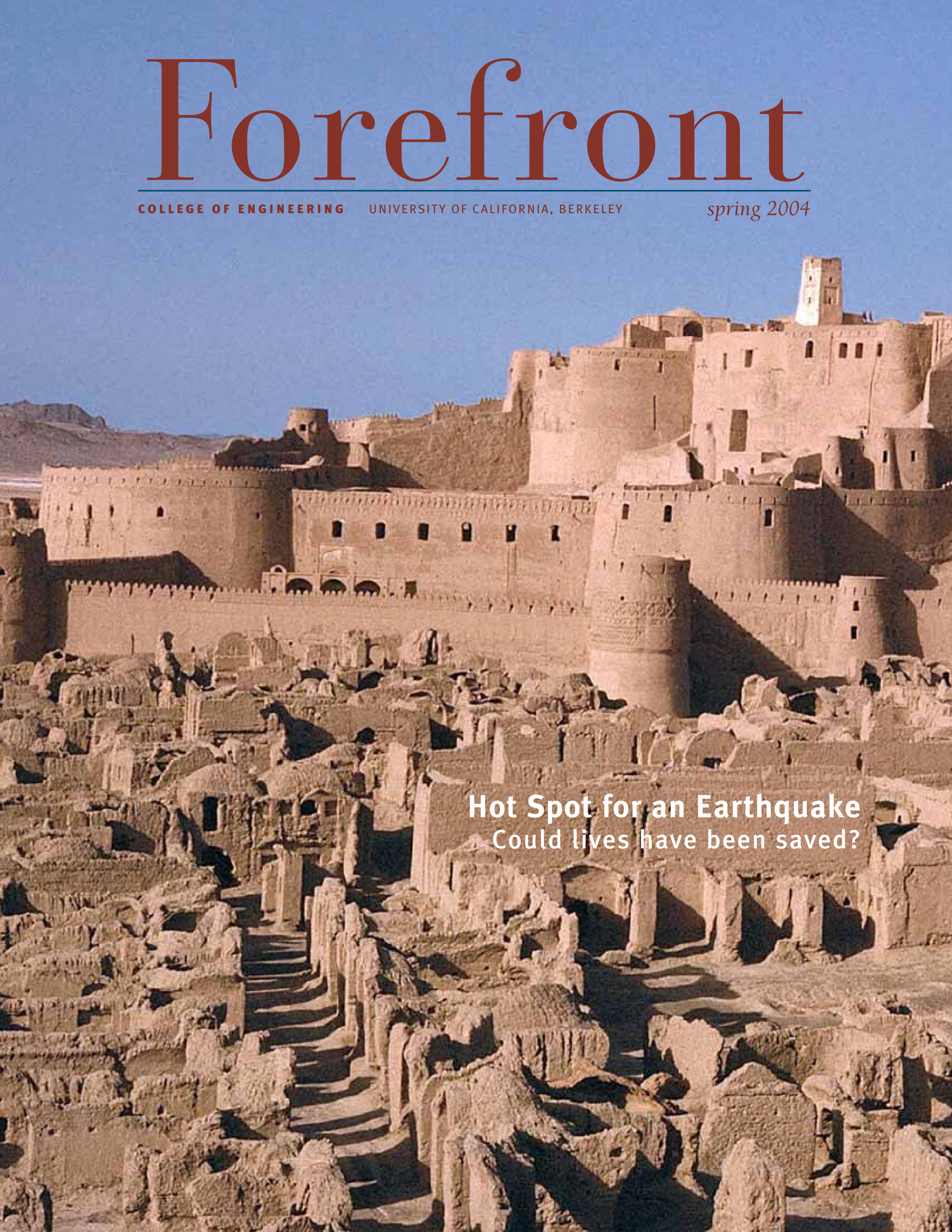
Forefront

COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA, BERKELEY *spring 2004*



Hot Spot for an Earthquake
Could lives have been saved?

dean's message:

A GLOBAL PEACE CORPS OF ENGINEERS

BART NAGEL PHOTO

The People's Republic of China produces 450,000 engineers annually—more than four times as many as the U.S.—and the difference is growing every year. Each newly minted Chinese engineer commands an average annual salary in China of less than $10,000 (U.S.), about one-fifth the starting salary of the average Berkeley Engineering graduate. Russia and India are also producing large numbers of engineers willing to work for much lower salaries than their American counterparts.

What can we do to continue to distinguish the graduates of Berkeley Engineering and ensure that they retain their high value in a growing global marketplace? It is indisputable that the U.S. leads the world in specialized skills, technology, and salaries. But our undergraduates tend to be woefully behind in worldly wisdom, international travel experience, foreign language abilities, and basic awareness of how other peoples live and think.

To maintain our leadership role, we must correct this imbalance. Fundamental studies in the sciences and mathematics will always form the core of our engineering programs, but our research universities must also begin to think globally by incorporating examples of diverse, real-life experience into the curriculum. My own belief is that this is best done outside of student life, away from campus and home, in some distinctly different place on the planet.

At Berkeley, we are creating a task force to consider such an experience as part of the curriculum—perhaps as part of a fifth year of study—through a global engineering technology 'peace corps.' I envision young engineers working in communities all over the world, partnering with practicing engineers, faculty and students from other disciplines, other universities, and perhaps other countries, and working within local infrastructures and governments to identify problems and to help find solutions.

As someone who left his native Australia to study at Berkeley, then traveled and lived for three months in a small village in India, I know firsthand that there is no comparable experience for a young, passionate student to learn that he or she has a great deal to offer, as well as a great deal to learn. I believe that the leaders of tomorrow will be those who truly involve themselves in our world today. We must provide an effective opportunity for our students to experience the realities of global engineering as a part of their Berkeley Engineering education. I welcome your thoughts and ideas 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
The 2,000-year-old mud-brick citadel in the Iranian city of Bam, a world heritage site, was destroyed in a 6.7 magnitude earthquake in December. Forty-one thousand people died in the quake. "We couldn't have prevented Bam," says Berkeley CEE professor Khalid Mosalam. "But as earthquake engineers, we hope to identify hot spots where strong earthquakes are likely to hit and introduce strengthening techniques for structures that could collapse."
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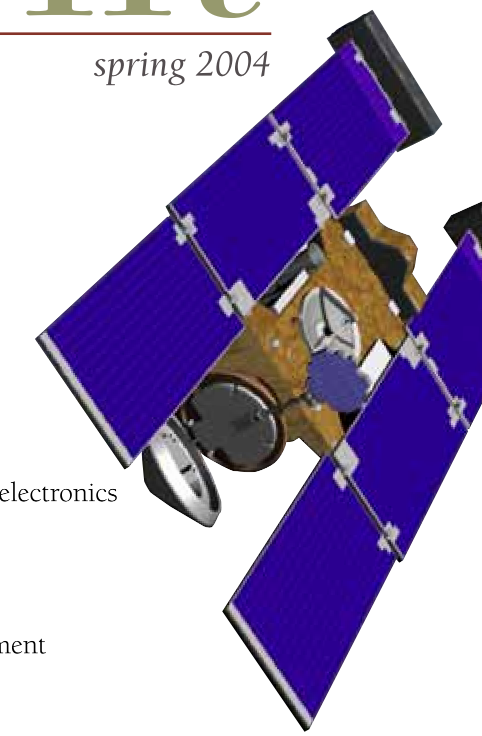

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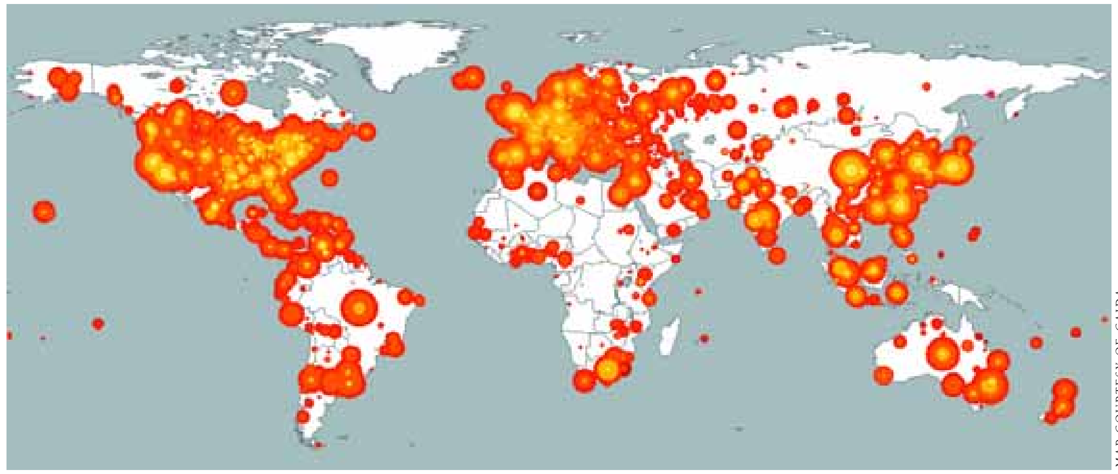


MAP COURTESY OF CAIDA

In January 2003, the Sapphire worm (aka Slammer) broke speed records as an unsuspecting Internet-using world went from worm-free to global impact (burnout zones) in only 30 minutes.

Berkeley researchers to help build Internet security testbed

A team of researchers from UC Berkeley and the University of Southern California Information Sciences Institute (USC-ISI) has received a three-year $5.46 million grant to build a mini-Internet, then hack into it, in an effort to develop better security methods against crippling computer viruses and potential terrorist attacks.

The ambitious project, known as the Cyber Defense Technology Experimental Research Network, or DETER, is funded by the National Science Foundation (NSF) and the Department of Homeland Security. Project architects will use sophisticated methods to build the most realistic model of the entire Internet to date, including routers and hubs to up to 1,000 personal computers. The system will be isolated so that researchers from government, academia, and the private sector can subject it to multiple disabling attacks without consequence to real-life Internet traffic.

"One of the challenges of developing defense programs that are effective against attacks from viruses and worms is that they can only be tested in moderate-sized private research facilities or through computer simulations that are not representative of the way the Internet works in reality," says Professor and Chair Shankar Sastry of EECS, who will serve as DETER's principal investigator. Sastry was also interim chief scientist of the Center for Information Technology Research in the Interest of Society (CITRIS) in fall 2003.

As dependence on the Internet grows, experts believe that more sophisticated attack techniques are being developed that will be impossible to defend against with current technologies. Most difficult are distributed denial of service (DDoS) attacks, which generate a flood of network packets from many different sources to snarl legitimate activity.

DDoS attacks increased tenfold from 2001 to 2003, affecting targets ranging from high-profile e-commerce sites to small Internet service providers. In January 2003, the Sapphire worm hit more than 75,000 hosts worldwide within 10 minutes, leading to ATM failures and network outages and disrupting airline flight schedules. In August, hundreds of thousands of unprotected computers were infected with the MSBlaster and SoBig worms, crashing PCs, Web servers, and transaction processing systems.

"We are no longer talking about nuisance pranks and vandalism, but potential losses in the billions of dollars," says Terry Benzel, assistant director for special projects at USC-ISI and DETER co-investigator. SoBig alone caused an estimated $14.62 billion in business losses.

Sastry appeared last year before the Congressional Committee on Homeland Security to testify about the need for the DETER testbed. Other participants at Berkeley include Anthony Joseph as co-principal investigator, CITRIS director Ruzena Bajcsy, and CITRIS researchers Doug Tygar and David Culler.

While DETER will focus on building the testbed's infrastructure, a companion project involving Berkeley's International Computer Science Institute (ICSI), Purdue University, Pennsylvania State University, and CITRIS researchers from UC Davis will develop testing and evaluation methodologies. ■

UC leads in patent activity

The University of California remains first in "technological strength" among universities in the U.S., as measured by both quantity and quality of patents issued, according to a report published by *Technology Review*.

UC was first in 2002, with 466 patents issued, up from its first-place showing in 1997 with 305 patents. To arrive at the ranking, the number of patents is multiplied by the current-impact index, a measure of how frequently in the current year an institution's patents from the previous five years are cited.

Patent activity at academic centers has experienced a boom in the last five years, the report claims, fueled by growing entrepreneurism on college campuses and a proliferation of university-related startup companies.

newsmakers

DAVID CULLER, EECS professor and an investigator for the Center for Information Technology Research in the Interest of Society (CITRIS) was named by *Scientific American* one of the top 50 Research Leaders of 2003, an international list of innovators in science, engineering, commerce, and public policy. Culler was singled out for his pioneering work on wireless sensor networks for military and environmental applications.

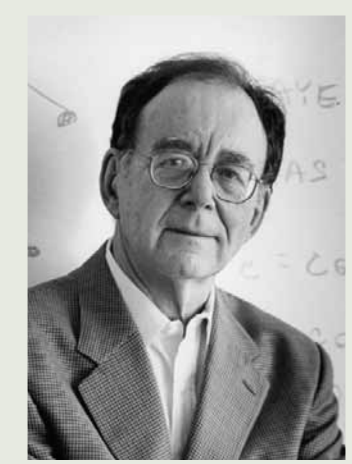
Executive Vice Chancellor and Provost **PAUL R. GRAY** has been awarded the 2004 James H. Mulligan Jr. Educational Medal of the Institute of Electrical and Electronics Engineers (IEEE) for his "exemplary contributions to electrical engineering education through mentoring of students, an influential textbook, and University-wide academic leadership." Gray is also the Andrew S. Grove Distinguished Professor of Electrical Engineering. He served as chair of EECS from 1990 to 1993 and was Dean of Engineering from 1996 to 2000.

David Culler

William Oldham

RICHARD KARP, University Professor of EECS, BioE, IEOR, and Mathematics and an investigator for CITRIS and the California Institute for Quantitative Biomedical Research (QB3), is the 2004 recipient of the Franklin Institute's Benjamin Franklin Medal in Computer and Cognitive Science for his "contributions to the understanding of computational complexity," including scientific, commercial, and industrial applications that help "programmers find workable solution procedures, avoiding approaches that would fail to find a solution in a reasonable amount of time." Recipients of the Franklin Award, initiated in 1824, have included Pierre and Marie Curie, Thomas Edison, Albert Einstein, and Stephen Hawking, as well as 100 Nobel laureates.

Dean **A. RICHARD NEWTON**, EECS professor and Roy W. Carlson Professor of Engineering, was named to the National Academy of Engineering, among the highest professional distinctions in engineering, for his "innovations and leadership in electronic design automation (EDA) and for leadership in engineering education." He also received the 2003 Phil Kaufman Award for his contributions to commercial EDA products.



Richard Karp

Retired EECS professor **WILLIAM OLDHAM** placed second among riders over 50 and 21st overall in last summer's Cycle to the Sun bicycle race for charity up Maui's 10,005-foot Haleakala volcano, billed as "one of the steepest roads on earth." Oldham, who has been biking competitively for two years, bettered his 2002 time by covering the 36-mile course in 3 hours 51 minutes.

Vice Provost and CEE professor **WILLIAM WEBSTER** retired last December following 34 years of service as a professor and administrator in a variety of positions. He was succeeded by Catherine Koshland, Wood-Calvert Professor in Engineering and professor in energy and resources and in public health, effective April 1, 2004.

William Webster

Send your faculty announcement to *forefront@coe.berkeley.edu*.

Stardust: Close encounter of a cometary kind

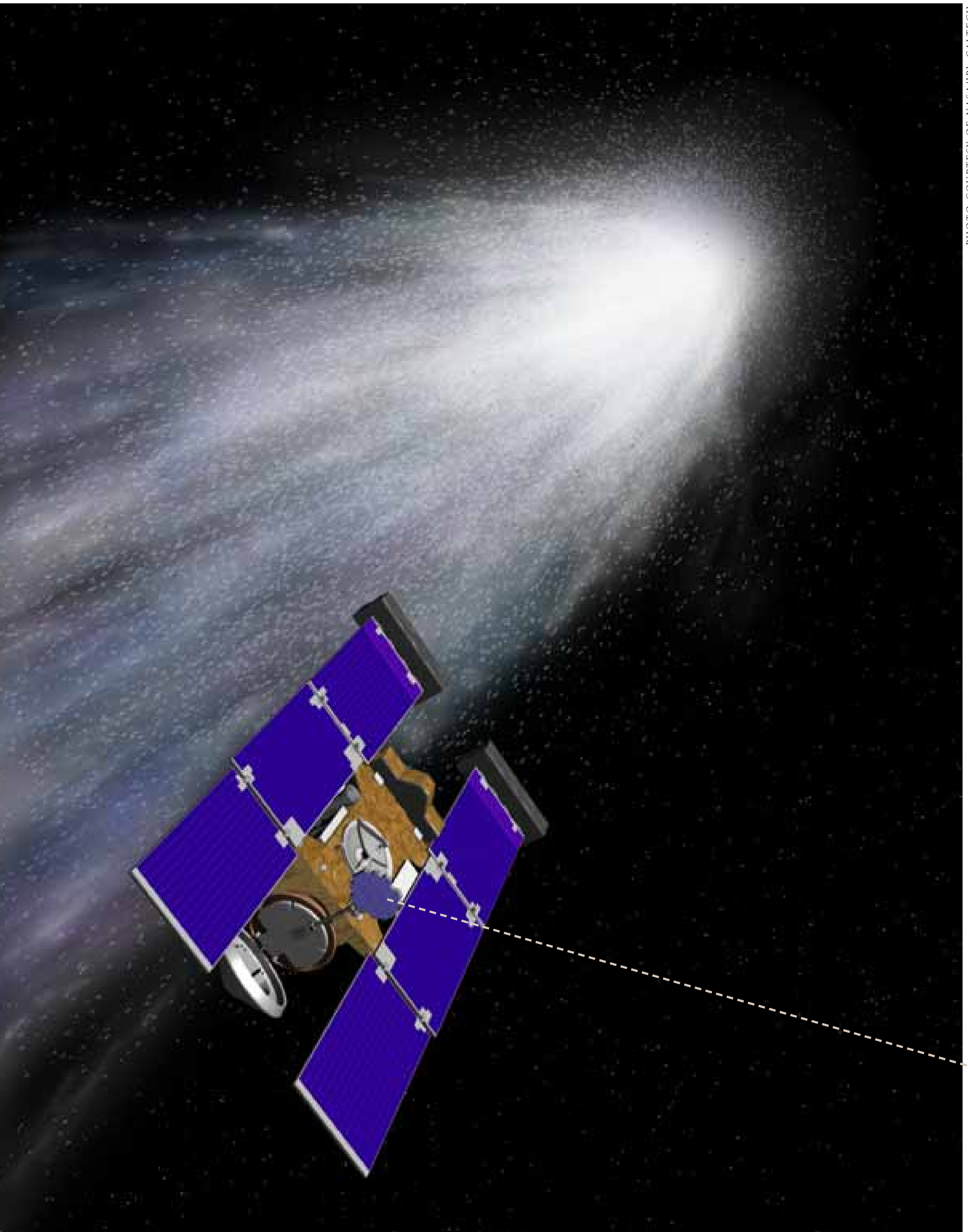


PHOTO COURTESY OF NASA/JPL-CALTECH

Stardust encountered Comet Wild 2 on January 2, entrapping bits of cometary dust in its tennis racket-like collector. At about 800 pounds, the relatively low-cost unmanned craft is solar powered and flies close to Earth to get gravitational boosts during its journey.

