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Forefront

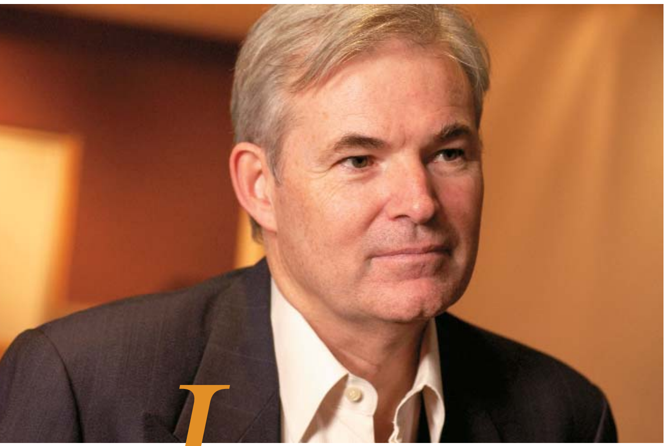
COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA, BERKELEY *spring 2005*

From Greenhouse to Lab: Artemisia's Promise for Malaria

- Stadium is cornerstone of campus building plans
- Students take a shot at Bay Bridge redesign
- Astronaut Chiao phones home from International Space Station

dean's message:

Truth in the Age of the Internet



BART NAGEL PHOTO

I recently heard about a couple shopping through consumer magazines for a clothes washer. They selected a top-rated national brand but changed their minds after finding Internet pages full of complaints about a mildew problem with the door seal. While at the store to make their purchase, they ran into a salesman representing the maligned brand and asked about the problem. "You know," he said, "we had a problem with that model a few years ago. But we recalled all the units, fixed it, and haven't had one complaint since. We just can't get those pages off the Web!"

The Internet has given new meaning to the words *caveat emptor*.

By a wide range of estimates, the one billion pages brought to you by the World Wide Web increase by one new page every four seconds. Recent studies show that only 40 percent of those pages are updated weekly, with 23 percent in the dotcom domain updated daily.

We love the Internet. It increases productivity and improves communications. About 66 percent of American adults use it for everything from paying bills to purchasing goods in a single click. Exciting developments happen daily in wildly creative blogs and peer-to-peer networks. How did we ever live without it?

The Web was built by data-sharing scientists on the venerable principle of open access. But the sheer volume of conflicting information, further degraded by valueless and outdated data, now threatens to become just so much white noise. People have already begun to tune out.

Even worse, the Web has engendered a new breezy attitude about manipulating data that's spilling over into every medium. We casually turn Gene Kelly into a hip-hop dancer, smear presidential candidates of both parties, and propagate "facts" that even lead nations to war.

Cybersaturation is blurring the lines between data and information, between knowledge and truth. The Web is also vulnerable to single powerful forces that could commandeer it for their own economic or political purposes. We are losing our framework of trust.

We can't solve this problem, but we can raise a question: Are there tools and services that we could create to help users gauge the reliability of data found on the Web? Filters that could detect derivative information, even when the author tries to camouflage the source? Algorithms that could synthesize "objective" searches on a given subject?

Of course, the first step for careful consumers and caring citizens is judicious use. Vint Cerf says, "There are no electronic filters that separate truth from fiction." But, as a responsible engineer, I'd like to see us try. I welcome your thoughts at **dean.forefront@coe.berkeley.edu.**

— A. RICHARD NEWTON
Dean, College of Engineering
Roy W. Carlson Professor of Engineering

Forefront takes you into the labs, classrooms, and lives of professors, students, and alumni for an intimate look at the innovative research, teaching, and campus life that define the College of Engineering at the University of California, Berkeley.

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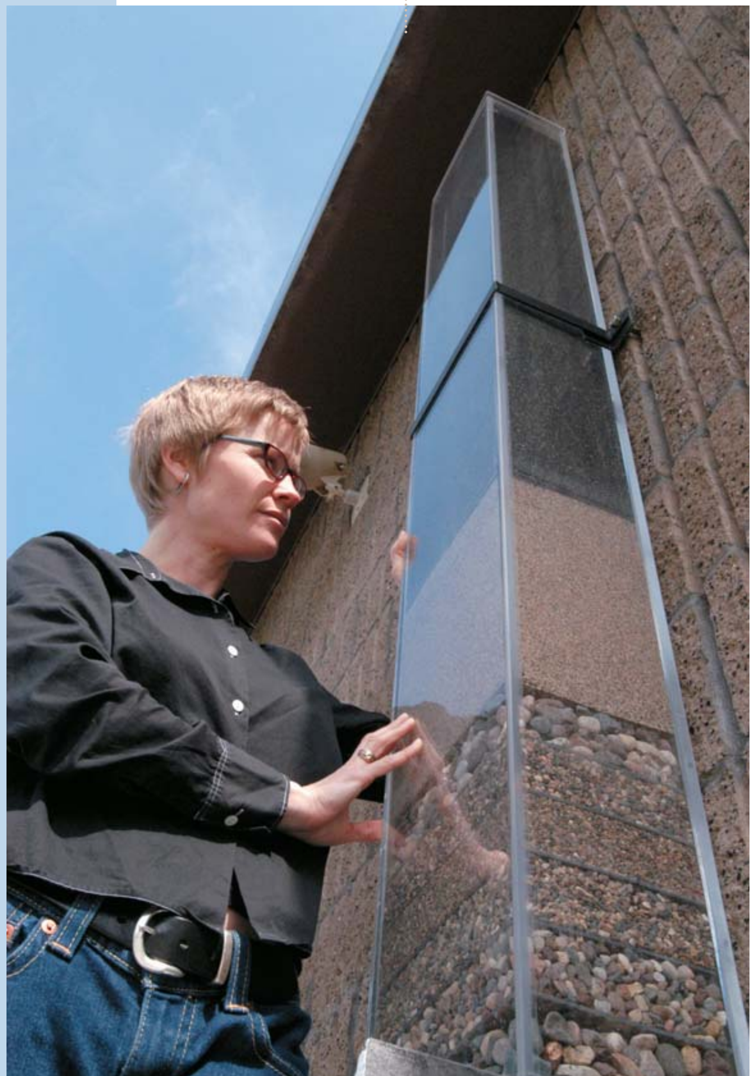
On the cover
Read the story on page 12.
Since A.D. 150, Chinese herbalists have treated fevers with an extract from *Artemisia annua*, the sweet wormwood plant. Since the early 1990s, when world health authorities embraced it as the first-line defense against malaria, speculators have hoarded the herb, driving up prices. But synthetic biologist Jay Keasling and his Berkeley team are close to synthesizing the drug, which would increase supply, decrease cost, and save lives.

COVER PHOTO BY BART NAGEL
BACK COVER PHOTO BY PEG SKORPINSKI

Forefront

COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA, BERKELEY *spring 2005*

CONTENTS



News from the Northside

What's New at Berkeley Engineering

Stadium to serve as cornerstone of campus building plans

Berkeley's 82-year-old Memorial Stadium will get a facelift and seismic upgrade as part of an ambitious development plan for the campus designed to better integrate the stadium and athletic activities with the surrounding campus and academic life.

The stadium will retain its existing footprint, but space below seating on the east and west rims will be rebuilt with new amenities for sports fans and state-of-the-art training and coaching facilities for football and 12 other men's and women's intercollegiate teams. Construction will be phased to ensure that the football team is displaced for only one season.

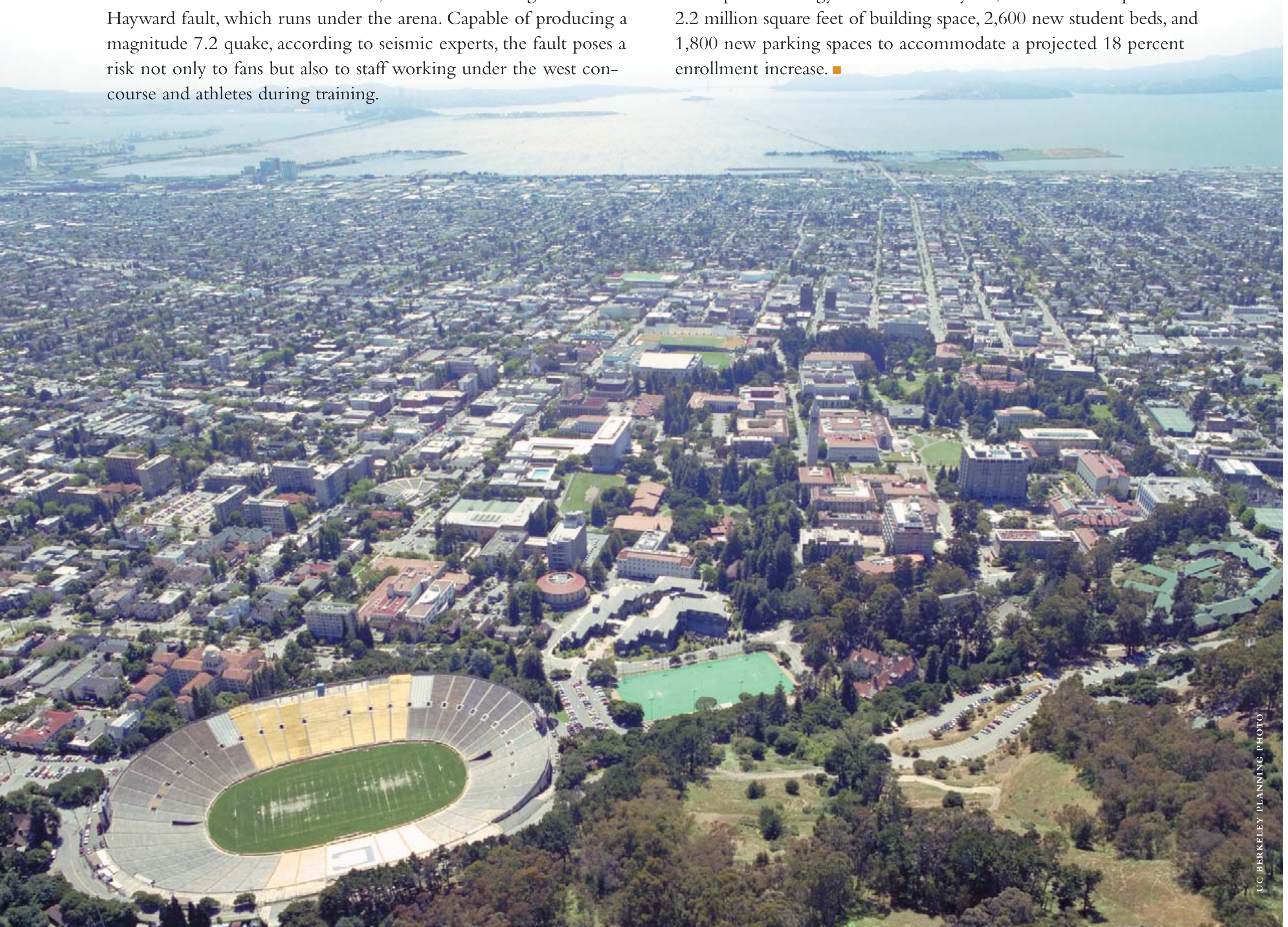
"Anyone who's ever gone to a ballgame would like to see the stadium upgraded," says CEE professor Nicholas Sitar, former chair of Berkeley's Seismic Review Committee. "It's beautiful and historic but long overdue for fixing."

The stadium was built in 1922-23, before official recognition of the Hayward fault, which runs under the arena. Capable of producing a magnitude 7.2 quake, according to seismic experts, the fault poses a risk not only to fans but also to staff working under the west concourse and athletes during training.

"We have the talent, experience, and know-how to create a design that will provide adequate life safety," Sitar says, adding that a previously vulnerable press box perched on the west rim was upgraded in 2002. The campus expects to select an architect this spring and have detailed schematic drawings and reliable cost estimates by fall. Funding will come from private sources, using a seat licensing campaign and other giving opportunities.

Also planned are a new academic commons building across the street from the stadium to serve Boalt Hall, Haas School of Business, and Intercollegiate Athletics, as well as a reconfiguration of Piedmont Avenue/Gayley Road with landscaping and pedestrian plazas that will enhance the everyday campus environment and the game day experience.

The stadium upgrade is just one element of Berkeley's long-range development strategy for the next 15 years, which outlines plans for 2.2 million square feet of building space, 2,600 new student beds, and 1,800 new parking spaces to accommodate a projected 18 percent enrollment increase. ■



UC BERKELEY PLANNING PHOTO

ARIANNA TIBUZZI PHOTO

During a July 2004 field trip to the Indian fishing village of Veerampattinam, a local fisherman (far left) explains to Berkeley's Eric Brewer (third from right) and team how each day's forecast is downloaded via the Internet and broadcast by bullhorns along the coast to warn of dangerous storms. When the first tsunami hit this beach on December 26, the system was used to clear the beach; only three people were lost.

Tsunami dramatizes value of simple IT solutions

In December, as massive tsunamis inflicted unprecedented devastation on Southeast Asia and beyond, Berkeley EECS professor Eric Brewer and a team of eight graduate students and researchers from Intel were searching for new ideas on how their research could help the troubled region.

"Life in these regions is fragile on a good day, so when something goes catastrophically wrong, it's far worse than the same thing would be here," says Brewer. "Technology can help."

In fact, there's evidence that it already has. A former resident was able to call one of the few phones in his Indian fishing village of Nallavadu, located in southeast India's Pondicherry region, to warn residents of the tsunami. The warning was broadcast over a public address system in time for residents to evacuate. Although 46 fishermen and others perished in neighboring beachside villages, everyone in Nallavadu survived.

"That's proof that even a very simple information system can save lives and, in fact, did save lives in this village," says Brewer. Nallavadu's public address system predated his presence in the region, but it is precisely the type of solution Brewer is looking for: low-cost, low-power systems, usable by people with little or no technical expertise and, therefore, viable in developing nations.

Brewer is principal investigator for Berkeley's five-year program known as Information and Communication Technology for Billions, or ICT4B, which is working with local residents, non-governmental organizations, and industry partners in India and Sri Lanka to investigate, create, and test technology systems designed specifically for the four billion people worldwide who live on less than $2000 per year. [*See fall 2004 Forefront.*]

The researchers are working in Nallavadu and similar villages to erect WiFi (wireless networking) antennas that reach distances of up to 30 kilometers to provide affordable and easy access to weather conditions for fishermen, crop prices for farmers, health news, and when possible, warnings of imminent disaster.

Affiliated with the multi–UC campus Center for Information Technology Research in the Interest of Society (CITRIS), the program is supported by a $3-million grant from the National Science Foundation and generous support from partners Intel, Microsoft, and others. Brewer points out that working with CITRIS has improved the project's effectiveness.

"CITRIS is valuable in this context because it's multidisciplinary," Brewer says. "CITRIS facilitates mixing social science and technology in a way that traditionally is hard to do." ■

BY JENN SHREVE

YVETTE SUBRAMANIAN PHOTO

JOHN M. PRAUSNITZ, professor of chemical engineering and faculty senior scientist at Lawrence Berkeley National Laboratory, was one of eight recipients of the National Medal of Science, the nation's highest scientific honor. President Bush presented the award at a White House ceremony March 14.

A native of Berlin, Prausnitz became an American citizen in 1944 and joined the Berkeley faculty in 1955. He is an applied physical chemist whose work focuses on molecular thermodynamics for designing separation operations in large chemical plants to increase efficiency and environmental safety and reduce energy consumption. His concepts and computer programs have been key to the design of large-scale chemical plants, including petroleum refineries and facilities for manufacturing polymers, plastics, and pharmaceuticals.

The National Medal of Science, administered by the National Science Foundation, recognizes pioneering scientific research and innovations that give the U.S. its global economic edge. Three of the eight medals awarded this year went to UC faculty, including Prausnitz; J. Michael Bishop, professor and chancellor at UCSF; and R. Duncan Luce, Distinguished Research Professor of Cognitive Science and Research Professor of Economics at UC Irvine.

