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Gifted Teacher builds on the basics

By Rebecca Rothenberg

Yaser Abu-Mostafa, PhD '83, professor of electrical engineering and computer science, is a fundamentally reserved man who comes alive when teaching. (Here, his attentive audience is grad student Malik Magdon-Ismail.) He's won every major teaching award at Caltech.

Let's say you've never seen snow in your life, you don't like the cold, and you're scared of heights—and one day someone drops you into three feet of powder at the top of a steep slope, straps skis to your feet, and gives you a nudge. You teeter, you flail in terror for a few yards—and then find to your delighted surprise that you can do it! You have the balance, reflexes, and nerve of a first-class skier. Who knew? When you arrive exhilarated at the bottom of the slope, the ski instructor



Excellence Award in 1986, '89, and '91; the Keck Foundation Teaching Award in '94, and the Caltech Graduate Student Council Teaching Award 1979 from Cairo University and his MS in electrical engineering from Georgia Tech in 1981. But it was at Caltech that he addressed an audience for the first time: in 1983 he presented a talk related to his doctoral research. Although he was "a

nervous wreck," the talk, he says, "went quite well." (Quite well indeed, evidently, since he was awarded the Clauser Doctoral Prize for that year's most origisays. "For me, understanding is black and white. When I see a new subject I am at a loss . . . I am at a loss . . . I am at a loss . . . and then I understand it very, very well indeed. There is very little in between for me." By the time he has prepared for a class, he says, his mastery of the material is so thorough that each lecture is a little story, a "focused performance with a clear goal," as former student Jack Lutz, PhD '87, describes it. The narrative is essentially memorized, since consulting notes disrupts his concentration and the flow of his story. (Because of this he prefers one-hour classes to longer sessions, an hour representing about the limit of what he can commit to memory.)

Lutz also calls Abu-Mostafa a dynamic and "very motivating speaker," both in class and in outside speeches. "Afterwards," Lutz says, "people are ready to sign on the dotted line." And Amir Atiya, PhD '91, who describes Abu-Mostafa as "a great teacher," also recalls his former adviser's ability to motivate and encourage his students. Since Abu-Mostafa studies and teaches how computers learn, and is himself an outstanding teacher, is there a connection? Have his research and his teaching experiences influenced each other? There's an uncharacteristic pause as he considers the question. "I'm thinking about it in real time," he says apologetically, then continues fluently. "There is a connection: a general principle that in machine learning and in science in general, the simplest theory is the most plausible theory. If I can find a theory that explains what happens and someone else has a simpler theory that also explains, he wins. So

rushes up and congratulates you on your performance.

This is the kind of story Yaser Abu-Mostafa, PhD '83, professor of electrical engineering and computer science and director of Caltech's Learning Systems Group, might use to describe his success as a teacher. Abu-Mostafa, whose areas of expertise are information theory, computational complexity, neural nets, and, appropriately, learning theory, has won nearly every teaching award at Caltech, a record that culminated in the third annual Feynman Teaching Prize in 1996. (The Feynman Prize, established by an endowment from Caltech Associates Ione and Robert E. Paradise, is awarded to a Caltech professor for "exceptional ability, creativity, and innovation in both laboratory and classroom instruction.") Prior to that he received the ASCIT Teaching in 1995.

Clearly the man was born to teach; according to one student's evaluation, he has "the God-given ability to teach better than anyone I've ever known in my life." And yet this talent came as a "complete surprise" says Abu-Mostafa from behind the desk of his spacious pastel office in the brand-new Moore Laboratory. It was all the more unexpected since, like our hypothetical acrophobic skier, he might be assumed to have one strike against him as a teacher: he is quite shy. He's nervous about meeting new people, he notes, and "really verynervous" when he meets many new people all at once-say, 100 bright, restless Caltech students staring up at him expectantly from the lecture hall.

Abu-Mostafa received his B.Sc. in

nal doctoral thesis at Caltech.)

That same year he joined the Caltech faculty; ready or not, he was a teacher, about to be nudged down that steep slope. At this point his father, an aeronautical engineer and a fan of von Kármán's work—hence Yaser's original interest in attending Caltech gave him "a very interesting piece of advice," one he would recommend to all aspiring teachers. "Just be yourself," his father told him. "If it works out, then it's great and effortless. If it doesn't work out, then you need to do something else. But at least explore the possibility that everything will go well."

And "being himself" has meant, for Abu-Mostafa, capitalizing on his own habits of mind. "I always like to understand things from first principles," he

## CAMPUS UPDATE



David Ho has made time for Caltech on commencement day '97, June 13.

## Time's Man of the Year to be Caltech's man on the podium

Caltech graduate David Ho '74, named the Man of the Year in January by *Time* magazine for his groundbreaking research on AIDS, will give the address at Caltech's 103rd commencement exercises on June 13—a ceremony that will also mark the hundredth anniversary of the Caltech Alumni Association.

A virologist and an MD, Ho, working with his research team, decided early on that AIDS was probably an infectious disease. In the mid-1980s, his pioneering work in virology revealed how the body fights AIDS in the earliest stages of infection. According to Time, Ho's "pioneering experiments vith protease inhibitors helped clarify how the virus ultimately overwhelms the immune system." These discoveries fundamentally changed the way AIDS was treated-moving treatment from later stages to the first few weeks of infection. At an international AIDS conference last July, Ho reported on his method of administering a "cocktail" of protease-inhibitors to patients who were in the earliest stages of infection. The HIV levels in his patients' blood had dropped so low that the virus could no longer be measured. It was for this research that Time honored Ho, saying, "In the shared achievement of the thousands of scientists and physicians who have helped



A feisty Michael Dukakis led an energetic discussion on public policy issues ranging from universal health care to reform of Social Security to expansion of NATO during a visit to campus in March. After the talk, the former Massachusetts governor and 1988 Democratic presidential candidate adjourned with a large group of interested students and other campus community members to the Athenaeum's Rathskellar, where the dialogue continued.

#### bring AIDS this year to what seems to be a historic turning point, one name stands out.

"Dr. David Ho was one of a small group of researchers who recognized from the start that AIDS was probably an infectious disease. He performed or collaborated on much of the basic virology work that showed HIV does not lie dormant, as most scientists thought, but multiplies in vast numbers right from the start. His insights helped shift the focus of AIDS treatment from the late stages of illness to the first weeks of infection. And it was his team's pioneering work . . . that first raised hope that the virus might someday be eliminated.

"For helping lift a death sentence for a few years at least, and perhaps longer—on tens of thousands of AIDS sufferers, and for pioneering the treatment that might, just might, lead to a cure, David Da-i Ho, MD, is *Time*'s Man of the Year for 1996."

Born in Taiwan, the 44-year-old Ho immigrated to America with his family at the age of 12 and took up residence in central Los Angeles. Ho knew virtually no English when he arrived in the United States, but by the time of high school graduation was so well-integrated into the American education system that he was admitted to Caltech, where he originally intended to major in physics. He later attended Harvard Medical School after redirecting his academic interests toward molecular biology.

After earning his Harvard MD, Ho moved to Los Angeles to serve as chief medical resident at Cedars Sinai Hospital in Los Angeles. It was there that he first saw patients who had mysterious flulike symptoms, later identified as early signs of AIDS. In 1982 he went to Massachusetts General Hospital in Boston in order to conduct research on AIDS. Ho was the fourth person to isolate the AIDS virus, and became an expert in detecting HIV in body tissues. He was the first to show that it grows in long-lived immune cells called macrophages. While serving as a junior faculty member at UCLA, Ho was tapped, at the youthful age of 37, for his current position as director of the Aaron Diamond AIDS Research Center (an affiliate of Rockefeller University), endowed by philanthropist Irene Diamond.

## Caltech researchers to participate in NSFsponsored computational coalition

Caltech will play a key role in the newly formed National Partnership for Advanced Computational Infrastructure (NPACI). Made up of a coalition of 37 research laboratories and universities, led by the University of California, San Diego, NPACI will consist of geographically separated, high-performance computers, data servers, archival storage units, and visualization systems that will be linked together by highspeed networks. Their aggregate power may then be applied to research problems that could not previously be handled by solitary computers.

Caltech's Paul Messina, assistant vice president for scientific computing and director of Caltech's Center for Advanced Computing Research (CACR), has been named the chief architect for the project. He will oversee the overall architecture of the project, including communications among the partners, deployment of hardware and software systems, identifying key technologies and applications, and determining user needs. NPACI will receive approximately \$170 million over five years from the National Science Foundation.

NPACI scientists and engineers will develop algorithms, libraries, system software, and tools in order to create a national state-of-the art metacomputing infrastructure—one that will provide both teraflops (one trillion computations per second) and petabyte (one billion megabytes) capability. A teraflops/petabyte-scale metacomputing environment would provide enough computing power to enable quantitative and qualitative advances in research being done in astronomy, biochemistry, biology, chemistry, engineering, fluid dynamics, materials science, neuroscience, social science, and behavioral science.

modes of computing," says Messina. "I look forward to the synergistic coupling of so many excellent scientists dedicated to creating an infrastructure that will profoundly impact future scientific endeavor."

In addition to Messina's participation, Caltech will contribute to NPACI as a partner in software development and as a provider of national access to some of the hardware needed to develop the software. Hardware already in place at the Institute includes the high-performance computing capabilities between Caltech and JPL, and the machines at CACR. According to Messina, many aspects of the new NPACI technology will be built upon several successful projects initiated and led by CACR, including the CASA Gigabit Testbed and the Scalable I/O Initiative. In the next two years, Caltech will acquire, with support from NSF and NASA, several new parallel computers to support NPACI, beginning with a 128 processor Hewlett-Packard Exemplar system currently being installed and including the very first model of Hewlett-Packard's Convex SPP 3000, which will be installed in 1999.

Four Caltech professors have already lined up research projects to use NPACI. One is the Digital Sky Survey project to be conducted by Professor of Physics Tom Prince, which will combine a large-area digital sky survey conducted in the optical, infrared, and radio wavelengths with the supercomputing power of NPACI. Other projects will be led by William Goddard, PhD '65, the Charles and Mary Ferkel Professor of Chemistry and Applied Physics; James Bower, associate professor of biology; and Aron Kuppermann, professor of chemical physics. Their projects will focus on materials science, brain and neuron modeling, and molecular science, respectively.

"NPACI provides unprecedented computational capabilities that will enable scientific breakthroughs and new

## Two faculty and one trustee are named to National Academy of Engineering

Two Caltech faculty members and one trustee have recently been honored with one of the highest professional distinctions accorded to an engineerelection to the National Academy of Engineering. They are Mark Davis, the Warren and Katharine Schlinger Professor of Chemical Engineering; Caltech Trustee Kent Kresa, chairman, president, and chief executive officer of Northrop Grumman Corporation; and Hans Hornung, the C. L. "Kelly" Johnson Professor of Aeronautics and director of the Graduate Aeronautical Laboratories, who was elected a foreign member. Their election on February 14 means that Caltech now has 29 faculty and 14 trustee members in the NAE.

Membership in the NAE honors "those who have made important contributions to engineering theory and practice, including significant contributions to the literature of engineering theory and practice, and those who have demonstrated unusual accomplishment in the pioneering of new and developing fields of technology."

Davis, who joined Caltech's faculty in 1991 after 10 years on the faculty of

Virginia Polytechnic Institute and State University, was honored for "pioneering work in the synthesis of new catalytic materials." A graduate of the University of Kentucky (PhD '81), Davis works in the field of hetero-

geneous catalysis, where he has developed catalytic materials that can selectively convert one substance into another for use in the petrochemical or pharmaceutical industries.

Davis received a Presidential Young

search is on the measurement of the flow in transitional and turbulent boundary layers over shapes such as aircraft, at hypersonic speeds, for which he uses Caltech's T5 shock tunnel. Hornung joined the Caltech faculty in 1987 after seven years as director of the Institute for Experimental Fluid Mechanics in Göttingen, Germany. Born in Israel, Hornung earned his PhD in 1965 from Imperial College, University of London. He is a scientific member of the board for DLR in Germany, a foreign member of the Royal Swedish Academy of Engineering Sciences, and winner of the ICAS-von Kármán Award for International Cooperation in Aeronautics.

Kent Kresa, who joined Caltech's Board of Trustees in 1994, was saluted for his "contributions to aeronautical technology." Chairman of the board, president, and chief executive officer of the aircraft manufacturer Northrop Grumman Corporation, Kresa oversees the design, system integration, and manufacture of bomber, fighter, and surveillance aircraft. Northrop also designs commercial and military aero-



In February, Stephen Hawking (right), who visits the Institute every winter, paid off the kind of bet you don't make every day. The renowned astrophysicist threw in the towel to Caltech colleagues (from left) John Preskill and Kip Thorne '62, PhD '65, conceding that a "naked singularity"—an infinitely dense concentration of light or matter unshielded by a black hole—is possible. As stipulated by the terms of the 1991 wager, Hawking also threw in £100 and "clothing to cover the winner's nakedness... embroidered with a suitable concessionary message" coverage that took the form of T-shirts adorned with a coyly draped blond and the words, "Nature abhors a naked singularity." Seeking to recover from his 0-2 record (this is the second bet he's lost to Thorne), Hawking then affixed his thumbprint to a third betting accord, this one dealing with the conditions under which a naked singularity might exist.

vice president and manager of the company's research and technology center and held various positions in the



Caltech's new NAE electees are, from left, Mark Davis, Hans Hornung, and Kent Kresa.

company until being appointed president in 1987, and CEO and chairman in 1990. Kresa is a fellow of the American Institute of Aeronautics and Astronautics. He serves on the boards of the Aerospace Industries Association, Chrysler Corporation, and ARCO, and the CEO Board of Advisers of USC's School of

## Honors and awards

Associate Professor of Chemistry *Erick Carreira* is one of 60 young researchers named by President Clinton to receive the first annual Presidential Early Career Award for Scientists and Engineers.

Associate Professor of History William Deverell has been elected to the board of the California Council for the Humanities. The Council both administers a competitive grants program and conducts projects of its own, including several planned for the California Sesquicentennial, beginning in 1998.

Professor of Geophysics Donald Helmberger has been selected by the American Geophysical Union to receive the 1997 Inge Lehmann Medal, which is awarded for outstanding contributions to the understanding of the structure, composition, and dynamics of the earth's mantle and core.





structures, precision weapons, electronic countermeasures, and information systems.

Kresa received the degree of Engineer from MIT in 1966. While there, he worked in the areas of ballistic mis-

Investigator Award in 1985, and the Allan P. Colburn Award of the American Institute of Chemical Engineers in 1989. In 1990 he was the first engineer to win the NSF's Alan T. Waterman Award.