Their unique exploration project just achieved its historic climax: an encounter with Comet Wild 2 to retrieve cosmic dust from beyond earth's orbit and snap the best ever photos of a comet's surface. Although indications are that everything went without a hitch on January 2, when the dramatic flyby occurred, project engineer Peter Tsou (B.S.'65, M.S.'66 EECS) and principal investigator Donald Brownlee (B.S.'65 EECS) won't really know until 2006—when the spacecraft returns safely to earth—whether the mission was an unqualified success.

"This has been my dream for the last 20 years, so I guess I'm pretty persistent," says Tsou, who also serves as deputy principal investigator on the project, known as Stardust. It is the first NASA mission dedicated to exploring a comet and the first U.S. mission designed to robotically obtain samples from deep space and return them to Earth. It is also NASA's first sample return mission since the manned Apollo mission of 1971-72.

"Getting a sample from a comet is probably the best chance we have of discovering what the solar system was like four-and-a-half billion years ago," Tsou says. "Comets develop far from the sun and are in the deep freeze for so many years that they have preserved a point in time when the solar system was forming."

Comets are bodies of dust and ice that accumulated at the edge of the solar system, near Pluto. When they travel close to the sun, the solar heat causes the ices to sublime, and the solar wind pushes the sublimed gases and dust to form a comet's characteristic tail, creating the spectacular shows Earthlings are so fond of. Unlike the planets—which have been altered by weathering, plate tectonics, and other factors—comets remain relatively unchanged, preserving the most pristine state of the material from which they originally formed.

Launched February 7, 1999, Stardust met Comet Wild 2 (pronounced *Vilt 2* after its Swiss discoverer) on January 2, 2004, an estimated 242 million miles from Earth. The craft flew through the coma—the cloud of dust and gas coming off the nucleus—picking up tiny particles of cometary dust using a special capture medium called aerogel. Meanwhile, a camera on board snapped 72 photographs as the craft passed within 142 miles of the comet's pockmarked surface.

Although Tsou and Brownlee graduated from Berkeley Engineering the same year, somehow they didn't cross paths until they teamed up on the Stardust project. Following his Berkeley degree, Tsou got his Ph.D. at UCLA and has been a behind-the-scenes researcher at Jet Propulsion Laboratories (JPL) for 29 years. Brownlee's path, which led to a Ph.D. in astronomy from the University of Washington and worldwide renown as a cosmic dust expert, started when the senior EECS major took an astronomy class on a lark. He ended the semester by launching a high-altitude balloon-borne cosmic dust collector from the Greek Theater.

"My engineering background has been a plus because most astronomers don't know a lot about engineering issues," says Brownlee. "A project like Stardust is primarily engineering: nuts and bolts, electronics, project management, the whole ball of wax."

The biggest challenge, Tsou and Brownlee agree, is working with the hypervelocity speed of objects in space. The capture occurred at 13,650 mph, about six times the speed of a high-powered rifle bullet. The spacecraft had to be equipped with defensive bumpers and shields to protect it.

Data beamed back after the flyby indicate that the ship encountered an abundance of the comet dust it went seeking. Stardust's tennis racket–shaped collector was expected to trap about 500 tiny particles (>15 µm), which should yield enough material to keep many analysts occupied for the next decade.

In returning to earth, scheduled for January 15, 2006, at Utah Test and Training Range, the spacecraft must withstand loads up to 100 times the force of gravity. By that time, Stardust will have spent seven years in space and covered 3 billion miles at an average speed of 48,000 mph.

The Stardust concept was born, Tsou says, when the Halley Intercept Mission he was working on in 1981 was scrapped as too expensive in an era of double-digit inflation. More than a decade later, Stardust was made possible by NASA's Discovery Program, which maintains low project costs by keeping scientific objectives highly focused, development timelines relatively short, and by recruiting experts from industry, business, and academics to collaborate on implementing the project for under $200 million.

For more details about the mission and images from the flyby, see the Stardust Web site at **http://stardust.jpl.nasa.gov**.

PHOTO COURTESY OF NASA/JPL-CALTECH

PHOTO COURTESY OF DONALD BROWNLEE

Donald Brownlee (LEFT)*, now a world-famous astronomer, launched his career in cosmic dust collection with his senior astronomy project in 1964* (ABOVE)*. It was a collector flown below two weather balloons to collect cosmic dust at 100,000 feet and launched from the Greek Theater.*

PHOTOS COURTESY OF NASA/JPL-CALTECH

Peter Tsou specially designed the capture medium, a continuous gradient density silica aerogel that is 99.8 percent air and so lightweight it almost floats. Particles captured in the aerogel (FAR LEFT) *will leave a carrot-shaped trail and be embedded at the tip. The flyby is expected to yield about one-thousandth of an ounce of cometary dust for study.*

NEW FACULTY PROFILE: IEOR's Rhonda Righter

JERRY KAPLER PHOTO

Rhonda Righter, who joined IEOR last July, also got her Ph.D. at Berkeley Engineering. "I feel like I'm coming home," she says of her new position.

The word that most frequently appears in her CV is *optimal*, as in one of her papers titled *Optimal ordering of operations in a manufacturing chain*. But Rhonda Righter never gets frustrated devising theories and models for optimizing what she calls "the messy reality" of everyday life.

"Teaching is so much fun," she says. "And my research is like solving puzzles all day. Sometimes I sit in the cafe solving problems on my laptop and I think, 'Wow! And they pay me to do this.'"

Righter joined IEOR last July after more than 15 years at Leavey School of Business at Santa Clara University, where she taught statistics and operations management. An Oakland resident and Berkeley Engineering alumna (M.S.'82 Eng Sci, Ph.D.'86 IEOR), Righter is glad to be working closer to her Rockridge home.

"Industrial engineering and operations research started in World War II with questions like, 'Where do you drop the bomb if the submarine is going to move?,'" she says. As the IEOR arena became larger and more interdisciplinary, it evolved first to manufacturing and then to industrial applications.

Now Righter is working on a National Science Foundation proposal to investigate operations in the service industries, which, she says, account for 80 percent of the U.S. economy. Her own research focuses on modeling and improving the performance of stochastic (random) systems, especially manufacturing, service, and telecommunication systems. The work has implications for workload distribution, employee training and flexibility, and workplace productivity.

"I see what I do as applied math theories, general enough that they could apply to computer communications or telecommunications," Righter says. "Think of phone calls instead of widgets; the models are not that different."

She is enjoying the transition from teaching quantitative subjects like statistics, which were her bread and butter at Leavey, to the computer-based and mathematical decision models she works with now.

"The students here are more self-motivated," she adds. "I can't imagine a better job." ■

OBITUARY: T.Y. Lin, renowned structural engineer, remembered

At a January memorial in the Faculty Club's Great Hall, about 300 family members, professional colleagues, and friends of Tung-Yen (T.Y.) Lin celebrated the life and achievements of the civil engineering professor emeritus whose pioneering work in prestressed concrete profoundly influenced modern structural design. Lin died last November at age 91.

"We will hear much this afternoon about T.Y.'s prowess as a builder of bridges and other magnificent structures," said Executive Vice Chancellor and Provost Paul Gray in addressing the private gathering. "But I want to speak about a different kind of bridge that T.Y. built. He crossed chasms of culture, voids of bitterness, filled in gaps in our ability to understand and appreciate each other. T.Y.'s life itself was a strong and mighty bridge."

PEG SKORPINSKI PHOTO

In attendance at the January memorial were (left to right) T.Y. Lin's daughter Verna Lin-Yee, son Paul Y. Lin, wife Margaret Lin, Executive Vice Chancellor and Provost Paul Gray, and Greg Fenves, CEE chair and the T.Y. and Margaret Lin Professor of Engineering.

Considered one of the greatest and boldest structural engineers of his time, Lin achieved world renown for combining elegance and strength in his design projects, such as San Francisco's Moscone Convention Center, Taiwan's Kuan Du Bridge, and the roof of the National Racetrack in Caracas, Venezuela. He was also recognized for innovative ideas like the 'Peace Bridge' he proposed across the Bering Strait between Alaska and Siberia.

Born in 1912 in Fuzhou, China, Lin earned his bachelor's degree in civil engineering from Jiaotung University. He came to Berkeley as a graduate student—the College's first student directly from China—and earned his master's in 1933. He joined the Berkeley faculty in 1946.

Lin's brothers, Tung Kwang of Los Angeles and Tong Qi of Boston, and his cousin T.H. Lin of Los Angeles attended the event, which opened with musical selections played by Lin's two granddaughters. For information on donations to the T.Y. Lin Fellowship Fund, please contact the Berkeley Engineering Fund at 510.642.2487. ■

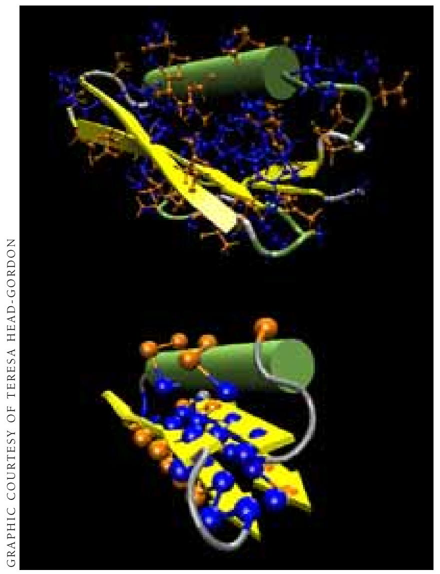
in the news

INNOVATIONS

Cutting-edge research from Berkeley Engineering

Innovations is a regular column featuring brief updates on the pioneering research done by Berkeley College of Engineering faculty and students. See more at **www.coe.berkeley.edu/newsroom.**

Boiling proteins down to basics



GRAPHIC COURTESY OF TERESA HEAD-GORDON

Head-Gordon's computer-generated models simplify the structural details to focus on why proteins aggregate around nerve cells in diseases like Parkinson's and Alzheimer's.

BioE professor Teresa Head-Gordon has discovered an innovative approach to imaging human proteins that may yield better information about how they behave in disease states like Parkinson's and Alzheimer's that involve protein aggregation. Representing each amino acid and chain that make up a protein, such as hemoglobin or collagen, is not only expensive but also computationally difficult and time consuming. Instead, Head-Gordon's models boil down the protein structure to three basic components modeling its behavior and shape rather than all its structural details. These images may help biotechnology companies produce proteins and may ultimately lead to gene therapies for some diseases.

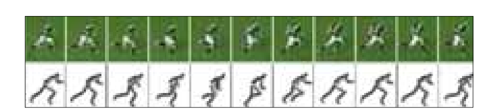
"Sometimes when you have so much detail, you get lost in the forest," Head-Gordon says. "With minimalist models, things are much easier to characterize, analyze, and understand." ■

A better way of forecasting water supply

CEE professor John Dracup is working on more probing methods for predicting how climate trends could affect the world's future water supply. Water managers currently factor in expected flow of surface water, predicted precipitation, and mean data from previous years to make decisions about how much water to store for the next crop irrigation season. Dracup uses computer-simulation models to evaluate climate variables—like El Niño—and more sweeping climate changes—like global warming—and predict their effects on water supply, agricultural production, salinity of rivers that yield drinking water, and other factors.

"Climate variability and climate change have been occurring for thousands of years," Dracup says, "but people have only recently begun observing them." ■

Computers that visualize motion



GRAPHIC COURTESY OF THE RESEARCHERS

The software captures moves from a videotaped soccer game and finds the best match from its library, rendering the motions as stick figures.

Jitendra Malik, EECS professor and associate chair for computer science, has developed software that enables computers to classify human motion, including everything from ballet movements to World Cup soccer play. With graduate students Alyosha Efros, Greg Mori, and Alex Berg, Malik has created a vocabulary of basic movement patterns—steps, walks, jumps, dances, and other movements—from different angles. When given a digitized video clip, the software computes the "optical flow" of the movement and compares it to the library of predetermined patterns.

"A big aspect of human intelligence is vision: how we, using our eyes, understand the world around us," says Malik, who is also a researcher in CITRIS, the Center for Information Technology Research in the Interest of Society. The software has many potential applications, including criminal surveillance and safety monitoring in areas like swimming pools. ■

Protecting our ports

Of the seven million ships that pass through U.S. ports each year, only two percent are inspected, due to tight time constraints.

To detect possible transport of clandestine nuclear weapons materials through U.S. ports, NE professor Stanley Prussin is working with scientists at Lawrence Livermore National Laboratory on a system that, under some conditions, might offer 10,000 times the sensitivity of others being tested. Prussin and Eric Norman of Lawrence Berkeley National Laboratory have demonstrated that delayed fission gamma rays are a characteristic signature of fissionable material. The research is in an early stage, and many practical issues must be addressed before the method could be applied for screening of large sea-going cargo containers. ■

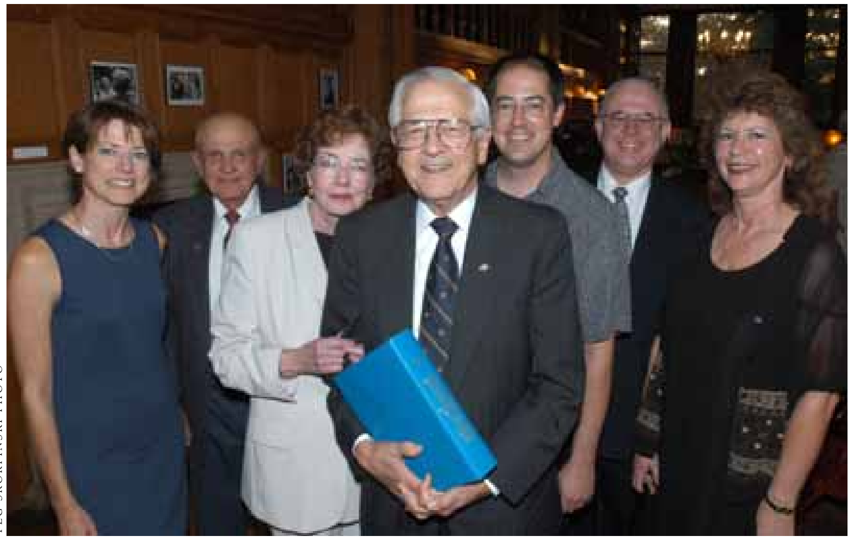
Berkeley awarded most doctorates in 2002

Berkeley awarded 799 doctorates in 2002, more than any other single institution in the U.S., according to a report sponsored by six federal agencies and published in the *Chronicle of Higher Education*.

Berkeley ranked fifth in granting engineering doctorates, behind MIT, University of Michigan-Ann Arbor, Georgia Institute of Technology, and Stanford, but ranked first overall and in the broad fields of humanities and the physical and social sciences.

According to the report, only 39 percent of engineering doctorates went to U.S. citizens. Between 1997 and 2002, the total number of engineering doctorates awarded nationwide dropped by 17 percent, although at Berkeley the number increased slightly during the same period. The full report is available at **www.norc.org/issues/docdata.htm.**

In a separate report published in *Black Issues in Higher Education*, Berkeley tied for first place in granting doctorates to African American engineers, based on preliminary figures from the 2001-2002 academic year. Both Berkeley and North Carolina Agricultural and Technical State University graduated six black engineering doctorates. The full report is available on line at **www.blackissues.com/Top1003.asp.**



PEG SKORPINSKI PHOTO

Karl Pister (center, with book) at the Morrison Library event with members of his family (from left to right), daughter Jacinta Pister Whitmore, brother Phil Pister, wife Rita Pister, son Kris Pister, son Karl Pister, and daughter Tracy Pearse Mulder.