AARON WALBURG PHOTO

CEE professor Yoram Rubin is designated director of the new National Center for Hydrology Synthesis (NCHS), a research center in development at Berkeley that will redefine hydrologic science and water resource management.

Berkeley selected to host hydrology research center

How does global warming affect water supply in semi-arid regions? Can scientists develop a theory to help predict the onset and duration of droughts? What is the effect of a carbon emissions–constrained world on the hydrologic cycle?

These are some of the questions that scientists will be investigating at a new research center now taking shape on the Berkeley campus that will forge an updated vision for hydrologic science and water resource management.

Berkeley was chosen from 14 competing proposals to host the center, known as the National Center for Hydrology Synthesis (NCHS). An October 2005 start date is planned, pending selection of a state-of-the-art site near campus and securing funding from the National Science Foundation (NSF). Together with NCHS partner support, funding is expected to total nearly $25 million over the next five years.

Strongly supporting the effort were Beth Burnside, vice chancellor for research, faculty and deans from engineering, natural resources, and physical sciences, and researchers from Lawrence Berkeley National Laboratory (LBNL), a range of participants that reflects the center's multidisciplinary appeal.

"It is clearly documented that the 20th century hydrology paradigm is inadequate in the face of the increased number, severity, complexity, and scale of water-related science questions facing the world," said CEE professor Yoram Rubin in describing the need for the center. An expert in hydrogeology who joined the Berkeley faculty in 1989, Rubin is the center's designated director. NCHS director of operations will be Susan Hubbard, staff scientist and head of LBNL's Environmental Remediation Program.

The center will provide a "think tank" atmosphere for international multidisciplinary research in hydrology, defined as the science of the Earth's waters, their occurrence, distribution, properties, and environmental relations. Research will be global in scope and performed by working groups, postdoctoral fellows, and sabbatical visitors in mathematics, engineering, and the physical, life, information, and social sciences.

Key elements will include broad involvement of academia, policy makers, industry, and government, as well as public outreach to ensure that NCHS research meets the needs of the hydrology community.

The center is one of four pillars of HydroView, a project masterminded by the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI), formed in 2001 to advance hydrology science. ■

PHOTO COURTESY OF RICHARD SEELEY

EECS professor Carlo Séquin was part of the five-man team that built this unique snow sculpture, entitled "Knot Divided," for the 15th International Snow Sculpture Championships in Breckenridge, Colorado, last January. The team spent five days building the structure, which begins with a trefoil knot formed by a band that also undergoes three half-twists when viewed from the top. Séquin designed the sculpture with custom software that his students built over the last five years, then prepared scale models on one of Berkeley's rapid prototyping machines to guide construction.

Team members included (from left) Dan Schwalbe of Minneapolis; Professor Stan Wagon of Macalester College in St. Paul (team captain); Séquin; Richard Seeley of Silverthorne, Colorado; and Professor John Sullivan of Berlin's Technical University.

Blanch

Culler

Howe

Kahan

Majumdar

Five Berkeley engineers elected to National Academy of Engineering

Five Berkeley Engineering faculty members were elected in February to the National Academy of Engineering (NAE), the highest professional honor for an American engineer. They are:

ChemE professor **HARVEY BLANCH** for advances in enzyme engineering, bioseparations, and biothermodynamics;

CS professor **DAVID CULLER**, for contributions to scalable parallel processing systems including architectures, operating systems, and programming environments;

EECS/ME professor **ROGER HOWE**, for contributions to the development of microelectromechanical systems in processes, devices, and systems; and

ME professor **ARUNAVA MAJUMDAR**, for contributions to nanoscale thermal engineering and molecular nanomechanics.

In addition, **WILLIAM KAHAN**, professor of CS and mathematics, was one of 10 foreign associates named for development of techniques for reliable floating point computation, especially the IEEE Floating Point Standards. Kahan is a native of Canada.

The five are among 74 new members nationwide elected to the academy this year. They bring to 87 the total number of Berkeley faculty in the NAE, 75 of whom are engineering faculty. Among academic institutions, Berkeley has one of the highest representations in the NAE.

New academy members will be formally inducted at a ceremony this fall in Washington, D.C.

AARON WALBURG PHOTO

PEG SKORPINSKI PHOTO

S. Shankar Sastry (right) takes over directorship of the Berkeley-based CITRIS as the center's new headquarters begin to take shape on the old Davis Hall North site, seen here from atop Cory Hall.

Sastry named new director of Berkeley-based CITRIS

S. Shankar Sastry has been named the new director of CITRIS, the Center for Information Technology Research in the Interest of Society. He succeeds founding director and EECS professor Ruzena Bajcsy.

A professor of EECS and bioengineering, Sastry (M.S.'79, Ph.D.'81 EECS) has been on the faculty since 1983. His areas of research include embedded and autonomous software, computer vision, robotic telesurgery, cybersecurity and network infrastructure, sensor networks, and hybrid and embedded systems.

He has served as director of DARPA's Information Technology Office, director of Berkeley's Electronic Research Laboratory and, most recently, chairman of the very department where he earned his Ph.D.

"CITRIS has already done a fantastic job addressing a wide number of societal-scale challenges and systems," Sastry said, "and I'd like to expand upon those successes. As CITRIS enters its fourth year, I plan to offer a new palette of challenges for us to take on."

His focus for the next three years, he says, will be on information technology applications to improve health care delivery at a lower price, advancing multimedia search technology, and improving security and trustworthiness of societal-scale systems.

CITRIS is one of four California Institutes for Science and Innovation established in 2001 to keep the state on the cutting edge of new technologies. The center currently unites more than 200 researchers from four UC campuses—Berkeley, Davis, Merced, and Santa Cruz—on more than 150 projects in areas such as disaster preparedness, environmental monitoring, energy management, and health care.

Sastry steps into the job as the center's new headquarters are under construction on the north side of campus. Building plans have been altered since excavation began last November to adjust for dramatic price increases in concrete and steel during the past two years. The new design will go out for bids this fall, with construction scheduled to continue through 2008.

See a live view of the CITRIS building site at **http://observe.berkeley.edu.** ■

A fresh look at water treatment

It's a do or dry situation for Australia's national water shortage. According to the Australian Water Services Association, the country is facing a 275-gigaliter shortage of drinking water in the next 10 years unless drastic conservation measures and new treatment methods are promptly put into place.

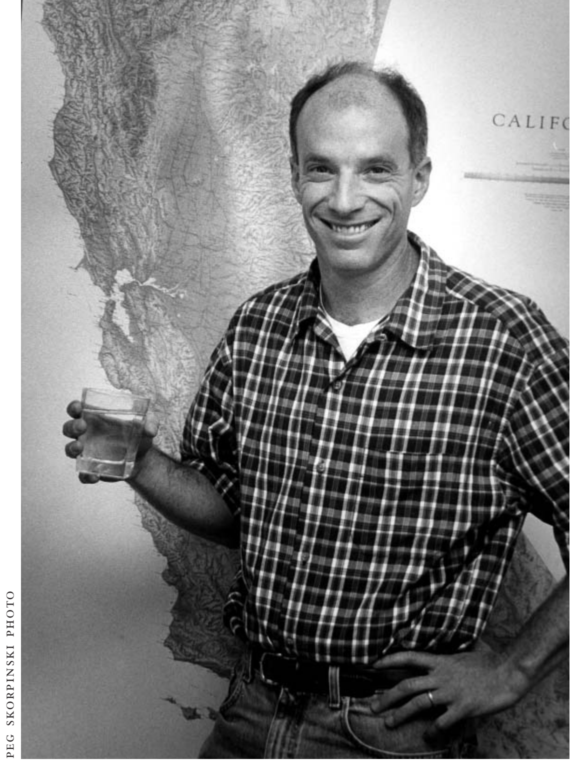
To CEE professor David Sedlak, the situation is similar to California's own water problems, only much worse. During a Fulbright fellowship last year at the University of New South Wales in Sydney, Sedlak worked on a novel treatment technique that could help in the purification of contaminated water and increase drinkable resources down under.

"There are a number of ways to treat groundwater or soil that's contaminated with organic pollutants like pesticides," Sedlak says. "The problem is that many of these methods are too expensive and relatively inefficient."

When Sedlak arrived in Australia, he was introduced to a recent discovery by graduate student Sung Hee Joo that had the potential to dramatically improve a time-tested technique of water treatment. Joo had observed that nanoscale particles of iron, when exposed to oxygen in contaminated water, become a powerful oxidizing agent that completely degrades the pesticides.

Sprinkling contaminated water or soil with iron filings scavenged from industrial trash is nothing new, Sedlak says. The filings act as a reductant, transferring electrons to the pollutant and thereby reducing the toxicity of the contaminant. The process is commonly used to clean up groundwater tainted by dry cleaning chemicals. In Australia, the researchers found that the iron particles transfer electrons to the oxygen, producing a reactant that, in turn, oxidizes the contaminants and purifies the water much more effectively.

Now, Sedlak, Joo, and their collaborators are taking a deeper look at the reaction to understand the chemical mechanisms involved in hopes of using the technique with contaminants such as benzene, the gasoline additive MTBE (methyl tertiary-butyl ether), and in other similar applications.

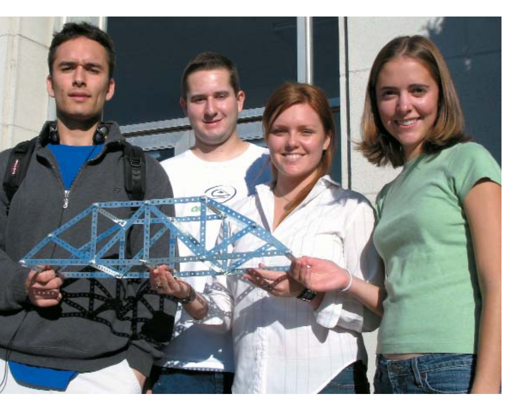

PEG SKORPINSKI PHOTO

"California and Australia are pretty similar in terms of geography and climate," says CEE professor David Sedlak, who won a Fulbright fellowship to spend a year in Australia investigating inexpensive, low-tech methods for reusing wastewater. In his spare time, he learned how to surf.

Back at Berkeley, Sedlak has had time to reflect on the different ways Australians and Californians are dealing with a threatened shortage of life's most precious fluid.

"In California, we prefer to solve our water problems with big approaches, like dams, high-tech treatment plants, and new water recycling facilities," Sedlak says. "In Australia, the public thinks more locally, down to collecting roof runoff to water their gardens. In the near term, I hope we'll also start thinking more about local solutions to our water shortage." ■

BY DAVID PESCOVITZ


RACHEL JACKSON PHOTO

Demonstrating a prototype bridge model are E36 students (from left) economics junior David Wood, ME junior Jimmy Quintana, CEE sophomore Kelsey Bulkin, and CEE junior Kyle Delwiche. Wood's team won the competition and a $500 prize.

Students take a shot at Bay Bridge Redesign

For his new class in engineering mechanics last fall, CEE professor Robert Bea challenged 115 undergraduates to do something that has deadlocked Bay Area city planners and politicians for the better part of last year: Design a replacement for the seismically challenged eastern span of the Oakland–San Francisco Bay Bridge.

The class was such a resounding success that not one, but two prize-winning teams emerged, and those who participated say the experience profoundly deepened their understanding of engineering.

"We take a lot of classes that are theoretical," said CEE junior Kyle Delwiche, "but in this one we got to apply the theory. I have a better idea of what engineering is really about."

Designed to provide a mastery of engineering mechanics core concepts, the class was centered on a project that would present practical obstacles and inspire creativity. Working in 21 teams, the students designed and built models of their bridges within the real-world constraints of aesthetics, load, safety, and budget, then presented their designs in class. The course culminated with a competition in Sibley Auditorium, where four top teams presented and tested their designs for a live audience, who then selected winners by ballot, "American Idol"-style.

Assisting Bea in designing and teaching the class were graduate student instructors Kofi Inkabi (M.S.'00 CEE), Jenet Alviso (M.S.'02 CEE), and Rune Storesund (B.S.'00, M.S.'02 CEE). ■

INNOVATIONS

Cutting-edge research from Berkeley Engineering

*Innovations features brief updates on the pioneering research done by Berkeley Engineering faculty and students. See more at **www.coe.berkeley.edu/newsroom.***

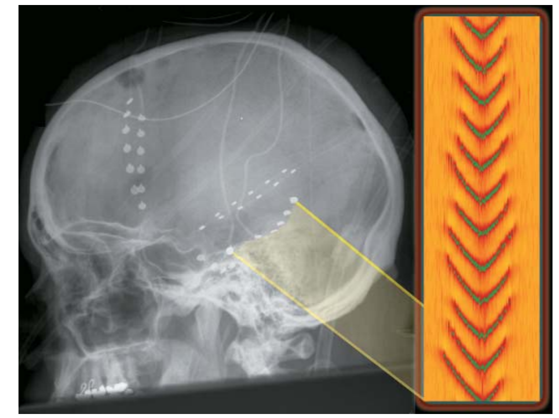


PHOTO COURTESY OF UC REGENTS

Skull radiograph shows an epilepsy patient's brain that has been implanted with electrodes to map electrical activity during seizures.

Seizure model reveals new understanding of epilepsy

UC researchers have created a mathematical model that simulates the electrical waves characteristic of a brain seizure, a model that may ultimately help neurologists better understand and treat epilepsy.

During a seizure, a strong pattern of traveling electrical waves suddenly emerges above the random fluctuations of normal brain activity. Using stochastic partial differential equations—the same type of equation used to spot stock market trends or predict complex weather events—the researchers simulated hyperexcitation of neurons in a portion of the brain and were able to duplicate the organized wave pattern associated with seizure.

"If we understand why and how these strong coherent waves progress over the surface of the brain, we have a hope of disrupting the signal," said principal investigator Andrew Szeri, professor of ME and applied science and technology (AST). Also working on the project were Mark Kramer, a Ph.D. student in the AST program, and Heidi Kirsch, UCSF professor of neurology. ■

Unmanned aerial vehicles making strides

Researchers with the Berkeley Aerial Robot (BEAR) program have successfully completed drills with 130-pound helicopters that not only fly autonomously—without human control—but also react to avoid obstacles in their path.

"Autonomous helicopters would be ideal in many situations too dangerous for humans to go," says Shankar Sastry, EECS professor and lead BEAR faculty member. The technology has potential in applications ranging from combat to civilian and agricultural settings like search and rescue, inspecting power lines, and fighting wildfires.

Reliable systems are still several years away, researchers say, but the computational foundations for such vehicles are in place. In developing computers to control the vehicles, researchers are incorporating the latest technological advances in inertial navigation and global positioning systems (for stabilization), wireless modems and Ethernet (for communication), computer vision (for flight and landing), and battery and solar technology (for power). ■


PHOTO COURTESY OF UC BERKELEY

BEAR researcher David Shim inspects an autonomous helicopter during field tests.

Smart parking may encourage public transit use

Drivers on Highway 24 can now get roadside updates on parking availability at Oakland's Rockridge BART station, part of a new "smart parking" field test initiated in December by Berkeley transportation researchers in conjunction with Caltrans and the BART district.

PHOTO COURTESY OF CALIFORNIA PATH

Two electronic road signs along Highway 24's westbound lanes near the Caldecott Tunnel alert drivers stuck in traffic of parking availability at the station, where 50 spots are earmarked for the project. Riders can alternatively reserve spaces ahead by phone or Internet.

"We'd like to know whether putting real-time information about the availability of BART parking along a congested freeway will help move people off the roads and into public transit," says Susan Shaheen, program leader for policy and behavioral research at Partners for Advanced Transit and Highways (PATH), a unit of Berkeley's Institute of Transportation Studies. "Many drivers do not drive to a BART station because they assume the parking lot is full. Our research question is whether individuals will now use transit if they know they will find an open spot at the station." ■

NICK LAMMERS PHOTO

Chenming Hu and Kris Pister in Cory Hall

Faculty-industry ties keep Berkeley Engineering connected to the "real" world

On the surface, they don't appear to have much in common. One, an internationally renowned microelectronics expert, can be seen dressed impeccably in suit and tie walking purposefully toward his orderly office in Cory Hall. The other, a young faculty member on the cutting edge of a new industry who customarily wears shorts and a T-shirt to work, gravitates curiously toward the window of his fifth-floor office in Cory to watch the bustling construction activity outside.