Honored as a foreign associate of the NAE, Hans Hornung was cited for "contributions to hypersonics and aerodynamics." Hornung's most recent re sile defense research and reentry technology. In 1975, he joined Northrop as

A new compact disc entitled "Darryl **Denning—Classic Guitar Artistry" by Caltech's guitar instructor and music** program coordinator can now be purchased through the Caltech Bookstore (818/395-6161). The wide variety of works featured on the CD include pieces by Spanish master composers Torroba, Mudarra, and Tarrega; and pieces by South Americans Villa Lobos and Yupanqui. The classics are represented by compositions from Bach, Satie, and four Italian Renaissance composers, one of whom was Galileo's father. Denning has been teaching guitar classes at Caltech since 1974, and has had a noted career in performance and recording in the United States and overseas.

#### Business Administration.



Chair of the Caltech Board of Trustees and cofounder of the Intel Corporation *Gordon Moore*, PhD '54, has received the Chairman's Award from San Jose's Tech Museum of Innovation, a science and technology museum whose mission is to engage a wide range of people in exploring current technologies, and to inspire young people to develop the technology of the future. The Chairman's Award recognizes extraordinary dedication to the museum's education

## CAMPUS UPDATE

## Hollywood meets applied physics

Graduate student Chris Springfield and current and former JPL employees have been doing some hot work for Hollywood. In fact, it's so hot it would probably explode right off their computer screens if it weren't in digital form and jealously protected by Universal Studios.

As part of a company called Digital Domain in Venice, California, the Caltech techno-wizards have created special effects for *Dante's Peak*—the recent thriller in which the fate of a small Pacific Northwest town depends on the unpredictable volcano towering above it. The one scientist who predicts disaster is ignored—but at what cost?

Well, it is rumored to have cost \$20.3 million for the fire, lava, and ash created by Digital Domain, according to an anonymous source on the Internet. The tab includes work by Springfield, a PhD candidate in applied physics at Caltech; JPL employee David Santiago; and former JPLers Kelly Cowles, Geoff Harvey, Candida Nunez, and Mike O'Neal. For instance, Springfield created the effect of lava approaching and surrounding Roughy, the dog. The digital effects have been incorporated with footage from live filming in Wallace, Idaho, and on soundstages in Los Angeles.

Encouraging people to catch his and his colleagues names in the credits, Santiago quotes Gene Siskel's review of *Dante's Peak* for the *Chicago Tribune*:

"When the volcano gets hot, so does the movie. The special effects of hot running lava, a snowstorm of volcanic ash and the resulting devastation are quite impressive. Unfortunately, there are also human beings in this story.... Maybe the special effects guys should have taken a shot at the screenplay." Dante's Peak stars Pierce Brosnan and Linda Hamilton. Before they even knew whether the film would flare or flame out at the box office (and it has done well), the Digital Domain technowizards had turned their attention to a futuristic adventure story called The Fifth Element and another disaster flick called Titanic.



## Caltech geologists find new evidence that Martian meteorite could have harbored life

As the controversy over the now-notorious Martian meteorite ALH84001 continues to heat up, two Caltech scientists and a colleague at McGill University have found strong evidence to support the view that the rock itself never became so hot as to eliminate the possibility of life. The findings by the Caltech scientists—Professor of Geobiology Joseph Kirschvnk '75, MS '75 and his graduate student Altair Maine—and their McGill colleague Hojatollah Vali, also suggest that Mars had a substantial magnetic field early in its history.

Finally, the new results suggest that any life on the rock existing when it was ejected from Mars could have survived the trip to Earth.

In an article that appeared in the March 13 issue of the journal *Science*, the researchers report that their findings have effectively resolved a controversy about the meteorite that has raged since NASA researchers first presented evidence for Martian life in 1996. Since that time, scientists critical of the NASA findings have suggested that the carbonate globules containing the possible Martian fossils had formed at temperatures far too hot for life to survive. All objects found on the meteorite, then, would have to be inorganic.

However, based on magnetic evidence, Kirschvink and his colleagues say that the rock has certainly not been weakly magnetized rock will reorient its magnetism to be aligned with the local field direction after it has been heated to high temperatures and cooled. If two such rock fragments are attached so that their magnetic directions are separate, but are then heated to a certain critical temperature, they will have a uniform direction.

The igneous rock (called pyroxenite) that makes up the bulk of the meteorite contains small inclusions of magnetic iron sulfide minerals that will entirely realign their field directions at about 350°C, and will partially align the field directions at much lower temperatures. Thus, the researchers have concluded that the rock has never been heated substantially since it last cooled some four billion years ago.

"We should have been able to detect even a brief heating event over 100 degrees Celsius," Kirschvink says. "And we didn't."

These results also imply that Mars must have had a magnetic field similar in strength to that of the present Earth when the rock last cooled. This is very important for the evolution of life, as In March, family and friends of the late Ed Posner gathered in 155 Moore Lab to dedicate the new Edward C. **Posner Communications Lab, named** in honor of the Caltech electrical engineering professor and longtime JPL scientist who was killed in June 1993 while riding his bike to work at JPL. "Such pleasant memories of Ed are left," said friend and colleague Robert McEliece '64, PhD '67, in remarks at the dedication, "which make it a pleasure to dedicate this lab to Ed today." As part of the ceremony, Posner's wife, Sylvia, an accomplished artist who has painted a number of Caltech scientists, presented to the lab a portrait she had painted of her late husband. From left, Posner's daughter-in-law Barbara, son Steve, Sylvia Posner, and McEliece.

the magnetic field will protect the early atmosphere of a planet from being sputtered away into space by the solar wind. Mars has since lost its strong magnetic field, and its atmosphere is nearly gone.

The fracture surfaces on the meteorite formed after it cooled, during an impact event on Mars that crushed the interior portion. The carbonate globules that contain putative evidence for life formed later on these fracture surfaces, and thus were never exposed to high temperatures, even during their ejection from the Martian surface nearly 15 million years ago, presumably from another large asteroid or comet impact.

A further conclusion one can reach from Kirschvink's work is that the inside of the meteorite never reached high temperatures when it entered Earth's atmosphere. This means, in effect, that any remaining life on the Martian meteorite could have survived the trip from Mars to Earth (which can take as little as a year, according to some dynamic studies), and could have ridden the meteorite down through the atmosphere by residing in the interior cracks of the rock and been deposited safely on Earth.

"An implication of our study is that you could get life from Mars to Earth periodically," Kirschvink says. "In fact, every major impact could do it."



hotter than 350 degrees Celsius in the past four billion years—and probably has not been above the boiling point of water. At these temperatures, bacterial organisms could conceivably survive.

"Our research doesn't directly address the presence of life," says Kirschvink. "But if our results had gone the other way, the high-temperature scenario would have been supported."

Kirschvink's team began their research on the meteorite by sawing a tiny sample in two and then determining the direction of the magnetic field held by each. The team's results showed that the sample in which the carbonate material was found had two magnetic directions—one on each side of the fractures.

The distinct magnetic directions are critical to the findings, because any

Caltech Trustee Gail Wilson brought her husband, California Governor Pete Wilson, to Caltech in March to take a tour of the Seismo Lab. President Everhart, left (partly hidden) and Tom Heaton, PhD '78, professor of engineering seismology (right), look on as Seismo Lab director Hiroo Kanamori, the Smits Professor of Geophysics, explains to the Wilsons what's shakin' in Southern California.

## FRIENDS



He's well known for his encouragement of young scientists and has received a few honors himself, so the Los Angeles Chapter of the ARCS (Achievement Rewards for College Scientists) Foundation looked no further than Caltech biologist and Nobel laureate Ed Lewis, PhD '42, when the time came to line up a guest speaker for the ARCS 1997 Scholar Recognition Luncheon in January. For this academic year, the ARCS Los Angeles Founder Chapter and Los Angeles ARCS Auxiliary has extended \$760,000 in scholarship support to outstanding undergraduate and graduate students throughout Southern California. Among the many students joining Lewis at the January event were Caltech's newest ARCS Scholars. From left, front row: Robert Lin, Shane Ross, Tessa Miller, Ed Lewis, Samantha Gizerian, Seth Blumberg, Adam Petrie. Back row: Kevin Crellin, David Haroldson, Aaron Higgins, Richard Gilmore, and Lee Ramsey.

## Caltech joins with public agencies and private companies to create TriNet

On the morning of March 18, Los Angeles residents, reporters, and camera crews responding to a 5.1-magnitude earthquake got their first taste of the potential impact of a new Caltech/ U.S. Geological Survey (USGS) earthquake monitoring system.

The impact was not only new but almost instantaneous. Within 15 minutes of the earthquake, Institute seismologists had already printed out a full-color poster-sized map of the region to show on live TV, and had already posted the contour map on the Internet. Moreover, they were able to determine the magnitude of the event within five minutes—a tremendous improvement over the time it once tion (DOC), the project is designed to provide real-time earthquake monitoring and, ultimately, to lead to earlywarning technology to save lives and mitigate urban damage after earthquakes occur.

TriNet was announced earlier this year when funding was approved by the Federal Emergency Management Agency. The new system relies heavily on recent advances in computer communications technology and data processing.

The map the seismologists printed out on March 18 (the ShakeMap) is just a preview of future TriNet products, many of which will be distributed through the Internet and other electronic communication channels. Among them will be a database needed for improvement of building codes, a feature that is seen as a central benefit of the TriNet Project.

## Mellon Foundation awards Institute grant to establish minority scholar program

Caltech has received a \$350,000 grant from the Andrew W. Mellon Foundation to increase the number of minority students in the Institute's doctoral programs.

The grant will enable Caltech to participate in the Mellon Minority Undergraduate Fellowship Program, which will be funded for the next six years. With foundation support, Caltech will recruit and mentor exemplary undergraduate students who wish to pursue doctorates in certain science fields that have traditionally attracted very few underrepresented minorities.

Caltech will select five fellows per year over the next four years, with sufficient funding to assure year-round faculty mentoring and research activity. Recipients will also receive a summer research stipend and enough financial support to attend professional conferences in their respective fields. In addition, Mellon Fellows who graduate and pursue a PhD in Mellon-designated fields are eligible to receive up to \$10,000 toward their undergraduate indebtedness.

According to Caltech President Tom Everhart, the grant is an important component of Caltech's goal to diversify its student body. The Institute is already providing special presidential scholarships to exceptionally talented minority applicants, and the administrative support for minority affairs has been increased with the recent creation of an associate deanship.

The faculty coordinator for the Mellon Minority Undergraduate Fellowship Program will be Associate Professor of History Douglas Flamming. A specialist in African-American history and labor history, Flamming is working on a book on the role of African Americans in the making of Los Angeles. The administrative coordinator will be Cheryll Hawthorne, Caltech's associate dean and director for Minority Student Affairs at Caltech. Her expertise in academic support programs and instructional methods contributes eight and one-half years of student affairs experience and 13 years of science education experience to the Mellon program.

Caltech joins a growing list of outstanding American undergraduate institutions that participate in the Mellon Minority Undergraduate Fellowship Program. Other participants include Cornell, Harvard, Princeton, Stanford, and the University of Chicago.

Photo Top: At the Associates board meeting this past January, new president Milton Mohr (third from left), welcomed new board members. From left: Duane McRuer '45. MS '48, Marguerite Hennacy, Mohr, **Margaret Rich**ards, Fred Richards, William Hurt, and Carel Otte PhD '54. **Below**, Mohr (now second rom left) ioin the new officers of the 1997 executive committee (left to right): Roland "Bud" Smoot '50, vice president; Janet Rogers, secretary; and **Robert Roney** PhD '50, treasurer. Not pictured: Ilene Marshall, vice president; and ex officio members Carl Larson. Warren Schlinger, and George Smith, all past presidents of the Institute support group.



took to confirm data.

"Today, we had a much better picture of how the ground responded to the earthquake than we've ever had in the past," said Dr. Lucile Jones, a USGS seismologist who is stationed at Caltech. "This was the largest earthquake we've had since September of 1995, and was the first time we've been able to use the new instruments that we're still installing."

The new instruments are made possible by the TriNet Project, a \$20.75million initiative for providing a stateof-the-art monitoring network for Southern California. A scientific collaboration between Caltech, the USGS, and the Division of Mines and Geology of the state Department of ConservaThe TriNet Project is also seen as the first step toward a prototype earthquake early-warning system for South ern California. Ground-motion information will be rapidly recorded and communicated almost instantaneously through electronic communication channels. Thus, Los Angeles could eventually receive warning of a major earthquake at the San Andreas fault some 30 to 60 seconds before the heavy shaking actually began in the city.

Of the funding for TriNet, FEMA will provide \$12.75 million, and the

## Road Trip!

Finding faults with the Caltech Associates



Deep in the heart of earthquake country, another sort of rumbling was going on. It was dinner time.

Forty-two Caltech Associates had begun the November day early in order to scout the greater Palm Springs area for evidence of earthquake faults. They were on a travel-study trip that had originated in Pasadena the previous morning. Two days of sleuthing with Caltech Professor of Geology Kerry Sieh had concluded, and tomorrow they would head home by way of an art museum, without their science expert. By this time, the travelers had reason to be seeking food and rest, but their minds were elsewhere.

"Kerry didn't go home yet, did he?" someone asked plaintively. Sieh was actually in the vicinity but had tiptoed in behind the bulk of the dinner crowd, admitting that he had used the cocktail hour as a chance to rest. Now he was hoping to continue in that vein by shifting out of the spotlight and listening to the last evening of dinner conversation from the sidelines.

No such luck. His fellow diners, insatiable in their appetite for knowledge, had no sooner grilled him on the



For some people, it's not enough just to live in earthquake country.

do they stop?" "Is directivity in a large earthquake like the Doppler effect?"

This was not your ordinary tour group. The questions were coming fast and furiously from Caltech alumni, retired JPL directors, CEOs, and the like—all members of the President's Circle of the Associates. Among peers who shared their interests and experience, many seemed eager to step out of the spotlight (as Sieh had tried to do) and be students for a change. "You're not writing about us, are you?" they asked, when they saw a writer along for the trip. "The science is more interesting."

Of course, gaining a deeper understanding of the earth wasn't the *only* motivation to attend. "I like Palm Springs," said Lew Allen, director of JPL from 1982 to 1991 and now a senior faculty associate on campus. Barbara Allen indicated a different reason for taking the trip, simply pointing toward her husband.

Many participants seemed up for adventure of any kind. Having already

boarding the buses, and packing as much fault finding into a two-day period as possible. On this trip, science was the roadside attraction.

Sieh gave lectures on the bus and at stops along the way. In between, he was asked about everything from the mineral content of rocks, to the natural vegetation of the area, to the physics of landslides.