ROHO chronicles engineering luminary Karl Pister

The illustrious career and life of Karl Stark Pister have been captured in a 600-plus-page oral history published last fall by the Regional Oral History Office (ROHO) and celebrated at a September event in Morrison Library.

Outgoing UC President Richard Atkinson, a colleague and friend since 1980, sponsored the project and describes Pister in the introduction to the volume as "one of the most remarkable leaders in the history of the University of California" who dedicated "his heart and soul" to the more than 20 positions he has held here.

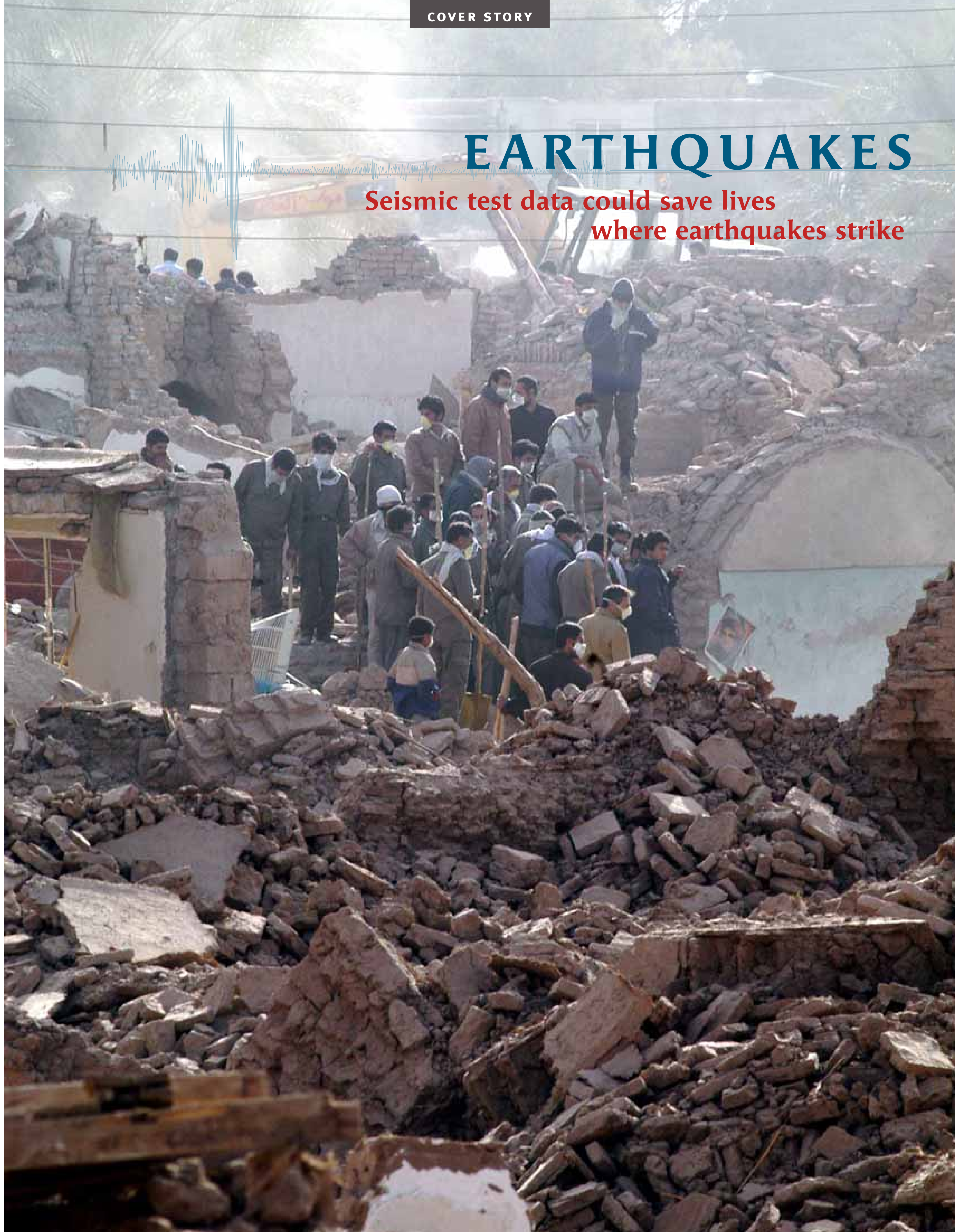
The history chronicles Pister's early years in Stockton, his civil engineering studies at Berkeley and the University of Illinois, his Navy service, and his 56-year academic career spent primarily at Berkeley as professor, engineering dean, researcher, educator, and administrator. The book is rich in detail about his personal history as son, student, sports fan, husband, father to six children, and a devout Catholic.

After two initial interviews, Pister spent a year reviewing his files, making meticulous notes, and developing an outline with ROHO interviewer Germaine LaBerge before resuming the interviews. The entire process, he observes, was both fun and rewarding.

"What it did was dramatically reinforce for me the fact that life is about people and the university is about people," he says. "Although there is a material content to your interactions, there is no question in my mind that the people in your life are the most important thing." Reviewing his life path also reminded Pister that he had made only a handful of significant decisions.

"There've been maybe half a dozen times in my life where I consciously had to make a personal decision that affected my own future. That's why I've tried to counsel my own children and students to keep themselves prepared, so that when doors are opened, you can make the right choice." He says his most important decision was to ask his wife, Rita Olsen Pister, with whom he recently celebrated 53 years of marriage, to marry him.

The new oral history is available through ROHO at the Bancroft Library. ■



EARTHQUAKES

Seismic test data could save lives where earthquakes strike

Minutes before dawn's first light on December 26, a 6.7 magnitude earthquake struck the southeastern Iranian city of Bam, severing power lines and transforming nearly every one of that ancient city's structures into rubble. Lost too were most of the city's historic quarter, an unprecedented 41,000 lives, and the city's 2,000-year-old mud-brick citadel—a world heritage site and the largest mud-brick structure in the world.

BY CHRISTOPHER JONES

Despite the fact that several major fault lines crisscross Iran, few buildings there are built to withstand earthquakes. In the last half-century, 11 earthquakes have killed 100,000 people in Iran. It's just one country among many that is woefully unprepared for the wrath nature wields when the earth shakes.

In much of the world, as in Iran, houses are built of mud-brick. It's cheap and keeps homes cool in the summer and warm in the winter. But it buckles and collapses in even a moderate temblor.

"Mud-brick is the oldest construction material around, and in many situations it works well," says Berkeley civil and environmental engineering professor Khalid Mosalam, "but not in an earthquake. Earthquakes move the ground in all directions, especially horizontally, leading to huge shearing forces. As soon as the bricks bend, they crumble. They can't carry the tension of bending and shearing forces."

In 1999, Mosalam traveled to northwest Turkey as part of a Pacific Earthquake Engineering Research Center (PEER) team visiting the site where a 7.4 magnitude earthquake decimated a densely populated city, leaving more than 17,000 people dead, 300,000 people homeless, and 350,000 buildings damaged or destroyed. Walking through a blighted urban area, he stopped to talk with an elderly man standing in front of what had been his home. The man showed Mosalam the small window through which he'd escaped, and then revealed that his family had been trapped inside.

Recalling how many times he'd heard similar tales in other areas devastated by earthquakes, Mosalam shakes his head. "Visiting damaged sites for reconnaissance work is an invaluable learning experience because this is the real laboratory. But it's an extremely hard task. When people see us, they think we're there to fix their homes. We go to collect data and to learn from the damage we see," says Mosalam, who has visited earthquake sites around the world for the last 12 years. "We don't have immediate answers for them. It takes a very long time to see results from our work. You have to do an awful lot of number crunching to turn this research into information that can be used in new engineering designs."

"The ancient practice of building with masonry is one of the most beautiful building techniques."

Mosalam is spearheading a critical research effort at Berkeley funded by the National Science Foundation that could save lives and preserve masonry buildings during earthquakes. With his current focus on masonry—from 800-year-old stone mosques in the Middle East to new brick buildings in San Francisco—he is evaluating how masonry behaves under simulated earthquake conditions.

An Egyptian native, Mosalam speaks of the awe he feels for the ancient structures that dominate the landscape of his childhood. "The oldest existing structures in the world are the great Egyptian pyramids," he says. "The ancient practice of building with masonry is one of the most beautiful building techniques. Yet masonry is one of the least understood materials, and that lack of understanding can lead to devastation, as it did in Bam."

LENNY GONZALEZ PHOTOS

"The major objective of our work as earthquake engineers is to preserve life," says Professor Mosalam. "We do this by providing ideas for new construction and offering ways to strengthen existing construction."

Packing some 95,000 pounds, this specimen is one of the largest and bulkiest ever tested on a shake table. Once hoisted onto the table, the team added a full-scale interior masonry wall, 80 sensors, and 150 strain gauges to measure the stresses and forces endured during months of testing.

To pick apart the resilience and the pitfalls of masonry, Mosalam and CEE graduate students Alidad Hashemi and Tarek Elkhoraibi have spent the better part of a year designing a series of earthquake simulation tests. Using state-of-the-art equipment at UC Berkeley's Richmond Field Station (part of the nationwide Network for Earthquake Engineering Simulation), the team developed two distinct tests to understand how a five-story building performs when the ground begins to rumble.

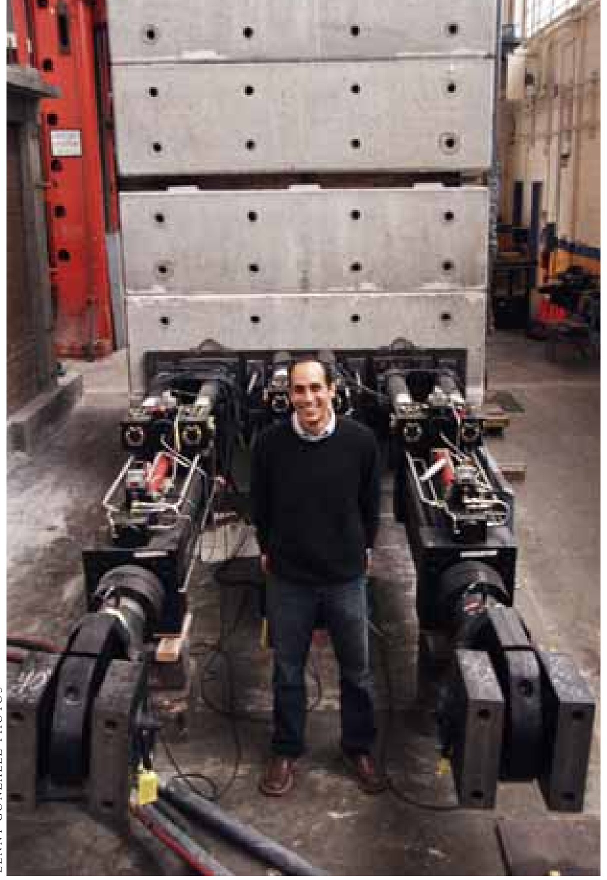
In preparation for their tests—designed to run over a seven-month period this spring—the team built two near-identical specimens. The first was a single-story structure, meant to represent the first of five stories, with masonry walls much like American buildings from the early 1900s and low-cost apartments in Third World countries. This specimen has six reinforced concrete columns that form three frames, including a vertical masonry wall down the middle. The second is composed of two separate frames, one of which has an unreinforced masonry infill wall. Built at 75 percent scale, these are among the largest specimens ever tested on a shake table.

To simulate the realities of a lived-in multi-story building, the team stacked some 57,000 pounds of lead weights—simulating the weight of people, furniture, and other building contents—atop the first structure. They'll learn from the hundreds of sensors and gauges meticulously placed inside and out what happens as the structures endure the stresses of many different kinds of simulated earthquakes. The sensors will measure the forces, accelerations, deformations, and strains that occur during the tests.

One of Mosalam's primary goals in this project is to measure how and why 'hybrid' structures—concrete and masonry in this case—break down during an earthquake. "Engineers often think of masonry as one of the nonstructural components of a building," Mosalam says. "But building with masonry stiffens a structure, which attracts more forces that may damage it."

MIMICKING NATURE'S WRATH

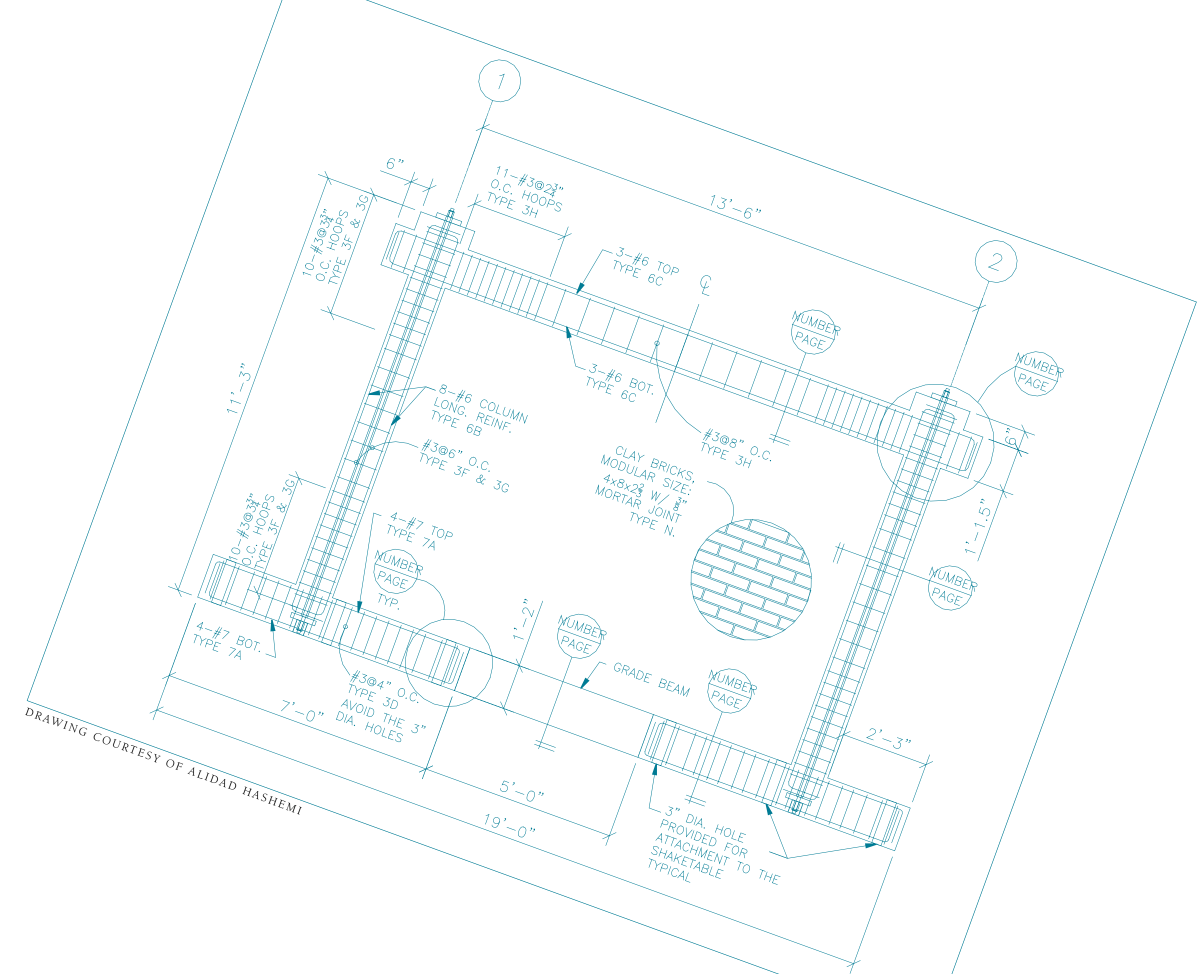
The first specimen was put to the test on the field station's 20' x 20' shake table—the largest and most powerful of its kind in the country. Really a huge slab of reinforced concrete, the shake table sits above an airtight pit containing 12 industrial-grade hydraulic actuators. Similar to giant jacks, the near-10-foot-long actuators use an oil-powered piston chamber to apply thousands of pounds of force to the table. The actuators, which are programmed to produce various motions on horizontal and vertical planes, simulate the unique forces and accelerations of earthquakes.



LENNY GONZALEZ PHOTOS

FAR LEFT: *Tarek Elkhoraibi and the hydraulic actuators he's using to run a series of pseudo-dynamic seismic tests this spring.*

LEFT: *With the help of five engineering students last summer, Alidad Hashemi prepared and embedded more than 200 sensors from which he'll extract seismic information from this year's shake table experiments.*



DRAWING COURTESY OF ALIDAD HASHEMI

Prior to initializing the series of tests, the pit is pressurized to balance the total weight of the table and structure against the difference in air pressure in the pit and the ambient air above. Picture a massive concrete slab plus its experimental specimen balancing on a balloon. When the test begins, the specimen is put to the test, shaking violently for about 30 seconds, a sequence that is repeated over and over at increasingly strong magnitudes.

In the fine art of simulated building destruction, another test yields even more refined data than the shake table yields. While a shake table test is fast and explosive, the pseudo-dynamic test is a more controlled, computer-intensive process.

In this test, several 11' x 9' reinforced concrete blocks are anchored in the middle of the simulation lab to form a wall where actuators are mounted and supported to form a reaction wall. On one side, a set of hydraulic actuators is bolted into the reaction wall. Each customized, industrial-sized actuator can apply up to 220,000 pounds of push-and-pull, lateral force against the structure, up to 1,000 times during one test—mimicking the grains of tectonic plates rubbing together to create shocks. On the other end, the actuators are bolted into the test structure.