"For some people it's terrible," says Pister. "But for me, with four small children, noise is just normal. Plus, I'm an engineer, so it's good noise: There are people working hard out there."

In addition to both being Berkeley alumni and EECS faculty members, Chenming Hu and Kris Pister both recently returned from industrial leave, working on projects close to their hearts. Now, both are delighted to be back on campus.

Hu (M.S.'70, Ph.D.'73 EECS) left Berkeley in May 2001 for Taiwan Semiconductor Manufacturing Company (TSMC), the world's largest dedicated semiconductor foundry, with $8 billion in annual sales. Hu's 32-year career has taken him from Taiwan to two top U.S. engineering schools and back again. A Berkeley faculty member since 1976, Hu is well known for his research in semiconductor device technology and reliability. He also led the development of the BSIM transistor model, which has become an industry standard and is used in integrated circuit design throughout the world.

"My research has always tended to be on the applied side," Hu says, "and I wanted to do something for Taiwan because that's where I got my pre-graduate education." So, when the second of his two sons left home for college in 2001, he arranged to spend three years with TSMC as chief technology officer. When he left to return to Berkeley last fall, he was lauded for making "a deep impact through the strategic planning and execution of TSMC's most advanced technologies and management."

In return, Hu says, the experience he gained in corporate decision making in technology, finance, intellectual property, and global dealings was invaluable and of great benefit to his students. When he returned to campus, he picked up where he left off, teaching Integrated Circuit Devices and advanced study seminars and supervising three Ph.D. students.

"I was very happy to get back to classroom teaching and interaction with the students," says Hu, "but I'd forgotten how hard it is to be a new professor!" His enthusiasm for teaching was recognized in 1997 with the Distinguished Teaching Award, Berkeley's highest honor for educators.

Pister (M.S.'89, Ph.D.'92 EECS), who joined the Berkeley faculty in 1996, took a two-year leave in 2003 to launch his start-up in a converted warehouse in west Berkeley. Based on his "smart dust" technology, Dust Networks is on the cutting edge of a fledgling industry in ubiquitous wireless sensor networks that analysts predict will be a billion-dollar business within 10 years. "We have the best product out there," Pister says excitedly.

> "The university environment is magical. The students and faculty are both here to make things better, and I find that energizing and intoxicating."

Wireless sensor networks, he explains, will be used initially in automated monitoring systems for security, fire alarms, and heating, ventilation, and air conditioning in large industrial buildings. The sensors are cheap, he says, and eliminate the significant expense required for wiring such systems.

"There's a certain adrenaline rush associated with making life or death decisions on a regular basis for your company," Pister says. "But 2003 was a difficult year. In a down economy it was very stressful to have a lot of employees. They would keep pictures of their kids on their desks to make sure I met payroll."

But meet payroll he did. With about 50 employees and venture financing secured, Dust Networks began shipping its product to customers last fall. It also received a U.S. Department of Energy grant to create a sensor-based monitoring system that adjusts lighting according to building occupancy. Although he originally planned a one-year leave, it took Pister two to get the technology and infrastructure in good enough shape to hire a CEO so that he could return to his Berkeley faculty position.

"The university environment is magical. Students and faculty are both here to make things better, and I find that energizing and intoxicating," Pister says. "That's why, of all the people who have gone on short-term leave to industry, we've lost very few."

Many EECS faculty members have taken time off to pursue outside research interests, develop entrepreneurial ventures, or establish consulting relationships with larger commercial firms. But few are lured away permanently. In fact, says engineering dean Richard Newton, the ability to pursue such relationships is more often an incentive to stay at Berkeley, since they provide an efficient outlet for faculty to transfer their work to an industrial setting and see it have real impact. Relationships with industry are also essential to keep faculty at the leading edge and thus prevent "ivory tower" syndrome.

"After all, engineering is a profession of practice," says Newton, who throughout his own career has, at one time or another, consulted for nearly every major U.S. chip company and helped found several design technology companies. "Our students must learn about the state of the art, and things are moving very quickly today. Having an effective working relationship with the very best industries is essential to maintaining our effectiveness as a world leader in teaching and research. These relationships are a lifeline between our faculty—and by extension our students and the entire College—and the industry."

Hu explains that support for such associations has grown appreciably since mid-1980s, and he credits the rich interaction between academic research and business applications with thoroughly preparing him for his three years in industry. The robust trend may signal Berkeley's growing comfort with close industrial collaborations, despite concerns about possible conflict of interest and the lure of big money.

"Now, over almost half a century of affiliations with industry, the College of Engineering has developed an effective way of maximizing the benefit for the University, the faculty, our students and, ultimately, for the companies involved," says Hu. "It's a balancing act that must be managed carefully. The most important thing is to have the right checks and balances in place, and I think we have learned how to do that."

Pister agrees that such alliances are overwhelmingly positive, both for him professionally and for the University as a whole.

"We gain a huge amount of real-world exposure, so the faculty can understand what the issues are out there," Pister says. "And, from a purely practical standpoint, the ability to get support and raise funds for our research and the departments is dramatically improved through the practical impact of our research. It's mutually beneficial across the board." ■

Monismith and Hochbaum honored

CEE professor Carl Monismith and IEOR professor Dorit Hochbaum were recently recognized with honorary degrees from universities outside the U.S.

Monismith (B.S.'50, M.S.'54 CE), the Robert Horonjeff Professor of Civil Engineering (Emeritus) and director of the Pavement Research Center, received the degree of Doctor of Engineering, *honoris causa*, from Carleton University in Ottawa. He was recognized for his contribution as a researcher and educator in civil engineering, particularly in pavement technology. A Berkeley faculty member for more than 50 years, Monismith has received the College's Distinguished Engineering Alumni Award and the Berkeley Citation.

Hochbaum received a *doctor scientiarum honoris causa* (honorary doctorate in natural sciences) from the University of Copenhagen in recognition of her groundbreaking achievements and leadership in optimization in general and in the field of approximation algorithms for intractable problems specifically. The degree was conferred in a ceremony last November in the presence of Queen Margrethe II of Denmark. Hochbaum joined the Berkeley faculty in 1981.

Hochbaum

Monismith

Berkeley-UNIDO fellow studies role of computers in Brazil's *favelas*

RODRIGO FONSECA PHOTO

RACHEL JACKSON PHOTO

A young visitor works on his computer skills at one of Brazil's shared access centers in Rio de Janeiro, an ongoing project studied by Berkeley graduate student and Brazilian native Rodrigo Fonseca (far right) during his UNIDO fellowship last year.

In the recent acclaimed Brazilian film *City of God*, a boy named Rocket comes of age in Rio de Janeiro's notorious urban slum, or *favela*, the Cidade de Deus housing project. Poverty, violence, and drug trafficking paralyze any sense of normal life, but Rocket escapes by learning photography and taking pictures for a local newspaper.

Some real-life Brazilians may be finding their own ticket out of poverty through computers. For the last 10 years, Brazil's Committee for Democratizing Information Technology (CDI) has been operating computing centers where neighborhood residents can learn basic computer skills. The goal is to inspire children to stay in school and help adults get jobs.

Is the CDI program working? Rodrigo Fonseca, a CS graduate student and Brazilian native, wanted to find out. For three weeks last summer he traveled to Brazil's inner cities with three other Berkeley graduate students: Joyojeet Pal from City & Regional Planning and Manisha Shah and Claudio Ferraz from Agricultural & Resource Economics. They observed and interviewed users of the centers to evaluate their effectiveness and determine which skills are most easily learned and applied in the everyday lives of low-literacy adults and children.

"There was criticism in Brazil that these organizations should be spending money on food for the poor, not computers," says Fonseca. "So we wanted to see if there was any measurable outcome."

The team presented its findings at last month's second annual Bridging the Divide conference, the research initiative jointly sponsored by the Management of Technology Program at Berkeley and the United Nations Industrial Development Organization (UNIDO). Held on campus in April, the conference serves as a springboard for interdisciplinary teams that travel to developing countries to study application of information technology in solving large-scale problems like poverty and poor education.

When Fonseca's team got to Brazil, he says, the researchers quickly discovered they had to assimilate and work within local customs.

"We couldn't e-mail people and ask a couple of questions. You have to be there, have a sip of coffee, and have dinner with them before you start to get information."

After collecting and analyzing their data, they found that knowledge of some computer programs does help people search for jobs, interact with the community, and do schoolwork. Although unable to quantify the CDI program's effect on these outcomes, the team did find success stories like Leandro Farias, a poor child who took classes at a CDI center and learned enough to work there. He stayed in school and was accepted into the university, where he's now studying sociology and running a computing co-op that provides networking and computer services for poorer neighborhoods.

Fonseca plans to continue the research and keeps a hopeful final impression of his recent visit. "My favorite memory," he says, "was seeing those kids using computers and talking about a future."

Go to **http://bridge.berkeley.edu** for more details about the Berkeley–UNIDO project. ■

BY RACHEL JACKSON

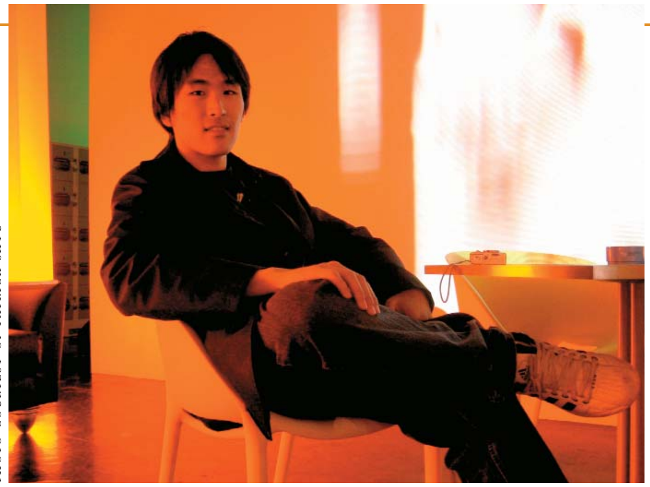


PHOTO COURTESY OF PATRICK SHYU

EECS senior Patrick Shyu was recently chosen as the inaugural recipient of the Gene Kan Memorial Scholarship for his website, Final Distance, *created in 2002 and now used by thousands of Berkeley students to construct conflict-free class schedules. The award, established in memory of alumnus Gene Kan (B.S.'97 EECS), carries a $1,000 cash prize for an undergraduate who has developed a simple, useful technology in keeping with the late Kan's innovative spirit. Shyu is honored by the recognition, he says, and hopes it will inspire others to develop their own projects. "Students can't just rely on coursework to get them by," he says. "They must develop zeal through independent work."*

DAVID PESCOVITZ PHOTO

ME professor Hari Dharan, holding one of the prototype booms, stands next to the machine used to fabricate the rolled carbon fiber tube. For three decades, Dharan has championed the use of carbon fiber composites in space vehicles. As an engineer at Ford Aerospace in the 1970s, he helped construct the 12-foot diameter carbon fiber dish antenna for NASA's Voyager 1 space probe, now the most distant human-made object in space.

A boom in satellite engineering

In October 2006, a group of five small satellites will ride a spacecraft "bus" into orbit to gather data about Earth's magnetosphere. The satellites' eight-foot long articulated limbs—outfitted with magnetometers, electrostatic analyzers, solid-state telescopes, and other instruments—will provide an unprecedented "bird's-eye view" of the magnetic substorms behind such spectacular phenomena as the Northern Lights.

ME professor Hari Dharan and graduate students Tien Tan, Tyler Williams, and Arezki Rahman are fabricating essential components for the mission, a $173 million NASA program known as THEMIS, or Time History of Events and Macroscale Interactions. Led by Berkeley's Space Sciences Lab, the project's goal is to determine how energy from solar wind is transported and explosively released, visible to us in the form of the Aurora Borealis and the Aurora Australis.

As director of the Berkeley Composites Laboratory, Dharan and his colleagues design, test, and fabricate new composite materials with high-performance properties, such as fiberglass, for use in structures from buildings to airplanes and space vehicles.

Dharan's specialty is carbon fiber composites, which combine incredible strength with very low weight and are ideal for space, where the approximate cost of launching something into orbit is roughly $15,000 per kilogram.

"In addition to being very stiff and strong, the carbon fiber structures we build have one-fifth the density of steel," Dharan says. In his Richmond Field Station lab, the researchers are constructing prototype booms out of the new carbon fiber composite through an elaborate fabrication process that involves wrapping the carbon fiber "fabric" around a form, oven-curing it into the desired shape, machining, and assembling it. Then the booms are tested under conditions that simulate the zero gravity environment of space.

"The main challenge here is dimensional stability and stiffness," Dharan explains. "Our carbon composites are designed to have a thermal expansion of less than 1/100th that of aluminum. Once you deploy an eight-foot long boom, you don't want it wobbling back and forth with the large temperature changes that exist in space."

In addition to the sensor booms, Dharan's group is building part of the main body structure for each spacecraft. Once the booms, structures, and mechanisms are complete, they'll be integrated into the rest of the space vehicle at the Space Sciences Lab. Then, next fall, if all goes as planned, Dharan will watch as his research truly takes off. ■

BY DAVID PESCOVITZ

PEG SKORPINSKI PHOTO

CS professor **DAVID PATTERSON**, the Pardee Chair of Computer Science, was inducted into the Silicon Valley Engineering Hall of Fame in February in recognition of his professional achievements and contributions to the community. Patterson led the design and implementation of RISC I, likely the first VLSI Reduced Instruction Set Computer, research that became the foundation of the SPARC architecture used by Sun Microsystems and others.

Patterson, who joined the faculty in 1977, is only the second Berkeley faculty member to be named to the Hall of Fame, following Chang-Lin Tien's selection posthumously last year. Sponsored by the Silicon Valley Engineering Council, the Hall of Fame was established in 1990 to recognize local engineers.

Letters to the Editor

When called to a challenge, our loyal alumni don't flinch. So here's the challenge: Write and tell us which stories you've enjoyed, which have put you to sleep, and why; what you'd like to see more of, less of, none of, and why. We value your input. Write to us at **forefront@coe.berkeley.edu**.

Miracles Happen

Synthetic biologists tap into ancient herbal pharmacy to cure malaria and AIDS

BY DAVID PESCOVITZ | PHOTOS BY BART NAGEL

For 3.6 billion years, evolution has governed the biology of this planet. Molecular biologists can now shift bits of DNA from one organism to another, but the parts they play with are limited to what nature provides. Recently, Mother Nature teamed up with a handful of researchers whose aim is nothing short of reengineering life. UC Berkeley is a core center of this new discipline, called synthetic biology, where genes, proteins, and cells are snapped together like Tinkertoys to build living systems.

Already, synthetic biology projects are under way at Berkeley to convert bacteria into chemical factories that produce anti-malaria treatments for pennies instead of dollars. Similar microbial factories could crank out the costly anti-cancer drug Taxol, synthesized from the Pacific yew tree, or produce a promising anti-AIDS drug derived from the Samoan mamala tree.

"The idea of synthetic biology is to do for biology what electrical engineers have done for circuit design and chemists have done for the synthesis of chemicals," says Jay Keasling, professor in the Departments of Chemical Engineering and Bioengineering. "We're turning biology into an engineering field."

Keasling is the hub of UC Berkeley's pioneering synthetic biology breakthroughs. In December, the Institute for One World Health—the first nonprofit pharmaceutical company in the United States—received a windfall $42.6 million grant from the Bill & Melinda Gates Foundation to support Keasling's development of a microbial factory to cure malaria—one of the world's deadliest diseases.

