with high-ranking Washington officials to advise government and



A glance at Bea's website reveals a philosophical approach to teaching, and to life. On a page entitled My thoughts about being an engineer, *he observes, "When you ask, how can we do this, also ask, should we do this? Watch out for unintended consequences. . . . Remember our planet is inhabited by people."*

the offshore drilling industry on engineering best practices and regulatory oversight. Another of the CCRM's major priorities is to establish a geo-referenced archive of environmental assessments and case studies that would be universally accessible and easily searchable by anyone interested in understanding recent disasters and preventing future ones.

There, Bea says, he sees many of the same flood control system problems that existed in New Orleans; but this time, he hopes to address them *before* catastrophe strikes. His work on Katrina was particularly charged because he and his young family had to evacuate their New Orleans home when Hurricane Betsy struck in 1965. Reliving that scene was painful, he says, because lessons were not learned from the earlier storm.

"When I got back there," Bea recalls, "I saw the people who had built a new home on our old foundation dragging oily, wet mattresses out of their front door, just as I had done 40 years earlier. That was an emotional shock."

While working on Katrina in 2005, he suffered what his doctors believe is a pulmonary fungus, presumably caused by the rampant toxicity, that is progressively damaging his voice. Nonetheless, he was back in New Orleans last spring to testify for three full days in a federal lawsuit over the Mississippi River Gulf Outlet, a channel that exacerbated flood damage to several homes and businesses. He believes the Deepwater Horizon accident will similarly spawn numerous lawsuits.

Whether he is exposing White House politics, leaking details of corporate misdeeds to the press, or testifying against the U.S. Army Corps of Engineers (his former employer, by the way), Bea tells it like it is. It's all part of his crusade to neutralize individual agendas and make industry and government more accountable to the public and the environment they are intended to serve. But his greatest achievement, he says, is his Berkeley students.

On campus Bea is famous for his killer CE180 course—Design, Construction and Maintenance of Civil and Environmental Engineered Systems—where students apply their engineering skills to real-world projects like building a center divide for the Golden Gate Bridge or designing an erosion prevention system for the California beach town of Pacifica. Students work in teams and tackle a demanding reading list that includes L.J. Dumans's *Lethal Arrogance, Human Fallibility and Dangerous Technologies.*

"There are some really good people out there today working in all walks of life to help prevent miserable things from happening," Bea says, referring to the 50 Ph.D.s, hundreds of master's students and several hundred undergraduates he has taught and advised. "I get students in law enforcement, the military and doctors and nurses in my classes, and this is an engineering class. Last semester one of them did a beautiful report on managing the risks associated with colonoscopies."

From medical complications to global environmental catastrophes, Bea is inspiring intelligent and thoughtful minds to help make the world a safer place, one problem at a time.

"When I got back [to New Orleans]," Bea recalls, "I saw the people who had built a new home on my old foundation dragging oily, wet mattresses out of their front door, just as I had done 40 years earlier. That was an emotional shock."

Increasing spheres of influence

"Bob Bea was one of the first to worry about catastrophic events in deep water in the Gulf of Mexico," says Professor Emeritus Robert Wiegel (B.S.'43, M.S.'49 ME), one of Bea's earliest Berkeley associates. "He's recognized for a long time that, in engineering planning, you have to hypothesize what might occur and be prepared. Now he's saying, OK, don't overreact, but for heaven's sake, please be careful. And please have a back-up plan."

In another Berkeley research center, the Resilient and Sustainable Infrastructure Networks (RESIN), Bea is working on the 1,100-mile system of earthen levees in California's Sacramento–San Joaquin River Delta. The highly developed region, the West Coast's largest estuary, provides two-thirds of the state's drinking water and is extremely vulnerable to flooding and earthquakes. RESIN is working to reinforce the Delta's flood control system, not just the outdated infrastructure but also the complexities caused by the more than 220 government agencies that have jurisdiction in the area.