Picture a massive concrete slab plus its experimental specimen balancing on a balloon.

The team used actual earthquake data to program the simulation, in this case the 1940 El Centro and 1994 Northridge earthquakes, which exhibited very different types of forces, frequencies, and periods. To simulate a 30-second earthquake, the software program divides the data into timed steps. At any individual step, the actuators can perform the corresponding stroke—each at different lengths and weight loads—to mimic the dynamics of the earthquake. They do this in controlled time frames rather than in real time. Using customized computational tools, Mosalam and his team can simulate behaviors in the structure, but with the pseudo-dynamic test, they have the advantage of controlling the time frames, slowing down the motion, even calling a temporary halt to take a read on the emerging data or simply to mark cracks as they appear.

"It gives us an enormous advantage," says Mosalam. "With the shake table, you tell it to move in a recorded motion, it takes 30-40 seconds, and it's done," he says. "Here we have much more control."

TRANSPARENT COATING BINDS BRICKS TOGETHER

Among the most critical factors in evaluating how a building gets through a quake is its ductility—the ability of materials to deform without losing too much strength. Mosalam hopes these sophisticated tests will provide information about how existing walls might be reinforced to ensure that they will undergo more deformation, or gradual rather than sudden disintegration, should an earthquake hit.

To that end, Mosalam and his students have been testing a material that could handily manage such a feat. Last spring, they ran a series of shear tests on small structures they'd 'painted' with a fiberglass reinforced polymer (FRP) coating composed of fibers and resins. These mini-shake tests confirmed that the affordable, easy-to-apply transparent coating significantly minimized building damage.

"FRP can be an economical way of strengthening new or deteriorating structures by applying a thin layer of polymer material, followed by an epoxy that binds and transfers stress between fibers," says Mosalam. "Because masonry walls crumble so quickly under earthquake forces, FRP can be an extremely effective and economical retrofitting technique, working the way straw, once routinely added to ancient mud-brick as a binder, functioned."

In this year's tests, the team will apply the FRP after the walls are damaged, then recreate the tests to see how well it strengthens them.

The impact of this type of research in countries like Iran, which is surrounded by tectonically active zones and experiences earthquakes on all sides, could be enormous, according to Alidad Hashemi, a native of Iran. He recalled the day in 1990 when the 7.3 magnitude Manjil-Rudbar earthquake struck in the mountainous Gilan Province in northern Iran, killing an estimated 40,000 to 50,000 people. At his apartment in Tehran that day almost 150 miles away from the epicenter, he remembers the water in the pool jumping violently and a nearby wall cracking. Should an earthquake strike closer to densely populated Tehran, he fears the damage and death toll could be considerably worse.

"The devastation in Bam a few months ago shows just how much work there is to be done," says Hashemi. "Tehran and its surrounding cities are a huge concern. It's a place where 20 million people live, close to one-third the population of Iran. I know of studies now that show terrible results if there is a strong earthquake. The casualties are estimated at more than 700,000, with up to 70 percent of the city's buildings destroyed. The city's infrastructure would be devastated."

In fact, in light of Bam's recent tragedy—now considered one of the deadliest natural disasters of modern times—Iranian authorities are considering what it would take to move the capital, which sits above a major seismic fault, from Tehran to a safer location, perhaps Isfahan in the center of the country.

"But," says Mosalam, "there are engineering solutions that are not nearly as drastic, that are realistic, and really would take very little to accomplish. If you have vulnerable structures, you have to find a way to mitigate their collapse. Tying the roof to the walls in intelligent and suitable ways can do it. When you look at Istanbul, which has seen so many earthquakes, buildings are still standing. As earthquake engineers, it's our hope that we can identify potential hot spots where strong earthquakes are likely to hit, study those areas, and introduce building strengthening techniques.

"We must keep learning about the structures that survive earthquakes. An earthquake of 6.7 like Bam's shouldn't have killed 41,000 people," adds Mosalam. "I wouldn't say the toll could be brought to zero, but the loss of lives could be much lower. There are so many areas vulnerable to earthquakes—India, Japan, Afghanistan, Turkey, China, and of course here in California. It's why it's so important to look closely at what happened in Bam." ■

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CHRISTOPHER JONES, a science writer at the Lawrence Berkeley National Lab, was formerly technology editor at *Wired News* and senior writer at *Webmonkey.*

Berkeley and Stanford researchers team up to achieve a milestone in the field of nanoelectronics

Giant leap

IN SMALL TECHNOLOGY

BY DAVID PESCOVITZ

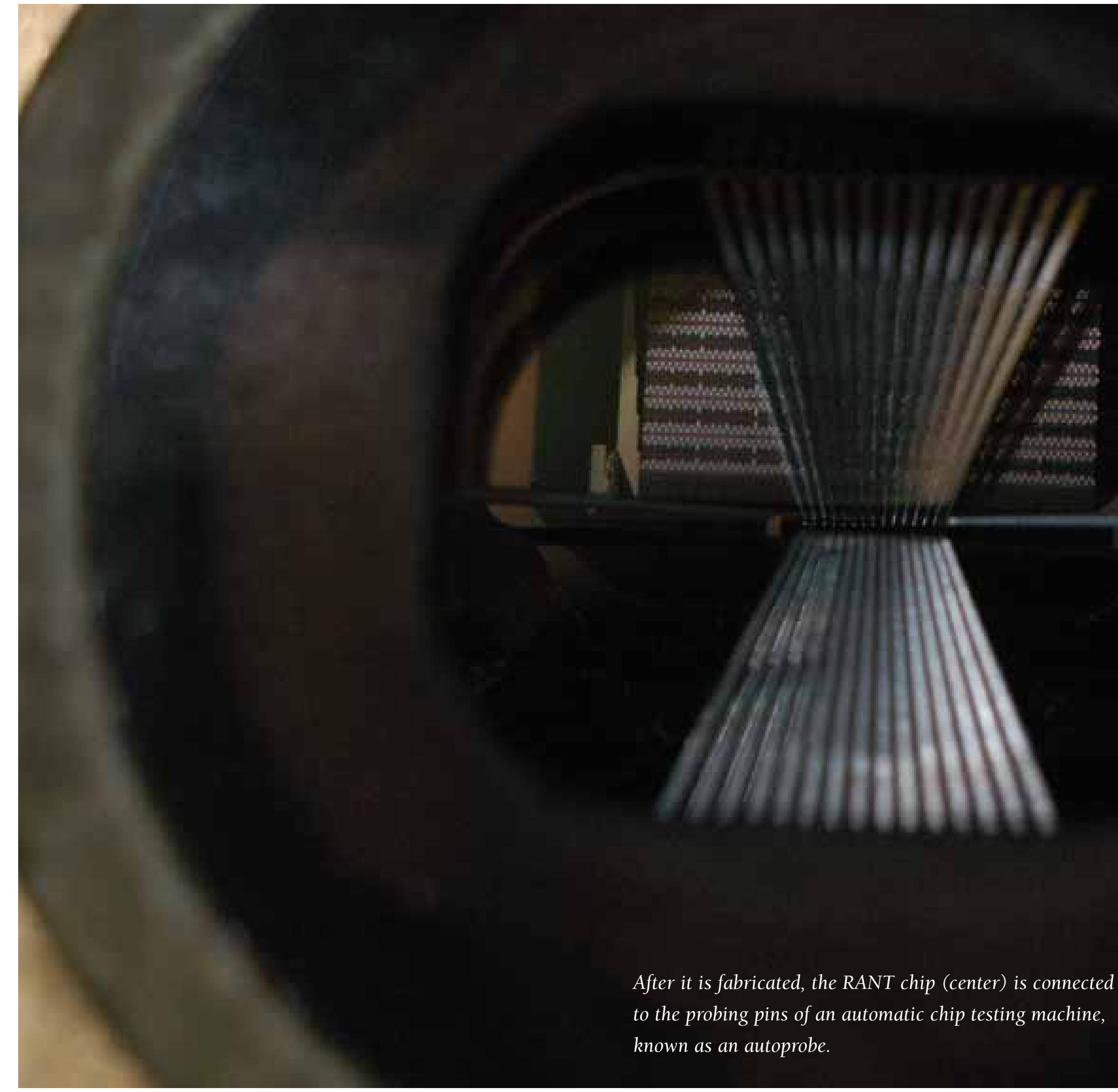
In the last decade, startling advances in nanoscience promised to open vast new horizons for the future of computing. The ability to understand and control matter at the atomic scale could someday lead to powerful new devices, including handheld sensors for sniffing out the tiniest traces of pathogens and massively dense computer memory chips that outshine today's state-of-the-art devices by an order of magnitude. Making these wee wonders a reality, though, requires bridging the nanoworld with the microworld of traditional integrated circuit technology.

In January, Berkeley and Stanford University researchers announced this giant leap in small technology with their fabrication of the world's first integrated circuit combining carbon nanotube transistors and silicon transistors on the same chip.

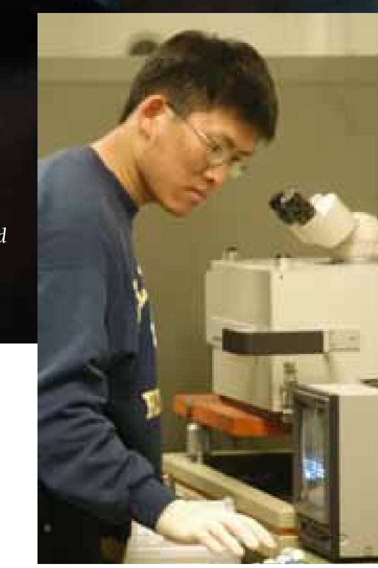
"This is a critical first step in building the most advanced nanoelectronic products, in which we would put carbon nanotubes on top of a powerful silicon integrated circuit so they can interface with an underlying information processing system," says Jeffrey Bokor, Berkeley professor of electrical engineering and computer sciences and principal investigator of the project.

Carbon nanotubes are carbon molecules that resemble rolls of chicken wire except that they are little more than a nanometer—just a billionth of a meter—in diameter. Depending on how they're grown, carbon nanotubes can either be semiconducting or metallic, making them well suited for electronic applications like nanowires and nanotransistors pioneered in the last few years by Bokor's collaborator Hongjie Dai, a professor of chemistry at Stanford University, and independently by researchers with Berkeley's physics department, the Lawrence Berkeley National Laboratory, and elsewhere. Because of their diminutiveness, carbon nanotube transistors can be packed far more closely together on a chip than their silicon counterparts, providing much more processing power or memory in the same amount of space.

An ongoing challenge is creating just the right chemistry to selectively grow defect-free carbon nanotubes with the desired electrical properties and control their placement. Researchers were unable to predict even the proportion of metallic and semiconducting nanotubes grown in each batch. As a result, each individual carbon nanotube had to be electronically probed by hand one at a time to determine its electrical properties. Quite simply, growing carbon nanotubes required far too much trial and error for practical electronic applications—until now.



After it is fabricated, the RANT chip (center) is connected to the probing pins of an automatic chip testing machine, known as an autoprobe.



RIGHT: *Graduate student Yu-Chih Tseng uses the autoprobe to test the RANT chip. Through a multitude of measurements, the autoprobe enables the researchers to quickly characterize whether the nanotubes are semiconducting or metallic.*

PEG SKORPINSKI PHOTOS

The novel hybrid chip fabricated by Bokor, Dai, Berkeley graduate student Yu-Chih Tseng, Stanford graduate student Ali Javey, and their collaborators automates that painstaking process.

"We succeeded in making a tool for nanotechnology researchers, and in the process we demonstrated the broader proof of principle that nanotubes can be successfully integrated in a complex circuit," Tseng says.

The random access nanotube test chip, or RANT chip, was fabricated in a two-part process that began in Berkeley's Microfabrication Lab. Using traditional integrated circuit patterning techniques, approximately 4,000 transistors were etched into a silicon wafer. After the transistors were patterned, wires had to be added that connect the transistors with each other, and later, the carbon nanotubes.

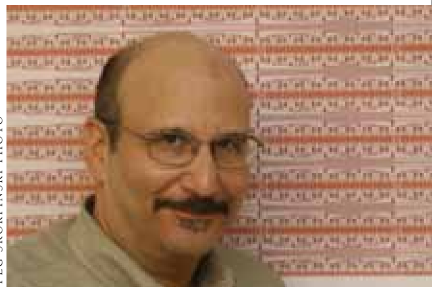
"Our challenge was to build an interconnect that would work for both silicon and the nanotubes," Tseng says.

The carbon nanotubes are grown directly onto "islands" containing the specific catalyst necessary for nanotube synthesis. It's a very hot process though, taking place in a one-inch furnace that climbs to temperatures of 875 degrees Celsius. Standard interconnect materials like aluminum and copper melt at such high temperatures. To prevent the circuitry from burning up, the researchers used molybdenum, a refractory metal that can withstand the heat of the furnace.

After spending two years tweaking the combination of materials to yield strong connections between the various components, the team produced a one-square-centimeter chip containing thousands of carbon nanotube transistors accessible via a network of silicon transistors. "The circuit is interconnected in such a way that only 22 control signals are needed in testing more than 2,000 nanotubes," says Tseng. "The key is that this can all be done by a machine and a computer."

RIGHT: *Magnified view of carbon nanotube grown on silicon MOS circuitry. The bright area on the upper right-hand side is the catalyst island upon which the nanotube was grown.*

Professor Jeffrey Bokor in front of a poster depicting the layout of the RANT chip's carbon nanotubes grown on top of the silicon circuit.



PEG SKORPINSKI PHOTO

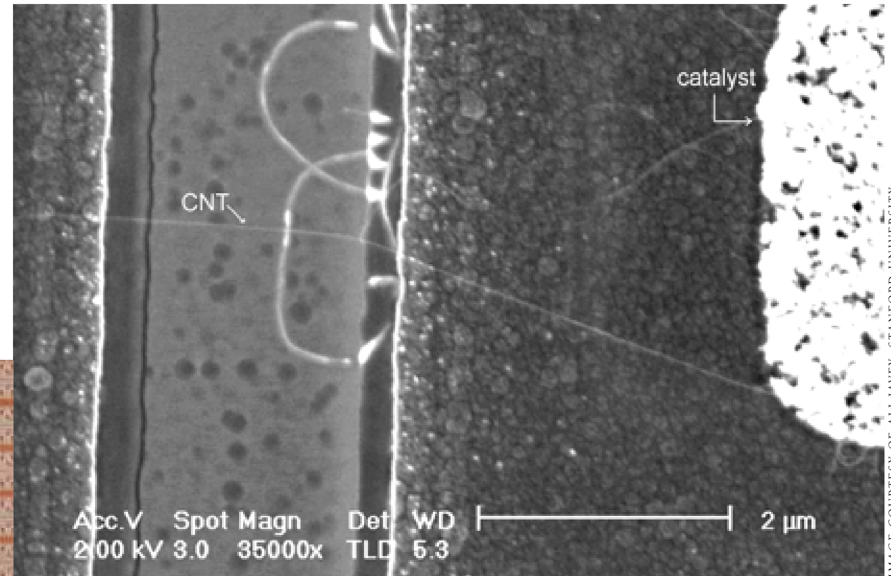


IMAGE COURTESY OF ALI JAVEY, STANFORD UNIVERSITY

The researchers probe the nanotubes using commercially available semiconductor test systems and automatic wafer-probing systems in their laboratory. Through a multitude of measurements, the nanotubes can quickly be characterized based on their conductivity.

"We can now grow a lot of the tubes, characterize them quickly, try something a little different in the growth process, and then characterize them again," Bokor says.

The researchers are quick to point out that the test chip is only the first application of their success integrating silicon circuitry with carbon nanotube transistors. For example, carbon nanotubes can be coated with a specific material so that particles of various environmental agents or chemicals—pathogens in the air, for example—stick to the outside of the tubes like barnacles on a ship. As the molecules bind to the carbon nanotubes, the electrical properties of the tubes change.

"They become selective chemical sensors," Bokor says. "And once you integrate them with electronics as we have, you can imagine a chip that could signal the presence of thousands of different chemicals."

Beyond handheld hypersensitive chemical sensors, integrating silicon technology with nanotube devices could also lead to extremely dense memory arrays capable of storing tens of thousands times more information in the same space occupied by a standard memory chip. Integrated electronics like those in the RANT chip could read and write data to a compact grid of nanotubes, with each tube storing a single bit of data.

"Specialized applications like sensors and memory … seem like a sensible approach to introduce carbon nanotube electronics into a commercial environment," Bokor says.

With these applications in the back of the researchers' minds, their next step is to hone their fabrication methods. Already they're studying other possible interconnect materials that aren't as finicky as molybdenum when it comes to mass production. They hope future generations of their test chip will lead to the development of nanotube transistors that can be fabricated in bulk and offer improved performance over their silicon counterparts.

"One of the key topics going forward will be in the area of technology benchmarking. By this I mean comparing new technology such as carbon nanotubes and silicon with the incumbent silicon technology itself," says H.S. Philip Wong, senior manager of the Exploratory Devices and Integration Technology Department at the IBM Thomas J. Watson Research Center. "If there is an advantage, then there is a market. More work such as [the RANT project] needs to be done."

The interdisciplinary research is funded by the Massachusetts Institute of Technology-based MARCO Materials, the Structures and Devices Focus Center, and the Defense Advanced Research Projects Agency (DARPA) Microsystems Technology Office (MTO). The project is part of a larger effort within the UC Berkeley-based Center for Information Technology Research in the Interest of Society (CITRIS) to bring an engineering perspective to nanoscience. Indeed, the RANT research will continue in a new state-of-the-art microfabrication laboratory slated for construction within a new CITRIS building planned for campus.