A parasitic blood disease, malaria claims more than one million lives each year in developing nations. Most are children under five and pregnant women in rural Asia or Africa, where people live without access to insecticides, protective netting, or glass windows to keep mosquitoes at bay. Synthetic quinine, once hailed as malaria's cure-all, is now considered largely ineffective because the disease quickly mutates into drug-resistant strains.

Ironically, the solution has been available for millennia. Since A.D. 150, Chinese herbalists have used an extract from *Artemisia annua*, the sweet wormwood plant, to treat fevers. Chinese researchers isolated the drug artemisinin 40 years ago to treat Vietnamese troops. Used in the early 1990s during a malaria epidemic, it cut the death rate by 97 percent. As other anti-malarials rapidly began to fail, world health authorities embraced artemisinin as the best first-line defense against the disease. The problem is there's just not enough of it.

Currently, the drug is extracted from wormwood cultivated in China and Vietnam. The plant takes eight months to mature, and drug companies have heard of Asian speculators hoarding what little remains of the herb. Last fall, the shortage caused artemisinin's price to quadruple.

Even if farmers dramatically stepped up production, harvesting the plant and extracting the chemical component that resides in its leaves is difficult, labor intensive, and costly. As a result, the price of the drug is $2.40 per treatment course, far too expensive for patients in developing nations. Keasling's technology would reduce the cost tenfold to as little as 25 cents a treatment course.

Fifth-year chemical engineering doctoral students Doug Pitera (right) and Sydnor Withers (left) are key members of the 20-person artemisinin project in Keasling's synthetic biology lab. Keasling (center) drew his team from a wide range of disciplines, including botany, chemical engineering, bioengineering, microbiology, and biophysics.

"We need a sea change in the way drugs are produced," Keasling says. "The cost of biopharmaceutical research, development, and production is pricing us out of medicine in this country. Now think about the developing nations where they spend less than $4 per person on health care annually. How can we ever make enough affordable drugs for the diseases that are really killing most of the people on the planet?"

The synthetic biology approach is to build more factories, albeit unusual ones—chemical factories inside bacteria. For several years, Keasling and his colleagues, including postdoctoral microbiology fellows Vincent Martin and Jack Newman and chemical engineering graduate students Doug Pitera and Sydnor Withers, labored in the wet lab to build a working microbial factory from just 12 genes borrowed from three organisms: bacteria, yeast, and wormwood. The human gut bacterium *E. coli* was the laboratory host of choice because it grows so quickly.

"We can engineer the bacteria we're working with to produce artemisinin," says Dae-Kyun Ro, a research scientist in Keasling's lab. "*E. coli* takes just 20 minutes to double in size under laboratory growth conditions."

It's also a very well-studied organism, Pitera adds. "Think of the system we're building as if it were a tree," he says. "We constructed the trunk of this tree, an eight-enzyme process, taking us from the base metabolites, or chemicals, in *E. coli* to the precursors we needed to create an isoprenoid, the large family of natural products of which artemisinin is one. Now, we're moving from those precursors down one branch of the tree to artemisinin," he says. "We could just as easily have taken the branch that leads to the anti-cancer drug Taxol, or the anti-HIV compound prostratin, even carotenoids or natural rubber—all isoprenoids, and only available in small quantities from natural sources."

Over the last few years, Keasling's team has stepped up production inside the microbial factory a millionfold. They are in the process of identifying a few more genes in wormwood that, if transplanted into *E. coli*, could enable the bacterium to go a few extra steps in the chemical process and actually produce artemisinic acid. "We've added a ninth enzyme that directed us down the path toward artemisinin, and we now expect that three more enzymes will be needed," says Pitera. "Once we have all the artemisinic acid we need, we'll be ready for industrial production of the drug."

UNIQUE PARTNERSHIP ACCELERATES PRODUCTION

As part of the Gates Foundation grant, startup Amyris Biotechnologies in Albany, founded by several of Keasling's former postdocs, will scale up the process and produce artemisinin at cost. OneWorld Health, headquartered in San Francisco, will then spearhead the regulatory work necessary to bring the drug to market.

"This is an extraordinary partnership between public and private institutions," says Regina Rabinovich, director of infectious diseases at the Bill & Melinda Gates Foundation. "I hope that Berkeley's participation will serve as a model for other academic institutions to apply their scientific knowledge and resources to critical global health problems."

While Keasling has focused his research on the "grand challenges" of global disease, synthetic biology spans many application areas. Currently, Keasling heads the Lawrence Berkeley National Laboratory's Synthetic Biology Department, the first of its kind in the country. The multidisciplinary department has prototyped a bacteria that eats toxic waste, such as heavy metals, and hopes to design an organism that can ferment cellulose into hydrogen as a source of renewable energy. Keasling is also leading the charge to engineer a single-cell soil microorganism, *Pseudomonas putida*, that would swim into a pool of pesticides or nerve agents and degrade the chemicals.

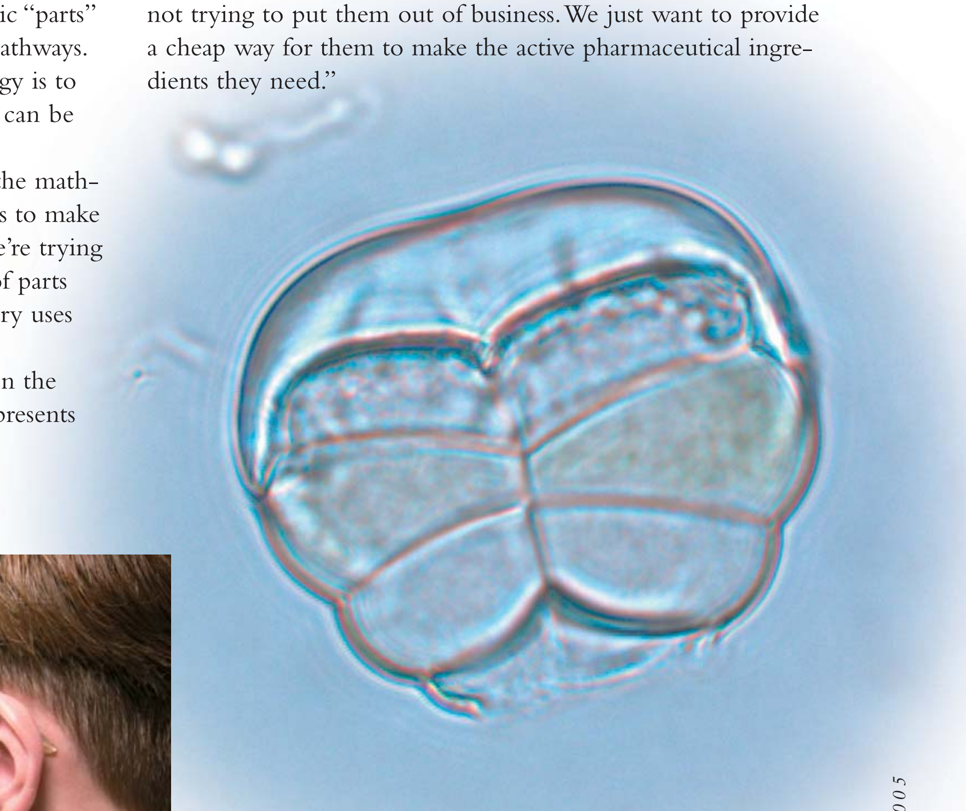
This spring, the Berkeley Center for Synthetic Biology opened its doors just a few miles west of campus. The Center, Keasling says, will draw researchers from the entire University. In one multidisciplinary project, Keasling is collaborating with EECS/ME professor Roger Howe to build nanoscale structures modeled after the ornately complex shells of brown algae. The biomimetic diatoms could be employed as filtration systems or self-contained catalysts in future nanodevices. Meanwhile, bioengineer Adam Arkin is writing software for the design of living systems from a library of validated interoperable genetic "parts" with specific functions, such as Keasling's metabolic pathways. Indeed, one of the long-term goals of synthetic biology is to create a library of interoperable genetic circuits that can be assembled into myriad devices.

"When Jay first started his research, he didn't have the mathematical models to guide him," Arkin says. "Our aim is to make the process orders of magnitude more efficient. So we're trying to develop a principled approach to creating a store of parts that we can then use much like the electronics industry uses transistors and capacitors."

Continuing the metaphor, Arkin is pushing ahead on the development of Berkeley BioSPICE, software that represents and simulates cellular processes such as gene expression and cell division. Think of it as CAD (computer-aided design) for genetic circuits. A project of the California Institute for Quantitative Biomedical Research (QB3), Berkeley BioSPICE is analogous to SPICE (Simulation Program Integration Circuitry Evaluation), the industry-standard tool invented at Berkeley for integrated circuit design. The BioSPICE project's motto, "open source biology," refers to the fact that the fruits of the research are freely available for anyone to use and improve. It's a concept that comes from open source software, a paradigm pioneered at Berkeley that makes the source code, the raw programming behind the software, accessible for anyone to build upon and change for free.

Some day, "open source" biology could result in a new business model for the biopharma industry. One reason many therapeutics are so expensive today, Keasling explains, is that drug companies spend huge sums researching patentable parts, ballooning the overall price of drug development. Open source biology would change that.

"I'd like to see the parts become inexpensively available for anyone to pull together and use," he says. "If biopharma companies could draw from open source parts to begin with, they could then patent their process to make the drugs. We're certainly not trying to put them out of business. We just want to provide a cheap way for them to make the active pharmaceutical ingredients they need."



ABOVE: *Trichomes like this magnified cluster of oil-producing cells contain the artemisinin made by the plant. Trichomes are purified in Keasling's lab to obtain the genes that encode artemisinin's biosynthetic pathway.*
KARYN LYNN NEWMAN PHOTO

LEFT: *Doug Pitera monitors a shake flask containing an amorphadiene-producing* E. coli *culture. The shake flask is loaded into a temperature-controlled incubator and set into rhythmic motion for 18–48 hours, mixing* E. coli *cells and growth media together.*

SAMOA'S MAMALA TREE COULD LEAD TO AIDS CURE

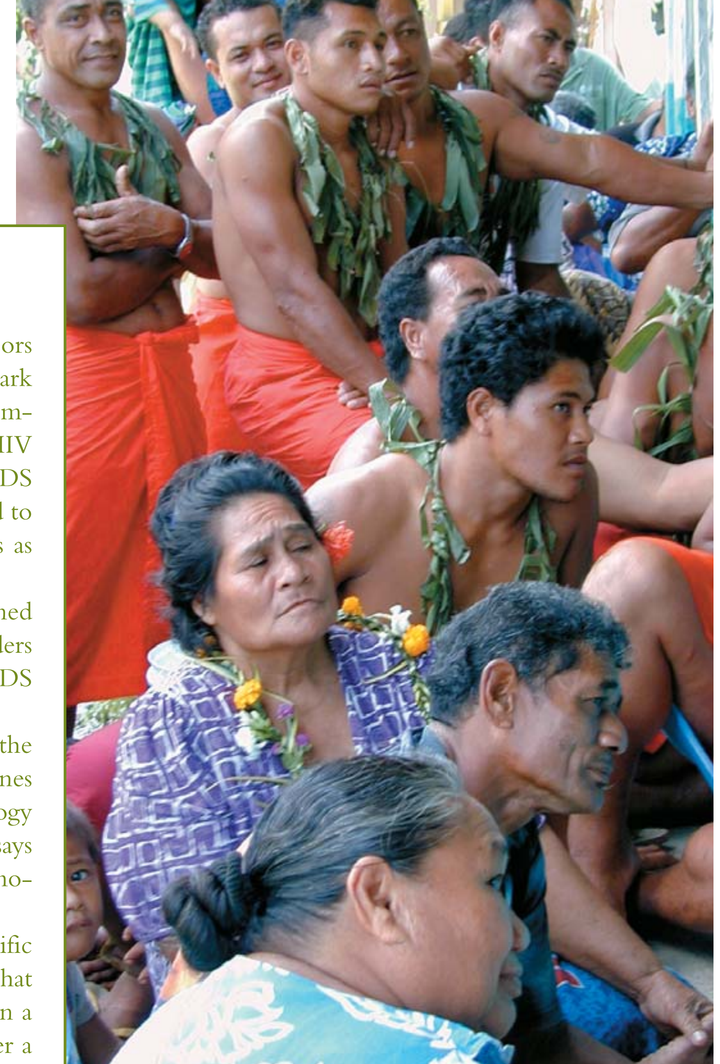
Last fall, Keasling visited Samoa, home of the mamala tree that harbors a gene for a promising anti-AIDS drug. Samoan healers use the bark of the tree to treat hepatitis, but scientists discovered that the compound derived from the tree, prostratin, also activates dormant HIV cells in patients so that the cells can be targeted by current anti-AIDS drugs. Clinical trials are encouraging, but the drug supply is limited to the small amount that can be extracted from the tree. If it works as well as researchers hope, there will be an immediate shortage.

That's where Keasling can help. Last September, UC Berkeley signed a landmark agreement with the Samoan government and village elders to return to them half the profits from production of an anti-AIDS drug Keasling hopes to produce.

The first step, he explains, is to identify the enzymes that build the prostratin molecule. Then, the aim is to clone the appropriate genes and slip them into the *E. coli*-based microbial factory where biology will bulk manufacture the valuable substance. A similar technique, says Keasling, could also supply Taxol, an expensive yet effective chemotherapy used to treat breast, ovarian, and lung cancers.

"Taxol is produced in minute quantities in the bark of the Pacific yew tree to kill beetles and fungi that attack the tree," he says. "That means, if you want to use it as a therapeutic, you have to cut down a lot of trees or collect a ton of pine needles. Or you could engineer a bacterium to produce it."

Eventually, Keasling adds, synthetic biologists might even synthesize a biological drug delivery system for Taxol. A bacterium designed to detect tumors could produce Taxol when triggered to do so and release it into the body. Once it reaches the tumor, the bacteria would go into kamikaze mode, secreting the toxin to kill itself and the cancer cells.



STEPHEN KING PHOTO

Last August, Keasling presented his research to an audience of Samoans. One month later, he signed a landmark agreement between UC Berkeley and the Samoan government offering village elders half the profits from production of the anti-AIDS drug prostratin, which he hopes to synthesize from Samoa's Homalanthus nutans, *or mamala tree. Samoans call the tree their "gift to the world."*

To that end, Berkeley hopes to bring together the academic leaders in synthetic biology from Harvard, MIT, and UCSF in a consortium that would ensure that the component parts each group develops are standardized and meet an agreed-upon set of specifications.

While progress is rapidly accelerating, synthetic biology is still in its infancy. In many ways, it's where genetic engineering was before the launch of the Human Genome Project. And the public fear surrounding genetic engineering is not lost on Keasling. Ideally, synthetic biology will be self-regulated, he says, without the need for government intervention. But before scientists can convince the public that the field is safe, they themselves have to be sure that it is safe. As a step in that direction, Keasling and his colleagues have initiated discussions with Michael Nacht, dean of Berkeley's School of Public Policy, to consider the bioethics of their breakthroughs.

Keasling needs two more years before his lab and Amyris Biotechnologies can synthesize the drug at the high levels necessary to begin producing the treatment pharmaceutical. "In a couple years, we'll be producing the end product in *E. coli's* growth medium," he says. Add in about two years of clinical trials, and this takes production to 2009–2010. Then the bacteria-produced artemisinin drug must still await approval from the Food and Drug Administration. It won't be a vaccine, but rather a drug akin to an antibiotic taken for infections, to kill the malarial parasite once the disease has been contracted.

"It's a very long haul," says Keasling. "Still, it's getting easier to engineer life, and synthetic biology will make it simpler still. If the public doesn't realize you can use it to make new drugs or renewable energy, it will look like we're tinkering with biology. As scientists, it's our responsibility to prove that synthetic biology has tremendous potential to save lives." ■

David Pescovitz writes *Lab Notes*, the College's award-winning online research digest, and is co-editor of the popular blog *BoingBoing.net*. Pescovitz's writing on science and technology has been featured in *Wired, Scientific American, IEEE Spectrum*, and the *New York Times*.