As he joked that the Associates never gave him a break, Sieh actually encouraged them by asking questions of his own, quizzing his elders the way he does his students, egging them on. Some problems involved simple math, like calculating the slip rate of the Mojave segment of the San Andreas fault, which the bus passed on its circuitous route to Palm Springs. "If the fault slips 500 meters in 15,000 years, how much is that per year? C'mon Ralph, you can get this," Sieh challenged, lest Ralph should take it easy on the bus ride.

Other questions were harder. Nearing the Wrightwood–Mojave region, the incidental tourists took a short jaunt to view some badly deformed trees that Sieh had discovered in the 1980s. Sieh held up a section of one tree, pointing to variations in the width of its rings—variations that, following exhaustive research, he and his colleagues had found to be related to two environmental calamities in the 19th century.

"How do we know we're not just looking at the effects of severe storms?" the professor asked. After letting the Associates squirm for a few minutes, he elaborated on someone's suggestion that location might be a clue. Indeed, he said, this type of damage was limited to nine trees, all within a few meters of the San Andreas fault. When earthquakes occur, the offsets in the ground can damage trees' roots and send shock waves up their trunks. The trees can then serve as "dendroseismoBy Hillary Bhaskaran

narrow rings that can signify a disruption in healthy growth patterns and thereby identify years of hardship.

Sieh and his colleagues found that the time periods represented by the narrow tree-ring patterns could be correlated with the historical record, pinning down the origin of both major quakes to the Mojave segment of the San Andreas fault. Although they haven't had the benefit of additional tree-ring studies, the scientists have used radiocarbon dating to look back through 1800 years of seismic history and ask how the previous clustering of quakes might foretell future activity in the area.

#### Siehing like a geologist, thinking like a consultant

When Sieh studies the history of earthquakes in a region—especially earthquakes that predate the written record—he depends on clues from trees, land forms, and layers of the earth to piece together the story of what occurred. Having "magic eyes" is a requirement for the job, he told the Associates. Where most people would see a section of a tree, he sees a potential seismometer. Where many would see an undulating landscape, he sees fault zones—great places to visit, but he wouldn't advise building right on them.

That brings Sieh to what may be one of his favorite questions. "How do you deal with the *slight* possibility that a destructive earthquake rupture could occur soon, recognizing that if it did, it would destroy overlying buildings?" After joking with the Associates that "moving" or "buying insurance" were not good enough answers, Sieh described the state's current approach. Current state law does not allow building across faults that are known to be "active," which means that they've moved within the past 11,000 years. "I've heard the law referred to as the 'geologists' full-employment' act," said Sieh, who explains that many geologists in California are in the business of locating active faults so that structures aren't built across them. Sieh had some ideas about how to influence land use effectively with respect to earthquake hazards. He suggested that earthquake insurance rates should reflect the geographic variability of seismic hazards more accurately. Insurance companies are making some effort to discriminate between regions, he says, but the maps they are using are quite crude and not very reliable. For

details of seismology than he was whisked away to another table to answer the questions of seven more sufferers of travel-study syndrome.

Heretofore undiagnosed, this syndrome shows every sign of being prevalent among university types. It manifests itself when the victim can't view something—in this case a landscape without wanting to know the origins, the explanations, the science behind it. This crowd was incurable.

"What triggers earthquakes?" "Why

risked their lives bungee jumping in New Zealand (Tom Tyson '54, PhD '67, president of the Energy and Environmental Research Corporation) or climbing as many mountains as possible (Duane McRuer '45, MS '48, president of Systems Technology Inc.), why shouldn't they head right to the heart of the San Andreas fault?

Then there were the nonscientific perks of staying at Smoke Tree Ranch, a private Palm Springs resort with enough recreational and gastronomic delights to fill a geologic epoch. And there was the luxury of having many of the hassles of travel handled by Nancy York, executive director of the Associates. But this trip was also about breakfasting at 7:30 a.m., quickly meters"-nature's record keepers.

How were Sieh and his colleagues able to discover and make use of the subtle records in this case? They had first used carbon-14 dating on peat beds in nearby Pallett Creek to establish rough time estimates of earthquakes along the Mojave segment of the San Andreas fault, which seemed to occur an average of once every 130 years. Also, historical records showed that major earthquakes had occurred in the area in 1857 and in an unspecified part of Southern California in 1812. To confirm whether one or both of these earthquakes had occurred along this segment of the fault, they took core samples from 65 trees near Wrightwood, and they looked for the



On the fence again, Sieh's explanations of how this fence was damaged in the Landers quake gives onlookers fodder to ask more questions of their fearless, and almost tireless, leader.

example, now that the Northridge earthquake has occurred, relieving stresses along that fault, should insurance in the San Fernando Valley cost less than it does in Lake Arrowhead? The latter community is where Sieh lives and where, he admitted, his rates are disproportionately low considering the risk of future earthquakes.

As the Associates enthusiastically toured fault zones, they viewed examples of both poor development, where local risks have been ignored, and thoughtful development. The first bathroom break was at Wrightwood—"a good example of bad planning," said Sieh. He wasn't talking about the fact that the break was a bit behind schedule and that the facilities were, um, rustic. He was talking about the town, exposed not only to the hazards of earthquake shaking and fault rupture, but also to landslides and floods. Earthquakes occur in the area an average of once every 105 years. Since the last one was 140 years ago, "it doesn't take a rocket scientist to realize the probabilities are high" for the next one, said Sieh. "We've scheduled one for 10 this morning."

Sieh showed how good planning can be as simple as mapping out shopping and parking areas. In the San Bernardino area, the bus passed a department store that had been built over a known fault zone just before stricter laws were enacted. Had the planners been more safety-conscious, Sieh said, the location of the store and the storefront parking could easily have been swapped. In contrast, the Desert Factory Stores sit right along Interstate 10 near Palm Springs, with parking lots tucked in behind. Here, the parking area is over the fault zone; it's the stores and the people inside who are on firmer ground. There was no slippage of concentration among the Associates as Sieh walked them through a junior college built astride a fault zone and showed them the fences bent by several meters of slippage on the Landers fault in 1992. At San Bernardino Valley College, the professor and his colleagues, including graduate students, had recently dug trenches at various sites to identify and learn about the fault zones there. Oftentimes the zones crossed right through campus buildings, such as the Student Union (where Sieh directed the Associates for the next rest stop) and the president's office. Mapping the zones was the basis for Sieh and his associates to make recommendations for the college's long-term



Professor Baldeschwieler (right) finds himself on an unfamiliar side of the board as Sieh explains the geologic structure below a junior college.

master plan, suggesting which buildings should eventually come down and where new buildings could be safely built. Many in the group were surprised that it would be acceptable, under current law, to build within 50 feet of a fault zone. trip that he and his wife, Marlene Konnar, took to northern Arizona, Baldeschwieler found the participants to be similarly "impressive" and the questions "fun—without being overwhelmingly intellectual. It was lively."

Trips such as these are one of the primary perks of their association with Caltech, say members of the President's Circle, who are looking forward to future excursions. Some will bring family members along on the Associates' All-Caltech Trip to the Galapagos Islands in June.

What motivates Sieh to lead what are at times exhausting trips? "They're fun," he says. "My milieu is geology and earthquakes. I'm like a fish in water."

Sieh's adroitness didn't go unnoticed. Says Konnar, "From a science writer's point of view, I think he does a terrific job handling a wide range of questions." She adds that her enjoyment of the trip was enhanced by the Associates' Nancy York, who has a knack for "subtly placing people in different parts of the bus and at dinners, so you come away feeling like everyone on the trip is your friend."

Hunt Holladay '56, currently an investment manager whose career has centered around the oil industry, likes to join the Associates on geology trips in particular. "After all," he says, "when you're born and raised in California, you can hardly ignore its geology."

On such trips, "you have a unique opportunity to have Caltech professors give you insights you wouldn't otherwise get," says William Pickering '32, PhD '36, professor of electrical engineering, emeritus, and director of JPL from 1954 to 1976. The Associates' avid curiosity "shows how fascinated they are or become with wherever the trip is going," says Pickering, and geology is a ready, tangible source of fascination. "A geologist can always say, 'Look at that rock over there,'" attracting a swarm of intrigued Associates in the process. So as he headed to New Zealand in February to help lead a second President's Circle trip to his native country, Pickering was doubly prepared. His coleader would be Clarence Allen, PhD '54, an emeritus professor of both geophysics and—you guessed it-geology.

## ASSOCIATES' EVENTS

All events will be held at the Athenaeum unless otherwise noted. Individual invitations for each event will be sent monthly.

April 14, President's Circle Dinner, with John Ledyard, professor of economics and social sciences, and chair, Division of the Humanities and Social Sciences; and Richard Spehalski, Cassini Program Manager, JPL: "The Cassini Mission to Saturn: The Caltech Connection and the Upcoming Launch."

April 23–24, All Associates Trip to Hawaii, with Maarten Schmidt, the Francis L. Moseley Professor of Astronomy, Emeritus. Visits to the W.M. Keck Observatory and the Caltech Submillimeter Observatory on Mauna Kea.

May 4, Regional Associates Event in West Los Angeles, at the home of Mrs. Charles Kennedy, Malibu.

May 5, *President's Circle Dinner*, with John Roberts, Institute Professor of Chemistry, Emeritus: "Is The Universe Really Expanding?"

May 17, Caltech Alumni Association's 60th Annual Seminar Day.

May 28, Associates, Children, and Grandchildren's Tour of the Jet Propulsion Laboratory. Includes dinner and program.

June 7, President's Circle Garden Party at the home of President and Mrs. Everhart.

June 16, Associates Dinner, with Harry Gray, the Arnold O. Beckman Professor of Chemistry, and director of the Beckman Institute: "Fighting Viruses With Cobalt Drugs."

June 18–27, A Caltech Family Adventure to the Galapagos Islands, with Henry Lester, professor of biology; Wallace Sargent, the Ira S. Bowen Professor of Astronomy; and Edward Stolper, the William O. Leonhard Professor of Geology, and chair, Division of Geological and Planetary

Reflecting on eye-opening experiences

"I hadn't understood how geologists locate faults," says John Baldeschwieler, an Associate and a Caltech professor of chemistry, after he and his travel-study companions returned to somewhat more stable ground in Pasadena. "It was a wonderfully informative tutorial to literally walk the ground and go where the faults are." Comparing this to a past Associates' Note: Since returning from this trip, Nancy York has retired from her position as executive director of the Associates but continues to run its travel program. Diane Binney is the new executive director. Sciences.

July 16, Associates Board of Directors Meeting.

August 14–18, President's Circle Extended Weekend Trip to Northern Cascade Mountains and Puget Sound, Washington, with Clarence Allen, professor of geology and geophysics, emeritus.

October 6, President's Circle Trip to the Cassini Launch, Cape Canaveral, Florida.

October 22–November 5, President's Circle Trip to Spain and Morocco, with Robert Rosenstone, professor of history.



A year ago, Mike Ross, PhD '77, looked to be cruising toward success. He was at the technical helm of a biotechnology company that he had steered through a public offering, a merger, and its first clinical test of a potentially lucrative asthma drug. This company showed all the signs of being on the brink of good fortune. And yet Ross was not happy.

Halfway through an interview last year to discuss his accomplishments at Arris Pharmaceutical-the San Francisco-based firm that he built over six years from little more than a corporate logo into a promising contender in the biotech business-Ross revealed that he was quitting the company. His reason: he likes being an entrepreneur so much that he was willing to walk away from a thriving operation like Arris to start a new venture all over again, even though he had no specific business in mind. It didn't take Ross long to find a new challenge. Only three months after leaving Arris, he became president and chief executive officer of MetaXen, a collaboration with Xenova Group PLC, a biopharmaceutical firm based in Slough, England. MetaXen's (and Ross's) mission is to speed up the pace of drug development, in part by using sophisticated software to design drug candidates by simultaneously optimizing multiple characteristics.

With only a handful of employees, MetaXen, based in Palo Alto, is a long way from putting a product on store shelves, but Ross is much happier than he was when he was at Arris, with its scores of employees and its place in the eyes of investors as a public company. "In two years, there could be 75 people working here, depending upon our success. But MetaXen is not likely to become a fully independent public company, and I'll focus on the big picture of the science done at MetaXen," Ross says.

Favoring polo shirts and sneakers,

Photo left: Scientist and CEO Mike Ross, PhD '77, here assumes both roles as he leads a discussion with MetaXen Company researchers on the development of small-molecule therapies for the treatment of blood clots. Photo right: Ajay Jain (left), principal scientist at MetaXen, and Julian Golec, director of medicinal chemistry at Xenova, which is collaborating with MetaXen in the development of these treatments, study a computer-generated image of such a molecule, which works by inhibiting a protein known to be implicated in clot-formation.

family friend, advised Ross not to attend the Institute. Says Ross, "George wrote me the strongest letter you can imagine, advising me not to go to Caltech or to any chemistry graduate school." Hammond insisted that a career in pure chemistry had its limitations and said that an MD/PhD degree would be more practical, given Ross's interests, since one could always get a job in a hospital or medical school with that degree.

"I don't take advice like that well," says Ross. He was impressed by the Caltech graduate students and faculty whom he had met when he visited the campus, and he liked what he saw as "a nurturing environment for doing things yourself. It was also a riskier thing to do" than entering an MD/PhD program. And if there's one thing that motivates Ross, it's high-risk endeavors that have the potential for a big payoff.

So he went to Caltech to do research in mechanistic organic chemistry, only to discover that those professors who had been conducting the specific research he wanted to do were exploring other fields. Eventually, he decided to work with Bob Stroud, a young professor who was using X-rays and electrons to decipher the structure of complex biological molecules. "I was fascinated by his enthusiasm, loved the challenge of the new field, and signed up," Ross says. For his thesis project, Ross used X-ray diffraction and electron microscopy to characterize the 3-D protein structure of an acetylcholine receptorpart of one of the most important neurotransmitter pathways in the brain and peripheral nervous system. A very large integral membrane protein, the receptor has not yielded its structural secrets at atomic resolution over the 20 years since Ross left Caltech. Ross says that he very much enjoyed his experience at Caltech. Among other advantages, as a small school, it gave him a window onto several different disciplines, a useful background for a biotech entrepreneur, and offered many formal and informal opportunities to interact with Caltech's faculty and students. In 1976, after completing his dissertation, Ross went to Harvard to do postdoctoral research in molecular biology, studying the mechanisms of gene regulation in viruses that infect bacteria. "I thought I wanted to go into academia," says Ross, but two years

Ross certainly has the more collegiate look of a scientist than the buttondown appearance of an executive. At 47, Ross has a voice that sounds a lot like that of actor Richard Dreyfuss, and he also possesses a bit of the latter's self-deprecating humor. Describing himself as a generalist trained in molecular biology, biochemistry, biophysics, and chemistry, he quips, "I would be dangerous in the lab in any one of those disciplines at this point in time." His wife, Jennifer, is a former economist who now runs an equestrian stable in San Gregorio, where Ross occasionally can be found mending a fence or fixing the plumbing. They met at

cians and those in large companies." Although Ross says that he's only now getting comfortable taking risks, he's been rejecting safety nets for a long time. Ross majored in chemistry at Dartmouth, which made sense since he was always interested in chemistry, a legacy of his high school science teachers in suburban Philadelphia, and his father, Robert, a former chemist with Rohm & Haas-a research-focused chemical manufacturer. By his senior year, he had also become interested in medical research, so he applied to and was accepted into three MD/ PhD programs. But he turned them down when he was also accepted into the chemistry graduate program at Caltech. Even so, George Hammond, then the chairman of Caltech's Division of Chemistry and Chemical Engineering, and a

rection when you're cruising smoothly

for success in business or science, Ross

says that he has the soul of an entrepre-

neur, and is only happy when he's creat-

a builder. I haven't had a history of per-

sonally finishing what I start, which is

sad. But I have historically hired excel-

lent people to finish it. As an entrepre-

unusual. But getting that across has been

difficult. It's hard to explain to academi-

neurial industrial scientist, I'm not

"I'm not a maintainer," says Ross. "I'm

ing rather than caretaking.

along doesn't seem like the typical recipe

into his Harvard postdoc, he received a call from Herb Boyer, a UC San Francisco biologist who was the chief scientific officer for a start-up company that had plans to manufacture human insulin. He asked Ross to join the venture, called Genentech.