"The days when large companies could have experimental laboratories for long-range integrated circuit research are gone," Bokor says. "We'd like the new microlab to be able to handle those kinds of efforts."

The new microlab, which will include an 18,000-foot, two-story clean room, will complement the Molecular Foundry Nanostructures User Laboratory at Lawrence Berkeley National Laboratory. Once completed, the new microlab will be a hub for Berkeley's groundbreaking efforts in nanoscience and nanoengineering.

"Nanoscience is powerful because it gives us control over the most fundamental physical properties of matter," Tseng says. "Having that control enables us, as engineers, to develop extremely interesting new devices with unique capabilities." ■

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David Pescovitz writes *Lab Notes*, the College of Engineering's online research digest, and contributes to *Popular Science*, *Small Times*, and *Business 2.0*. His writing on science and technology has been featured in *Wired*, *Scientific American*, *IEEE Spectrum*, and the *New York Times*.

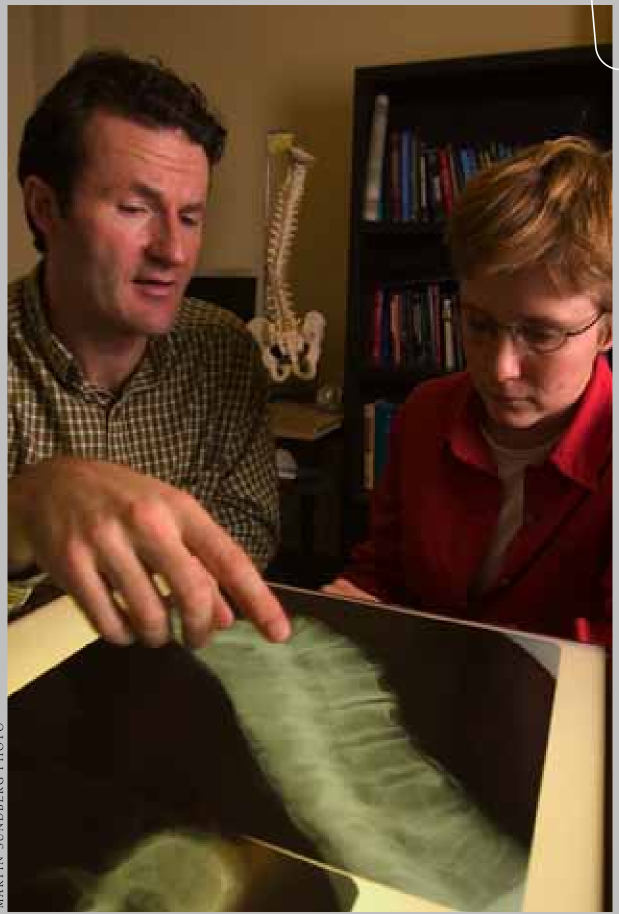
BONE BREAKING WORK

By Jenn Shreve

New scan for osteoporosis opens the door to earlier diagnosis and treatment

You'll be going about your daily life for years, unaware that the bones inside your body are slowly, steadily deteriorating, then one day—snap! You're bending to pick up your grandchild or the car door swings shut and thwacks you on the hip and you end up with not a bruise but a fractured bone that may take months or years to heal.

Developing a scan that could leap into the third dimension took some creative thinking and near hands-on bone cracking.



MARTIN SUNDBERG PHOTO

"We're in the business of trying to predict who's going to get this disease before they actually get it," Keaveny says to grad student Jenni Buckley, who is creating finite element models of the spine—complex mathematical formulations—for computer simulations.

Osteoporosis, called a "silent disease" because of the way it creeps up on you, affects as many as 10 million Americans; 34 million more are considered at risk due to factors like low bone mass, family history, hyperparathyroidism, and vertebral abnormalities. "As our population lives longer," says Berkeley bioengineering and mechanical engineering professor Tony Keaveny, "this disease is becoming more common and much more of a problem. More than just a bone break, fractures caused by osteoporosis often signal the end of life."

As director of the UC Berkeley Orthopaedic Biomechanics Laboratory and working closely with the Department of Radiology at the University of California San Francisco (UCSF) School of Medicine, Keaveny has spent much of his 20-year career studying the factors affecting bone strength—from the cellular and molecular structure of bone to the mechanics of an actual break. Now, he and a multidisciplinary team of software experts, Berkeley mechanical engineering and bioengineering professors and students, and physicians from UCSF's Departments of Neurological Surgery and Radiology hope to prevent the trauma of sudden, low-impact bone breaks for millions of at-risk people with a new diagnostic bone scan, expected to enter clinical trials as early as July.

"Our goal is to create a better gold standard, a more accurate predictor, for diagnosing osteoporosis much earlier so that doctors can predict who is going to get this disease before it actually strikes," says Keaveny, who hopes the research will also enable pharmaceutical companies to greatly reduce costs in the clinical evaluation of new osteoporosis drugs in the pipeline.

The breakthrough technology Keaveny's team has been working on for almost 10 years is what they term a biomechanical computed tomography, or BCT scan. "If we're successful," says Keaveny; "it could be the next big thing in diagnosing osteoporosis, with applications in surgical planning and assessment of the effect of drug treatments."

Osteoporosis—literally *porous bone* from the Greek—is a condition in which low bone mass and structural deterioration of the bone can lead to increased risk for fractures, most often in the hip, spine, and wrist. Bone loss is an unfortunate but natural part of aging, beginning at the unexpectedly youthful age of 30, the time bone begins to break down at a faster rate than new bone replaces it. For women, this process accelerates significantly during menopause. One of the universal levelers of aging is that everyone experiences this decrease in bone mass over the years, but only some of us will develop osteoporosis. "The definitive clinical marker of osteoporosis is a fracture," explains Keaveny. "Unless you've broken a bone, you don't feel the effects of osteoporosis. But because clinically one doesn't want to wait until a fracture before starting treatment, osteoporosis is often defined in terms of only bone density."

The current diagnostic protocol for the disease is a dual energy X-ray absorptiometry, or DXA scan, routinely offered to women 65 and older and other high-risk patients. More refined than a chest X-ray, DXA produces a 2-dimensional digital X-ray that measures "areal" bone density, or the amount of bone mineral per unit area of a predefined region. From this, a statistical measure or "T-score" is calculated, the difference between the subject's bone density and that of an average 30-year-old of the same sex, expressed in standard deviations. According to World Health Organization guidelines, a T-score of –2.5 deviations below the norm signals the presence of osteoporosis, and a medication regimen is often initiated. Values between –1 and –2.5 signal osteopenia, or low bone density, a risk factor for developing osteoporosis.

But the problem with DXA, says Keaveny, is that it's an extremely limiting and crude test. "DXA flattens the image, distorting the information about what's happening inside the bone. Because bone is three-dimensional, assessing bone strength depends on a 3-D picture. Our process starts with a clinical CT scan. To produce the BCT scan from that, we take the entire 3-D geometry of the bone from the CT scan and add in the relevant biomechanics and finite element modeling. This gives us the full picture of bone strength. It's crucial because osteoporosis is a condition related to the shape and structural integrity of the bone, not just to how much bone is present, as measured rather crudely by DXA."

Ultimately, the strength of a structure is controlled by its weakest region, so the distribution of material in the bone plays an important role, according to Paul Crawford, who received his doctorate at Berkeley and is now a research engineer at UCSF's Department of Neurological Surgery. "By using complete information on the three-dimensional distribution of material in the bone, we believe we have developed a more sensitive and specific test of bone strength." Crawford, a colleague and visiting scholar in Keaveny's lab for the past three years, helped put together the computational, experimental, and statistical details for this project.

It's conceivable that people with a T-score in the –1 to –2.5 range could pass the DXA scan. Because they have high bone density in all the wrong places, their structure could collapse, according to Jenni Buckley, third-year mechanical engineering doctoral student and researcher in Keaveny's lab. "These are the people at risk of fracture who'd be missed in a DXA scan," she adds. "Then there are people who have low bone density, but it might be distributed in such a way that it doesn't compromise bone structure. Clearly a test that provides a more complete picture is needed for more accurate diagnosis and more specific treatments."

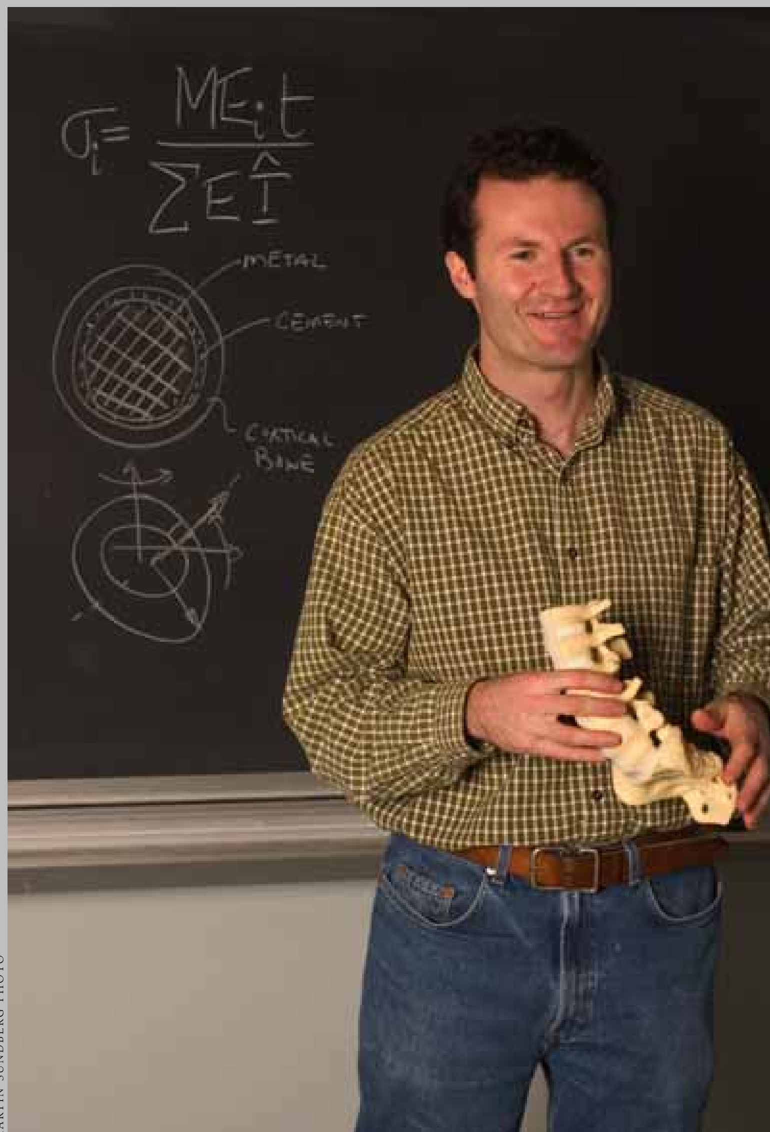
To develop a scan that could leap into the third dimension took some creative thinking and near hands-on bone cracking. "The most accurate way to assess the load a spine could handle would be to take the bone out of the body and break it," says Buckley. Ruling out animal tests frequently used in bone experiments because they don't apply to human scenarios, the team worked with vertebrae removed from cadavers and scanned them using the 3-D CT scan.

Then, to get an accurate measure of the bone's load strength, they fractured the bone, using a standard mechanical testing machine. The set of complex measurements gave them the tools necessary to develop their CT-based finite element model, "a fancy name for a 3-D computer model that behaves like a piece of bone," says Buckley.

MARTIN SUNDBERG PHOTO

One in six osteoporosis cases, or some 200,000 men suffer from osteoporosis fractures each year. "There's a 50 percent morbidity rate after a hip fracture," Keaveny tells former ME grad student, now ME staff member, Atul Gupta.

"As our population lives longer, this disease is becoming more common and much more of a problem."



MARTIN SUNDBERG PHOTO

Irish native and former jazz saxophone player (known in music circles and among his students as T-Bone Keaveny) is a world leader in finite element modeling as it applies to the cancellous, or spongy, bone found in the center of the vertebral body.

The resulting software generates a computer model from the 3-D CT scan of a spine and applies virtual forces to the bones to calculate the strength. "It allows us to pay close attention to structure and how the bone density varies within the bone itself," says Buckley.

Keaveny began making 3-D computer finite element models from CT scans of bone as a doctoral student almost 20 years ago. He has been tightening the agreement between the cadaver experiments and the computer models during his 10 years at Berkeley.

One remaining challenge is getting the model to account for the action of muscles, which aid and support the spine, says Keaveny. The team also wants to improve the existing hip modeling, bringing it up to par with that what they've developed for the spine. "But once the model is perfected, I believe it will be a far more accurate measure of fracture risk, providing a higher level of information than the DXA to doctors and drug manufacturers," all of which will soon be tested in clinical trials.

The National Institutes of Health (NIH) is currently reviewing a $2,250,000 grant application that, if approved, will enable Keaveny's team to further refine their CT-based finite element model and apply it to data from an ongoing NIH clinical study of 6,000 men with osteoporosis.

Keaveny's team plans to piggyback their research on the ongoing trial, an ideal proving ground for their theories because it includes both DXA and CT scans for all participants. While it may seem at first glance an oversight for osteoporosis trials to be limited to men, in fact it isn't, says Keaveny.

"We were very lucky to find a suitable existing clinical trial, saving millions of dollars, and at no cost to the results," he says. When it comes to the ability of the computer models to predict bone strength, there should be no difference between men and women, so that's not a crucial factor at this juncture."

If all goes as planned, the team will spend another two years refining the biomechanics of the team's computer model and another two analyzing the data. "We're very close," says Keaveny of the slow but steady process. "We hope to have a definitive answer in about four years. Then the challenge will be convincing clinical radiologists to use the test, which could gobble up another few years," he adds.

"Osteoporosis is a very serious bone and joint disease, but it is preventable," Keaveny adds. "We hope to be able to drastically reduce the incidents of fracture and to spur drug companies to use the test to better understand how the drugs they currently produce are working." ■

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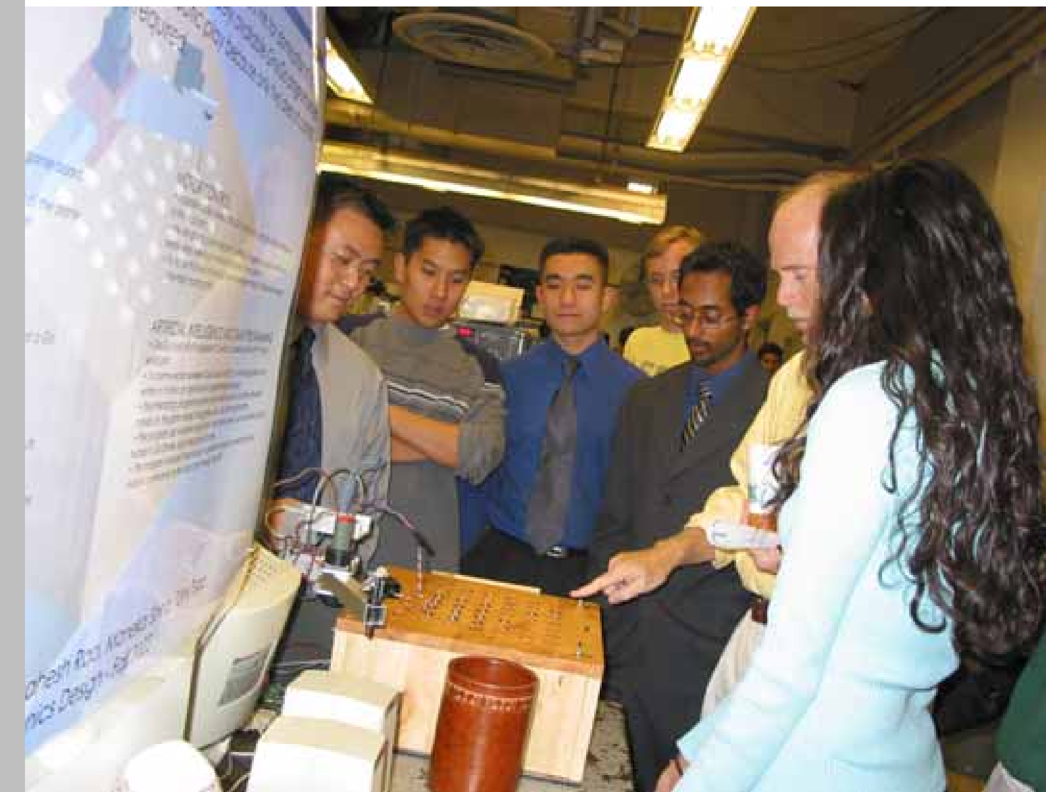
Oakland-based freelance writer Jenn Shreve writes about technology and other subjects for *Wired*, *Photo District News*, and *Slate.com*, and is currently pursuing an M.F.A. in creative writing at San Francisco State University.



ANGELA PRIVIN PHOTO

LEFT: *One student team demonstrated their invention, GoBot, a robot that plays the ancient game of Go with a human opponent.*

BELOW: *Among the profusion of useful devices showcased by students of ME 102B last semester was a blood alcohol level detector for drivers to check their legal limit before getting behind the wheel.*

ANGELA PRIVIN PHOTO

ME majors demonstrate their ingenuity at semester-end open house

On a quiet, overcast afternoon last semester just before finals, Etcheverry Hall was buzzing with tiny electric cars and wagons, shining with the beams of souped-up headlights, and swinging with models of industrial indoor cranes. There were even a few "designated drinkers."