Algorithms that serve up really good goop

O'Brien models the brittle, the viscous, and the volatile world

BY DAVID PESCOVITZ

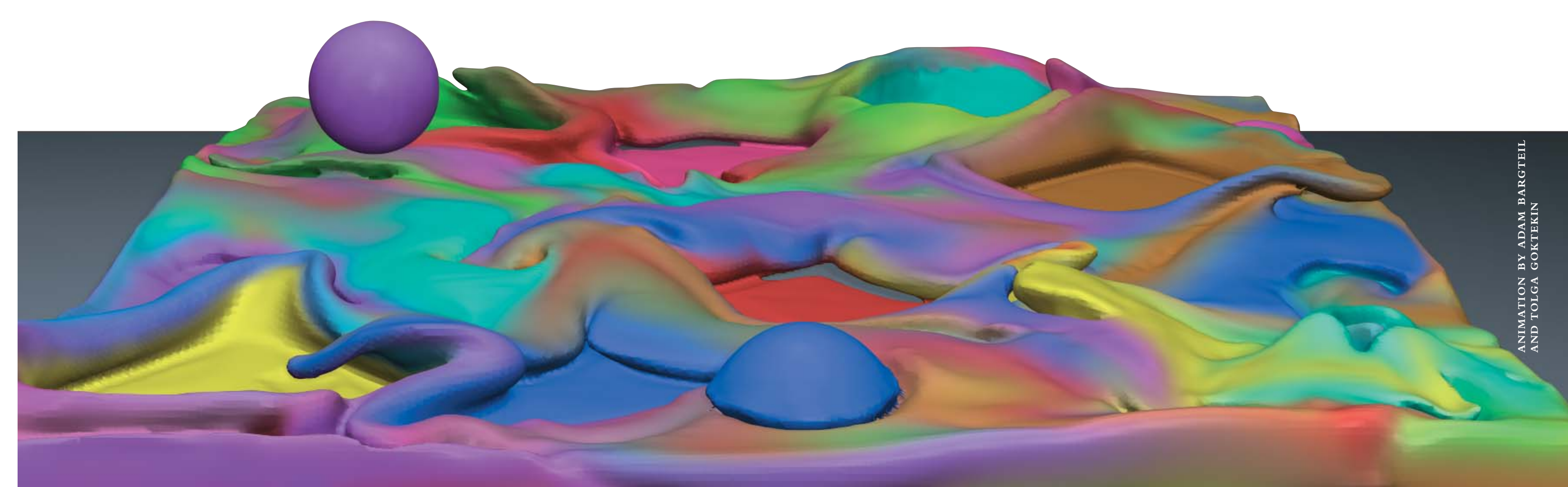
Early one morning last winter, a graduate student walked into the Berkeley Computing Animation & Modeling Laboratory hoping to catch up on some work while most of her lab mates were still home asleep. Expecting a few hours without distraction, she was instead greeted by the cacophony of genetically enhanced super soldiers wielding plasma rifles and massive insect-shaped tanks galumphing across a bombed-out battleground. Someone was playing a round of Halo 2, a new video game for Microsoft's Xbox video game platform. Wielding the joystick was laboratory director James O'Brien. And he had been playing all night long. This was research.

O'Brien, a professor in the Department of Electrical Engineering and Computer Sciences, models complex physical systems from snow and blood to explosions and shattering glass for computer animations. Already his algorithms have made their way into the arsenal of digital effects tools at Sony, makers of the PlayStation 2 video game system, and Pixar, the animation powerhouse behind *The Incredibles*. In the future, O'Brien's techniques could enhance training simulations for surgeons, soldiers, and firefighters. No matter the application, the goal is the same: Make the unreal seem as real as possible.

"If a special effect is done well, you shouldn't even notice it," he says.

While his research is meant to be invisible, O'Brien himself is definitely being noticed. In January he was profiled in *Time* as one of the world's top experts in his field. Last October, he was named to *Technology Review* magazine's 2004 TR100, a prestigious list of the world's top young innovators under age 35. According to O'Brien though, recognition by his peers is the greater honor.

Last year, he and his students presented four new modeling techniques at the Association for Computing Machinery SIGGRAPH conference. A short film demonstrating one thread of his research wowed audiences of the popular Electronic Theater program. The brief animation showed off the researchers'



ANIMATION BY ADAM BARGTEIL AND TOLGA GOKTEKIN

AARON WALBURG PHOTO

Professor James O'Brien with students from the Berkeley Computer Animation & Modeling Group (from the bottom up)—Tolga Goktekin, Adam Kirk, Adam Bargteil, Bryan Feldman, Hayley Iben, and Chen Shen.

method for animating viscoelastic fluids—fluids that are neither perfectly liquid nor perfectly solid. Appropriately enough, the film was entitled *Gratuitous Goop*.

"Viscoelastic fluids behave like solids up to a certain threshold," he says. "But when the strain is too large and goes beyond the threshold, the material starts to flow."

Paint is viscoelastic. So is mud. It's solid until you squeeze it. If a special effects artist wants to add a spray of mud to a scene of a spacecraft crashing into a forest, O'Brien says, "treating the computer-generated mud like viscous water just won't look real." The key difference between basic fluids and solids, he explains, is the presence or absence of elastic forces. "If you squirt a little ketchup on a plate, it doesn't flow into a puddle, but rather sits there as a glob," he says. "That's because there's a very small amount of elastic force."

The algorithm O'Brien developed with graduate students Tolga Goktekin and Adam Bargteil takes existing fluid simulations and adds the ingredient that gives materials like toothpaste, lard, and mucus the specific characteristics of both liquids and solids.

The team's algorithms are rooted in computational fluid dynamics methods that compute how fluid materials dynamically move in response to environmental forces like stormy winds, rain, and earthquakes. Before they began programming though, the researchers took a trip to the toy store. There they found a wide variety of goops, slimes, and gross-out toys. After making a mess, it was time to do the math.

"It's nice to do something that involves very complicated math but is still artistic."

As O'Brien explains the mathematics, he tugs on a glob of Silly Putty. The rubbery material will flow if you tug on it, he points out, but it also behaves elastically. Just throw it on the floor and it'll bounce, a fundamentally elastic behavior. A material like saliva has a very low threshold before it flows. Blood is somewhere in the middle. Setting the correct thresholds and modeling the flow accurately results in an animated slime that looks appropriately, well, slimy.

"It's nice to do something that involves very complicated math but is still artistic," says Bargteil, whose favorite goop toys remain on his desk as inspiration.

According to O'Brien, modeling viscoelastic fluids is not so different from animating ductile materials—those that deform a great deal before they finally fracture. For example, if you gently try to bend a spoon just a little bit, elastic forces cause it to spring back to its original shape. But apply enough pressure and the molecules flow into a new configuration, leaving the spoon bent. Deform it further and the metal will actually tear. O'Brien's success several years ago animating this type of ductile fracture led directly to the viscoelastic fluid modeling.

"The physical reason that a material tears instead of shatters is actually similar to the reason that goop behaves like goop and not like water," he says.

O'Brien's quest to model the brittle, viscous, and volatile world began while he was a graduate student in the late 1990s at Georgia Institute of Technology. At the time, his research focused on processing X-ray images of the heart for coronary angiograms. Then one evening over a beer, a few fellow computer graphics students planning to enter their work in a film festival told him that they wanted to animate a man diving into a pool.

"They were convinced that the splash would be impossible to model," O'Brien says. "I thought that all you needed was a good algorithm."

He was right. After immersing himself in the water-modeling project, O'Brien's next challenge presented itself while he was on a mountain vacation. As his snowmobile raced over the peaks, valleys, and gentle curves of the terrain, he considered the mathematics of modeling snow accumulation. That work continues today in his lab, where graduate students are modeling snowdrifts. The aim is not to compute the position of every flake, but rather to provide just enough realism to trick the eye and mind.

"In a film, the criteria for a simulation is that it look real enough that the audience doesn't realize it's not," he says. "In a video game, it's about using limited processing power to make something look more real than the competition."

Indeed, while the immediate impact of O'Brien's work is on the big screen, video games have recently grabbed his attention. Chalk it up to faster processors, he explains. In 1999, he developed fracture simulations for his thesis, which would take all night to render on a computer. Now, the video game company that is in the process of licensing the algorithm can run the simulations on an Apple laptop at two frames per second.

"It's still not fast enough for a game," O'Brien says, "but at least it's in the ballpark." And while he's admittedly excited that his research might ratchet up the realism in tomorrow's video games, he sees more serious applications of his algorithms on the horizon. "Video games are just another name for 'training simulation,'" he says.

Recently, O'Brien, EECS/IEOR professor Ken Goldberg, and graduate student Ron Alterovitz launched a loose collaboration to explore "virtual surgery." The idea is that physicians would rehearse on the screen before ever putting scalpel to flesh.

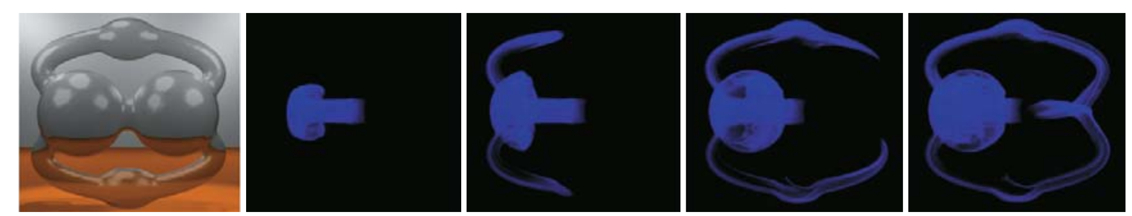
"One of the places you'll see a ton of fluids with all sorts of very interesting and different properties is inside the human body," O'Brien says. "If you're able to model the human body with a high degree of accuracy, a surgeon can train on a medical simulator like a pilot trains on a flight simulator."

Along with surgeons, O'Brien believes that firefighters could benefit from porting video game technology over to professional training simulators. Two years ago, he and graduate student Bryan Feldman devised an efficient way to model incredibly large explosions and approximate the spray of burning liquids. The method is now employed by the special effects wizards at Digital Domain, a production house founded by James Cameron, director of the *Terminator* films and *Titanic*. Someday though, far from Hollywood, a synthetic burning building complete with digital blasts could help prepare a firefighter for the worst.

"In 10 years, you'll expect the same quality in training simulations and games as you demand from movies," O'Brien says. "That's the road ahead for me." ■

AARON WALBURG PHOTO

James O'Brien



ANIMATION BY BRYAN FELDMAN AND BRYAN KLINGNER

Computer-animated smoke. Far left is a hollow glass object; progressing right, smoke is injected into its center as the object slowly fills.

Kara Nelson

Easy Water: Transforming waste water's murky image into gold

BY GORDY SLACK | PHOTOS BY PEG SKORPINSKI

When writer Wallace Stegner was asked by a California newcomer what he should know about the state, Stegner answered, "Water. It's about water."

Californians are notoriously desperate for water and will do just about anything to get it. Some of our most remarkable engineering accomplishments are monuments to both our water needs and our determination to slake them. California's bitterest environmental battles are fought over water: Owens Valley, Mono Lake, Hetch Hetchy Reservoir, and the Peripheral Canal. And some of the state's most outlandish ideas have been water related, too. Remember the proposals to tow icebergs from the polar regions, or notions to create a floating offshore water pipeline to transport water to California from Washington state?

Despite efforts to conserve and redistribute water, our thirst is outpacing our ability to secure more sources. By the year 2020, says the State Department of Water Resources, California will face a shortage of between two and nine million acre-feet of water per year. A million acre-feet is water enough to keep some five million Californians hydrated each year.

"The struggle to secure safe water affects just about everything that's important to us: environment, industry, public health, economy, agriculture, and simply having enough safe drinking water," says Kara Nelson, Berkeley professor of civil and environmental engineering and an expert on wastewater reuse.

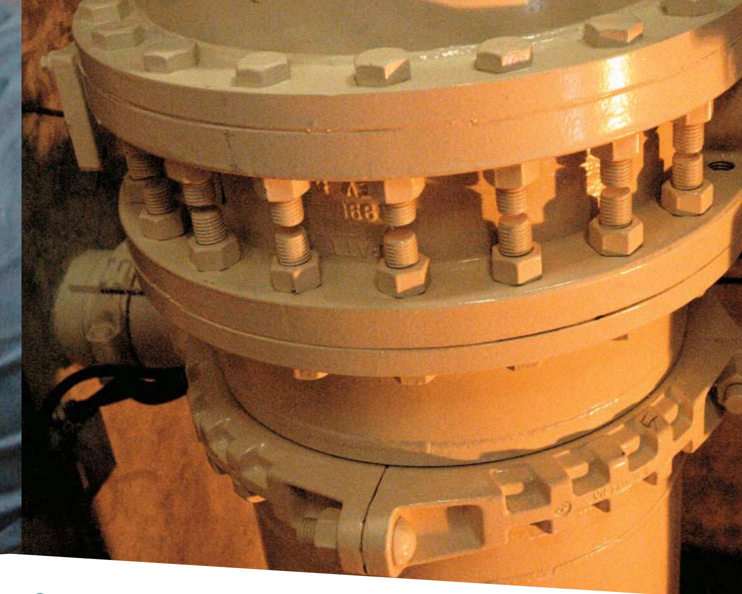
While some engineers ponder how to conserve water or get more of it delivered where it's needed, Nelson and her colleagues are taking a different tack. They hope to increase the safety and efficiency of reusing water that would otherwise be disposed of. "As water becomes more scarce, we are more reluctant to throw it away once it's been used," says Nelson. "I view wastewater as a valuable resource. By irrigating with wastewater, we can return the organic matter and nutrients it contains back to the soil, mimicking the same cycles that occur in nature. But we must be extremely careful to protect public health by removing pathogens from the water first."

Nelson is currently focusing her efforts on Monterey County's Salinas Valley, where she hopes to help boost the amount of water the regional recycling plant can process and deliver to farmers each year.

For decades now, as both local agricultural and municipal water demands grow in the Salinas Valley, and groundwater is extracted faster than it can be replenished, salt water from the Pacific is seeping further and further into the aquifer. Water must now be drawn from very deep down, and once pumped up, it may be too salty even to use on crops.

Seven years ago, the Monterey Regional Water Pollution Control Agency (MRWPCA)—the regional water recycling body—began taking urban wastewater from nearby municipalities (Monterey, Pacific Grove, Seaside, Sand City, Del Rey Oaks, Marina, Salinas, Castroville, and Moss Landing) and running it through an extra filtration process, making it pure enough to use again for crop irrigation. By sating much of farmers' irrigation needs with recycled water, they have been able to reduce the amount pumped from underlying aquifers by 20,000 acre-feet per year. If farmers use less groundwater, that leaves more for residential customers without overtaxing the aquifers. The effort has already paid off, says Nelson—2004 was the first year in decades that saw a rise in the aquifer's water level.

Although only seven years old, the MRWPCA's tertiary treatment plant already has a bottleneck. The need for irrigation water is greatest during the peak summer tourist season when full hotels and restaurants at the seaward end of this popular area are creating more municipal wastewater than the plant can pass through its filters. More accurately, the plant receives more than is legally permitted by Title 22 (the state law regulating



If farmers use less groundwater, that leaves more for residential customers without overtaxing the aquifers.

water quality standards). That, as it turns out, is a key distinction, one that may point the way toward significant relief for the Salinas Valley's—and California's—water woes, says Nelson.

When Title 22 was adopted by the state legislature in the 1970s, it set the rate at which water could be loaded into tertiary filtration plants at five gallons of water per square foot of filtration media per minute (5 gal/ft^2 – min). Along with much of Title 22, that loading, or flow, rate has become the worldwide "gold standard" for tertiary filtration plants, says Nelson. And because it was known to be a product of the widely respected 1977 Pomona Virus Study, the figure was never critically assessed.

"They just picked 5 gal/ft^2 – min as the highest rate they were going to study and never looked any higher or explored the possibility that higher rates might also be safe," says Nelson.