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 **www.coe.berkeley.edu/alumni/class-notes** and click on *"Submit a new Class Note."*

2000s

IAN ALEXANDER DAY (B.S.'07 MSE) of Lomita, California, is working as a manufacturing engineer in the aerospace industry. He participated with Team Stealth Ginger in the Red Bull Flugtag, held last August in Long Beach, California.

PAUL TILLBERG (B.S.'09 EECS/MSE) of Culver City, California, was awarded a

2010–11 fellowship from the Fannie and John Hertz Foundation, one of the most competitive and prestigious graduate fellowships in science and engineering. One of 15 fellows selected from among 600 applicants, Tillberg received $250,000 to support his doctoral studies at MIT. His undergraduate research at Berkeley focused on a technique to direct the assembly of fluorinated small molecules at the surface of a thin film using block copolymer-based macromolecules. He is now working on applying traditional antenna design techniques to tiny metallic structures, which has potential applications in improving the efficiency of near-field microscopy. He plans to pursue a career in academic research. Tillberg also holds a B.A. in comparative literature from the University of Southern California.

ERNEST Y. YOUNG (B.S.'03 BioE) of Cleveland, Ohio, received a master's degree in bioengineering from the University of Southern California, then worked in a lab in Irvine, California, for three years. He got married in June 2009 and started medical school at Case Western Reserve University the following month.

HELEN ZHU (B.S.'00 ME)

married Richard Ho in May at the Stanford Park Hotel in Menlo Park. The couple, together with Corrine Chan (B.S.'97 EECS), designed and programmed the fashion networking site **Chictopia.com**, which they launched from their San Francisco apartment in 2008. Since then, the site, where users post pictures of themselves in favorite outfits for the approval and ratings of their peers, has been featured in *Nylon* magazine and *Women's Wear Daily*, and its following has grown to more than 100,000 registered users. The Zhu–Ho wedding was covered in the June 11 edition of the *New York Times*.

1990s

ERIC GAGEN (B.S.'97 Earth Resources Engineering) of Arnaudville, Louisiana, is a senior district engineer for Coil Tubing Services, LLC, in Broussard. He is married with two children.

PETER C. HSUEH (B.S.'93 MSE/NE) of Arcadia, California, is now a partner at intellectual property law firm Christie, Parker, Hale LLP in Pasadena. His clients range from large, multinational firms headquartered in Korea to local inventors in the San Gabriel Valley. He still enjoys working with the newest generation of technological innovations through writing patent claims and overseeing the entire patent process. In his spare time he surfs the Internet and can't resist buying new, but inexpensive, gadgets (to his wife's continued annoyance). He writes, "Hey, Cal inventors! Send me your intellectual property work and I'll make you a deal. No discounts for Stanford alums (just kidding!)." E-mail Peter at **pch@cph.com**.

JASON MIKAMI (B.A.'92 East Asian Languages, B.S.'98 EECS) of Oakland, California, has started Mikami Vineyards **(mikamivineyards.com),** a winery located in Lodi that focuses on limited-release, handcrafted artisanal Zinfandels. By day he is senior director of operations at SugarSync, a Cloud storage and backup company.

1980s

GAIL BRAGER (M.S.'82, Ph.D. '84 ME) of Orinda, California, served as interim chair of architecture from spring 2009 to July 2010 in UC Berkeley's College of Environmental Design. A professor of architecture and associate director of the Center for Environmental Design Research, Brager has published extensively in the area of thermal comfort, indoor air quality, task conditioning and adaptation in naturally ventilated and air-conditioned buildings. Her many awards include the Progressive Architecture Research Award and the Presidential Young Investigator Award from the National Science Foundation.

LANCE C. KING (B.S.'81 ME) of Newark, California, is married to Terri (Parker) King (M.B.A.'86), and they have an 11-year-old son. He writes, "I am now recovering from a high-speed bicycle collision with a turkey (the bird): broken bones, fractures, contusions and road rash. Hope to be riding again soon. Similar story three years ago from a hang glider crash. In the past I designed class 8 trucks at Peterbilt Motors, then designed software in the desktop computer and medical device industries."