The event—part block party, part schoolwork, and part technological showcase—is the annual Inventor's Open House held by the students of ME 102B, Mechanical Engineering Design II, an upper division core class required for mechanical engineers to graduate.

"I want the students coming out of this course to be scientists and engineers, not just hobbyists," says Professor Homayoon Kazerooni, who has been teaching the class for several years. "Everything they invent is based on solid engineering foundations." About five years ago he started changing the conventional format of the class to incorporate the multidisciplinary syllabus, expand the project focus, and create the showcase event.

The 70 students enrolled last fall split up into groups of four or five. Their mission is to build a device using mechanical and electrical elements incorporating machining, design work, and programming. All the inventions must be computer controlled, so every project group gets a microcomputer.

The result was an abundance of creative inventions for tackling life's problems large and small, entertaining young and old, and potentially saving lives and limbs.

For the lazy golfer there was a smart loader that electronically loads balls onto a tee. For those wanting to conserve sweat, there was the Personal Trailer, a cordless red wagon that follows you and carts your heavy books. But most of the projects fell into the category of safety or lifesaving devices.

Car safety was a big theme. There were car headlights to provide longer beams for turning corners and a 'stay-awake monitor' to keep drivers from falling asleep at the wheel by monitoring heart rate. One group came up with a foolproof blood alcohol level detector designed to prevent intoxicated drivers from starting their cars; the exhibit included a "designated drinker" and plenty of beer to facilitate adequate testing.

Acculin, a precision insulin injector, was designed to draw the right amount of insulin into the needle every time. Also exhibited was an infrared sensor, which, when attached to a camera, serves as a cordless tracking vehicle to perform such services as remote babysitting or military surveillance.

One of the goals of the course, Kazerooni says, is to show students that the theories they learn in class can be put to good use. The projects help build students' confidence that they can invent and build machines that are useful and important to the community, he adds.

"I have found that when you give students freedom to build their own dreams, you realize how intelligent and sophisticated they are," Kazerooni says. "They flourish when you give them creative freedom." ■

ANGELA PRIVIN PHOTO

Bridging the Digital Divide volunteers (left to right) sophomore Vincent Liu, senior Kun Gao, sophomore Rach Liu, sophomore Kedar Shah, and senior Jason Bayer, all EECS students at Berkeley, perform information technology services for the community through the East Bay professional chapter of IEEE.

DAVID LIN PHOTO

Preparing for action at Kappa Continuation High School in Richmond are project volunteers (left to right) Rach Liu, Kedar Shah, Vincent Liu, Devang Parekh, Philip Godoy, and Vikram Savani.

IEEE Students Team Up to Bridge the Digital Divide

Civil engineering students aren't the only ones building bridges. Members of the Institute of Electrical and Electronics Engineers (IEEE) are building digital bridges that they hope will help financially strapped communities and schools overcome the digital divide—the rift of opportunity between those who have and those who don't have access to technology.

Recognizing that they are on the fortunate side of the digital divide has spurred some IEEE members to help others by creating Bridging the Digital Divide, a community service project spearheaded by Berkeley Engineering alumnus Christopher Flores (M.S.'81 IEOR, Ph.D.'83 EECS) and implemented in conjunction with the East Bay professional chapter of IEEE.

"As students of technology we feel we have the obligation to help provide technology to those who can benefit," says Digital Divide organizer and EECS sophomore Kedar Shah. "It is nice to know that even as students we can make a difference."

While federal law mandates that all public schools have computers for Internet access, technical problems can shut those systems down. Sometimes schools don't have the resources or manpower to solve the problem. Case in point: Kappa Continuation High School in Richmond, where a technical problem with Internet ports was neglected until the Digital Divide team stepped in.

The team—including EECS senior Devang Parekh and EECS sophomores Philip Godoy, David Lin, Rach Liu, Vincent Liu, Vikram Savani, and Kedar Shah—volunteered to repair the Kappa network. Although none of them had ever done this type of work before, in only four hours they single-handedly restored high-speed Internet access by fixing the connection to broken ports.

"The scope of what we had to do seemed daunting at first, but it was rewarding when we got it done," says Rach Liu.

Digital Divide members don't just fix technical problems, but they also pitch their services to local institutions. They presented a networking seminar on campus for students in March and are planning to conduct their main IEEE-funded project for a community organization later this semester. To maximize their impact, the group is also considering teaching introductory programming classes to underserved middle and high school students.

"Another part of the digital divide is not having a role model," says Jason Bayer. "Fixing infrastructure is one thing, but interacting with students is another. We want to help motivate them to become engineers."

While the motivation to bridge the digital divide may be philanthropic, participating students say that they gain personally from the experience.

"Even though we've taken a lot of computer classes, we don't often get much practical experience solving real world technical problems like this," says Vincent Liu.

To learn more or to get involved, go to **http://ieee.eecs.berkeley.edu.** ■

Native American Student Finds His Niche

While College of Engineering statistics claim there are six students of Native American descent enrolled, engineering physics sophomore Franklin Dollar hasn't met any of them.

As a Native American student, Dollar dreams of forming a community of Native American engineers at Cal. But until then, he finds the academic support he needs as a member of both the Hispanic Engineers and Scientists Society and the Black Engineering and Science Students Association.

"Unfortunately, I don't know any other Native engineers, so I joined those groups to be a part of a minority engineering group that supported me in my academics," he says. Dollar is also active in the Native American Retention and Recruitment Center (NARRC), a group dedicated to coaxing more Native American students to come to Berkeley.

"We fly people out and spend the weekend with them to try to encourage them to come here," says Dollar. It was NARRC's recruitment effort that persuaded Dollar not just to apply to Berkeley, but to consider college in the first place.

"Growing up on the reservation, you're given the message that college is not for you because it's so expensive and difficult. I bonded with the NARRC students I met, and they showed me that I could also come to Cal," he says. "I buckled down in high school and studied hard my last two years so I could come here."

In an effort to bring more Native American students to Berkeley, Dollar is doing his share of local, hands-on recruiting through NARRC. He often visits reservations and Native American boarding schools statewide to spread the message, primarily though example, that college is an attainable dream. The recruiting paid off, Dollar says, when 15 Native American students matriculated as freshmen this year, compared to only five last year.

Born in San Jose, Dollar grew up on the Dry Creek Rancheria in Geyserville and graduated near the top of his high school class of 38 students. He says that, although Berkeley's "small metropolis" atmosphere may intimidate some students from tiny schools, he found an immediate community and wealth of support through NARRC.

"I really like the fact that Berkeley is big and yet so community oriented at the same time," he says. "It is both a safe and exciting place." ■

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BY ANGELA PRIVIN,
ENGINEERING PUBLIC AFFAIRS

ANGELA PRIVIN PHOTO

Engineering physics student Franklin Dollar, of the Dry Creek Pomo Tribe, is trying to raise awareness among his fellow Native Americans that a college education is within their reach.

Letter from the Real World

ANGELA PRIVIN PHOTO

EECS alum Tobin Fricke graduated from the College of Engineering in spring 2003. Forefront will stay in close touch with Tobin through a series of letters, following him as his life-after-Berkeley unfolds.

San Diego, California

Sitting on the terrace at the UC San Diego Institute for Geophysics, I'm writing this letter in winter's early twilight. I hear the roar of waves crashing on the ocean; on the horizon the gray blue of the sea meets the glowing remnants of what must have been a fine sunset. There's just one star visible.

I spent the day meeting researchers and grad students—networking in its purest form. I came here at the invitation of my advisor from an internship in Alaska who's now consulting here. Riding a burst of optimism, I've been thinking this could be a fine place for grad school.

I spent last summer in Switzerland at CERN, my last undergraduate summer internship. Lectures in high-energy particle physics, afternoons climbing around the test beam apparatus, and long evenings in the Geneva countryside were the routine. I learned that the practical operations of an experiment at an accelerator laboratory more often involve tangled cables and scarce oscilloscopes than mathematical formalism.

This internship buffered me from the practicalities of post-graduation career hunting. I was going to CERN; it could wait! But now it's hit me: Is it going to be work? Grad school? Computer science? Engineering? Physics? It's time to specialize and that scares me.

Job hunting has been harsher than I'd expected. The experiences I've had so far have woken me up to some of the peculiar realities of the engineering hiring world.

I left one on-campus interview feeling elated. I described my experience on a robotics project with a group of friends, and the interviewer dutifully jotted down 'team player.' They called back, saying they wanted to fly me to Boston for another interview, but then I never heard from them again.

Then I was lucky enough to have an interview with that famous Internet search engine company in Mountain View. But eventually a sympathetic HR representative said, "There wasn't a strong enough match." It was a wake-up call to the realities of hiring in an industry that recruits the best of the best, where interviews consist not of a discussion of previous accomplishments, but an on-the-spot technical exam.

As for grad school, I've never seen anything strike with so much fear, self-doubt, and pessimism. I have one friend, a straight-A Harvard student, who is vacillating over whether to take the GRE again; others who wonder whether they should even apply to MIT. Few of us are confident about our applications no matter how impressive our resumes.

The self-doubt is infectious. Each application, each earnestly written personal statement, seems like a shot in the dark. Lots of undergraduate research, a GPA that's good but definitely shows the wear and tear of taking on too much, a huge number of basic technical courses, but no clear focus—now to find a doctoral program that believes in such a resume.

Tobin Fricke

TOBIN FRICKE
Tobin@alumni.eecs.berkrley.edu

student*newsmakers*

THREE BERKELEY ENGINEERING GRADUATE STUDENTS were selected for the new Homeland Security Scholars and Fellows Program at the U.S. Department of Homeland Security's Office of Science and Technology. They are:

- CE master's student Eric G. Chang of Oakland, working on developing sensors to gauge structural damage following natural disasters;
- EECS Ph.D. student Daniel A. Hazen of Berkeley, investigating wireless sensor networks to better detect terrorist activity at U.S. borders; and
- EECS Ph.D. student Ryan M. White of San Carlos, working on improving computer visual recognition of faces using a database of human faces from the Web.

The fellowships—which cover up to three years of tuition, research, and living expenses—are intended to produce expertise in improving domestic security, especially against terrorist threats. The students do an eight-to-ten-week summer internship with the Department of Homeland Security and, after graduation, are encouraged to consider employment offers from the department. From nearly 2,500 applications, six Berkeley students were named among 13 statewide and 101 nationally.

ANGELA PRIVIN PHOTO

The three engineering students who received Department of Homeland Security fellowships are (left to right) Eric Chang, Ryan White, and Dan Hazen.

APPLIED SCIENCE & TECHNOLOGY PH.D. STUDENT JASON CLARK won second place in the 2003 3-D MEMS Design Challenge for his floating electromechanical systems (FLEMS) prototype design. Clark received $5,000 and a prototype of his design.

"The proof mass in a FLEMS device is mechanically decoupled," says Clark, "setting it apart from typical electrostatic sensors." Sponsored by Microfabrica (formerly MEMGen), a Burbank-based microdevice manufacturer, the competition drew 132 entries. Three winners and three honorable mentions were selected, based on design novelty, commercial utility, and effective use of the EFAB process.

PHOTO AND GRAPHIC COURTESY OF JASON CLARK

Jason Clark and his FLEMS device

CALIFORNIA ALPHA (CA A), the Berkeley chapter of engineering honor society Tau Beta Pi (TBP), was recognized at TBP's 98th annual convention last fall with a Secretary's Commendation for the third year in a row for meeting all reporting deadlines. The commendation carries a $500 scholarship, which will be awarded to an engineering student or students selected by the CA A officers based on such factors as level of participation and character. This was CA A's sixth consecutive year to achieve a commendation and its fourth consecutive year to receive a scholarship. CA A also won a project award for implementing 40 chapter projects and the Telebears Advising Session service.

RAYMOND THOMPSON PHOTO

Brian Love (right), last semester's president of CA A, accepts the Secretary's Commendation award from TBP Executive Council President Matt Ohland.

PHOTO COURTESY OF WILLIAM HARTMAN

Hartman says his fantasy of building his own amusement park helps him bear the pressure of Berkeley Engineering.

ME JUNIOR WILLIAM "WOODY" HARTMAN was featured as an "engineering student you'd love to hire" in a January issue of *Design News*. "Before it was time to go to college," the magazine says, "Hartman was already building high-tech, sensor-equipped haunted houses in his backyard. He says his 'lofty dream' is to design and manage his own amusement park, and this dream is what motivates him, keeps him going every day, and helps him survive all the nerve-wrecking exams."

Hartman is taking the semester off to do an engineering co-op at FormFactor, a Livermore-based company that manufactures probe cards used to test memory and processor chips. "Finally I have the opportunity to apply the fundamentals I'm learning in the 'real engineering' world," Hartman says.

UC BERKELEY FACILITIES SERVICES PHOTO

PEG SKORPINSKI PHOTO

FAR LEFT: *CITRIS headquarters will replace the 71-year-old north wing of Davis Hall near the intersection of Hearst and Leroy Avenues.*

LEFT: *Joanne and David Lee, with Chancellor Robert Berdahl in 2001, support many academic, medical, and theological efforts, including the Asian Bone Marrow Donor Program and the Lydia J. Lee Professorship in Pediatric Oncology at Stanford.*

David and Joanne Lee: Helping build CITRIS a home of its own

As founder and CEO of a successful Silicon Valley firm fueling the digital revolution, David D. Lee (B.S.'83 M.S.'86 Ph.D.'89 EECS) knows all about being on the cutting edge.

Lee is the driving force behind Silicon Image of Sunnyvale, which he founded in 1995 and nurtured from semiconductor startup to global leader in high-speed digital communications solutions. The company established the DVI (Digital Visual Interface) and HDMI (High-Definition Multimedia Interface) standards in digital content delivery and is facilitating the rapid shift from analog to digital connections and worldwide access to rich digital media.

"The most important thing I learned during my years at Berkeley," Lee says, "is that success in one's academic endeavors requires balancing one's work with an equal focus on family and friends."

Lee and his wife Joanne are facilitating another cutting-edge effort, CITRIS, the Center for Information Technology Research in the Interest of Society, with a generous pledge toward construction of the new CITRIS headquarters. The building will be a hub for CITRIS's cross-disciplinary research in information technology solutions to address the world's big-picture challenges like education, environment, energy, and health care.

"Our gift to the CITRIS headquarters reflects our commitment to improving the quality and safety of human life worldwide through affordable state-of-the-art technology," Lee says. At his request, an area of the building will bear the name of David A. Hodges, EECS professor emeritus and former dean of engineering, who was Lee's mentor and has served on the board of Silicon Image since the company's inception.

With construction expected to begin in late 2004, the facility will promote interaction among faculty and students from 50 departments and feature high-tech classrooms, flexible lab space, distance learning facilities, a Lifelong Learning Center, and an Integrated Microfabrication Lab for design and manufacture of silicon chips. To be a part of this exciting project, you can make a pledge through the Berkeley Engineering Fund at 510.642.2487. ■

Parikh Scholars Program focuses on interdisciplinary studies

Financial burdens will be considerably lighter this year for John Cason, Fan Lau, Tuan Nguyen, Natalya Sokolovskaya, and Bill Trac, five Engineering Science undergraduates who have each received a $5,000 scholarship, thanks to the Parikh Scholars Program.

Initiated this year with a $100,000 gift from Mihir Parikh (B.S.'69 Eng Physics, M.S.'71 Ph.D.'74 Eng Sci) and his wife Nancy, the program supports students in the Interdisciplinary Studies (IDS) program, the college's multidepartmental curriculum combining engineering with studies in physics, medicine, and other natural sciences.

"Over the years, I have worked in completely different disciplines, including electron lithography, radiation physics, and semiconductor automation," says Parikh. "This has provided me with the confidence of taking knowledge from various disciplines and adapting it to solve a problem at hand."

A native of India, Parikh started his engineering studies at Berkeley in IDS. After working at IBM and HP, he founded and for 18 years served as chairman and CEO of Asyst Technologies, a global public company that provides automation solutions for the semiconductor, flat panel display, and related industries. New scholarship recipients will be chosen each year through a competitive process. ■

PEG SKORPINSKI PHOTO

Celebrating the new program are (left to right) Parikh scholars Bill Trac (Eng Physics), Fan Lau (Eng Physics), Natalya Sokolovskaya (Env Eng), and John Cason (Eng Physics), with Mihir and Nancy Parikh and their son Michael.

Alumni Update brings you news from Berkeley Engineering graduates, as well as news and events of interest to alumni.

Please keep in touch by mailing your news and photos to us at Class Notes, College of Engineering Public Affairs, 102 Naval Architecture Building #1704, Berkeley, CA 94720-1704. Or go to **www.coe.berkeley.edu/classnotes** and click on *Submit Your Class Note*.

CLASS NOTES

2000s

DAVID DANIELSON *(B.S.'01 MSE)* of Somerville, Massachusetts, has just begun his third year as a Ph.D. student in MSE at MIT. His thesis research is in Ge on Si–based photovoltaics. He has also been consulting with Evergreen Solar in the Boston area. **dtdaniel@mit.edu**

KISHAN GUPTA *(B.S.'03 EECS)* of Fremont is now pursuing an M.D.-Ph.D. in BioE.