"The company consisted of only three people," Ross says. "In 1978, there were no biotechnology companies." The operation seemed highly speculative, so Ross turned down the offer. Boyer persisted, and invited Ross to San Francisco to give a seminar and spend a few days with his Caltech thesis adviser Stroud, who by then had moved on to UC San Francisco. Ross agreed to come, and learned of Genentech's ambitious plans to manufacture human insulin in bacteria. But even after his visit, he was still not convinced that Genentech was right for him or that it would be a viable venture.

He began to have second thoughts, however, when he returned to Cambridge and was met at his lab door by a Harvard professor and future Nobel laureate, Walter Gilbert, who was involved in a competing project to clone and produce human insulin. Gilbert, says Ross, had never before given him the time of day, but he had evidently found out about Ross's trip to San Francisco and now welcomed him back like a long-lost friend. "He pumped me for hours, trying to find out what Genentech was doing," Ross says. Gilbert urged him not to go to Genentech, and once again Ross found himself inspired by negative advice. "I realized at that very second that the guys at Genentech must be pretty damn good, if Wally Gilbert was that worried about them. So I went."

Ross stayed at Genentech for 12 years, holding half a dozen jobs over that time and watching the birth of an industry. He started as a senior scientist, playing an integral role in making the first quantities of human insulin by genetic engineering and helping to develop the method that served as a basis for its commercial production. Until that time, insulin had been extracted from the pancreas glands of slaughtered cattle and pigs, a low-tech process that yielded a product different from human insulin and occasionally led to medical complications. Ross was also involved in the company's successful effort to make the first genetically engineered human growth hormone. This product had previously been extracted from the pituitary glands of human cadavers, an expensive method that was ultimately found to be unsafe.

The Genentech research led to successful marketing of a safe and effective recombinant product marketed in the early 1980s by Genentech and its partner Kabi, since merged into Pharmacia & Upjohn.

As head of Genentech's protein biochemistry de-

partment, Ross and his group helped produce alpha interferon and gamma interferon. These genetically engineered hormones were originally considered to be revolutionary cancer therapies, but though they have failed to live up to that potential, alpha interferon is now administered to treat a wide variety of cancers and hepatitis B. And gamma interferon has proved to be a life-saving treatment for chronic granulomatous disease, a rare genetic disorder in which the body's white blood cells are unable to fight infection.

In 1983, Ross was appointed vice president of development at Genentech, with responsibility for regulatory affairs, quality control, clinical research, and pharmacology. As part of his duties, he helped Genentech develop Actimune, a blood-clot dissolver, now used for the treatment of heart attacks, pulmonary emboli, and stroke.

"I learned at least as much per day at Genentech as I learned as an undergraduate or a graduate student," Ross says. "It was like going to Genentech University," learning how the drug industry works, from discovery to development to marketing. "In order to make biotechnology succeed, we all needed to learn about fields of which we knew nothing. We were fortunate enough to succeed in making genetic engineering a useful tool for creating protein drugs." In 1987, Ross became vice president of Genentech's medicinal and biomolecular chemistry department, and with that oversaw the formation of the company's departments of chemistry, biophysics, and protein engineering. He helped put Genentech in the small-molecule business: making drugs that can be taken orally instead of by injection. Over the 12 years that Ross worked at Genentech, it grew from a start-up



company with a handful of people to a giant in the biotech industry with 1,700 employees. Ross had seen closeup the financial mechanisms that Genentech used to raise money for product development. "It was great training for starting a company and getting involved in new ideas," Ross says. And that's exactly what he decided to do.

"I'm definitely a small-company person, so I came to the conclusion that I'd been at Genentech long enough and that it was time for me to move on and do something else," he says. That something else was Arris.

Ross left Genentech in 1990, and shortly thereafter he started talking to venture capitalists, looking for a young company that he could direct. Ross figured that it would be easier to mold a firm that already had financial backing than to start from scratch. One of the first companies he looked at was Arris, a software company based in Cambridge, Massachusetts, that planned to come up with artificialintelligence solutions to drug-discovery problems. Founded by five professorsfour from MIT and one from Harvard—and five venture capitalists, Arris was looking for a chief executive. Although Ross was intrigued by the notion of using computers to design molecular structures of compounds that might make effective drugs, he didn't like the fact that the company did not have wet labs, and was intending to produce and sell software rather than drugs. Nor was he keen on moving to the East Coast, where Arris was based. After being hired as Arris's president and chief executive officer in September 1990, Ross convinced the founders to move Arris, which consisted of only a handful of employees, to San Francisco, the heart of the biotechnology industry, and to re-create it as a drug-discovery company. Once he took over Arris and got a closer look, he discovered that the company's plan

to use computers to develop drugs was more a dream than a reality. Arris's founders believed that they could dramatically change the drug discovery process by applying modern computer science (artificial intelligence) to chemistry. Doing this would require specialists from several disciplines-molecular biology, combinatorial chemistry, artificial intelligence computation, biochemistry, and synthetic chemistry. "That was a good idea," Ross says. "In fact, the idea of using artificial intelligence to discover drugs was quite visionary." However, Ross wanted Arris to be judged by the drugs it discovered, not its technology.

Having committed himself to Arris, Ross proceeded to redesign the company, and moved it into an abandoned Genentech building. He then started Arris on a program of drug discovery, eventually focusing on two projects: tryptase inhibition and erythropoietin mimetics.

Tryptase is a protease—a naturally occurring human regulatory enzyme secreted by mast cells that had been cloned and extensively studied by two scientists at UC San Francisco. They thought that inhibiting this enzyme would relieve asthma symptoms, since data from clinical studies showed that tryptase appeared in cells involved in asthma and other allergic inflammatory diseases. "We bought into that hypothesis and supported their research for a couple of years," Ross says. "We then turned it into our own research program." In November 1994, Arris signed a deal with Bayer, the German pharmaceutical manufacturer, to develop Arris's tryptase inhibitors, and has since been conducting clinical trials of the drug for asthma treatment.

It was Ross's idea to take the risk of finding a small-molecule, orally active replacement for a multi-billion-dollar drug, erythropoietin, a recombinant protein given by injection. Erythropoietin helps regulate the production of red blood cells and treats anemia caused by chemotherapy. It works by taking two cell-surface receptors that are normally independent and bringing them together. This signals the cell to grow. Ross's plan was to develop a synthetic molecule that would not only mimic this action, but could also be taken orally. Arris scientists convinced Amgen in 1993 to support this research, and though the status of the project remains confidential, the scientific literature, says Ross, seems to point to the conclusion that this molecular mimicry can be successfully accomplished. By January 1993, Arris had grown to 45 employees, and Ross had raised about \$30 million in venture capital to keep it going. He and his board of directors now felt it was time to go public. "I knew I did not yet have the skills to be president of a public biotech company, since that requires a



Housed in architecture reminiscent of the oldest buildings on campus, the Sherman Fairchild Library contains the newest computer and networking equipment available for electronic information delivery.

## The Sherman Fairchild Library sets a new standard for library science

#### **By Betsy Woodford**

It was 400 years ago that the philosopher Sir Francis Bacon observed, "Knowledge is power." One source of knowledge has always been Caltech's library system, which with the opening of the Sherman Fairchild Library of Engineering and Applied Science on January 2 has now increased its power from kilobytes to gigabytes. "It's the most exciting library that I've ever been involved with," says Anne Buck, university librarian. "The Sherman Fairchild Library gives us the opportunity to dramatically move forward into electronic information delivery and to set a new standard for library services at Caltech." Resources such as the World Wide Web, electronic databases, and CD-ROMs take an equal place alongside books and bound journals in the Sherman Fairchild Library. "The first goal was to exploit the many new technological advances in information delivery," says Professor Bradford Sturtevant, the Hans W. Liepmann Professor of Aeronautics, who chairs the steering committee for the Sherman

Fairchild Library. "However," he adds, "we also wanted to maintain the responsive, expert library services that have always been available in the department libraries and build an aesthetically pleasing and inviting environment."

The campus community had the op-

"The many materials available here will certainly be tasted, and there will be much chewing and digesting, but," concluded Caltech's president, "I have found few Caltech professors or students who swallow things whole."

The library was made possible by a \$9.6 million grant from the Sherman Fairchild Foundation, which seeks out projects that recognize Mr. Fairchild. A pioneer in the fields of photography, aviation, and sound engineering, Sherman Fairchild founded Fairchild Camera & Instrument Corporation and the Fairchild Engine & Airplane Corporation. At Caltech, the foundation has sponsored the Sherman Fairchild Distinguished Scholars Program and the Sherman Fairchild Postdoctoral Scholars in Physics, Mathematics and Astronomy.

"The Institute has been enriched in many ways by the Sherman Fairchild Foundation," said Everhart at the dedication. "It is fitting that we have a physical, permanent memorial to Sherman Fairchild in the form of this pioneering library that we dedicate today."

Gordon Moore, PhD '54, chair of Caltech's Board of Trustees and chairman of Intel Corporation, had his own thanks to add. "I am especially glad to see a building at Caltech named for Sherman Fairchild because he played an important part in my early career," Moore said. "When a group I belonged to was looking for support for a semiconductor company, we approached 35 companies traded on Wall Street that we thought would be interested. We were turned down by all 35 without anyone even talking to us. Then, Caltech Trustee Arthur Rock introduced us to Sherman Fairchild, who supplied the support that I needed to get going in the semiconductor industry.

Moore also thanked Walter Burke, past president and current treasurer of the Sherman Fairchild Foundation and a Caltech senior trustee. "Caltech owes a particular debt of gratitude to Walter because this library is an important addition to the campus, where faculty and students together can examine the literature, work together, and make Caltech a closer-knit community."

Achieving the physical embodiment of this ideal presented some challenges according to Sturtevant, who oversaw the planning and design stages. "We were constrained by the dimensions of



Thomas engineering laboratories," says Sturtevant, "but we wanted a classic library structure, one that is airy, with a central staircase lit by a skylight."

The result, says Buck, is that "the Sherman Fairchild Library is a tremendous asset for the entire Caltech community. It can provide technical services that few if any other college libraries can supply, but it has a human scale and a human warmth."

In the opinion of many first-time library visitors, the most spectacular room of all is the third-floor reading room, which contains an arched ceiling paneled in cherry wood, an alcove with a reading bench, and Arts and Crafts– style library tables and chairs. "Both Buzz [Yudell, the architect] and I attended Yale in the 1950s," says Sturtevant. "There is a reading room

portunity to celebrate the success of those goals and to explore the new resources available for their use at the library's dedication ceremony on January 14. The threat of rain did not dampen the spirits of participants on a day that President Tom Everhart called "a terrific day in the history of Caltech." Said Everhart, "The Sherman Fairchild Library is a very special place that will set the stage and pace for libraries developed in the future."

President Everhart also invoked Bacon in predicting how he thought the library would be used. "Francis Bacon said, 'Some books are to be tasted, others are to be swallowed, and some few to be chewed and digested,'" he said. the site located between Spalding and



Walter Burke, center, former president and now treasurer of the Sherman Fairchild Foundation cuts the ribbon to open the new library as his wife, Connie, and President Everhart look on.

there, the Linonia and Brothers Room,



that we both agreed could serve as the perfect model for the character of the third-floor reading room." Along with this old-school charm comes the element that makes the library special: all of the library tables are wired with fiber optics for full access to the campus computer network system.

"The whole building is networked with high-capacity fiber-optic cable to allow for future expansion," says Kimberly Douglas, newly appointed director of the Sherman Fairchild Library and head of technical information services. "The current connections are 10 times faster than the Ethernet available around campus. There are 23 public workstations that can be used to access on-line library resources, the Internet, and the World Wide Web."

As these numerous on line capabili

programs can all be projected onto the screen, as well as images on paper through use of a document camera. The conference room's equipment is controlled from the podium with a touchscreen computer. The information to be presented can come from a floppy disk, a CD, or the network. The projection screen can be split to display images from different sources, and the images can also be sent to each of the conference room's 14 seats via laptops plugged into the network. Video conferencing will also be available with The Sherman Fairchild Library was built between two existing buildings—Spalding Laboratory and Thomas Laboratory. This view of the corner of Fairchild and Thomas shows the new garden in what used to be a parking lot.

two cameras—one focused on the speaker and one on the audience.

The library's technological capabilities include a document workroom that has a VCR viewing station at which videotapes can be created and edited in either American or European format, and a high-tech computer workstation for creating advanced graphics and desktop publishing. "Eventually," says Sturtevant, "we want to electronically publish various technical reports from Caltech professors via the World Wide Web. In the future, it may be possible to form a consortium with other universities and professional societies so that faculty members can electronically retrieve archived publications and submit papers for peer review to an on-line referral system."

Information stored in the Sherman Fairchild Library's 50-gigabyte server will be available from any workstation on campus. "CLAS (Caltech Library Automated System) has become much more user friendly through its conversion from a Telnet-based application to a Web-based one," says Douglas. "The Library's server also supports a CD-ROM jukebox, which makes more than 150 CDs available on-line. We'll also be purchasing access to a new on-line bibliographic system, 'Cited References,' which not only gives author names, article titles, and abstracts, but also the list of references used in the paper. It is a very powerful tool, because it allows the user to follow the trail of citations used to develop a paper."