But four years ago a group of water reuse specialists looked critically at the flow rate limit and realized that it was more of a cultural artifact than a scientifically established limit. When the 1977 study was conducted, 5 gal/ft^2 – min was the highest loading rate tested.

"When it comes to finding new water sources, we thought all the low-hanging fruit had already been picked," says Bahman Sheikh, a co-PI with Nelson and three other scientists on the Monterey project, known as Filter Loading Evaluation for Water Reuse, or FLEWR. In this case, however, some choice low-hanging fruit was hiding right behind some mistaken assumptions, says Sheikh, who was among the scientists who first thought of re-testing the loading rate for tertiary filtration plants.

"This was an area where a huge amount of good water might be safely recycled without a lot of new infrastructure or expense," adds Nelson. "The state is in desperate need of recycled water. If we can safely raise the loading rate to 7.5, we could increase the capacity of such plants by 50 percent, which is just incredible. It means more water. It's as simple as that."

To test the hypothesis, Sheikh and the team at MRWPCA recruited Nelson to design a study establishing the actual top end of safe filter loading rates for tertiary plants like Monterey's. The challenge appealed to Nelson in part because of its potential international ramifications. She did her doctoral work on water recycling near Mexico City and has always been interested in finding affordable ways for developing nations to recycle wastewater for agriculture.

If the rate could be safely increased at the Monterey plant, it might be safe to raise it in nearly 100 other California tertiary treatment plants as well. "Beyond that," says Nelson, "there are thousands of tertiary treatment plants around the world that take the Title 22 loading rates for granted. If many of them could safely increase their filtration rates too, the worldwide impact could be…well, very significant."

To find the safe upper limit for plants like Monterey's, Nelson and graduate student Gordon Williams set about designing what they call "the Mercedes Benz" of pilot-scale plants. It is an impressive $300,000-dollar apparatus, designed to mimic as closely as possible the workings of the tertiary wastewater treatment plant nearby.

The pilot plant is just 18 feet tall, a model built at a scale of roughly 1/1000th of the actual plant. Its five test filters—made of clear PVC pipe so everything is easily observed inside—are, however, the same height as those in the full-scale plant. "In the vertical direction, everything has to be exactly the same," says Nelson. The water that enters the filters is the same water that passes through the main plant, and in both plants, the water is filtered through four feet of anthracite coal and one foot of sand before being disinfected with chlorine to kill any remaining pathogens.

Each of the five experimental filters is fitted with an array of computerized systems to control flow and monitor water quality. About 150,000 data points are recorded in the computers per day, says Williams, who worked with specialists to develop the data analysis programs. The roughly five million data points accumulating over 40 filter runs will be analyzed to compare the effectiveness of the filters at different loading rates.

From the research, Nelson and her colleagues hope to learn more about the fundamental mechanisms by which wastewater particles and pathogens are removed by filtration. On the practical side, they are working closely with the State Department of Health Services to develop four criteria to assess performance of the pilot plant's filters to see if higher loading rates are safe.

First, the team monitors removal of total coliform bacteria, which indicates removal of any pathogenic bacteria from the wastewater. Second, at regular intervals they add MS2 coliphage, a specific virus that can only infect bacteria, and monitor its removal. Third, they monitor particle removal in the 2–15 micrometer range—the size of the ubiquitous water-borne pathogens *Cryptosporidium* and *Giardia*—using an instrument that continuously shoots a laser across a vial of filtered water to count the suspended particles. The final indicator, turbidity or cloudiness, is a measure of the concentration of particles and a crucial indicator of the overall filter performance.

"Our preliminary studies suggest that a rate of 7.5 may be safe," says Nelson. "The highest flow rate we've explored was twelve and one-half, and it was definitely too high. At that rate the filters clogged too quickly and treatment was poor. But the difference in performance between the 5 and 7.5 rates has been rather insignificant," she says.

"The treatment process we are studying is not so terribly innovative," says Nelson. "What's innovative is that we're trying to come up with an upper limit for safe filtration loading rates, and in the process, we are beginning to understand the effect of loading rate on fundamental treatment mechanisms. This is the first study looking in depth at these higher loading rates."

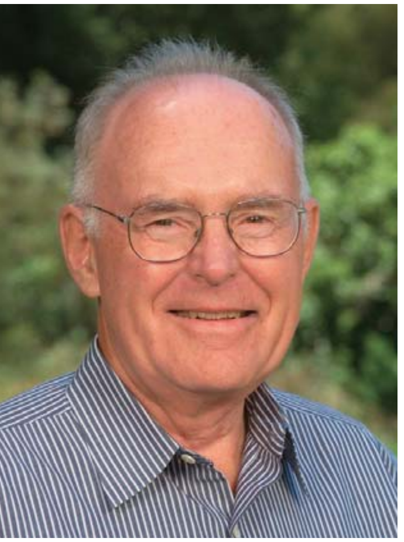
The final results for FLEWR's first phase will be completed this summer. If they are as promising as the preliminary results suggest, Nelson and her colleagues will petition the state to allow the actual Monterey tertiary plant, as well as four other treatment plants in the state, to operate their full-scale filters at higher flow rates. "We'll analyze that data over about a year," she says, "and if we get good results, we'll ask the state to adopt a new state standard, changing the law so that all facilities can operate at this higher loading rate."

Right now, wastewater recycling produces 500,000 acre-feet of usable water per year in California. If we could increase that by 50 percent, says Nelson, we'd have an extra 250,000 acre-feet of water annually. That would surely be one of the largest recent contributions toward mitigating the intensifying water crunch in the Salinas Valley, California, and beyond. It sure beats towing icebergs. ■

Gordy Slack is an Oakland-based science writer specializing in evolution and the environment. He is a frequent contributor to *Forefront*. His work appears in *California Wild, Wired, Mother Jones, Bay Nature,* and *Sierra*.

PAGE 21: *The Monterey Regional Plant (seen in the aerial photo used courtesy of MRWPCA) irrigates 12,000 acres of farmland in Monterey County, supplying up to 21 million gallons of processed wastewater to nearby farms each day.*

PAGES 22–23: *Far left: Kara Nelson is dwarfed by the filtration plant's vast system of underground pumps and pipes. Center left: CEE doctoral student Gordon Williams in the pilot plant he helped design. Far right: Tom Kouretas, an engineering technician at the treatment plant, adds then swirls aluminum chlorohydrate and cationic polymer in water samples in order to calculate the daily chemical coagulant dose at the pilot plant.*



PHOTOS COURTESY GORDON & BETTY MOORE FOUNDATION

Through their foundation, Gordon and Betty Moore support a wide range of conservation and educational projects. "Berkeley is clearly the premier state university," Gordon says. "Nothing else comes close."

Gordon and Betty Moore: A better world through philanthropy

Gordon Moore (B.S.'50 Chemistry), co-founder and chairman emeritus of Intel, has devoted nearly half a century to creating and advancing technologies that make our world a better place to live. Retired from Intel since 1997, he and his wife of 54 years, Betty, now focus their attention on philanthropic efforts aimed at preserving that world for generations to come.

In 2000, they founded the Gordon and Betty Moore Foundation to support a wide range of projects to which they are dedicated, primarily environmental science and higher education efforts.

Through the foundation last fall, the Moores made a five-year, $5.6 million grant to Berkeley's Biology Scholars Program (BSP), designed specifically to help underserved and underrepresented students prepare for careers in medicine and science and, ultimately, help diversify the health care workforce in the U.S.

Currently, underrepresented minorities—including African Americans, Hispanics, and American Indians—represent only 9 percent of nurses, 6 percent of doctors, and 5 percent of dentists nationwide. Since it was established in 1992, the BSP has supported more than 800 students, and current enrollment is 450.

"I got a very good education here," Gordon says. "But institutions like Berkeley can't expect to get all their funding from the government. They have to look to alumni and others to support some of their more ambitious projects."

In 1998, the Moores made a generous contribution to the Hearst Memorial Mining Building renovation and retrofit. They are also active in the environmental organization Conservation International, for which Gordon serves as board member and executive committee chair. The organization is dedicated to preserving the Earth's "hot spots" of biodiversity, which comprise a mere 1.4 percent of the planet's surface but are believed to contain 60 percent of all terrestrial plant and animal species.

"Gordon and I have been very close to conservation issues all of our lives," says Betty. "We were both raised in rural areas and have always been aware of what the soil could do for us. To see the devastation of these wild places is heartbreaking."

The Moores have traveled to many of these remote areas to witness what is happening. "Unfortunately, these regions are being opened up and developed or wiped out," adds Gordon. "If these hot spots can't be saved, we may be looking at the last generation who will have wild places on Earth." ■

BY CAROL MENAKER

H.T. and Jessie Chua cap longtime support with new professorship

Hua-Thye Chua (M.S.'61 EE) and his wife Jessie (M.A.'61 Statistics) of Los Altos Hills returned to campus in January to meet MSE professor Robert Ritchie, the inaugural holder of the H.T. and Jessie Chua Distinguished Professorship in Engineering.

Born in Malaysia and raised in Singapore, H.T. had a 25-year career in Silicon Valley that included positions at Fairchild Semiconductor, Intel, and Monolithic Memories before he co-founded QuickLogic in 1988.

"We received excellent educations at Berkeley," says Chua, "and this is one way we can continue to give in return." The Chuas, who met on campus as graduate students, are longtime supporters of Berkeley Engineering. Their many gifts to the College are commemorated in the Soda Hall atrium, which is named for them.

Ritchie, who joined the Berkeley faculty in 1981, has held positions at Lawrence Berkeley Lab as deputy director of materials sciences and director of the Center for Advanced Materials. He is known for his work in fracture mechanics and fatigue-crack propagation. ■

PEG SKORPINSKI PHOTO

Celebrating the inauguration of the H.T. and Jessie Chua Distinguished Professorship in Engineering are (from left) H.T. Chua; Jessie (Tsao) Chua; Professor Robert Ritchie, holder of the new Chua distinguished professorship; and EECS professor Ming Wu.

Go to **www.coe.berkeley.edu/alumni** for the latest news and events of interest to Berkeley Engineering Alumni.

Class Notes

Keep in touch by mailing your news and photos to us at Class Notes, College of Engineering Office of Marketing and Communications, 1925 Walnut St. #1704, Berkeley, CA 94720-1704. Or go to **www.coe.berkeley.edu/classnotes** and click on *Submit Your Class Note.*

2000s

PETER CHIEN *(B.S.'04 EECS)* of Sunnyvale works as application engineer for Cypress Semiconductor of San Jose, a leading supplier of SRAM, clocks, physical layer devices, and communication system applications. **pete_c@cal.berkeley.edu**

RISHI CHOPRA *(B.S.'03 EECS)* of Burlingame is currently working at IBM on the WebSphere Product Center. He is considering pursuing an M.S. in electrical engineering at Texas A&M this fall. **rchopra@alum.berkeley.edu**

CHRISTINA HWANG *(B.S.'00 BioE)* writes, "I've been working in Tokyo for the past few years, but now I'm back in San Francisco. I've digressed from engineering and currently work for a hedge fund [a type of mutual fund investment partnership]."

STANLEY KAO *(B.S.'02 EECS)* of Atherton writes, "Hey Jan: Working in San Francisco now; e-mail me if you see this message." **aircow33@hotmail.com**

T. JOHN KOO *(Ph.D.'00 EECS)* of Nashville, assistant professor of computer

engineering in the Department of EECS at Vanderbilt University, received the National Science Foundation (NSF) Faculty Early Career Development (CAREER) award for his work on "Computation Platform for the Design of Hybrid Systems." He has been an associated faculty member of the NSF Information Technology Research Center for Hybrid and Embedded Software Systems since 2004 and was a visiting professor in Berkeley's EECS department in 2002. **john.koo@vanderbilt.edu**

ANITA VILLANUEVA *(B.S.'00 EECS, MSE)* of Cambridge, Massachusetts, writes, "I'm currently having a great time in grad school at MIT!" **anita@coe.berkeley.edu**

1990s

ROBERT BERTINI *(Ph.D.'99 CE)* of Portland, Oregon, was promoted and awarded tenure in 2004 and is now associate professor of civil and environmental engineering and urban studies and planning at Portland State University. He is a recipient of the National Science Foundation's

Real World Engineering attendance best ever

NICK LAMMERS PHOTO

These Berkeley Engineering women were just three of the more than 350 undergraduates who attended Real World Engineering, an annual networking event where alumni participants help young engineers plan their futures.

More than 350 undergraduate engineering students packed the house at February's Real World Engineering 2005, a forum and networking event held annually to introduce students to alumni who are living their professional lives to the fullest following their Berkeley Engineering degrees.

It was the largest attendance since the event was initiated five years ago to help students chart academic and career paths during and after their undergraduate years. Nearly 60 alumni returned to campus to participate in 12 separate panel discussions on a range of engineering fields, network at a sushi reception following the formal program, and answer students' questions about how to find the right major or job, whether or not to go to graduate school, and how to translate their engineering degrees into successful and fulfilling careers.

Associate Dean Dave Auslander set the tone with his opening remarks. "Think of yourselves not as students but pre-alumni," he told the audience in Sibley Auditorium. "It's easy to get into class and forget everything else. But your education here is just as much about learning what you want to do as it is about learning the class material."

Real World Engineering is held every February. If you are an alum and would like to participate in the 2006 event, please let us know by filling out and submitting the form at **www.coe.berkeley.edu/alumni/volunteer**. ■

CAREER award and director of Portland's Center for Transportation Studies.

BRIAN BOARDMAN *(B.S.'90 CE)* of Oakland is a senior project engineer in the geotechnical department at Kleinfelder, Inc. His specialties include liquefaction and seismic hazard analysis. **tboardman@kleinfelder.com**

R. GLENN BOOKER *(M.S.'90 ME)* of Cherry Hill, New Jersey, was appointed auxiliary assistant professor at Drexel University. **gbooker@drexel.edu**

ROBERT CEDENO *(M.S.'94 CE)* of Weston, Florida, graduated from law school and is practicing construction and real estate law in south Florida. **rac@raclawoffice.com**

CHARLES FIELDS *(M.S.'95, Ph.D.'97 EECS)* of Calabasas, California, writes, "Hello friends: Hope you're all well. I'm still working at HRL Laboratories in Malibu and enjoying life in sunny Southern California. Life is good."

TINA HERRERA *(B.S.'91 ME; M.B.A.'04 Bus. Ad.)* of Montara, California, writes, "I recently returned to Cal as a part-time evening student while continuing to work full-time at Cisco. I completed my M.B.A. in May 2004 and was honored to be our class speaker at graduation."

KAMALA KRISHNA *(Ph.D.'92 ChemE)* of Danville joined ChevronTexaco in 1992, working at the company's El Segundo, California, refinery for five years. He is now involved in catalytic process development at the Richmond refinery.

SUNIL KULKARNI *(B.S.'93 ME)* of Menlo Park writes, "After Cal, I went to law school and have been with the Palo Alto office of Morrison & Foerster LLP for the last seven years. I handle patent litigation, which is a great reason to keep my engineering textbooks around. I was married this past July to Dr. Sujata Patel, who sadly is an unrepentant *Stanfurd* alum. (I love her anyway.)"

LISA (LEHMAN) LYONS *(M.S.'94 CE)* of North Andover, Massachusetts, writes, "I'm enjoying life as an environmental project manager and the mother of Jimmy, age three. My husband Jim and I recently celebrated our seventh wedding anniversary."

JEFFREY NEAL *(M.S.'98 CEE)* of Vienna, Virginia, writes, "I'm in the Navy Civil Engineer Corps, currently with Amphibious Construction Battalion Two. We're preparing to deploy personnel to the Indian Ocean to provide tsunami relief. While stationed in Norfolk, I look forward to alumni events in the area."

JEFFREY SHNEIDMAN *(B.S.'99 EECS)* of Lake Forest Park, Washington, received a master's degree in computer science from Harvard in 2003.