MARTIN R. KURTOVICH (B.S.'82 CEE) of Alameda, California, participated in a panel discussion about early career choices at the Berkeley Leadership Symposium on February 8, 2010, on campus.

RICHARD MORALES (M.S.'86 CEE) of Alpharetta, Georgia, recently returned from several months working on a design and logistics team to expand the Panama Canal's Pacific Access Channel (PAC-4) project, to be completed by 2014. He is engineering manager for L.B. Foster Piling, the sole source provider of more than 20,000 tons of flat sheet piles for circular cofferdams that will be used to widen the canal at the Borinquen Dam, near the Miraflores Locks and Dam. He writes, "Having had the opportunity to study at UC Berkeley's Structural Engineering and Structural Mechanics Division continues to provide amazing possibilities, especially working on one of the world's greatest engineering feats of our time."

1970s

ELIZABETH ANKER (M.A.'71, C.Phil.'73 CS) of Minneapolis is performing with Kairos Dancing Heart, an award-winning, evidence-based art program that engages frail elders in dance movement.

CHARLES "CHUCK" H. BALLARD (M.S.'74 EECS)

of Emmaus, Pennsylvania, retired from energy company PPL Corporation and published his first book *A Leadership Vacuum: Why American Business Keeps Trying to Suck Employees out of the Equation*. He and his wife Vi are enjoying traveling, including a trip to Australia earlier this year.

Peter Hsueh and family

PEG SKORPINSKI

Gail Brager

1960s

JESSE ANTE (B.S.'68, M.S.'70 ME) of Fremont, California, writes, "Congrats to my youngest daughter, Marisal, who just graduated from Ohlone College Nursing School. Woohoo! Now I can do more mentoring and fundraising for Cal. Go Bears!"

Jesse Ante and his daughter Marisal

EDWARD W. DODGE (B.S.'66 EECS) retired in 2006 after 40 years with Varian Associates scientific equipment company. He is living in Monterey, California.

JAMES H. GIBBS (B.S.'67 EECS) of Belvedere Tiburon, California, is a public finance consultant at investment advisory firm Sperry Capital Inc. in Sausalito. He is also involved in renewable energy project financing.

ALLAN MARIS (M.S.'67 MSE) of Albany, California, volunteered with the San Francisco chapter of Engineers without Borders on a water distribution project in Ngelenge, Tanzania.

1950s

JOHN AARON CASNER JR. (B.S.'50 ME) lives in Kingwood, Texas, with Jean, his wife of 62 years. His career has been devoted to the technology, manufacture and use of oil well casing, tubing and drill pipe. He has worked for Texaco, Youngstown Steel, Hydril Co. and finally as vice president of technology for Sumitomo Metal Industries, Ltd. He retired on his 80th birthday in 2006.

Champion of sustainability

Every year, UC Berkeley spends $35 million on its energy bill. Lately, though, the campus has saved money—$650,000 annually—thanks to Karl Brown (B.S.'80, M.S.'82 ME).

An energy efficiency expert at UC, Brown led an effort to install energy performance metering systems in 10 Berkeley buildings. The meters continuously diagnose system inefficiencies, identify measures to improve operations and suggest retrofits based on monitoring results, among other benefits. Prior to that, many buildings had no meters at all or included traditional meters that were read just once a month.

For his effort, Brown was named 2010 University of California Sustainability Champion. He is deputy director of the California Institute for Energy and Environment (CIEE), a UC-wide program based at Berkeley that supports public interest energy research across the state. Brown has more than 25 years' experience in the energy field, 19 of them at CIEE.

UC leaders also honored Brown for several other green initiatives: crafting UC's Policy on Sustainable Practices, helping establish UC Merced as a sustainable campus in which each building is LEED- (Leadership in Energy and Environmental Design) certified, and pioneering an annual state conference that shares best practices for reducing environmental impacts campus by campus.

Brown is perhaps best known for his role in promoting monitoring-based commissioning (MBCx), a term that harkens back to the process of taking a ship on a test run before putting it into service. In the case of a new building, "you run it through a series of tests before it's occupied to make sure the heating, air conditioning and other systems are working efficiently," Brown says.