1990s

SHERENE BAN *(B.S.'98 BioE)* of Singapore is a portfolio manager focusing on Asia-Pacific equities. **sherene@cal.berkeley.edu**

VICTOR CHU *(Ph.D.'96 ME)* of Milpitas is leading a forecasting project at Yahoo! and co-authoring a book on the lifetime of a psychic. **cal@hypnomaster.com**

WILL HALIM *(B.S.'95 EECS)* of Santa Clara is still at Applied Materials. His son just turned three.

MING-LUN HO *(B.S.'95 Engineering Math)* of Oakland joined the math faculty at Chabot College in Hayward this spring, after completing a master's in education at Berkeley in 2002. He has been teaching at Arroyo High School in San Lorenzo for three years. **mingho@cal.berkeley.edu**

PETER HSIEH *(B.S.'93 IEOR)* of Santa Cruz is managing the intellectual property department of a Fortune 500 company. **peter.hsieh@plantronics.com**

BENJAMIN LIN *(B.S.'97 Environmental Engineering Science)* of Rancho Palos Verdes is in his final year at Loyola Law School. **Jamming_28@yahoo.com**

CHRISTOPHER RIDLEY *(M.S.'99 CE)* of San Francisco and his wife are pleased to announce the birth last year of their first daughter, Elizabeth.

JENNIFER TRUE WILCOX *(B.S.'99 CEE)* of San Francisco recently married Tim Wilcox (B.S.'98 Business Administration) and is enjoying being project engineer at Turner Construction Company.

BioE alumna tackles mysteries of the human body

PHOTO COURTESY OF BOSTON UNIVERSITY

Tejal Desai counts among her many honors the 2001 National Academy of Sciences Frontiers in Engineering Award and a 2000 CAREER Award from the NSF.

At age 31, Tejal Desai (PhD'98 BioE) is a celebrated professor at Boston University who has been nationally recognized for her work in diabetes, medicine delivery, and artificial blood vessel research. *Popular Science* magazine named her one of its "Brilliant Ten" researchers of 2003.

For her Berkeley degree, Desai built an implant to eliminate the daily insulin injections individuals with diabetes must administer to control their blood sugar levels. Colleagues said the task was too hard and warned that she would never graduate, but she proved them wrong.

"Six or seven years ago when I started the project, it was unknown to merge micro- and nanotechnologies with human cells or biological entities," Desai says. "Now it's a hot topic." After spending four years coaxing cells to grow on chemically modified silicon, Desai developed a microscopic device that delivered ongoing, regular doses of insulin in rats. The product is now under development by a private company for application in humans.

Desai got her career inspiration in high school, when she heard a biomedical engineer speak about building artificial organs and limbs for spinal cord injury victims. In addition to her insulin implant, she has developed a tiny plastic device that can release medication when implanted in the intestinal lining. Next, she plans to develop an artificial blood vessel that helps the body generate replacements, then biodegrades, leaving the new natural vessels behind.

"I went into academia to combine my interest in research, teaching, and policy. I can work with companies, government, and patients," she says. "It encompasses everything."

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BY ANGELA PRIVIN, ENGINEERING PUBLIC AFFAIRS

1980s

JANET (GARDNER) ANVICK *(B.S.'82 EECS)* of Cupertino writes, "After working for HP/Agilent for 20 years, I was laid off when our division was downsized. I am currently enrolled at San Jose State University, pursuing a secondary teaching credential in mathematics. **jganvick@aol.com**

YEW CHUAH *(B.S.'82, Ph.D.'85 ME)* of Taipei was appointed chairman of the Department of Air Conditioning and Refrigeration Engineering at the National Taipei University of Technology. **yhtsai@ntut.edu.tw**

LEELA GILL *(B.S.'88 MSE)* of San Francisco is director of marketing and customer operations for Direct Commerce, a Web-hosted accounts payable software company. Previously she worked as director of worldwide product management for a subsidiary of Tyco International and held management positions at Raychem and R&D positions at Lawrence Berkeley Labs. She earned her MBA from Duke University and is living happily with husband Charles and son Trevor. **leela.gill@alumni.duke.edu**

LINDA HERKENHOFF *(M.S.'81 Master of Engineering)* of Orinda is director of human resources at Stanford, where she oversees benefits, compensation, training, and organization development. She also holds adjunct professor positions at JFK University and St. Mary's College.

MICHAEL MATSON *(B.S.'84 CE)* of Walnut Creek is a principal and head of quality assurance at Raines, Melton & Carella, serving Bay Area districts and municipalities and helping solve their water-related issues.

MARTIN TEAL *(B.S.'87 CE)* of San Diego was promoted to vice president of WEST Consultants, Inc., a water resources consulting firm, and manages the company's San Diego office.

PHILIP WU *(M.S.'80 Naval Architecture)* writes, "Greetings! Since graduation I have worked in offshore oil drilling and U.S. Naval ship design and construction in Texas and Washington, D.C. I recently joined Anteon Corp. as senior principal engineer after managing a small engineering consulting firm, Sealift International, for seven years. My wife Grace works for Bank of America, and we have three sons: Alex, 15; Victor, 11; and Chris, 9.

Alumnus working to build a better world for Hispanics

It was a Hollywood movie that inspired him to immigrate to the U.S. from humble roots in South America. But rather than personal fortune and fame, Victor Pinzon *(BS'64 ME)* was seeking something much loftier: a better life for himself and his people.

"My future in Colombia did not look bright or challenging," Pinzon says. "I made up my mind that, if I was allowed to enter the U.S., I would do any and all work within the law necessary to accomplish my goal."

Now, 45 years later, Pinzon is effecting change economically, socially, and culturally as president of The Americas Global Foundation (AGF), the Washington, D.C.-based think tank and advocacy organization he founded in 1991. His goal is to empower Hispanics in the U.S. and the peoples of Mexico and Central and South America and build a bridge of understanding linking the Americas.

"In order to accomplish any change, we have to come together with other people to exchange ideas and adjust our thinking," Pinzon says. "In math there is one solution to every problem, but that's not so in engineering or in life. I look for solutions where everybody wins."

The idea of coming to America hit him like a thunderbolt in 1957, when he saw "Rebel Without a Cause," the James Dean film dramatizing the angst of marginalized youth. Pinzon spent a year raising funds through his own mattress manufacturing business and, on a snowy morning just after his 18th birthday, arrived in New York City.

Although the first advice he received from a fellow countryman was to turn around and go home, he held fast to his vision. Within six months, Pinzon found a high school where he could get his diploma. In 1959 he was accepted at Berkeley to study engineering and topped that off with a Berkeley M.B.A. in 1966. He paid his way with numerous jobs, sometimes as many as four at one time, including selling magazines, teaching tennis, busing dishes at the Faculty Club, and working as a teaching assistant, while still managing to play varsity soccer.

For AGF's two major programs—one to bring students to Washington to mobilize them politically, and another to build affordable housing for low-income families—Pinzon has succeeded in getting the attention of U.S. congressmen to secure federal matching funds. He does most of the work at AGF himself. Challenged by modest resources, he counts on members, advisors, and volunteers around the globe for support.

"I may be a dreamer, but I believe all of this is doable," he says. "I invite those who are really hungry to do something for themselves and their communities to join us." For more details on AGF, visit the Web site at **http://theamericas.org.**

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ABOVE: *Victor Pinzon (left) meets with a delegation of Guatemalan community leaders invited to the U.S. by AGF's Come to Washington Program.*

1970s

WILLIAM DAY *(M.S.'75 CE)* of New Britain, Connecticut, is working on the International Geophysical Year 2007-2008 Atlases.

REINHARD LUDKE *(M.S.'76 CE)* of San Anselmo is principal structural engineer in the Bridge and Earthquake Engineering Group and vice president at C+D Consulting Civil and Structural Engineers. **rludke@cdengineers.com**

MARK SCHANFEIN *(M.S.'74 MSE)* of Vienna, Austria, works at the International Atomic Energy Agency (IAEA) in the Department of Safeguards, enforcing the Non-Proliferation Treaty. He is unit head for Unattended Monitoring Systems. He writes, "Currently more than 80 systems have been installed to monitor nuclear material at facilities around the world 24 hours a day, 365 days a

PEG SKORPINSKI PHOTO

Attending the WICSE event were (left to right) Ph.D. student Kris Rosfjord, former WICSE president Myra Boenke (Ph.D.'89), Dubravka Bilic (M.S.'00, Ph.D.'01), undergraduate Elaine Cheong, and former WICSE president Megan Thomas (M.S.'99).

WICSE CELEBRATES 25 YEARS OF ACHIEVEMENT

Faculty, students, and friends gathered with 70 doctoral alumnae last September to celebrate Women in Computer Science and Electrical Engineering (WICSE) and its 25 years of success promoting women in Berkeley Engineering's EECS department.

Just eight years after Kawthar Zaki became the first woman at Berkeley to earn a doctorate in EE, WICSE was founded by six women graduate students in 1977. The robust networking and advocacy organization has been successful in attracting and sustaining women students through sponsoring pre-college outreach and hosting activities from weekly lunches to national conferences. WICSE was also instrumental in forging the Parent Policy, enacted in 1994 and later adopted campuswide, allowing students flexibility in progress toward their degree during childbearing years.

"WICSE is even more important now, since the passage of Proposition 209, when diversity programs are under attack," says Sheila Humphreys, academic coordinator for student matters in EECS. She credits WICSE's success to its continuity, its ongoing contact with successful alumnae and other prominent women in the field, and support it receives from EECS for staff, space, and funding.

Using the WICSE model, many Berkeley alumnae—like Mor Harchol-Balter at Carnegie Mellon University and Amy Wendt at the University of Wisconsin-Madison—have initiated similar advocacy organizations on their campuses across the country. WICSE was recognized with the 2002 award from the Women in Engineering Programs and Advocacy Network for the "sustained national impact" of its efforts.

year, maintaining continuity of knowledge. The multicultural environment in the IAEA and the current political crises in sensitive countries with nuclear activities make this a very challenging and exciting time." **m.schanfein@iaea.org**

PHILIP TRINGALE *(M.S.'79, Ph.D.'82 CEE)* of Moraga was named president of Treadwell & Rollo, Inc., an 80-person environmental and geotechnical consulting firm headquartered in San Francisco. **ptringale@treadwellrollo.com**

DEBORAH WYLIE *(B.A.'77 Architecture, M.S.'78 CE)* of Los Angeles writes, "After 17 years in private architectural practice, I have been with the Cal State University system for eight years and am now University Architect in the Office of the Chancellor. I'm married to J. Scott Carter (M.Arch.'76) and we have three kids. Our son Morgan entered Berkeley in fall 2002."

1960s

WILLIAM BALLHAUS *(B.S.'67, M.S.'68, Ph.D.'71 ME)* of Palos Verdes Estates, California, is president and CEO of The Aerospace Corp.

DAVID BARNHART *(B.S.'66, M.S.'67 CE)* retired in 2002 as Riverside County's Director of Transportation, after nine years in that capacity.

RICHARD CAJIAO *(M.S.'66 CE)* of Bogota, Colombia, works as a consulting engineer for large civil works, including hydroplants, high dams, and long tunnels. **rcajiao@gomca.com**

PETER CROSBY *(B.S.'67 IEOR)* of Pacific Palisades is a supply chain reengineering consultant.

LYNDEN DAVIS *(B.S.'64 ME)* of Albany, California, is now ASME (American Society of Mechanical Engineers) region IX vice president, after having retired in July 2002 as regional director of ASME western office.

WILLIAM DURBIN *(M.S.'68 CE)* of Chesterfield, Missouri, retired from URS Corporation in June 2003 but still works there part time.

JOHN DUREIN *(B.S.'65 ME)* has taught math for 32 years, the last 27 at Carmel High School in Carmel, California.

ALBERT GREEN *(B.S.'67 ME, M.S.'69 Naval Architecture)* of Benicia retired in 1996, when Mare Island closed, after 16 years there and 10 years as engineering duty officer in the U.S. Navy repairing nuclear subs. Recently he has been a caregiver for his parents, now both deceased.

GARY HUCKELL *(M.S.'67 EE)* of San Diego retired from SPAWAR System Center in 2001 after 41 years and is now working for Titan. **ghuckell@cox.net**

JARED JONES *(B.S.'68 EE)* of San Jose retired two years ago from high tech and is now building houses with Habitat for Humanity and doing volunteer work with the South San Jose YMCA. **jaredejones@earthlink.net**

KENT LEUNG *(M.S.'63 ME)* now lives in Moraga with his wife Stephanie. **kkleung@comcast.net**

CARLOS MORALES *(B.S.'69 IEOR)* of Jackson, New Jersey, writes, "The week of Nov. 9, along with five other Berkeley alumni and their spouses, I celebrated the third bi-annual reunion of the Berkeley Big Bang (BBB) Club, an informal association of mostly engineering alumni formed in 1999. Most of its members graduated in the mid- to late-sixties. The BBB Club's second reunion took place in Managua, Nicaragua, in October 2001 and was hosted by several alumni who reside there. This time, the location was Mexico City, with visits to San Miguel de Allende and Guanajuato. Our Mexican host did a great job organizing the reunion, and a great time was had by all, drinking "sangritas" and remembering those days in the sixties when we were all so young and Berkeley was so full of wonder. We plan to have the next reunion in 2005 in Guayaquil, Ecuador, with a side trip to the Galapagos islands. Anyone interested?" **carlosm224@aol.com**

KATTA MURTY *(M.S.'66, Ph.D.'68 IEOR)* of Ann Arbor writes, "Engineering is decision making, and engineers need math modeling, computational, and algorithmic skills to make good decisions. Students can learn these mostly by themselves using well-written books, so I am preparing a series of Web-based books in self-teaching style. First is a sophomore level book on linear algebra; next will be a junior level book on math models for decision making, with an MS level book also planned."

KENNETH OBERT *(B.S.'65 EECS)* of Torrance, California, retired from Hughes Aircraft in 2000. He writes, "I cheer for the Bears, hike, and take serious astronomy classes at UCLA." **RonObert4@aol.com**

PRENTISS ROBINSON *(M.S.'60 EECS)* of Anaheim has retired from Boeing and is teaching part-time at California State Polytechnic University in Pomona.

JAMES UNMACK *(B.S.'64 EECS)* of Rancho Palos Verdes, California, is a consulting industrial hygienist in private practice and teaches occasional classes in industrial hygiene at CSU Dominguez Hills. **jim@unmack.com**

1950s

LOWELL ALLEN *(B.S.'51 CE)* of Eureka, California, retired from Caltrans Structures in 1991 and now serves on dispute resolution boards. **Lcaeng@aol.com**

RICHARD CHALMERS *(B.S.'52 ME)* of Champlin, Minnesota, has been retired for 13 years after 38 years in engineering design with FMC Corporation.

BURTON CORSEN *(B.S.'50 ME)* is happily retired after 34 years with IBM in the San Jose area.

DON FARAUDO *(B.S.'51 Electronics Engineering)* of Livermore writes, "My wife Nancy and I trailered to Iowa and followed the Missouri and Columbia Rivers to Fort Clatsop, Oregon, on the trail of Lewis

*alumni*newsmakers

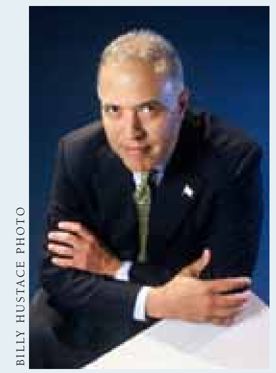
ARMANDO FOX *(Ph.D.'98 CS)* was recognized by *Scientific American* as one of its top 50 Research Leaders of 2003, a list of top innovators working worldwide in science, engineering, commerce, and public policy. Now assistant professor of computer sciences at Stanford, Fox is working on micro-rebooting, a process that could protect networks from disastrous crashes in individual servers. He was recognized by the magazine as "a leader in the growing trend" of incorporating micro-rebooting into computer network design.

JASON HILL *(B.S.'98, M.S.'00, Ph.D.'03 EECS)* and **MIKE HORTON** *(B.S.'94, M.S.'95 EECS)* have been named to *MIT Technology Review's* "100 Top Young Innovators" for 2003, the magazine's annual list of 100 researchers in technological fields under the age of 35 who are "poised to make a dramatic impact on our world." Hill, who cofounded Dust, Inc., left Berkeley last year to form his own company, JLH Labs, in Capistrano Beach. He was cited for writing software that facilitates communication among wireless sensors. Horton, founder, president, and CEO of Crossbow Technology of San Jose, was cited for engineering tiny sensors "that can be spread like crumbs around a battlefield or factory."

PHOTO COURTESY IBM

JEAN PAUL JACOB *(M.S.'65, Ph.D.'66 EECS)* received the Research Leadership Award in Computer Sciences and Engineering, instituted in 1998 by EECS to recognize exceptional service to the department. An EECS lecturer since 1971, Jacob is also manager of external technical relations for IBM Almaden Research Center in San Jose. He was recognized for his "steadfast commitment to the betterment" of EECS through his many contributions as a faculty member, industry liaison, and supporter of student internship and outreach programs.

ERIC SCHMIDT *(M.S.'79, Ph.D.'82 EECS)*, chairman and CEO of Google, Inc., was named by *Business Week* magazine as one of the 100 best managers of 2003 in its January report, for which it surveyed its staff of 140 writers and editors in New York and 21 bureaus worldwide. In just under three years, Schmidt has quintupled the staff of the popular search engine as continuing company growth warranted.