KEN SUSILO *(B.S.'90, M.S.'91 CE)* of Culver City recently joined GeoSyntec Consultants and opened their west Los Angeles branch office. **ken_susilo@cal.berkeley.edu**

1980s

YASMIN (KAHN) BYRON *(M.S.'83 CE)* of Brookline, Massachusetts, writes, "After practicing engineering for over 10 years, I began work on a book about my father. *Engineering Architecture: The Vision of Fazlur R. Zhan* was published in 2004."

JIAN CHEN *(M.S.'88, Ph.D.'92 EECS)* of San Jose is happily making flash memories at SanDisk Corporation.

BRIAN DEMCZYK *(M.S.'85 MSE)* received a Ph.D. in materials science at SUNY Stony Brook in 1999 and did a one-year postdoctoral fellowship at Lawrence Berkeley Lab in the Materials Science Directorate. He has been employed as a staff process engineer with Maxtor Corporation in San Jose since 2001.

MELISSA FARRELL *(M.S.'86 ME)* has been appointed president and CEO of Stellar Solutions Aerospace Limited, a U.K.-based company providing engineering services globally for aerospace programs. She will manage operations supporting the company's European clients.

SHAFRIRA GOLDWASSER *(M.S.'81, Ph.D.'84 CS)* has been named to the National Academy of Engineering. RSA Professor of Computer Science and Engineering at MIT and professor of mathematical sciences at the Weizmann Institute of Science in Israel, Goldwasser was recognized by the Academy for her contributions to cryptography, number theory, and complexity theory and their applications to privacy and security.

MIKE RAVICZ *(B.S.'82 ME)* of Somerville, Massachusetts, works in hearing research at the Eaton-Peabody Laboratory of the Massachusetts Eye and Ear Infirmary in Boston. He is team leader for the City Year's Annual Serve-a-thon and an instructor for the Appalachian Mountain Club's Backcountry Ski Workshop.

STEVEN SHAFFER *(B.S.'81, M.S.'86, Ph.D.'90 MSE)* of Columbus, Ohio, writes, "Still employed! Fourteen years at Battelle Memorial Institute applying materials science and mechanical engineering to solving tribology (the study of friction, wear, and lubrication) problems worldwide."

1970s

SUNIL GUPTA *(M.S.'76, Ph.D.'80 CE)*

writes, "I am president and CEO of OLMM Consulting Engineers, a structural engineering firm with offices in San Francisco and Oakland. We have been responsible for the structural design of some of the most notable projects in the Bay Area, including the base-isolated San Francisco Main Library, designed by I.M. Pei. I live in Walnut Creek with my wife Seema and two children, Utsav and Preetika." **sunil@olmm.com**

TOM HORIYE *(B.S.'78 EECS)* of San Jose is director of product and test engineering at Sipex Corporation. He has been married 21 years. His wife Terri works and volunteers at the schools of both their boys, Anthony, 17, and Ryan, 12.

JOHN ONETO *(M.S.'70 EECS)* of Campbell, California, is a retired computer engineer from Amdahl Corporation/Fujitsu.

RUSSELL TRAHAN *(Ph.D.'77 EECS)* of New Orleans was appointed dean of engineering at the University of New Orleans (UNO). He received his B.S. and M.S. degrees from then Louisiana State University (now UNO) before attending Cal. After receiving his Ph.D., he returned to UNO and served on the faculty for 27 years and as chair of electrical engineering before being appointed dean. **rtrahan@uno.edu**

alumni update

NASA astronaut Leroy Chiao (B.S.'83 ChemE) performs a test in the Russian Soyuz spacecraft, which carries the crew to and from the space station. The suit Chiao is wearing is pressurized for protection in case they lose pressure inside the spacecraft during the trip. At right, Chiao's view of the moon from the space station.

PHOTOS COURTESY OF LEROY CHIAO AND NASA

Astronaut Leroy Chiao phones home from space station

Leroy Chiao (B.S.'83 ChemE) likes to keep in touch. From his temporary home on the International Space Station, he regularly e-mailed his parents and—whenever satellite conditions allowed—made weekly calls to their Fairfield home. A proud fan of Bears football, he phoned members of the team from the station to wish them luck in January's Holiday Bowl. He even voted last November, becoming the first American to vote in space for president.

From 260 miles above the border between Chile and Argentina, Chiao checked in with *Forefront* one day to talk about his space station experience. After six months in orbit, what did he miss most?

"I miss my family and friends most of all," Chiao says. "Besides that, I miss nature, the smell of the fields after a rain, feeling the heat of the sun or a cool wind. And, of course, the food!"

From last October 13 to April 25, 2005, Chiao served as commander of the two-man crew on the International Space Station, the joint program of the U.S., Russia, Canada, Japan, and Europe to operate a permanent station in space. The tenth crew to continuously staff the complex since November 2000, Chiao and Russian crewmate Salizhan Sharipov spent 193 days managing daily operations, taking spacewalks to service external systems, and conducting scientific research on humans living in zero gravity (themselves), all while orbiting the Earth at a speed of about five miles per second.

"This mission and becoming commander of the station is the culmination of my career," Chiao says. "It's my chance to bring together all the experiences and skills I've learned in my 15 years as an astronaut."

Now a veteran of four shuttle missions and six spacewalks, Chiao is considered an expert in extravehicular activity (EVA), the art of dexterously performing manual operations in a spacesuit loaded with 500 pounds of gear.

"Anyone can be a gymnast in zero gravity," Chiao says. "But the challenge is working in a spacesuit. It's like being inside a balloon. You're weightless but you still have momentum, so every time you touch a handrail you start spinning off in the other direction."

The hardest part, he says, is staying focused and dealing intelligently with the inevitable glitches, especially when the view is so "exhilarating." His Berkeley education served him well in that regard, Chiao says, making him self-sufficient and focused on his goals.

"Cal had a tremendous effect on me, maybe the biggest in my life," he says. "I graduated near the top of my high school class, but so did everyone else. There was no handholding; we had to learn to rely on ourselves to get things done." Between his Berkeley years and joining NASA in 1990, he completed his M.S. and Ph.D. in chemical engineering at UC Santa Barbara, then worked briefly at Hexcel in Dublin and Lawrence Livermore Laboratory, where his father was a chemical engineer.

"Since the moment he watched the moon landing on TV [at age eight], he got very excited," says Chiao's mother Cherry (Ph.D.'76 MSE). "When he built a space vessel in the garage, I thought he was just playing. But then in graduate school he started talking about becoming an astronaut; that's when we knew he was serious."

Chiao tells anyone with similar aspirations to choose a field that will qualify them for the job, but more importantly, one they are deeply interested and involved in, since NASA selects astronauts from many fields.

"Becoming an astronaut was a dream for me," Chiao says. "You've got to have a dream. The worst thing that can happen is that you come to the end of your life and you realize you didn't work hard to try to achieve it."

But what about that freeze-dried, thermo-stabilized, irradiated food?

"Once we get to space, we get used to it," says Chiao. "It becomes really delicious, especially after a few days. I believe that, with a reset of expectations, humans are remarkably adaptable." ■

PEDRO WOO *(B.S.'70 EE)* writes, "I am running a consumer electronics manufacturing company in Hong Kong that designs and develops innovative high-tech consumer products. The Sharper Image is one of our customers."

1960s

JESSE ANTE *(B.S.'68, M.S.'70 ME)* of Fremont writes, "I retired from PG&E practicing 'Let there be light!' I was employed by the California Public Utilities Commission practicing 'Power to the people.' I was named California Alumni Association's Distinguished Mentor of the Year on March 5, 2004, at the Charter Day Banquet."

BALDWIN CHAN *(B.S.'66, M.S.'67 ME; M.S.'78 Bus. Ad.)* writes, "After working almost 20 years at PG&E and about 13 years before that at Bechtel, I decided to take an early retirement in the early part of 2005. My wife and I will continue to stay at our home in El Cerrito and shall attend some of Cal's activities from time to time."

PETER CROSBY *(B.S.'67 IEOR)* of Pacific Palisades is a consultant at CGR Management Consultants in Los Angeles, where he specializes in the food industry, working on strategy, cost reduction, and supply chain information systems projects. His daughter Kelly graduated magna cum laude with a doctorate in pharmacy from the University of Texas at Austin and is a pharmacist at Walgreens. His son Michael graduated academic all-American (water polo) with a B.A. in biology from Harvard. He now teaches chemistry and biology at Loyola High School in Los Angeles, where he's also head water polo coach for the Cubs.

JOHN DRACUP *(Ph.D.'66 CE)* of San Francisco retired from Berkeley last June after 40 years of teaching and research in civil and environmental engineering. He continues doing research with his graduate students in water resource systems and hydrology. He and his wife, Kathleen, who is dean of nursing at UCSF, have five children and nine grandchildren. John swims competitively with U.S. Masters Swimming and does competitive skiing with the Far West Masters Racing. **dracup@ce.berkeley.edu**

HOWARD FLEMMING *(B.S.'66 EE)* of Valencia, California, received the Samuel L. Warner (SMPTE) Memorial Medal Award in fall 2003 and a 1996 Academy Award for his pioneering work leading to motion picture digital sound. **flemming@earthlink.net**

RALPH GERCHBERG *(M.S.'60 EE)* of Ardsley, New York, received the NASA New Technology Award for inventing the high-efficiency Positive Taper Traveling Wave Tube (1967). He was a special fellow of the National Institutes of Health at the Cavendish Laboratory at Cambridge University in England (1967–1970) and at MIT (1975–1976). He co-discovered the Gerchberg Saxton algorithm to solve the Fourier inverse (phase retrieval) problem (1972). He also discovered the Gerchberg algorithm to extrapolate bandwidth in *N* dimensions (1974) one year before Papoulis discovered the same algorithm and published an almost exact replica of his paper.

WILLIAM BRAD HARDIN *(B.S.'62, M.S.'65 ME)* of Venice, Florida, recently retired from the U.S. Nuclear Regulatory Commission after 29 years. He previously worked at Lawrence Livermore National Lab. **deebradhardin@netzero.net**

TONY JOHNSON *(B.S.'60 IE)* of Carmel writes, "I retired from the U.S. Army and currently am teaching part time for Chapman University in Monterey and Hartnell College in Salinas. Go Bears!"

THOMAS LAYCOOK *(B.S.'63 EE)* of Los Angeles is still active as a senior systems engineer for global air traffic control landing systems. He is also actively involved in racing and is looking forward to retirement. **tom@ltracing.net**

DON NURISSO *(B.S.'65, M.S.'67 ME)* of Pacifica is engineering manager for Keen Engineering, a leader in sustainable design of facilities. **nurisso@mindspring.com**

KENNETH (RON) OBERT *(B.S.'65 EE)* of Torrance writes, "I continue to take astronomy classes at UCLA. Last summer included week-long hiking trips in the Sierra and Washington state. The fall found me in Memorial Stadium for all five home games."

MARSHALL SILVER *(M.S.'67, Ph.D.'69 CE)* is chief technical advisor for disaster risk reduction for the United Nations Development Program in Vietnam. He lives in Hanoi.

Crunching data to make weak bones strong

FRANCISCO CHANES PHOTO

Joyce Keyak's (B.S.'89 ME, Ph.D.'96 BioE) devotion to her work is balanced by a number of outside interests, including the care of Roika, her spirited Hungarian pointer, and seven curious tortoises who enjoy nibbling on the hibiscus that flourishes in her yard.

It's the future of medicine. Imagine a surgeon viewing a three-dimensional computer model of a bone weakened by cancer or osteoporosis and treating the condition with minimally invasive surgery in an outpatient center. If Joyce Keyak (B.S.'89 ME, Ph.D.'96 BioE) has her way, the procedure will be headed for clinical trials on cancer patients in as little as one year, and her innovative research could improve the quality of life for hundreds of thousands suffering from bone-weakening conditions.

Keyak is associate professor of orthopedic surgery, biomedical engineering, and mechanical and aerospace engineering at UC Irvine. With her colleague and mentor Harry Skinner, professor and surgeon at UC Irvine Medical Center, Keyak has developed a technique that uses computed tomography (CT) scans and structural analysis to calculate how much force a bone can withstand. With such exacting measurements, physicians can pinpoint more precise diagnoses and treatments than ever before.

"Until now, the tools for evaluating hip strength in women at risk for osteoporosis provided only a two-dimensional view of bone density," Keyak says. But low bone density, she adds, is only one risk factor.

"The current measurements don't take into account other factors, such as the bone's shape and size or the forces on the bone," she explains. "With three-dimensional analysis, we can do a much better job of determining risk and identifying patients who need treatment."

Keyak's research on metastatic bone tumors is equally promising. The tools used to model bone strength and fracture risk can also be used to simulate surgery and calculate the resulting increase in bone strength. The surgery—a minimally invasive outpatient procedure—involves making a small incision, drilling a hole, removing the tumor, and injecting a specially designed medical cement to reinforce the bone. Recovery time and surgical risk are significantly reduced compared with current surgical methods.

The analyses, which require meticulous attention to detail, also have potential applications for improvements in prosthetic implant design and bone remodeling and may lead to new methods for preventing bone fracture. Keyak says the work is painstaking but rewarding.

"For every hour of lab experiments, there could be as many as 500 hours of analysis," she says. "But my whole purpose is to get my research into the clinical arena so patients can actually benefit from it." ■

BY CAROL MENAKER

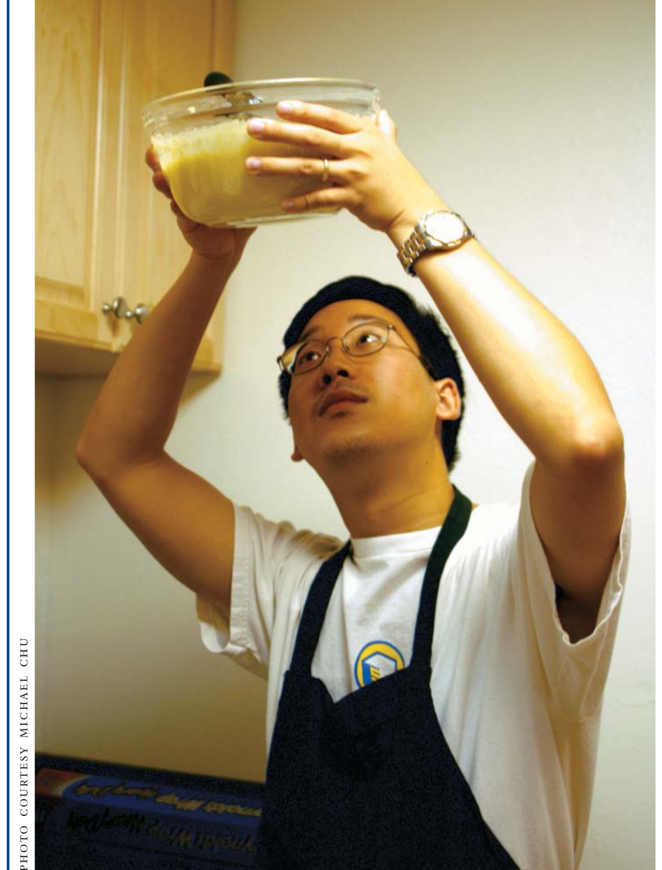


PHOTO COURTESY MICHAEL CHU

EECS alum Michael Chu (B.S.'99 EECS) tests recipes and shares tidbits aimed at the science crowd on his cooking website. Go to ***www.cookingforengineers.com****.*

Food for scientific thought

On this new cooking website you'll find the usual gourmet fare: mouth-watering recipes and gadget reviews of spice grinders and kitchen scales. But you'll also find tidbits like this:

> *U.S. cups are not quite the same size as British Imperial cups. Both are eight fluid ounces, but the U.S. fluid ounce and the British fluid ounce differ slightly. A U.S. cup (236.6 mL) is about 4 percent larger in volume than the British cup (227.3 mL).*

The site is **www.cookingforengineers.com**, and the mastermind behind it is Berkeley alumnus Michael Chu (B.S.'99 EECS). It features not only recipes Chu has tested in a precisely diagrammed format, but also an illustrated ingredient dictionary, a substitution list, a measurement conversion tool, and a chart on the smoke point of oils. Premiering last June, the site has received as many as 250,000 visits in one month, was featured on *Slashdot*, and in March won a 2005 Bloggie Award for best food website. For the success, Chu credits his site's distinctive focus.