At Berkeley, his metering system will be installed in 14 more existing buildings, with plans to upgrade most of campus within three years. Also involved in the program are David Culler, professor of electrical engineering and computer sciences; Paul Wright, professor of mechanical engineering and CITRIS director; and other CITRIS researchers.

.....

See more at **http://berkeley.edu/news/media/releases/2010/07/27_sustainability.shtml**

BY CATHY COCKRELL, CAMPUS NEWSCENTER, AND RACHEL SHAFER

ANDREA HICKLIN

***BROWN IS THE NEW GREEN:** Karl Brown (B.S.'80, M.S.'82 ME) is this year's UC Sustainability Champion awardee. The UC system, he estimates, is responsible for about 1 percent of California's statewide energy footprint.*

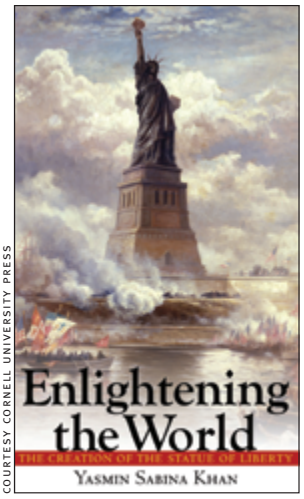
Are you a champion of sustainability?

What's your latest project to save energy and the environment?

Perhaps you're designing electric cars or next-generation power plants, or you've rigged up your own home energy monitoring system!

Write and tell us about it at **forefront@coe.berkeley.edu.**

Shining new light on the Statue of Liberty



COURTESY CORNELL UNIVERSITY PRESS

***TALL TALE:** Of her new book on the Statue of Liberty, Yasmin Khan (M.S.'83 CE) says she was inspired by Allan Temko's* **Notre Dame of Paris** *to "explore a monument as meaningful to our nation as Notre Dame is to France, and as universally cherished."*

The highlights of the story of the Statue of Liberty are widely known: the unsolicited French gift to the United States to commemorate a political alliance dating from the Revolutionary War. But Yasmin Sabina Khan (M.S.'83 CE) brings new life to the elegant monument that graces New York Harbor in her recent book, *Enlightening the World: The Creation of the Statue of Liberty.*

"I enjoyed trying to understand the context for the design, the friendship between the two countries and the history of the 1860s and '70s," Khan says.

Following her own 14-year career in building design, Khan wrote her first book, the 2004 *Engineering Architecture*, detailing the pioneering structural designs of her father, Fazlur Khan. In the new book, Khan goes beyond engineering and architecture to explore the major players and the unlikely confluence of events that brought the statue to life.

Taking inspiration from ancient wonders like the Colossus at Rhodes and classical allegorical statuary, and foreshadowing structural achievements like the Eiffel Tower and wind-resistant skyscrapers, the statue required a long-term team effort. Alexandre-Gustave Eiffel built the metal frame at a time when metalwork was increasingly replacing wood and stone as a building material; he exploited new methods of calculating wind resistance, including diagonal forces, which advanced modern structural design.

In examining the various influences on French sculptor Auguste Bartholdi, who designed and built the statue, Khan describes how liberty is symbolized in sculpture, painting, architecture, even furniture making. Bartholdi's decisions about what elements to include—the statue's tablet and torch, the drape of her robe and crown of sunrays—would be critical to its success, Khan argues.

STEPHEN D. BYRON

During her research, she became fascinated by Édouard Laboulaye, the French jurist, professor and author who championed the statue and invested 18 years of his life getting the megaproject financed and built.

"Other books said he was trying to reform the government of France," Khan says, "but I was also trying to understand what Laboulaye admired about the United States, his concerns about slavery, and what made him want to devote so much to the statue."

Khan has decided against doing a promotional tour for the book, due to a recent diagnosis of Parkinson's disease. While progressing slowly, the illness has affected her right motor skills and tolerance for stress. To cope she moved her computer mouse to her left hand and learned how to use voice-recognition software to help with note-taking.