In concert with the library's quest to explore electronic media is the Campus Computing Organization's Media Integration Laboratory, which has been experimenting with digital media for several years. Now renamed the Digital Media Center, the facility moved to the Sherman Fairchild Library. According to Wayne Waller, who heads the center, the mission is the same, "to be a campuswide resource in the creation of digital media."

"The completion of the Sherman Fairchild Library means the end of an era for engineering's department libraries," says Douglas. "The collections from aeronautics, applied physics, electrical engineering, chemical engineering, computer science, engineering, and environmental engineering were moved to the Sherman Fairchild Library last year." The former libraries will now be overseen by their individual departments, and many will become reading rooms, with comfortable furniture, copies of the latest journals, and often-used references. Each will have a workstation connected by a high-speed fiber network to the Caltech library system.



Numerous computer workstations throughout the library allow patrons to electronically find materials and conduct research.

The librarians who staffed these libraries have received other assignments within Caltech's library system, some at the Sherman Fairchild Library.

"Any library is a special place," says President Everhart, "but the Sherman Fairchild Library, with its capabilities to reach a vast amount of on-line information and an ability that provides for new collaborative experiences for faculty and students, is a very special place indeed."

As these numerous on-line capabilities suggest, the library of the future may rely less and less on paper, and that is one frontier that Buck is trying to explore through the Sherman Fairchild Library. "There are many electronic options out there," she says. "The library gives us a chance to research these options and customize them for the Caltech community. This research allows us to expand services throughout the Caltech library system."

The impact of these new services can be seen in the Library's new multimedia conference room. A 70-inch television screen dominates one wall and will serve as the focal point for a variety of presentations. Video, slides, transparencies, and computer presentation



The spectacular third-floor reading room, with its arched ceiling of cherry-wood slats alternating with skylights, has already become a popular venue for studying.

## Ross

Continued from page 9



lot of selling to your main customers, your stockholders." So Ross stepped down as CEO and became Arris's chief technical officer. Arris went public in the fall of 1993.

In 1995, Arris bought Khepri Pharmaceuticals, a small biotechnology company, allowing Arris to expand the protease-inhibitor side of its business and to grow to more than 150 employees. Depending upon the success of Arris's clinical trials, its first product, most likely an asthma drug, could take as long as three years to hit the market. That may seem like a short time in today's pharmaceutical business, but Ross says he knew that he'd be happier starting something different than waiting for a product to debut. "I had been at Arris for six years," he says. "For me, that was forever. It's more interesting to do something new."

Ross first got the idea of leaving Arris early last year, when he met Xenova's chief executive officer, Louis Nisbet, for drinks at a San Francisco hotel. Nisbet was attending a conference and called Ross, whom he had met years before when Genentech contracted work with Xenova.

"I told Louis I was thinking of leaving Arris later in the year," Ross recalls. "He told me that he was interested in buying a combinatorial chemistry company." Nothing happened for a few months. Then Ross did leave Arris and decided to start a company with two other scientists, Lutz Giebel and Maris Hartmanis. During the summer of '96, Ross says that he took about eight trips to England to meet with Nisbet and hammer out the deal between MetaXen's founders and Xenova, which was announced in September. MetaXen's job will be to take Xenova's leads from its collection of 20,000 pharmacologically active microorganisms and develop them into new drug candidates to be produced by Xenova or large pharmaceutical-company partners. Pharmaceutical companies have traditionally optimized drug candidates by addressing their limitations one by one. MetaXen plans to simultaneously analyze candidate compounds for such factors as potency, oral availability, toxicity, and metabolic

stability, and attempt to redesign their chemical structures to make them worth producing. Other companies are catching on to this method, which in part uses advances in automation to rapidly screen chemical compounds, but Ross also hopes to reduce the typical drug-discovery process by introducing improved biochemical analysis techniques that do a better job of predicting such properties as blood halflife and absorption. Currently, most companies rely exclusively on animal testing to determine these characteristics, a more time-consuming-and sometimes socially controversialprocess. The company's initial focus is on cancer drugs, and Ross hopes it will soon find a partner to begin clinical testing of its first product.

"No pharmaceutical concern has a unique corner on a technology," Ross says. "You've got to be fast and efficient and have to have unique projects." Starting with natural products from Xenova, says Ross, gives MetaXen an edge over those companies relying on leads from what are called chemical libraries-the roster of compounds that the company knows how to make synthetically, but which are not necessarily pharmacologically active. Xenova has the advantage of working with organisms that make compounds that are pharmacologically active. "It is our job to turn these molecules into drugs," Ross says.

MetaXen's Palo Alto location is already its third site in less than six months of operation, and Ross figures that by summer MetaXen will have to move again as the company grows. He expects that the company will be employing 40 people by the end of the year. Beyond that, MetaXen's future is anyone's guess. It can take seven years for a drug to hit the market, and Ross has no idea what MetaXen will look like by then. "We have no guarantee that any single partner will be behind us for an extended period of time, so we will have multiple partners," he says. "Things undoubtedly will evolve, but I predict that MetaXen will be successful as an independent entity, whether as part of Xenova, as an affiliate of another firm, or as an independent company." As for Ross, though he intends to stay with MetaXen for a long time (for him), even he can't predict where he'll be in the future, and that's just fine with him. "My professor friends don't get it," Ross says. "You don't leave a place every six years. My father thought I had flipped out when I left Genentech, and when I left Arris, he thought I was flipping out again. But I'm not atypical of an entrepreneurial scientist. There are a whole breed of us in biotechnology who do this for a living. This is my job. I hire good people to finish what I start. That's the mode of being an entrepreneur. I don't seek out physical risks, I don't like climbing mountains, I don't like hang gliding, I don't like jumping out of airplanes and stuff like that. But I do

like intellectual risk. I like trying really hard things and making them work."

Drug discovery is important to Ross because of the sense of accomplishment it gives him. "Through drug discovery, you can make a really big difference for society. You can save people's lives. You can change the whole way medicine is done if you find the right drug. I've been lucky enough to witness that, and it's a fantastic feeling, because it can give a tremendous meaning to your science."

### TriNet

Continued from page 5

USGS has provided \$4.0 million. The balance is to be matched by Caltech (\$2.5 million) and the DOC (\$1.75 million). Several private-sector partners, including GTE and Pacific Bell, are assisting Caltech with matching funds for the Institute's portion of the TriNet balance.

The TriNet Project is being built upon existing networks and collaborations. Southern California's first digital network began with the group of seismographs known as TERRAscope, and was made possible by a grant from the L.K. Whittier Foundation and the ARCO Foundation. Also, Pacific Bell through its CalREN Program has provided new frame-relay digital communications technology.

A major step in modernization came in response to the Northridge earthquake, when the USGS received \$4 million from funds appropriated by Congress for the National Earthquake Hazard Reduction Program. This money constituted the first step in the TriNet Project, and the USGS has been working with Caltech for the last 27 months to begin design and implementation. Significant progress has already been made, and new instrumentation is now operational. These include 30 state-of-the-art digital seismic stations that are operating with continuous communication to Caltech/USGS; 20 strong-motion sites installed near critical structures; and automated maps of contoured ground shaking that are available on the World Wide Web (http://www-socal.wr.usgs.gov) within a few minutes after felt and damaging earthquakes. . DOC's strong-motion network in Southern California is a key component of the TriNet Project, contributing 400 of the network's 650 sensing stations. DOC's network expansion and upgrade through the funding of this project will allow much better information about strong shaking than was possible for the Northridge earthquake. These data are the key to improving building codes for earthquake-resistant structures.

## Honors and awards

Continued from page 3

mission and to the betterment of Silicon Valley through philanthropy and volunteer involvement. Previous recipients are William Hewlett and David Packard.

Professor of Theoretical Astrophysics Sterl Phinney '80 has been elected a Fellow of the American Physical Society for his contributions to the understanding of black-hole dynamics, active galactic nuclei and quasars, binary and millisecond pulsars, and globular cluster dynamics; and for his method of measuring the intergalactic magnetic field.

Caltech's political science faculty has been ranked sixth (after adjusting for size) in the nation by the journal Political Science and Politics, behind such institutions as Stanford, Harvard, Yale, and the University of Michigan. Since most political science departments number more than 20 members and Caltech only has nine, the Institute's high ranking was especially remarkable. "Up until 1974 we were not even ranked, and now we stand in the top ten," said John Ledyard, chair of Caltech's Division of Humanities and Social Sciences, which includes political science, economics, history, law, and literature. "I think that's quite an achievement."

*Robert Rosenstone*, professor of history, has been selected for the 1997–98 Florence Fulbright Chair at the European University Institute in Florence, Italy.

Krishna Shenoy, postdoctoral scholar in biology, has been awarded the 1995– 96 Doctoral Thesis Prize by the Fannie and John Hertz Foundation for his thesis "Monolithic Optoelectronic VLSI Circuit Design and Fabrication for Optical Interconnects." The award, which includes a cash prize of \$2,500, recognizes particularly outstanding doctoral theses in the applied physical sciences.

*Edward Stolper*, the William E. Leonhard Professor of Geology and chair of the Division of Geological and Planetary Sciences, has been named a Geochemistry Fellow by the European Association for Geochemistry, for his outstanding contributions to geochemistry.

Petr Vogel, senior research associate in physics, mathematics and astronomy, has been elected a Fellow of the American Physical Society for his innovative theoretical work in doublebeta decay and neutrino interactions, including his definitive calculations of reactor neutrino spectra.

## ALUMNI







## Which prank tops them all? Alumni Centennial Dinner will tell the tale.

What's the greatest prank in Caltech's history? For the past several months, alumni have had their say as they sent in their votes for one of the five finalists pictured at left. A grand prize for the winner, a salute to the runners-up, and a trip (no pun intended) down memory lane with protean pranksters of the past will be among the highlights of the Alumni Association's Centennial Dinner Gala, which will take place on the evening of Seminar Day, Saturday, May 17, at the historic Ritz-Carlton Huntington Hotel in Pasadena. All alumni and their families are invited to attend.

Along with the pranks revival and the opportunity to share reminiscences, the latest news, and fine food and drink, alumni will be paying tribute to Caltech's retiring president, Tom Everhart, for his contributions to the Institute and all its graduates. The evening will conclude with a concert by the Caltech Women's Glee Club as it celebrates its 25th anniversary.

The Association looks forward to welcoming alumni on this memorable occasion, and, to make the event more affordable in such an attractive venue, will be subsidizing ticket prices in cooperation with Caltech Institute Relations. To reserve a place at the dinner for yourself and family members, please fill out the registration form that you received in the Seminar Day brochure or contact Patsy Gougeon at 818/395-8366 by no later than May 5, if possible. We hope to see you there.

## It IS a "Wonderful Life"

This past Christmas, many of us sat down with our families and enjoyed an annual visit to Bedford Falls as we watched Frank Capra's *It's a Wonderful Life.* A month later, the presidential inauguration might have prompted some of us to take in a broadcast, or video, of *Mr. Smith Goes to Washington.* 

And who needs a

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It Happened

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Association President Ed Lambert

Watching these classic films is a particular treat for Caltech alumni, because, of course, Frank Capra was an Institute alumnus from the class of 1918. Whenever I see one of Capra's films, I am always struck by the variety of career paths that Caltech alumni have taken and by the extraordinary range of effects Techers have had on our society. To illustrate this point, let's take an imaginary journey like Jimmy Stewart's George Bailey in Wonderful Life and imagine what our world would be like today without the presence of Caltech alumni. A case can be made that it would be profoundly different.

To begin with, the electronic backbone of modern society would not exist in its current form. The developmental path of the integrated circuit is inextricably linked with Caltech alumni. Franklin Jewett, one of the first alumni in 1898, was the founder of Bell Laboratories. All of modern electronics grew from the invention of the transistor at Bell Labs. Coinventor William Shock-

#### By Ed Lambert '82

ley '32 founded Shockley Semiconductor Laboratory to develop silicon transistors. In Silicon Valley argot, Shockley Semiconductor begot Fairchild Semiconductor. One of the cofounders of Fairchild, who left to cofound Intel, was Gordon Moore, PhD '54. Moore's Law has since served as a framework for the development of the electronics industry. Without the integrated circuit, our world's financial markets and businesses would be far less efficient and productive. Hence, all the processing power that drives so many aspects of our society owes a great debt to these and countless other Caltech alumni.

The aerospace industry is similarly indebted to Caltech graduates. Without the satellites developed by TRWcofounded by Si Ramo, PhD '36-and by Caltech alumni at Hughes, Lockheed, and elsewhere, we could not forecast the weather as we do, nor could we benefit from the instantaneous communications we now take for granted. The Jet Propulsion Laboratory has not only excited and inspired us in recent decades with its planetary explorations, but it also served a vital national security role in World War II and afterward. JPL was founded by Caltech alumni, including Bill Pickering '32, PhD '36, and Frank Malina, MS '35, MS '36, PhD '40, and has since been staffed by hundreds of dedicated and talented Caltech alumni.

Many of the inventions that we now take for granted in our lives grew from the creativity and tenacity of Caltech alumni. Without the laser of Charles Townes, PhD '39, we would not have many of the medical instruments that help heal us; the CD and similar devices that entertain and educate us; or many of the scientific devices that help expand our knowledge of the world. Without the invention of xerography by Chester Carlson '30 we would still have blue hands from relying on mimeographs to make our copies. On the other hand, we also wouldn't be clearing paper jams 10 minutes before the start of important meetings.

The contributions listed above only scratch the surface. They cannot begin to do justice to the breadth of influence that Caltech alumni have had on our society and on the world. To convey a fuller sense of the scope and impact of their contributions, the next issue of Caltech News will carry an eight-page "pride piece," profiling 20 representative alumni-two from each decadeand their diverse achievements in arenas ranging from space science to sports, movies to medicine. Even as this special tribute is being prepared, Caltech alumni are out influencing society in ways that we cannot begin to appreciate at this point. But we can begin to develop a deeper appreciation of what that future impact is likely to be as we reflect on the accomplishments and attributes of our fellow graduates, past and present. I hope that you, like me, are looking forward to reading this special tribute and will enjoy the opportunity it provides to celebrate and salute our fellow alumni in this, our centennial year.



## Alumni invited to march at commencement

In honor of the Alumni Association's centennial year celebration, the Institute is inviting all Caltech alumni to join their fellow alum and this year's commencement speaker David Ho '74 (see story, page 2) as marchers in the procession that will open Caltech's 103rd commencement on June 13. A commencement participation form has been included in the Seminar Day packet that has been sent to all alumni. Alumni who wish to march are asked to fill this out and return it to the Alumni Association by no later than May 5, if possible. Please be sure to indicate both your class year and whether you received the BS, MS, and/ or PhD degree. Alumni of the class of 1931 and beyond are asked to wear robes and mortarboards (either their own, or ones they can rent through the Alumni Association, which will have them available at a cost of \$30 apiece).