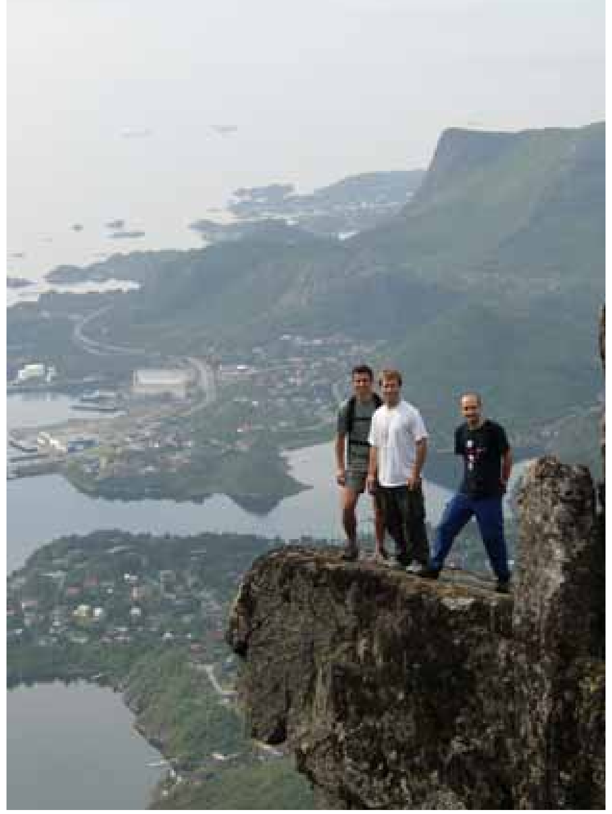
BILLY HUSTACE PHOTO

ARUN SARIN *(M.S.'78 MSE)*, CEO of Vodafone Group Plc, the largest mobile phone company in the world, was honored with the University of California Trust (UK) Award for distinguished achievement by a UC affiliate in the UK. Also an alumnus of Haas School of Business (M.B.A.'78), Sarin was named the Haas Business Leader of the Year in 2002. He serves on both the College of Engineering Executive Committee and the Haas Advisory Board. He was appointed to the top job at Vodafone in July 2002.

CHARLES SHANK *(B.S.'65, M.S.'66, Ph.D.'69)* will resign as director of the Lawrence Berkeley National Laboratory at the end of 2004. During his 15-year tenure heading one of the nation's top basic research labs, he has overseen a staff of 4,000 scientists and technicians doing cutting-edge research in astrophysics, computing, genomics, and nanoscience. He doubled the facility's budget from $229 million to nearly $500 million. Shank will return to Berkeley as a tenured faculty member in physics, chemistry, and EECS.

CALL FOR DEAA NOMINATIONS: SUBMIT BY MAY 15

The Engineering Alumni Society invites you to submit nominations for the 2004 Distinguished Engineering Alumni Awards. Candidates must be Berkeley Engineering alumni and, for the Outstanding Young Leader Award, 40 years or younger. For more information, go to **www.coe.berkeley.edu/deaa.**



LEFT: *IAESTE matches interns to paid positions lasting 12 weeks to 12 months in more than 80 countries, including Norway, where these three IAESTE interns traveled in 2003.*

BELOW: *Justin Hsiao (foreground center, in blue shirt), at an IAESTE dinner in 2003, says his internship was a great opportunity to brush up on communication skills and make international contacts.*

EECS alum interns in Finland through IAESTE

Justin Hsiao (B.S.'03 EECS) had such a good experience studying at Sussex University in England the summer after his sophomore year that he wanted to do it again. But with the rigors and requirements of his EECS major, he couldn't take time to study abroad without delaying his graduation.

In a search for international opportunities that would not hold up his graduation, Hsiao encountered the Berkeley chapter of IAESTE, the International Association for the Exchange of Students for Technical Experience. IAESTE Berkeley is one of 21 chapters of IAESTE United States, the nation's only professional society dedicated to providing international experiences for science and engineering students and technical professionals with global interests.

After graduation, Hsiao began a 16-week IAESTE internship with Helsinki Polytechnic University in Finland, where he investigated the remote detection of breathing problems and emergency medical conditions such as sleep apnea and chronic asthma using wireless technology.

"Given Finland's specialties in excellent health care and wireless technologies, the internship helped me a lot with research experience, in addition to my previous research at Berkeley," Hsiao says. "It also helped solidify my choice to pursue a career in bioengineering." In fact, his experience was so successful that he will be returning to work for his Finnish employer this spring for another six months before pursuing his Ph.D. in bioengineering.

Hsiao is one of more than 6,000 students IAESTE U.S. has placed in paid technical internships in 86 countries worldwide since it was founded in 1950. As part of a reciprocal exchange organization, each chapter is responsible for generating local jobs for international interns, and for each of those, the chapter gets to send a student member overseas.

"IAESTE internships are mutually beneficial exchanges for both interns and employers interested in connecting with the technical global community," says David Hodges, EECS professor emeritus and former dean of engineering. Hodges is Berkeley IAESTE faculty advisor and an alumnus of the organization; he did an IAESTE internship in Norway in 1960. In addition to offering engineering students paid international internships and opportunities to work on the local committee, Hodges says, IAESTE can help professors seeking to host international interns to perform research.

IAESTE recently introduced professional membership to help forge connections between technical professionals and students who want to become leaders in the global marketplace. It also sponsors regional, national, and international conferences and symposia for both student and professional members. For more details, see Berkeley IAESTE on the Web at **www.ocf.berkeley.edu/~iaeste/** or the national chapter at **www.iaesteunitedstates.org**.

and Clark. We gained some ground and are only 199 years behind them. A wonderful two-month trip with beautiful scenery and great interpretive centers all along the way."

RONALD GERDES *(B.S.'57 ME)* of Mount Hermon, California, works part time at NASA-Ames Flight Simulation Laboratory as engineering test pilot on the Lockheed-Martin F-35 Joint Strike Fighter Program. **vstolguy@aol.com**

HUGO HANSON *(B.S.'51 M.S.'69 CE)* of San Rafael is working part time as a geotechnical engineering consultant for Kleinfelder & Associates.

MERLE JOHNSON *(B.S.'59 CE)* of Orinda has been retired since 1994.

HARRY KRUEPER *(B.S.'51, M.S.'53 CE)* of San Bernardino is consulting in civil and traffic engineering, focusing on the Western U.S., Alaska, and Hawaii.

CHARLES LARSON *(B.S.'53 Engineering Physics)* of Sunnyvale continues tutoring, mostly math in East Palo Alto.

CHARLES LEITZELL *(B.S.'50 CE)* of Mokelumne Hill, California, writes, "Since retiring from Calaveras County in 1987, I have been a consultant for public agencies and private developers in traffic engineering. Spare time is spent traveling and researching family genealogy."

HOWARD MIZUHARA *(B.S.'59 MSME)* of San Mateo retired in 1991 as research director of GTE (now Verizon). Currently he is consulting in the fields of ceramics and metals.

NORMAN SCHNEIDEWIND *(B.S.'51 EE)* of Pebble Beach was interviewed by Steve Lohr of the *New York Times* on February 6, 2003, following the Columbia tragedy about the shuttle software. The story was published the following day and on the Web site. He was also interviewed on the same subject by Mat Fordahl, technical writer for the Associated Press.

JAMES SPIRAKIS *(B.S.'55 IEOR)* is retired and living with his wife Ruth at the Villages Golf and Country Club in San Jose. **jamesspirakis@msm.com**

GEORGE WATSON *(B.S.'57, M.S. '58 EE)* is finishing construction on his new home, which he designed and contracted himself, in St. Helena in the Napa Valley of California. **watsongg@aol.com**

CHARLES ZELL *(B.S.'50, M.S.'53 CE)* of Sacramento writes, "It may appear that some old civil engineers just do not know when to quit. In May I spent the month in the Philippines inspecting the old fortifications on Corregidor, checking out the new light rail systems in Manila, and of course, riding an old steam engine at a sugar mill. Next year my plans are to tour the trolley systems in a number of cities in Russia, then take a steam train to north of the arctic circle. It has been 50 years since I received my master's degree [with a concentration in] transportation engineering, and I have been a lifetime rail fan."

1940s

RINO BEI *(B.S.'46 CE)* is retired and living in Sonoma. He and his wife Beverly have seven children and 18 grandchildren. Rino is currently on kidney dialysis.

ROBERT BREWER *(B.S.'49 CE)*, living in Oakland with his wife Nancy, just celebrated his 83rd birthday.

JOHN CLEGG *(B.S.'49 CE)* was in active duty in Guam from 1952-54. He worked for Santa Barbara County, the City of Oakland, Bechtel, and L.G. Brian of Redwood City before going into private practice as a land planner and surveyor in Palo Alto in 1961. He moved south to San Diego when he retired in 1981.

ROBERT COIT *(B.S.'42 ME)* of Houston took four years of ROTC and was inducted into the Army on May 26, 1941.

ROBERT CROMMELIN *(B.S.'49, M.S.'55 CE)* of Rancho Mirage, California, is pleased to have been elected an honorary member of the Institute of Transportation Engineers, the 71st such member in the last 70 years. **grumpy1928@aol.com**

JOHN DURYEA *(B.S.'44 EE)* of Chambersburg, Pennsylvania, is student pilot and towrope specialist for the Mid-Atlantic Soaring Association in Fairfield, Pennsylvania and Frederick, Maryland.

CHARLES FAULDERS *(B.S.'48 ME)* of Camarillo, California, retired in 1990 from North American, Inc. (later absorbed by Rockwell International), after 36 years with the company. He attended his 50th year Cal reunion for the class of 1948.

They called him "Mr. Honeycomb"

Andy Marshall (BS'43 ME) still gets excited about honeycomb sandwich, a type of composite construction he helped popularize after World War II that made the building of large weight-critical aircraft more practical and paved the way for a revolution in the aviation industry.

"Now sandwich is everywhere," he says, noting that a low-tech version is used in public bathroom stall partitions. "But in the early years, all the customers were involved in aircraft."

Sandwich construction consists of two thin facings rigidly attached to any light and inexpensive core. The first honeycomb core, Chinese paper decorations dating back 2,000 years, was probably inspired by the hexagonally shaped nest chambers wasps have been building for more than 25 million years.

A pilot from the age of 14, Marshall was drawn to honeycomb through his flying. Following service in the U.S. Navy during the war, he worked from 1950 to 1978 for Hexcel Corporation. Started from a basement laboratory by his college roommates, Roger Steele *(BS'43 ME)* and Roscoe Hughes *(BS'43 ME)*, Hexcel today does $1 billion in business worldwide and remains the industry leader. Marshall was Hexcel's western regional manager, with a region so large—everything west of the Mississippi—that he had to buy his own plane to effectively do the job.

"Nominally I was a salesman," Marshall says, "but actually I was an engineering missionary, teaching people who were already good engineers why honeycomb was a logical answer to the problems faced in designing airframes. You really couldn't sell this stuff unless you taught people how to apply it where it made sense."

He did so much to facilitate the use of honeycomb sandwich that he was known at Hexcel as "Sandwich Engineer" and industry-wide as "Mr. Honeycomb." He refined manufacturing processes, championed potential applications, and solved problems like identifying effective adhesives that could resist damage from moisture and bacteria. First used in radomes (radar equipment housing domes) and wings, then in airframe parts, honeycomb was eventually incorporated throughout entire planes.

"Major loads are confined to a small part of the structure," Marshall explains, "so all those square feet aft of the spar [the main frame for a plane's wings] that don't do much are candidates for honeycomb."

Marshall was a member of the Engineering Alumni Society for many years and served as its president in 1971–72. He left Hexcel in 1978 to form his own consulting firm, serving major airframe manufacturers including Boeing, Bell, Lockheed, Douglas, and Martin.

He recently wrote an entertaining history of honeycomb for SAMPE, the Society for the Advancement of Material and Process Engineering. The "tribute" book, which includes a brief biography of Marshall, is available at **www.sampe.org/publicat.html**.

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BELOW: *Andrew "Mr. Honeycomb" Marshall (center), worked on the Voyager craft that flew around the world in nine days in December 1986, piloted by Dick Rutan (left) and Jeana Yeager (right). He marvels that aviation has evolved so briskly in 100 short years. "It's been an amazing industry," he says.*

PHOTO COURTESY OF ANDREW MARSHALL

alumni update

IVAN GENNIS *(B.S.'49 CE)* is semi-retired in Sacramento and serves as engineering consultant to several local engineering firms. **ivan.gennis@nolte.com**

WILLIAM GIANELLI *(B.S.'41 CE)* of Pebble Beach retired in 1984 as assistant secretary of the Army and in 1989 as chairman of the Panama Canal Commission. He recently completed 12 years on the Board of the Pebble Beach Community Services District and eight years on the Board of the Monterey Regional Waste Management District. He now volunteers at the Monterey Bay Aquarium.

JOHN GOERL *(B.S.'48 IE)* is still active as a self-employed consultant in construction and property development and management.

CARROLL HENWOOD *(B.S.'40, M.S.'50 ME)* of Davis has been retired as a rancher since 1972. He and his wife Mariana have two sons who are UCD graduates in engineering, one with a master's, the other a Ph.D.

PAUL HERNANDEZ *(B.S.'43 ME)* of San Francisco writes, "My last fun job was working on the rebuilding of a World War I De Havilland-4 biplane with the Crissy Field Aviation Museum Association."

FRANK KREITH *(B.S.'45 ME)* of Boulder recently completed the second edition of his *Handbook of Mechanical Engineering*, which will be published soon by CRC Press. **fkreith@aol.com**

DOUGLAS MARTIN *(B.S.'48 CE)* is retired from the City and County of San Francisco Department of Public Works as senior civil engineer and division engineer for the Recreation and Park Engineering Division.

ALLISON MAYFIELD *(B.S.'46 CE, M.S.'54 ME)* of Irvine retired from Caltrans in 1981. He spent the summer with a friend in British Columbia and did a tour of historical sites in England, including his World War II air base site in Norfolk County.

ROBERT PERKINS *(B.S.'40 EE)* of Arcadia, California, is retired and taking it easy.

MORRIS RUBESIN *(B.S.'45, M.S.'47 ME)* of Menlo Park is enjoying retirement.

ROGER SHERMAN *(B.S.'44 ME)* has been a forensic engineer for the last 30 years and has written a book about some of his cases. Entitled *Point of Impact*, the book is published by Lawyers and Judges in Phoenix.

ROBERT WEYAND *(B.S.'41 Metallurgy)* of Prescott, Arizona, has been a consultant for a number of years on aircraft and cold storage facilities. **boblenore@earthlink.net**

1930s

JAMES BARKLEY JR. *(B.S.'36 EE)* retired from Chevron in 1976 and is enjoying life with his wife Elma at Rossmoor in Walnut Creek.

JOSEPH HARKNESS *(B.S.'35 EE)* has a home metal workshop and is prayer chain coordinator for Faith Presbyterian Church in Sun City, Arizona.

GEORGE NOLLER *(B.S.'36 EE)* of Rohnert Park retired in 1978 following 15 years with the General Services Administration and continues his public service efforts through donations to science projects and student researchers at El Dorado High School in Placerville.

in memoriam...

LYNN BEEDLE *(B.S.'41, M.S.'49, Ph.D.'52 CE)* died last October at the age of 85. A distinguished professor of civil engineering at Lehigh University, Beedle was a leading authority on and a passionate advocate for skyscrapers and more hospitable cities. He was long-time director of the Council on Tall Buildings and Urban Habitat, which he founded at Lehigh in 1969. As director of Lehigh's Fritz Laboratory and author of two widely used books on steel design, he introduced modern design concepts to the construction of steel buildings in the 1950s. Beedle was elected to the National Academy of Engineers and received the Distinguished Engineering Alumnus Award in 2000.

GEORGE CONSTANTIAN *(B.S.'52 EECS)* of Walnut Creek died last August.

WILHELM "BILLY" KLUVER *(M.S.'55, Ph.D.'57 EECS)* died of melanoma at his home in Berkeley Heights, New Jersey, last January at the age of 76. Kluver was a scientist and engineer whose collaborations with artists helped give birth to multimedia art forms in the 1960s. He started his career as a staff scientist at Bell Labs and became drawn to art through his love of film. He founded Experiments in Art and Technology (EAT), which earned him a Chevalier des Arts et des Lettres from France and the Royal Order of Vasa from Sweden and gave him a role in developing iconic works by such artists as Robert Rauschenberg, Andy Warhol, and composer John Cage.

LOUIS PARENTEAU *(M.D.'58 Sanitary Engineering)* died suddenly at his home in Denver last June at the age of 86 years and 10 days. He was still mentally sharp and in fairly good physical health. He is survived by three children.

HARRY "TED" ROWE *(B.S.'31 CE)* died last June at the age of 94. He worked on construction of the SF Bay Bridge and many highways in the Bay Area and served with the U.S. Navy from 1940 to 1970, retiring as captain in the Civil Engineer Corps. Since 1970 he lived in Santa Rosa and did volunteer work with the Boy Scouts.

ROBERT THOMAS *(B.S.'34 EECS)* of Belen, New Mexico, died last July after a five-year struggle with Alzheimer's, Parkinson's, prostate cancer, and a stroke in 2003. He was 91 years old.

CHARLES WOJSLAW *(B.S.'66 EE)* of East San Jose died last December of cancer. His initial diagnosis was made in December 2002, at which time he retired from Catalyst Semiconductor. He went on to receive his M.S. from Santa Clara University in 1969 but his Cal degree was his most cherished, and he remained a loyal Bears fan at many football and basketball games in the 1970s and 80s. He is survived by his wife Toni, son Chris, daughter Nicole, and sister Florence.

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STAY CONNECTED

NICK LAMMERS PHOTO

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