"I love research and reading," Khan says, "so that helps." And her four years on the project gave her a deep admiration for her subject.

"As I came to know her story, I came to see her as a beautiful figure, expressing hope, progress, justice, commitment and, of course, liberty."

BY PATTI MEAGHER

in memoriam

WILLIAM E. CHYNOWETH (M.S.'59 Eng Sci/ME)

of Sanger, California, died this year at age 86. He attended West Point Academy and later served as a paratrooper in the 11th and 101st Airborne Divisions, then in the U.S. Army Corps of Engineers. After his Berkeley studies, he earned a law degree at Stanford and practiced patent law. He served as deputy district attorney in Tulare County until his retirement in 1978. He had many interests outside his work and was a fruit farmer, painter, voracious reader and animal lover. He also loved the outdoors and was an accomplished athlete all his life, holding the age 60–64 world record in javelin for three years and the age 80–85 American record for three years.

CHARLES F. DEWOLF (B.S.'49 ME) of Emeryville, California, died in May at age 94. An engineer and business owner who invented machinery and tested compressors, he also served in the U.S. Merchant Marine. An avid scuba diver, he was active in the Rotary Club and enjoyed spending time with his family.

WOLFGANG S. HOMBURGER (M.S.'51 CE) of Kensington, California, died in June at age 83. His work on traffic safety engineering helped inspire the founding of UC Berkeley's Traffic Safety Center, a joint partnership of the School of Public Health and the Institute of Transportation Studies (ITS). He joined the ITS staff as a junior researcher in 1955 and retired in 1990 as its assistant director. He was also a lecturer and wrote the textbook *Fundamentals of Traffic Engineering*, now in its 16th printing. Born in Germany, he immigrated to the United States and served in the U.S. Army Corps of Engineers from 1951 to 1955, working in construction and pavement design. He and his wife, the late Arlene Levinson (B.A.'52 Social Welfare), were strong supporters of International House, where they first met, and of Neve Shalom-Wahat al-Salam, a village in Israel where Jewish and Arab families live together in a peace-building effort.

PAUL W. HUGHETT (Ph.D.'95 EECS) of Philadelphia died of cancer in June. For the past 12 years he was employed at University of Pennsylvania Hospital as a research associate, working in medical

LAWRENCE G. HARRIS (B.S.'50 CE) is retired and living in Meridian, California. He writes, "I spend my time farming and playing."

VINCENT DANIEL PAUL (B.S.'51 CE) of Santa Rosa, California, writes, "Retirement life is quite enjoyable, although more lonely now with the recent passing of my wife. I try to keep myself up-to-date with ongoing civil engineering projects all around the world."

ALBERT J. ROTHMAN

(Ph.D.'54 ChemE) of Livermore, California, retired in 1986 and has published poetry as well as stories. His first book, *A Brooklyn Odyssey: Travails and Joys of a Boy's Early Life*, was published in 2008 by Wingspan Press. He writes, "I'm still living and breathing at age 86. However, I'm no longer interested in engineering and am working on two more books as long as the person 'upstairs' allows me to stay on Earth. I remain an avid hiker on the East Bay Regional Park District Trail Safety Patrol."

ROBERT R. SHERRILL (B.S.'55 CEE) is retired and living in Elk Grove, California.

1940s

ROBERT E. BLAU (B.S.'48 ME) of San Rafael, California, has been retired for the last 30 years. Prior to that, he designed overhead traveling cranes (including the circular traveling crane for the Bevatron), machinery for cement plants and grain elevators, and forklift trucks. He also served in the military during World War II.

EDWIN D. JONES (B.S.'49 Eng Sci) of Pacifica, California, is affiliated with Web Security Alliance.