Alumni may also sign up on Seminar Day on May 17—and please note that because of the time-frame, any rental payment for cap and gown will be required at that time.

What could be more totemic of the Caltech experience than the Institute's own high-five? Taking it from the top: A model-T is reassembled, a Rose Bowl game unexpectedly carded, and the Hollywood sign reworded. A Big Mac contest gets max'd out, and Techers score again at the Rose Bowl. The effective dates: 1940, 1961, 1987, 1975, 1984. Alumni who received any of their degrees—undergraduate or graduate prior to 1931 are not required to wear robes and may be seated with Caltech faculty and trustees on the stage during the commencement exercises.

Commencement day brings with it an array of special events and festivities. All participating alumni are invited to join students and parents in these activities, which will include a Ditch Day stack tour, a video presentation of Caltech's now-renowned annual mechanical engineering competition, presentations by SURF students, and, of course, the postcommencement reception for Caltech's newest graduates now its newest alumni.

## ALUMNI

## ALUMNI ACTIVITIES

April 19–26, The Last Frontier of Texas: Big Bend National Park Travel/Study Program, led by William Muehlberger '49, PhD '54, professor of geological sciences, University of Texas at Austin.

April 28, Houston Chapter Meeting, with guest speaker Thomas Everhart.

April 29, New Mexico Chapter Meeting, with guest speaker Thomas Everhart.

May 15–17, 60th Annual Alumni Association Seminar Day and Alumni Reunion Weekend. Classes of '27, '32, '37, '42, and '47 on the 15th; classes of '52, '57, '62, '67, '72, '77, '82, '87, and '92 on the 16th; Seminar Day on the 17th.

May 17, Caltech Alumni Centennial Celebration Dinner, Ritz-Carlton Huntington Hotel. (See article, previous page.)

June 13, *Caltech's 103rd Commencement*. Alumni are invited to march in the procession to celebrate the Alumni Association Centennial year. (See article, previous page.)

June 21–July 1, Alaska Travel/Study Program, led by Robert Sharp, the Robert P. Sharp Professor of Geology, Emeritus, and Lee Silver, the W. M. Keck Foundation Professor for Resource Geology, Emeritus.

September 26–October 5, *Rio Grande del Norte—Geology and Culture of the Rio Grande Travel/Study Program*, led by Lee Silver, the W. M. Keck Foundation Professor for Resource Geology, Emeritus.(See article, facing page.)



Left: At the site of the Temple of Abu Simbel in Egypt, Ray Tasker '47, MS '48, and his wife, Edie, marvel at the exquisite interior of the Temple of Nefretari, first wife of Ramses II, as they stand beside one of the six pillars depicting Hathor, the Egyptian goddess of joy and music. The entire temple was dismantled and reconstructed on the summit of a rocky outcrop to save it from being submerged following the construction of the Aswan Dam. More than 40 alumni and family members took part in the 10-day February trip, "Wings Over the Nile," which took travelers to Cairo, Memphis, Thebes, and the Sinai, and on a four-day cruise through the valley of the Nile. Below: The Caltech group pauses for a moment in front of the Sphinx at the site of the Great Pyramid of Giza, the only one of the seven wonders of the ancient world to have survived to the present day. From left are: Elmer Ward '51, Barbara Bair, Bill Bair '44, Barney Flam '47, Evelyn Flam, and Bob Wayman '40.







Louise Kirkbride '75, MS '76, a Young Alumni Trustee and the founder of the pioneering software company Answer Systems, will speak on "The Good, the Bad, and the Ugly: A Sight-Seeing Tour of the World Wide Web," when she addresses Caltech alumni on May **17 as the General Session Speaker for** the Association's 60th Annual Seminar Day. The day's activities will also include talks by Caltech and JPL researchers, and graduate and undergraduate students; lunch in Dabney Garden; tours of the new Fairchild Library and many other campus venues: and a variety of exhibits and displays. Rounding out this year's event will be the Centennial Celebration **Dinner in honor of the Association's** 100th anniversary.

## Association makes board nominations

This past February, the Alumni Association Board of Directors accepted the proposals of the nominating committees for new board officers and board members. The term of office for directors and officers will begin at the close of the annual meeting in June 1997.

Nominations for officers are: president, Tom Tyson '54, PhD '67; vice president, Warren Goda '86; treasurer, Kent Frewing '61; and secretary, Blair Folsom, PhD '74. Association President for 1996–97 Ed Lambert '82 will become official past president for 1997–98 when the new terms begin this summer.

The following were nominated to serve on the board: Debra Dison-Hall '74, Hubert Dubb '56, Julia Kornfield, '83, MS '85, Joseph Rhodes '69, Dave Ritchie '80, and Harrison "Jack" Schmitt '57. Bruce Abell '62, president of the New Mexico Chapter, was named chapter representative. Section 5.01 of the Association bylaws provides that members of the Alumni Association may make additional nominations for directors or officers by petition, signed by at least 50 members in good standing, providing the petition is received by the secretary no later than April 15. In accordance with section 5.02 of the bylaws, if no additional nominations are received by April 15, the secretary casts a unanimous vote of all regular members of the Association for the election of the candidates nominated by the board. Otherwise a letter ballot is required.

### For the record

In the photo of the officers of the new Caltech alumni chapter in Hong Kong, which appeared on page 10 in the last issue of *Caltech News*, Professor Allen Chwang of Hong Kong University was incorrectly identified as Professor C.K. Poon. John Ledyard, professor of economics and social science, and chair of the Institute's Division of the Humanities and Social Sciences, spoke on the topic of "What's New in Business Economics and Management at Caltech," in December to members of Caltech's Tri-State Chapter (above). Those in attendance included a large group of alumni involved in finance and investment in the New York City area. Left to right (standing): Kaytaro Sugahara '61; Jan Dash '63; Peter Laventhol Ex '78; Stefan Feuerabendt '85; Phil Neches '73, PhD '83 (now a Young Alumni Trustee); Gino Thomas '89; Gordon Murphy '48; Miral Kim-E '78; Roger Goodspeed '72; and Ken Winston '73, MS '74. Front row (seated): Jerry Nunnally, Caltech's vice president for Institute Relations; Victor Wouk, PhD '42; and Ledyard.

## Join Alumni Association for grande tour

The Alumni Association invites you to participate this fall in *Rio Grande del Norte: Geology and Culture of the Rio Grande*, a travel/study program that follows the geology of the upper Rio Grande as it courses through Colorado and northern New Mexico. Led by Lee Silver, PhD '55, the W.M. Keck Foundation Professor for Resource Geology, Emeritus, the trip is scheduled for September 26–October 5, 1997.

Starting in New Mexico, Dr. Silver and the participants will explore the beautiful high country (7,000-12,000 foot elevations), valleys, volcanoes, and other major structures that define the Rio Grande rift, and will follow the river to its source. The program will begin and end in Santa Fe, with stops in Española, Chama, Creede, and Taos, and opportunities to visit Native American pueblos and Hispanic villages and churches, as well as some of artist Georgia O'Keeffe's favorite countryside. The spectacular Cumbres and Toltec Scenic Narrow-gauge Railway line from Chama, New Mexico, to Antonito, Colorado, will be explored for a day

Early fall is a time of major waterfowl migration along the Rio Grande flyway, and we will travel through two major wildlife refuges, where we hope to catch glimpses of flocks of sandhill cranes and their rare traveling companions, whooping cranes. Professor Silver has selected some of his favorite dining spots for evenings in Santa Fe and Taos. Accommodations will range from rustic to deluxe and will be characteristic of the locales. The pleasant September weather and beautiful fall colors for which New Mexico and Colorado are known should make this trip particularly enjoyable.



The highflying Cumbres and Toltec Railway will be a highlight of the Association's September trip to Colorado and New Mexico.

The price per person of \$1800 double occupancy and \$2350 single occupancy includes all accommodations, transportation, and meals while with the group. The cost of transportation to and from Santa Fe is not included.

To take advantage of this special opportunity to explore the rich and varied geology, history, and topography along the Rio Grande, complete and return the form below. Detailed information will be sent to you upon receipt of your reservation with deposit. Space is limited to 40 participants, and priority will be given to Alumni Association members who register by June 1, 1997. If you have questions, please call Arlana Bostrom at 818/395-8363.

#### Caltech Alumni Association Travel/Study Program Rio Grande del Norte: Geology and Culture of the Rio Grande September 26–October 5, 1997

I/we wish to participate in the *Rio Grande del Norte: Geology and Culture of the Rio Grande* Travel/Study program in New Mexico and Colorado for 1997. Enclosed is my deposit of \_\_\_\_\_\_(\$200.00 per person), representing \_\_\_\_\_ participants.

## Gifted teacher

#### Continued from page 1

what I teach in the course is that if you have two models, you pick the smaller."

And, by extension, in his teaching he tries to find "the simplest way that actually captures the material." Sometimes what not to include is more important than what to include, he says, "because too much material distracts people. If you say ten things, the audience will give one-tenth of their attention to each thing you said, and if five of them don't matter, then you've wasted half of their concentration." People listen to you, he adds, when they know that what they are listening to matters. "In the first couple of lectures you say only things that are important . . . and the chemistry of the class changes. People listen to you."

Former student Ruth Sivilotti, PhD '91, agrees that one of the hallmarks of a lecture by Abu-Mostafa is its lack of clutter, its "clarity and brevity. Yaser



"The one unbreakable appointment." That's how Abu-Mostafa describes the teaching experience. Another appointment he kept was for the dinner honoring his 1996 Feynman Teaching Award. Here Associate Ione Paradise (who, with husband Robert Paradise established the prize at Caltech) seems as rapt as one of Abu-Mostafa's EE 156 students.

always tries to make things as clear as possible," she says. "He doesn't try to get in everything there is. You walk away from his class thinking, 'Wow! I learned something!' With some instructors who pack in everything, you feel trampled on." To maintain this clarity and focus, both for himself and his class, Abu-Mostafa employs a trick he learned from one of his own teachers at Caltech, the late Herb Ryser, professor of mathematics. Before class begins, he writes on the board the highlights of the previous class, and begins his lecture with a short review. Sivilotti remembers these "roadmaps," as she calls them, saying they "gave students something to think about" while they were waiting for class to start, and former student Lutz, now a professor of computer science at Iowa State, comments

that he's incorporated this technique into his own teaching. "I always try to begin each class with a clear summary," he says.

So Abu-Mostafa's thorough, orderly thought processes, along with a proclivity to approach subjects from a basic, almost childlike level-to ask the question, "Why are we studying this and not something else?", for example-all serve him well as a teacher. So does his voice, which can race along at breathtaking speed without sacrificing clarity of enunciation. But so, oddly enough, does his one apparent liability, his shyness. Like other performers, he's found that stage-fright raises the emotional stakes. "This is why I make the effort to perfect my teaching," he says, "because I know that if I do it badly I'll feel terrible." So that while teaching is on average extremely rewarding for him, "the fluctuations," he observes, "can be too much for me." He wishes he could average his performance, he says, and "leave every class with a small smile instead of euphoria or misery."

It's particularly stressful to teach a new class, such as Learning Systems, which he taught for the first time this semester. (He has also taught Introduction to Linear Systems, and Information and Complexity; and Information Theory and Pattern Recognition jointly with other people.) And yet the new courses are the most exciting; by the time he has taught something several times he is relatively at ease, but bored. For someone of Abu-Mostafa's temperament, teaching may always be something of a "love-hate" relationship.

What is the greatest honor he has received as a teacher? The Keck Award? The Feynman Prize? The glowing student evaluations? Actually, says Abu-Mostafa, it's an experience he had while he was teaching an undergraduate course early in his Caltech career. And undergraduates-"Let's put it this way," he says delicately, "they don't often go to class." He covered the course material in the first nine weeks, and then told them, "This is the last homework, everything has already been covered." What he was going to do during the tenth week was to cover an altogether different subject-stochastic processes-because he felt that everyone needed to understand the funda mentals of that field, and that he could bring a fresh approach to teaching it. But it would not be on the final exam. The result? "The last week was a full house," he says, and smiles. "Very complimentary."

	Class year:		

\_\_Please reserve a single room (subject to availability).

Please make check payable to the Caltech Alumni Association and return by June 1 to: Rio Grande del Norte, Caltech Alumni Association, Mail Code 1-97, Pasadena, CA 91125

## PERSONALS

#### 1938

STAN WOLFBERG, of Capitola, California, writes that, as a result of an item in the Caltech News (Vol. 30, No. 2) Personals, he made a trip to Fort Lauderdale, Florida, to meet ROBERT OSBORNE COX '40, chairman of the Lauderdale Marina, the world's largest Boston Whaler dealer for the past five years. "As a member of the United States Coast Guard Auxiliary for the past 25 years," Wolfberg says, "I have examined hundreds of Boston Whalers to check out their safety equipment." So, during a visit to Key West and Hallandale, which are only a few miles from Fort Lauderdale, he invited himself to a mini alumni reunion with Cox, hoping to "learn a great deal more about Boston Whalers to enhance my examination skills." A miscommunication led to Wolfberg missing Cox at his office, but he "managed to track him down at the Fort Lauderdale Marina, where he was lunching and exchanging sea stories with his nautical buddies." They did get together, Wolfberg received a free lunch—"no longer can you use the expression 'there's no such thing as a free lunch"-and he and Cox caught up on one another's careers. "Had a good time," Wolfberg writes, "but still have to rely on my own experiences as far as Boston Whalers are concerned."

#### 1940

REYNOLDS "TEX" BROWN writes, "My wife, Floy, and I continue to live in our home in Horseshoe Bay, Texas, where we retired in 1979 after 40 years in the producing and exploration portion of the oil industry, with our last assignment in Nigeria. Life is pleasant here, but we miss the excitement of an exploration and producing area. From 1859 to the 1960s, a unique culture existed in the oil fields, with a close camaraderie that followed from generation to generation. Everyone looked forward to the next discovery or 'boom' because it offered the opportunity to leave one's troubles (and sometimes debts) behind, to make new friends, and to find new opportunities in a different area. My boom was in Sundown, Texas, in 1941 and '42, before going into the Navy. Twenty years later, I met an old (only 62) friend who hit me up for a job in Prudhoe Bay in Alaska. 'Man,' I asked, 'why do you want to go way up there?' 'I just want to make one more boom,' he replied. I know how he felt!"

#### 1947

ROBERT B. HARRIS, MS, professor emeritus of civil engineering at the University of Michigan, has received the 1996 Richard R. Torrens Award in recognition of 16 years of outstanding achievement as editor of the Journal of Construction Engineering and Management. He is a past recipient of the ASCE Peurifoy Construction Research Award, the ASCE Construction Management Award, and the Chi Epsilon Harold T. Larson Award.