"It's written and presented in what I hope is an analytical viewpoint," he says, "with interesting tidbits of info that most cooks don't bother to find out but that engineers and science-minded folks like to know."

Chu's article about the brining process, for example, provides detail that challenges traditional explanations:

> *The salt solution on the outside of the meat and the less salty solution inside the meat set the stage for the flow of solvent and solute. The salt (solute) diffuses into the meat when some water (solvent) diffuses out. Then (this is the key), the extra salt that enters the meat begins to denature the proteins in the meat, producing both additional solutes and additional 'holes' for water to fill up. The osmotic pressure inverts and water begins to flow into the meat at this point, producing juicier meat.*

Chu peppers his recipes with editorial comments, such as:

> *Traditionally served over linguine, shrimp scampi makes a quick and easy dinner that works equally well eaten in front of the computer or as the main dish of a romantic candlelight dinner.*

A technical computer failure inspired the project. When a server at work deleted all his recipes but tuna noodle casserole, Chu decided to find a better way to store and share them. The site premiered with Chu's variation on *Cook's Illustrated* recipe for salsa cruda.

The Silicon Valley hardware application engineer didn't cook at all as an engineering student. It was only after he started working six years ago that he began focusing his analytical skills in the kitchen. The process is cathartic after a hard day's work, he says.

"I'm just someone who likes to cook who decided to sit down and write about it." ■

BY RACHEL JACKSON

PHOTO COURTESY OF KATE MAHER

CEE alumna Kate Maher (M.S.'01 CEE), front, has won five individual national championships in women's collegiate cycling. She wants to train for the Olympics after she finishes her doctorate in earth and planetary science.

Speeding is her way of life

Kate Maher (M.S.'01 CEE) races her bike at one speed: faster. Her favorite type of cycling race, the criterium, consists of many laps around a short course. In these races she exceeds 30 mph, flashing by onlookers, brushing handlebars with competitors, and leaning into the never-ending corners that make up the racecourse loop.

Usually, there are crashes. Last summer she broke two ribs but still seems unfazed by the dangers inherent in her sport.

"I like the aggressiveness and risk taking," she says. "As soon as the gun goes off, you go as fast as you can."

Maher's racing provides a dramatic counter-balance to the slow, careful rhythm of science, which has been her life for the last several years at Berkeley. She first worked on environmental fluid mechanics for her environmental engineering master's and now studies reactive transport modeling of uranium and strontium in groundwater for a doctorate in earth and planetary science.

Maher was an alpine ski racer when she was younger and began cycling at age 12, when her mom took her mountain biking in the hills behind their Ashland, Oregon, home. By the time she entered Dartmouth College as an undergraduate, she was competing in 20-mile cross-country mountain bike races. She turned professional in her junior year, only to lose her sponsorship in 1998 due to budget cuts.

The experience put graduate school into focus, and she came to Berkeley in 1999, she says, primarily because of its outstanding teachers and focus on applications. She concentrated on her research for the first year and a half until, in 2001, some friends convinced her to join the Cal women's cycling team. She made the switch to road racing and managed to find time between classes and research to earn five individual national championships in a range of events (including criterium and road race), boosting the Cal team to first place finishes in the Road Nationals in both 2002 and 2003.

"I like to win, but I'm not obsessive or malicious about it," she says. "It's for fun." Many engineers are involved in cycling, Maher adds, possibly because of their fascination with the mechanics of a bike.

These days, Maher has scaled back her cycling, but she still manages the occasional 7 a.m. ride with girlfriends. And she hasn't relaxed the urge to win. After she completes her Ph.D., she may start training for the Olympics. "I'm getting stronger every year." ■

BY RACHEL JACKSON

1950s

LOWELL ALLEN *(B.S.'51 CE)* of Eureka retired from Caltrans Structures in 1991 and now serves on dispute review boards for Caltrans contracts. **lcaeng@sbcglobal.net**

J. KIRK ASHFORD *(B.S.'58 ME)* of Anaheim writes, "From 1993 until recently, I was based in Kensington, London, working with Western U.S. Properties (investment properties) for the vast OPEC resources, as macro-managed by National Westminster Bank. When OPEC changed their investment policies after George W. Bush sanctioned the U.S. invasion of Iraq, I retired to the West Coast of the U.S."

WILLIAM BLYTHE *(M.S.'57 CE)* of Palo Alto retired after 42 years on the faculty of the civil engineering department at San Jose State University and is still active as a consultant.

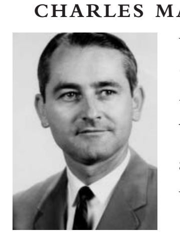
WILLIAM BRIDGES *(B.S.'56, M.S.'57, Ph.D.'62 EE)* retired from the EE and applied physics departments at Caltech as the Carl F. Braun Professor of Engineering, Emeritus, in 2003. He writes, "My wife, Linda McManus, and I have now completed our 'ultimate retirement home' in Nevada City, California, where we have six acres of forest on a hilltop. We split our time about two-thirds there and one-third in our old residence in Sierra Madre, California." **w6fa@caltech.edu**

BURTON CORSEN *(B.S.'50 ME)* of San Jose retired from IBM.

ROBERT GORDON *(M.S.'57, Ph.D.'62 NE)* of Los Altos writes, "I have finally published my book, *Ethics Based on the Science of Evolution: Nature and Nurture*."

ALAN LEVY *(B.S.'50, M.S.'52 Metallurgy)* retired from Lawrence Berkeley National Laboratory and is living in Sacramento.

CHARLES MATHEWS *(B.S.'50 CE)* writes, "Thanks to the G.I. Bill, I was able to go to college. I chose Cal because my mother graduated from there in 1917. I was a mediocre student (graduating with one grade point), but my education served me well in a career that spanned 40 years in both the private and public sectors with 21 years on overseas assignments in Morocco, Spain, Bolivia, Turkey, Chile, and Jamaica. I retired in 1990 and have settled back in Penn Valley, California."



THOMAS N. MCKAY *(B.S.'55 CE)* of Atherton writes, "I'm retired and have been living on the San Francisco peninsula for the past 30 years. Still rooting for those Golden Bears and next year's visit to the Rose Bowl."

S. JAMES MORIZUMI *(B.S.'55 ME)* of Rancho Palos Verdes, California, writes, "I am 81 years old and in a rehabilitation program (post-hospital care) following my stroke. I was born in San Francisco in 1923 and spent four years in Berkeley, then got a Ph.D. in math from UCLA. I am proud of the great 2004 football team at Berkeley. Congratulations!"

LOWELL PATT *(B.S.'56 CE)* of Murrieta, California, had a very satisfying career in municipal energy, housing development, and redevelopment. He is now retired and working on his golf handicap (13).

GORDON RALLS *(B.S.'54, M.S.'55 ME)* of Pleasant Hill is starting his 18th year of retirement after spending 34 years in construction and manufacturing management for Shell Chemical and Shell Oil Companies. He was a licensed mechanical engineer in California, Ohio, and West Virginia. During his Shell career he worked in California, Ohio, Oregon, and New York City. For several years prior to retirement, he taught evenings in the School of Management at Diablo Valley College in Pleasant Hill.

JACK REETZ *(B.S.'56 ME; M.B.A.'59 Bus. Ad.)* is retired with his wife Joyce in southern Maine, 10 minutes from their grandchildren in Kennebunk. He spent 27 years with Honeywell as a software development manager and program manager. **j.reetz@worldnet.att.net**

CHARLES SCHEFFEY *(M.S.'51 CE)* of Arlington, Virginia, writes, "I have now retired (for the third time) and live in Sunrise Senior Living. My wife Ella passed away in August 2004. I keep busy with the analemma [the figure-eight pattern traced out by the Sun's movement over the course of the year], activities of the American Society of Civil Engineers, and here at Sunrise." **chuckschef@aol.com**

PHILIP WARRINER *(B.S.'56, M.S.'61 CE)* of Sacramento writes, "I'm totally retired and enjoying it. Among other things, I have recently traveled to France and Egypt." **p.warriner@worldnet.att.net**

1940s

DONALD ALDEN *(B.S.'47 CE)* of Carmichael, California, learned to row at Cal under Ky Ebright and has lots of old friends that also row. He is still rowing competitively at age 83.

HOWARD ANDERSON *(B.S.'49 CE)* of Carson City, Nevada, is still involved in highway safety and design and works in many states. He also enjoys traveling here and abroad.

CHARLES AVERY *(B.S.'47 Metallurgy)* of Sparks, Nevada, writes, "I left smoggy, noisy, frenetic L.A. in 1999 for quiet, big sky, scenic, clean air, rural Washoe County, Nevada, near Reno. Keeping healthy and busy with old accounts, home improvement, gardening, fitness, photography, nature, friends, dancing, community events, and studying in and organizing my extensive *book* library of engineering, health, nature, photography, humanities, gardening, and miscellaneous other titles. I still have active registration in the state of California as a metallurgical, corrosion, and safety engineer."

ALVIN DAVIDSON *(B.S.'48 ME)* of Stockton retired in October 2003 from Acme Trucks, Inc., where he was chairman of the board. He worked for Acme Truck Parts and Equipment, Inc.; Specialty Truck Parts, Inc.; and Acme Lift Trucks, Inc.

RICHARD FOY *(B.S.'42 EE)* of Redondo Beach, California, has been taking yoga classes since 1995. It has been a great help in keeping in shape. He has been participating in Omnilore, a senior study discussion organization, for about eight years. It has been a great help in keeping his mind in shape. He has been traveling internationally since 1974 with his first trip, not counting those south of the border, to Hong Kong, which has helped to keep his interests broad and joyful. **rhfoy@earthlink.net**

CARLETON HARDY JR. *(B.S.'49 ME)* of Fremont retired from Ford Motor Co. in 1994 at age 70, then spent 10 years as a volunteer with the Cystic Fibrosis Foundation. He writes, "We have five married kids, 17 grandchildren, and two great-grandchildren. Our eldest grandson is a sergeant with the 82nd Airborne in Iraq."

JOHN (JACK) KNIVETON *(B.S.'48 Petroleum Engineering)* of Napa writes, "I traveled on many Bear Treks, ranging from Antarctica to the Baltic. Every alumnus should continue to support the College of Engineering as well as the new athletics program."

FLOYD LOOSCHEN *(B.S.'44 EE)* of Florence, Oregon, writes, "I'm a retired electrical/electronic engineer after being part of the blossoming electrical, electronic and digital age. And a wonderful journey it was. Thanks to UC for the education that made it possible."

JAMES NEIGHBOURS *(B.S.'40 ME)* of West Caldwell, New Jersey, is a full-time caregiver for his wife with Alzheimer's. After graduate work at MIT, he spent 21 years in active duty as a naval aviator, then 10 years as plant manager for Grumman, then 10 years as a manager for Eastern Airlines.

GEORGE QUINN *(B.S.'47 ME)* writes, "I'm enjoying retired life in my Portola Valley home with my wife Mary. Keeping busy with family, travel, and home improvement projects."

1930s

FRANK LORD *(B.S.'30 EE)* of Redding writes, "As a 96-year-old retiree, I'm coasting along."

LEE MOHLER *(B.S.'38 ME)* of Costa Mesa, California, writes, "I'm 90 years old. My formula for a happy long life: Marry a lover. Stay mentally, physically, and spiritually active. Engage in life. Participate."

PAUL SHERIDAN *(B.S.'30 CE)* of Sacramento writes, "I'm very busy with senior activities: I bowl, direct duplicate bridge games, participate in caregiver support groups, etc., etc."

1920s

JOHN HOMSY *(B.S.'28 Mechanics)* of Sutter Creek, California, has been enjoying retirement since 1962.

EVAN AURAND *(B.S.'75 EECS)*, a San Jose engineer who worked at Memorex, Fairchild, Adobe, and Excite before devoting himself to music and musical equipment, died recently of a heart ailment at the age of 52. He played guitar for Little George blues band and jammed regularly at the Road House in Sunnyvale and JJ's in San Jose. He was a vintage amplifier expert and engineered sound systems for Eddie Money and the Sons of Champlin, among others.

DON CUNNINGHAM *(B.S.'43, M.S.'44 ME)* died last December in Penn Valley, Nevada, at age 85. On Berkeley's mechanical engineering faculty for more than 40 years, he made significant contributions in medical applications, especially in ballistocardiography and automotive/wheelchair designs to facilitate driving for the handicapped.

BRADLEY GARRETSON *(B.S.'41 CE)*, a registered architect and licensed civil, structural, and mechanical engineer, died in April 2004. He was co-founder in 1956 of Garretson and Elmendorf Consulting Engineers of San Francisco, which was responsible for buildings at Lawrence Berkeley, Lawrence Livermore, and Sandia Labs. He served in the U.S. Army during World War II and was later promoted to captain in the army reserves. He served as president of the UC Berkeley Engineering Alumni Society in 1982–83.

JASON LIAO *(B.S.'97 EECS)* died in a car accident last December at age 25. He was living in Salinas after accepting an engineering position with CTB/McGraw-Hill.

JAMES MCCARTY JR. *(B.S.'47 CE)*, a longtime engineer for Oakland, died in January. He served on the 269th Engineers Combat Battalion during World War II, then returned to school and began working for the city in 1947. He engineered an extensive flood control project and many bridges, roads, and buildings that helped define the city of Oakland. In 1961, he became director of public works, where he presided over several large freeway projects and BART's Oakland portion.

ROBERT NANNIZZI *(B.S.'63 EE)* died last May in Alameda. An electrical engineer with Bechtel Corporation for 30 years, he specialized in the design of large facility power systems and power plants, including the Jim Bridger Power Plant in Rock Springs, Wyoming.

FRANK POULSEN *(B.S.'40 CE)* died in 2002 in Brentwood, Tennessee. He had retired in 1989 after a successful 35-year career in utilities in Santa Rosa.

JOHN "JACK" RHETT JR. *(M.S.'52 CE)* of Arlington, Virginia, died in January at age 79. He served in both Korea and Vietnam in the Army Corps of Engineers and earned three Legions of Merit before retiring from active duty in 1972. He then joined the newly established Environmental Protection Agency and in 1979 was appointed federal inspector by President Jimmy Carter of the Alaska Natural Gas Transportation System, overseeing construction of portions of the pipeline now used to transport natural gas from Canada to the U.S.

LAWRENCE TALBOT, Berkeley emeritus professor of mechanical engineering known for his work in fluid mechanics, died last March at age 79. When he joined the faculty in 1951, his work in high-altitude and high-speed aerodynamics was used largely in satellite design. In the late 1960s, he turned his attention to bioengineering in the early days of that field, working on biofluid dynamics. He also did research in shock structure, combustion and flames, and real gas effects, continuing this work beyond his retirement in 1991.

GAY WEBER *(B.S.'47 EECS)* of Fort Wayne, Indiana, died last October at age 82. He designed jet engines for General Electric for 40 years in Pennsylvania and Ohio. While at Cal, he was on the gymnastics and diving teams and was president of Phi Delta Theta fraternity.

DONALD PEDERSON, professor emeritus of EECS at Berkeley, died last December at age 79. Best known in the field of electronic design automation for spearheading the development of SPICE (Simulation Program with Integrated Circuit Emphasis), his vision laid the groundwork for advances in the design of the complex integrated circuits that drive modern electronic devices. He served in Germany as a private in the U.S. Army during World War II from 1943–46, worked at Bell Telephone Laboratories from 1953–55, and joined the Berkeley faculty in 1955. "Almost everything Pederson did was the first in the world," said Richard Newton, Berkeley EECS professor and engineering dean, recruited here from Australia by Pederson nearly 30 years ago. In 2001, Berkeley dedicated the Donald O. Pederson Center for Electronic Systems Design in honor of his contributions to computer-aided design of microelectronic systems.