FRANK KREITH (B.S.'45 ME) of Boulder, Colorado, recently published the seventh edition of his textbook, *Principles of Heat Transfer*. First published in 1959, when he was an assistant professor of mechanical engineering at Berkeley, the book is a classic in the field of heat transfer. Updates include newer applications and analysis tools, as well as engineering problems of current interest like solar energy, micro-scale heat exchangers, nano-scale devices and nuclear power. He writes, "The book has been translated into five languages and has been used by students all over the world. I hope to teach a course and use it as the text next year if my health permits." Kreith is professor emeritus of mechanical engineering at the University of Colorado at Boulder, specializing in thermal and solar engineering as well as heat transfer.

HARVEY LUDWIG REMEMBERED

Not many people spend 70 years in their career. Harvey Ludwig (B.S.'38, M.S.'42 CE) of Bangkok, Thailand, did just that, working in environmental engineering with verve and distinction until April 24, when he died at age 93.

Just one month before, Berkeley Engineering interviewed him for *Innovations*, the college's online journal. Ludwig, we learned, was passionate about what engineering can and should do for developing countries.

For 26 years, he ran his own environmental engineering consulting firm in the United States before moving to Thailand in 1973 with his wife, who is Thai, to start a small company. His firm consulted on water and sanitation projects there and in other developing countries around Asia, the Middle East and Africa. "Within a couple years, I learned that technology developed in America and other industrialized countries wasn't appropriate, so I focused on modifying it to suit the existing economics and environmental standards of that country," he said.

But Ludwig didn't build shoddy systems. He modified designs to the level of U.S. standards and practices circa 1940, a recommended practice for developing countries, he said. "That provides about 85 percent of today's standard level of environmental protection at about 15 percent of the total production cost," he explained. "The water and sanitation infrastructure situation in most developing countries today is similar to America circa 1900. So this represents a great leap forward."

During Ludwig's career, environmental engineering expanded its reach from water pollution control in the 1930s to all kinds of development projects today, assuming a larger environmental mandate.

Ludwig considered himself both an environmentalist and a proponent of development. "Decision makers in all countries push economic development as the number one priority," he said. "My goal is to get decision makers from developing countries to agree to change all project plans, not just water and sanitation, as needed to minimize environmental degradation or even enhance the environment in cases where a small amount of extra money significantly improves sustainability."

COURTESY HARVEY LUDWIG

Ludwig freely shared his insights on how to translate Western technologies into best practices for emerging markets. He published papers, opined in journals and advised heads of environmental agencies in Asia. He also contributed to textbooks, including the chapter "Appropriate Technology for Developing Regions" for *Environmental Engineering: Water, Wastewater, Soil and Groundwater Treatment and Remediation*, 6th edition (Wiley).

WEB EXTRA **http://innovations.coe.berkeley.edu/vol4-issue2-mar10/ludwig**

BY RACHEL SHAFER

imaging in the neuropsychiatry department. He was active in his own neuroscience research as well and published numerous papers. He greatly esteemed the life of the mind and the institutions from which he earned his advanced degrees, MIT and UC Berkeley.

LAWRENCE RUBY of Lake Oswego, Oregon,

died in May at age 84. Born in Detroit and educated at UCLA, he was a professor in UC Berkeley's Department of Nuclear Engineering from 1960 to 1987. He and his wife, Judith, then moved to Oregon, where he continued to teach at colleges in the Portland area. He was also active in community activities and served on the Lake Oswego Planning Commission.

Engineering matters

BIOTECH DOUBLE TAKE

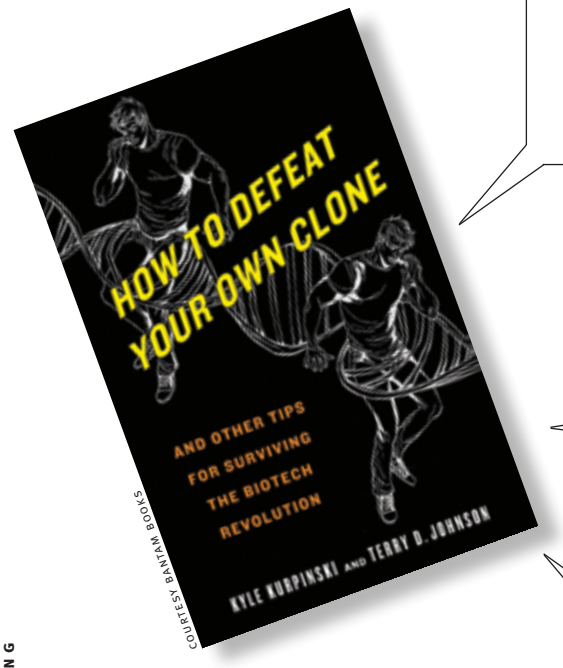
The year is 2045. Walking down the street, Bam! You run into someone familiar. Very, very familiar. Your clone. What do you do?