## Association seeks class agents for new "Alumni News" feature in Caltech News

Acting on a recommendation made by the Alumni Relations Task Force regarding ways to increase alumni news in *Caltech News*, the Alumni Association is looking for a few good men and women to agree to sign on as initial class agents for their Caltech undergraduate classes.

Class-agent responsibilities would include communicating annually with former classmates and seeking information about their lives and activities; agreeing to have one's name, address, phone, fax, and e-mail numbers printed in *Caltech News* so that unsolicited information on classmates might be submitted; writing a class-notes section based on input from classmates and sending it to the Institute for inclusion in *Caltech News*; and writing a brief summary of one's own life and current activities for the premier class-notes section scheduled to appear this June in the Alumni Association Centennial *Caltech News*.

Although this project is currently concentrating on undergraduate class agents, advanced-degree representatives from the divisions will be sought in the future. This expanded alumni news section will replace the current "Personals" section in the paper; *Caltech News* editors will continue to compile obituaries.

Letters seeking volunteers have been sent to those alumni whose records indicate that they were elected either class secretary or class president during their undergraduate days at the Institute or who were identified in some other way. Among those who have already responded are: Jay Albert Romoli '34, Joe Peterson '37, Paul Winter '44, Don Tillman '45, Tom Tracy '48, Jim Workman '57, Frank Ridolphi '62, Spicer Conant '64, Bill Bradley '70, Peter Beckman '74, Sue Fuhs '80, Eric Korevaar '81, John Beck '87, Won Bang '94, and Tobe Corazzine '95. Our thanks to all of them for their willingness to contribute to this new undertaking.

We will list the addresses of these new class agents and those of any additional agents when the first edition of "Alumni News" is published in the next issue of *Caltech News*. In the meantime, if you have news to share with your fellow alumni and have not been contacted by an agent, or do not yet know the address to write to, please send your update to the Caltech Alumni Association, Caltech 1-97, Pasadena, CA 91125.

If your class is not among those listed above, and you are interested in learning more about getting involved with this project, please respond to Kent Frewing, 455 Noren Street, La Canada-Flintridge, CA 91011-2756, 818/354-6780. Or e-mail him at this address: h.k.frewing@jpl.nasa.gov.

#### 1953

GENE M. JORDAN, of Bradenton, Florida, retired August 31 as president and CEO of FAAC Inc. of Ann Arbor, Michigan. He remains chairman of the board. "We have retired to Florida to enjoy the weather, golf, and the water," he writes. "We also travel extensively most recently to Singapore and Japan. My wife, Neva, also retired at the same time from Aisin Warner Transmission Engineering Co., where she was human resources manager."

#### 1962

C. ROLAND HADEN, MS, vice chancellor and dean of engineering for the Texas A&M University System, has been named to the new Texas Science and Technology Council by Governor George W. Bush. Haden, who also directs the Texas Engineering Experiment Station, returned to Texas A&M in November 1993 from Louisiana State University, where he was vice chancellor for academic affairs and provost. He previously served as dean of engineering at Arizona State University and later as vice president for academic affairs. In 1969, he taught electrical engineering at Texas A&M and was director of the Institute for Solid State Electronics. He received his PhD from the University of Texas at Austin.

industry, and the development of commercial spaceports for domestic and international use. A resident of Huntington Beach, California, Liang received his PhD in aerospace engineering from USC in 1990.

VIRGINIA TRIMBLE, MS, PhD '68, is the new chair-elect of the Astronomy Section of the American Association for the Advancement of Science, and will serve as chair 1998–99. She was elected to the Council of the American Physical Society earlier this year.

#### 1966

JOHN T. COOKSON, JR., PhD, has joined Sverdrup Civil, Inc., as vice president and principal for environmental technology. This follows a 31-year career in environmental consulting, research, and policy development, during which he has served as an adviser to foreign governments, the World Bank, and U.S. federal agencies. He founded JTC Environmental Consultants, Inc., in 1973, serving as president and CEO, and was president of the International Network for Environmental Training from 1991 to 1996. The founder of the University of Maryland's Environmental Health Science and Engineering Program, he served as the program's first director, and he currently serves as an adjunct professor to Johns Hopkins University, teaching bioremediation engineering; he is the author of *Bioremediation Engineering*: Design and Application, which is used by the environmental programs of many universities. He has been selected by Washington University as the recipient of the 1997 Engineering Alumni Achievement Award for outstanding distinction and accomplishment in his career.

JERRY YUDELSON, of Hillsboro, Oregon, and CEO of World Envirotech Services & Technologies, Inc., writes that his company "is aiming to commercialize innovations in vaporphase biofiltration, a new technology to bioremediate hazardous air pollutants." In October, he was the keynote speaker at the second annual national biofiltration conference at USC.

#### 1969

OKITSUGU FURUYA, MS, PhD '72, of Pasadena, California, has been named a Fellow of ASME International (the American Society of Mechanical Engineers). He is president of Syn Tech Ltd. and a member of the Japanese Society of Naval Architecture.

#### 1970

JAMES L. GOULD, a professor in the ecology and evolutionary biology department at Princeton, writes: "The Carnegie Foundation for the Advancement of Teaching named me the 1996 New Jersey Professor of the Year for 'extraordinary dedication to undergraduate teaching.' This is mostly in recognition of a series of innovative uses of computer technology in labs, lectures, and student tutorials." The second edition of one of his seven books, *Sexual Selection*, and the sixth edition of *Biological Science* have been published.

#### 1972

GEORGE P. KREISHMAN, PhD, professor of chemistry at the University of Cincinnati, received an honorary doctorate from the University of Latvia in September and at the same time was appointed a full professor. "I am looking forward to continue teaching in Riga and at the University of Cincinnati in the future."

JEFFREY KARL OCHSNER, Ex, in September was appointed chair of the department of architecture in the University of Washington's College of Architecture and Urban Planning.

#### 1976

TOM GERARD, MS, of Alexandria, Virginia, has been working with a team that recently completed a Programmatic Environmental Impact Statement on the Storage and Disposition of Surplus Fissile Materials. Tom is now working for Universal Systems Inc., in Chantilly, Virginia, as project manager of computer-based training for environmental systems.

#### 1978

ROBERT FRUEHOLZ, PhD, of Torrance, California, and until recently director of the lasers and optical physics department in the Electronics Technology Center, Technology Operations, the Aerospace Corporation, has been appointed the center's principal director. He joined the company in 1978 as a postdoctoral research fellow in its chemistry and physics laboratory and became a member of the technical staff in 1979. He was promoted to section manager in 1984 and subsequently has held management positions of increasing responsibility. The author of more than 45 journal articles related to diverse areas of chemical and atomic physics, he received the company's President's Award for Scientific Achievement in 1983 for contributions to improving the reliability of atomic clocks used on Global Positioning System and Milstar satellites. His primary technical interest is in the physics of atomic frequency standards and precise timekeeping.

#### 1952

EDWIN KURTZ, PhD, of Flagstaff, Arizona, writes, "With 1997 I begin my second 30year period of being on the editorial board of Ranger Rick Nature Magazine, published by the National Wildlife Federation. I have been on the editorial board since the first issue was published in 1967." He is retired from the University of Texas of the Permian Basin, where he is professor emeritus of life sciences.

#### 1965

ALEXANDER C. LIANG, MS, chief engineer, Space Launch Operations, the Aerospace Corporation, has been appointed to the Commercial Space Transportation Advisory Committee by Secretary of Transportation Federico Peña. Formed to address issues associated with the government's role in regulating or certifying the safety of commercial space activities, especially in the area of launch vehicles, the committee will advise the secretary on risk management, government support of the commercial launch

#### 1979

SATWINDAR SINGH SADHAL, PhD, professor and associate chair of mechanical engineering at USC, has been named a fellow of ASME International (the American Society of Mechanical Engineers). He is also a member of the American Institute of Aeronautics and Astronautics and the American Academy of Mechanics and a fellow of Clare Hall College, University of Cambridge, England.

#### 1984

DANIEL D. HANLE, PhD, of Southbury, Connecticut, writes that he has been appointed vice president, engineering and product development, for SORVALL, L.P., "a world leader in centrifuge products for the life science research, blood processing, and bioprocessing markets." This appointment follows 12 years with Du Pont, in research and development, sales, marketing, general management, and international venture management. He will continue to live in Southbury with his wife, Carolyn, and their two children, Donny and Elizabeth.

#### 1986

SCOTT KARLIN writes that he is currently a graduate student in Princeton's computer science department, working toward his PhD. He and his wife, Rosie, reside in Plainsboro, New Jersey, with their three-year-old daughter, Molly.

STEVE RABIN, of San Diego, writes: "Since founding Best Proto two years ago, I have seen great increases in demand for our products and services, and therefore I am looking to hire engineers with strong ASIC and electronics CAD backgrounds."

MICHAEL D. VARNEY, PhD, senior director of chemistry at Agouron Pharmaceuticals, in La Jolla, California, announces the arrival of Dalton Harris "Blaze" Varney, born October 24 and joining three-year-old Jordan Alexandra "Feathers" Varney. Michael Varney's wife, Jennifer Ball, has a new novel, Catalyst, coming out this spring from Faber & Faber, "about chemists in graduate school, and a rock band."

#### 1987

LOUNETTE DYER, MS, PhD '91, is one of 20 "Women of the Valley" listed in the December 30 issue of *Forbes* magazine.

#### 1988

ANDREA DONNELLAN, MS, PhD '92, member of the technical staff at JPL and a visiting associate at Caltech's Seismo Lab, was one of six NASA professionals (and one of two scientists from JPL) to receive the Presidential Early Career Award for Scientists and Engineers. The award, presented at a December 16 ceremony in Washington, D.C., recognizes outstanding young scientists and engineers expected to be leaders in the 21st century. Besides receiving \$500,000 to support their research for the next five years, recipients also will serve as advisers to the president regarding trends and discoveries in their fields. Donnellan specifically was recognized for her work using Global Positioning System satellite technology to study earthquakes and the corresponding movements of the earth's crust.

PETER SERCEL, MS, PhD '92, an assistant professor at the University of Oregon's Materials Science Institute, is one of the recipients of the Presidential Early Career Award for Scientists and Engineers. The award, presented at a December 16 ceremony in Washington, D.C., recognizes outstanding young scientists and engineers expected to be leaders in the 21st century. Besides receiving \$500,000 to support their research for the next five years, recipients also will serve as advisers to the president regarding trends and discoveries in their fields. Sercel is developing techniques for fabricating nanoscale devices such as semiconductor microlasers one-tenth the diameter of a human hair.

awardees, received a \$5,000 stipend and will deliver a lecture next spring about his research. An associate professor in UNC's department of chemistry, he works in the field of bioinorganic chemistry, seeking ways to exploit unique chemical features of unusual elements to reach important goals in either the diagnostic or therapeutic aspects of medicine. He has also received the Alfred P. Sloan Fellowship, the Camille Dreyfus Teacher-Scholar Award, and a National Science Foundation Presidential Young Investigator Award. He has been director of the chemistry depart-ment's undergraduate program since 1995.

#### 1991

MARK LYTTLE, research assistant and PhD candidate in materials science and engineering at the University of Virginia, published in the November 1996 *Metallurgical and Materials Transactions A.* a paper, "Plastic Anisotropy of an Al-Li-Cu-2R Alloy in Unidirectional Deformation," which describes his recent work. He also presented a paper on the same topic at the TMS/ASM annual "Materials Week" conference in Columbus, Ohio, in October 1996.

#### 1992

SHENDA BAKER, PhD, an assistant professor of chemistry at Harvey Mudd College, has recently received two awards from the federal government. One, the Presidential Early Career Award for Scientists and Engineers, was presented at a December 16 ceremony in Washington, D.C., in recognition of outstanding young scientists and engineers expected to be leaders in the 21st century; besides receiving \$500,000 to support her research for the next five years, Baker will also serve as an adviser to the president regarding trends and discoveries in her field. The second, the Department of Energy's Defense Programs Young Scientist and Engineer Award, recognizes the potential of her work to increase understanding of how materials age in existing weapons systems. Using the scattering behavior of neutrons, she examines how solids, liquids, and thin films interact with each other at the points where they make contact.

## OBITUARIES

#### 1926

HERMANN F. SCHOTT, PhD '33, of Santa Barbara, California, on December 2; he was 92. Starting in 1931, he applied himself to cancer research, with the results being published in a series of journal papers. He also wrote and published in the field of symbolic logic, which he studied during the 1940s under Hans Reichenbach and also with Bertrand Russell, who took Schott and a few other advanced students through the entire Principia Mathematica. He freely gave of his m time to others, offering students a place to live and sometimes helping them through college; he and his wife, Vita, sponsored at least two musical careers. He helped to bring three families over from Hitler's Germany. He donated land to the city of Los Angeles for a park and was instrumental in founding, organizing, and operating a cooperative housing project, a co-op grocery store, a community credit union, a day-care center, a riding stable, a swimming pool, and a summer day camp. Predeceased five years ago by Vita, he is survived by three sisters, Alice Richards, Helen Pedotti, and Mary Lou Dangerfield; two sons, David and Max; an honorary son, Dale Brooks; and 10 grandchildren and six great-grandchildren.

#### 1927

ALBERT C. BILICKE, MS, of Riverside, California, on January 3, 1995.

EUGENE H. RIGGS, on September 24; he was 91. A longtime resident of Pasadena, he had for many years worked for the Metropolitan Water District, after retiring from the U.S. Air Force with the rank of colonel. He had participated in a number of Pasadena organizations, including the First United Methodist Church, the University Club, and the Lions Club. Predeceased by his wife, Barbara, he is survived by three stepsons, Larry Stump, Steven Stump, and Malcom Hamilton; a sister, Geraldine Whiting; and two nephews, Tim and Gene Whiting.

RALPH M. WATSON, MS '28, of Syracuse, New York, on August 20; he was 91. A life member of the American Society of Mechanical Engineers, he was associate vice president and director of research for the Worthington Corporation and chairman of the department of mechanical engineering at Syracuse University; he retired in 1969 as associate dean of that school's College of Engineering. He held more than 20 patents in the field of centrifugal pumps and compressors. Predeceased by his first wife, Catherine, and his second wife, Gertrude, he is survived by his wife, Helen; a son, Ralph; a daughter, Ranita; a brother, Wilford; a sister, Ruth Hostrman; and four grandchildren and three great-grandchildren.

#### 1928

MOE W. GEWERTZ, of San Diego, California, on January 28, 1996.

DONALD T. TARR, of Pine Grove, California, on April 27, 1995.