Don't fear, dear readers! Terry Johnson, bioengineering faculty lecturer, and Kyle Kurpinski (Ph.D.'08 BioE) have you covered in *How to Defeat Your Own Clone*, published by Bantam earlier this year. The book, a tongue-in-cheek yet earnest chronicle of biotechnology, examines what's realistic, and not so realistic, in the future. (Yes, meeting your clone is possible, but he or she won't be exactly like you and probably not as hostile as you think.)

"People hear 'genetically engineered,' and it's like, Whoa! A horror movie," Kurpinski says. "Biotechnology is doing extremely cool stuff, yet there are so many misconceptions. We wanted to write a fun, yet science-based book." National Public Radio in July named it one of this summer's best science reads.

Kyle Kurpinski

Terry Johnson



> *"In the not-so-distant bioengineered future, you'll be faced with a lot of awesome possibilities—like genetic facelifts and chocolate-flavored broccoli. Along with these benefits will come a lot of scary possibilities—like viral warfare and biologically enhanced Richard Simmons clones."* —Prologue

> *"At the moment, there are still several technical, ethical and regulatory hurdles to overcome in terms of human cloning, but the groundwork has already been laid in other species, which means that it's only a matter of time . . ."* —p.38

> *"In addition to finally liberating us from the shackles of SARS and bird flu, engineered immunity will provide greater opportunities for some of life's little indulgences. Next summer, forget the sunblock and wide-brimmed beach hat. Instead you can bronze for hours without the hassle of melanoma."* —p.89

STORY AND PHOTO BY RACHEL SHAFER
COVER ART AND ILLUSTRATION BY MING DOYLE

We're NOT afraid to take on...
Ting Chen '11

...and conquer BIG challenges.
Diana Louie '10

Every gift makes a difference.

During their years together at Berkeley Engineering, civil engineering students—and scholarship recipients—Ting Chen and Diana Louie became great friends. They also became intellectually fearless, ready and willing to take on any challenge they might encounter in their profession. One secret to their success is the **Berkeley Engineering Annual Fund**, which helps ensure the quality of a Berkeley Engineering education—and helps take the challenge out of affording one.

Berkeley Engineering
ANNUAL FUND

Make a gift—and make a difference—online:

coe.berkeley.edu/giving

or use the envelope at the center of this issue.

Photo: "Thanks to Berkeley..." PhotoBooth Project

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

NEW FOR FALL 2011

The Berkeley Engineering **Professional Master's Program**

This one-year professional master's degree could be right for you.

Is your background in engineering, science or technology?

Do you want to lead teams using both managerial and technical strengths?

Taught by top Berkeley Engineering faculty, the program gives you the knowledge, skills and connections to fast-track your career as a technology professional or executive:

Gain **leadership skills** by mastering finance, operations and strategy for technology enterprises.

Connect with **industry partners** by designing innovative products with real-world applications.

Sharpen your **technical expertise** with engineering courses you can tailor to your own interests.

The Berkeley Engineering professional master's program opens in fall 2011.
For program and application information, please visit:

www.funginstitute.berkeley.edu

Berkeley Engineering

FUNG INSTITUTE
ENGINEERING LEADERSHIP

COLEMAN FUNG INSTITUTE FOR ENGINEERING LEADERSHIP
COLLEGE OF ENGINEERING, UC BERKELEY
320 MCLAUGHLIN HALL #1700 | BERKELEY, CA 94720-1700 | 510-642-2487