EDWARD E. TUTTLE, of Pasadena, California, on August 15; he was 88. A prominent Los Angeles attorney and a former supervisor in the development of the atomic bomb, he had graduated first in his class from USC's law school and in 1941 had started his own firm, when his practice was interrupted by World War II. He worked until 1946 on several classified projects at Caltech and on the Manhattan Project, and received for his service the Naval Ordnance Development Award and the U.S. Office of Scientific Research and Development Award. He was president for many years of Los Angeles-based Essick Manufacturing, which made cement mixers, and at the time of his death was president of Essick Investment Company. He served as a trustee of Pomona College and on the boards of the Los Angeles World Affairs Council, Orthopaedic Hospital, the Caltech Associates, the Rotary Club of Los Angeles Foundation, and the Merchants and Manufacturers Association. He is survived by Helen, his wife of 60 years; his son, Edward; and four grandchildren.

#### 1929

KENNETH E. LOHMAN, MS '31, PhD '57, of Fairfax Station, Virginia, on February 25, 1996.

#### 1931

JOSEPH C. HARKER, Ex, of Rolling Hills Estates, California, on March 12, 1996.

EDWARD S. KINNEY, of San Diego, California, on February 2, 1996.

1932 J. B. GROSE, MS, on July 9, 1995.

MERIT P. WHITE, MS, PhD '35, of Whately, Massachusetts, on December 1; he was 88. His postdoctoral research at Harvard focused on the response of structures to earthquakes, and as an assistant professor at the Illinois Institute of Technology he did original work associated with shatter velocity and shock waves. During World War II he held several positions with the National Research Committee of the Office of Scientific Research and Development, and after the war he supervised the compilation of 60 volumes detailing all nonmilitary physics research done in Germany during the war, work for which he received the President's Certificate of Merit in 1947. He also was involved in the planning and evaluation of the results of the nuclear tests Greenhouse, Teapot, and Plumbbob. In 1948 White began research and teaching at the University of Massachusetts, heading the department of civil engineering for 27 years, serving on more than a dozen professional committees, and continuing to consult for government agencies. He was an honorary member of the American Society of Civil Engineers and the Boston Society of Civil Engineers; a life fellow of the American Society of Mechanical Engineers; and a member of the Earthquake Engineering Research Institute, the Institution of Mechanical Engineers in London, and Phi Beta Kappa, among many other organizations. Predeceased by his wife, Jarmila, he is survived by four daughters, Ellen, Mary White-Kaba, Irene Berwick, and Elizabeth Randall; and by 10 grandchildren.

#### 1933

AMMON S. ANDES, MS, of Independence, Missouri, on September 28; he was 91. Before retiring in 1976, he had been professor of aerospace engineering at the University of Kansas for 34 years, and department chairman for nine. He was an active member of the Sigma Gamma Tau Engineering Society and had been a professor at Washington State University for seven years. He had also been the mayor of Liberator Village, Texas, and was an Elder in the Reorganized Church of Jesus Christ of Latter Day Saints. Predeceased by his first wife, Gladys, he is survived by his wife, Bernice; two daughters, Mildred Wujek and Mary Ruth Rimmer; three stepchildren, Rosa Lee Albin, Frank A. Einhellig, and Mark Einhellig; one brother, Wilmer; and 11 grandchildren and eight greatgrandchildren.

LAURENCE K. GOULD, of Pasadena, California, on December 20; he was 85. He had retired in the early 1980s after 20 years as president of Gould Music Company, an 85-year-old piano and organ retail franchise comprising eight stores. Before taking over the company from his uncle Cecil in 1961, he had held jobs ranging from shipbuilding during World War II, to working as a sound engineer at an RKO Studios soundstage, to serving as vice president of an insurance firm, Johnson & Higgins. He spent his retirement years enjoying gardening, traveling, and his family. He is survived by his wife, Betty; daughters Lindbeck and Susan Holland; and a son, Laurence.

#### 1989

HOLDEN THORP, PhD, was one of four faculty members honored October 11 as 1996 recipients of the Philip and Ruth Hettleman Prizes for Artistic and Scholarly Achievement by Young Faculty at the University of North Carolina at Chapel Hill. The prizes recognize achievement by junior tenure-track or recently tenured professors. Thorp, like each of the

#### 1930

LAWRENCE C. NYE, of Los Angeles, on September 30; he was 88. After graduating from Caltech, he received his master's degree in psychology. He served in the Pacific during World War II, both on General MacArthur's staff and establishing radar sites. He retired from the air force with the rank of captain, having earned the AP Theater Ribbon with three Bronze Stars, and five Overseas Service Bars. From 1956 into the 1980s he worked as a psychotherapist. He was predeceased by his first wife, the mother of his sons, Lorraine, and by his second wife, Doris, to whom he was married for 37 years. He is survived by his sons, Philip and Warren; a sister, Lucile Asquith; and seven grandchildren.

GREGORY K. HARTMANN, of Garrett Park, Maryland, on April 8, 1996; he was 84. He was retired technical director of the U.S. Naval Ordnance Laboratory (now the Naval Systems Weapons Command) in White Oak, Silver Spring, Maryland. During his tenure as director, from 1955 to 1973, the lab achieved several of its greatest accomplishments, including the development of the SUBROC missile system, the MK48 torpedo, and the Navy's first nuclear weapons. After graduating from Caltech, he was a Rhodes Scholar at Queens College, Oxford, earning a degree in mathematics in 1936, and he received his PhD in the physics of ultrasound from Brown University in 1939. He taught physics at Brown and at the University of New Hampshire prior to World War II, and during the war served in the Bureau of Ordnance. During the late 1940s he was involved in the development of instrumentation for Operation Crossroads and Sandstone, a series of nuclear tests held at Bikini Atoll and Eniwetok. Hartmann was a founding member of the Federal Professional Association in 1962 and its president during 1964, and he was a senior visitor in the department of applied mathematics and theoretical physics, Cambridge University, 1964-65. During his retirement years, he authored two books, Weapons That Wait: Mine Warfare in the U.S. Navy, published in 1979 and updated in 1991, and Public Enterprise: How to Make the Government a Success, published in 1993. He received the National Civil Service Award and Distinguished Civilian Service Award from the Navy and the Department of Defense, respectively, in 1946; the National Civil Service League Award in 1963; and the Brown University Citation for Distinguished Public Service in 1989. He is survived by his wife, Harriet; his sons, George and John; his daughters, Karen Maury and Joan Johnson; and five grandchildren.

OLIVER D. HOFMANN, of Sonoma, California, on July 24, 1995. He is survived by his wife, Phyllis.

CHARLES D. PERRINE, JR., of Santa Rosa, California, on April 7, 1996. He began his career while still at Caltech, designing advanced radio communications and audio equipment and contributing to technical journals. Recognition of his work led him in 1937 to the Hughes Aircraft Company, in Culver City, California, where he became head of the Hughes Radio Division and was responsible for the communications and emergency radio equipment used in Howard Hughes's 1938 flight around the world. For Hughes, he directed the development of special avionics equipment for the military and started development of the first supersonic air-to-air guided missile. In 1945, he moved to the Fairchild Guided Missile Division, in Farmingdale, New York, as manager of the electronics department. Over the next two decades he held high managerial positions at the Bendix Corporation and General Dynamics Corporation, his final position at the latter being that of vice president for tactical weapons programs. In 1972 he joined the staff of the Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, as assistant to the director and West Coast representative. He retired in 1980. Predeceased by his wife, Hester, and two sisters and a brother, he is survived by his sister Charlotte Elizabeth.

ing vice president and general manager of the Steel Fabrication Division. He retired from Vinnell in 1968 and moved to Fort Bragg, California, where he acted as an independent consultant until his complete retirement in 1978. He is survived by a son, Edward.

### PAUL A. JOSEPH, in May 1996. He is survived by his wife, Adelaide.

#### 1937

EDWARD J. HORKEY, MS '38, of Phoenix, Arizona, on July 26. Involved at North American Aviation with the development of classic fighters like the P-51 Mustang, F-86 Sabre Jet, and F-100 Super Sabre, he willingly shared with others his lifelong love of aviation, writing books and passing on information, assisting Mustang owners and pilots, and promoting the adaptation of the P-51 for air races. He had other interests besides, forming an investigations company, Horkey and Associates, after moving to Arizona, and in addition founding an industrial firm that designed and manufactured chains for mines and cement companies. He also loved the outdoors and had a strong interest in the environment, and, among other projects, developed bird feeders for distribution nationwide. He is survived by two sons, Gregory and Gary; a daughter, Susan Gibson; and a sister, Josephine.

MARTIN J. POGGI, of Bellevue, Washington, on November 18; he was 81. A retired manufacturers' representative, he worked for a number of years in California's aircraft industry. He moved to Seattle in 1951 and established Martin Poggi Co., representing suppliers in the aircraft industry, and every Boeing airplane from the B-29 to those in production at the time of his retirement in 1988 contained equipment that his firm had sold. He was also involved in founding and developing the Caltech alumni fund that provides scholarships for promising students. An outdoorsman, he loved saltwater fishing. He is survived by Janet, his wife of 51 years; three daughters, Virginia Matteson, Carol Fidler, and Alice Nestingen; and six grandchildren.

MARTIN SUMMERFIELD, MS, PhD '41, of Lawrenceville, New Jersey, on July 18. A professor emeritus of aeronautical engineering at Princeton University, where he taught on the faculty from 1951 to 1978, he had been Astor Professor of Applied Science at New York University from 1978 to 1980, and was president and chief scientist of Princeton Combustion Research Laboratories, Inc., an R & D firm specializing in such areas as combustion science, gasdynamics, energy conversion, software development, and related technologies. From 1940 to 1943, he was a research engineer with the Army Air Corps' jet propulsion project, based at Caltech, and from 1942 to 1945 he continued his war-related research as chief of the liquid rocket development department at Aerojet Engineering (later Aerojet General) Corporation. He then spent several years as chief of the rockets and materials division at JPL, a position he left in 1949 to join Princeton, first as editor of the university's aeronautical publications series, then as a faculty member. A member of the National Academy of Engineering, Summerfield was also a Fellow of the American Association for the Advancement of Science, the American Institute of Aeronautics and Astronautics, and the American Rocket Society, and he served as vice president and president, respectively, of the latter two organizations. He received several honors for his aeronautics and combustion research, held patents in the area of rocket motors and related devices, and served on numerous advisory committees to NASA, Congress, research institutions, and industrial firms. In 1994, a gift from him and his wife funded the \$1.5 million Summerfield Chair at Caltech. He is survived by his wife, Eileen, and his daughter, Jacqueline.

WILLIAM O. WETMORE, MS '39, PhD '41, on December 7; he was 81. He was a former vice president of Aerojet General Corporation in Sacramento. After receiving his doctorate from Caltech, he worked for the Navy and for several private engineering firms before joining Aerojet in 1958. During the 1960s and '70s he managed the development, testing, and manufacturing of advanced rocket engines. In charge of Aerojet's nuclear-rocket-engine operations, he ran, among other things, the Polaris missile program and the manned mission to Mars program known as NERVA (Nuclear Engine for Rocket Vehicle Application). A resident of Fair Oaks, California, he was a former member of the governing board of the Fair Oaks Parks District and an avid golfer who belonged to the Del Paso Country Club. He is survived by his wife of 56 years, Eleanor; two sons, Stephen and Donald; and three grandchildren and a great-grandchild.

#### 1938

FREDERIC H. MOORE, on September 17. A process design engineer for Texaco from July 1938 to March 1980, he worked in New York; Los Angeles; Wilmington, California; Montebello, California; and Houston, Texas. Later he worked for the Saudi government, in Saudi Arabia. He was a registered professional engineer in Texas and California.

DAVID M. SHERWOOD, MS '39, of Laguna Beach, California, on October 13; he was 79. After graduating from Caltech, he attended Columbia University, where he earned a degree in sonar engineering. He joined Bendix Oceanics (later part of AlliedSignal Ocean Systems) in 1947 as a sonar engineer, and his career there spanned more than 35 years. He guided Bendix's pioneering work in underwater acoustic navigation and positioning systems in the early 1950s and was instrumental in Bendix's development of several naval systems: the MK 46 torpedo guidance and control system, the airborne helicopter dipping sonar, and the thin-line towed array; based on this latter program, Ocean Systems later became the U.S. Navy's leading supplier of towed arrays for ships and submarines. Sherwood also served as chairman of the Ocean Surveillance Subcommittee of the Antisubmarine Warfare Advisory Committee for the Navy. After retiring officially in 1981, he continued in the role of chief scientist as an Ocean Systems consultant for almost 10 years. "Throughout his distinguished career at Ocean Systems, he served as mentor to a generation of young engineers and scientists. He possessed the rare blend of a man who demanded high standards, tempered always with a kind, constructive, and respectful manner." Under Sherwood's direction, his scientists and engineers won the Corporate Technical Achievement Award five years in a row. He is survived by Ann, his wife of 47 years, and by three children and six grandchildren.

#### 1939

FRANKLIN R. HEPNER, MS, of Cupertino, California, on October 3, 1995.

#### 1940

increased velocities, he published 14 textbooks and some 130 scientific papers in the fields of fluid and plasma dynamics. After teaching for several years in Nanjing, China, he began his U.S. professorial career at Cornell University in 1947. He moved to the University of Maryland in 1953 and retired in 1983 as professor emeritus. He was also a founder of the Institute for Physical Science and Technology at that university's main campus in College Park, Maryland. He is survived by Alice, his wife of 36 years; three sons, Stephen, Robert, and Lou; a daughter, Sue Wang; two sisters, Shih-Yan Pai and Shih-Zhan Pai; and nine grandchildren. His first wife, Chi Yu Feng Pai, died in 1958.

WILLIAM D. SMITH, of Thatcher, Arizona, on February 19, 1996; he was 78. During World War II he worked for Douglas Aircraft, and in 1952 he moved to North American as an aerospace engineer, eventually joining Project Apollo. In 1966 he and his family moved to Grand Junction, Colorado, where he operated a ranch and a blueprint business. After receiving a teaching degree from the University of Colorado in 1970, he taught for two years at the University of Guam and two years at Daytona Beach Community College in Florida. He and his wife, Bette, finally settled in Thatcher in 1975, where he joined the faculty of Eastern Arizona College as an engineering instructor and remained until his retirement in 1982. He spent his retirement years traveling, doing community work, and enjoying his family and friends. He is survived by two daughters, Judy Smith and Wende Henley; two sons, Gary and Robert; two sisters, Virginia Gunderson and Peggy Hunter; and six grandchildren. Bette died on January 4, 1995.

#### 1941

QUENTIN ELLIOTT, MS '42, of St. Paul, Minnesota, on June 28, 1996; he was 76. A chemical engineer, he helped pioneer the development of solid rocket propellants at Caltech and at the U.S. Naval Ordnance Test Station, China Lake, California. In 1956 he moved to 3M, in St. Paul, where he remained until his retirement in 1982, working in manufacturing and laboratory management in new business development. He was also active in community service organizations and in many activities connected with his church, and was a member of S.C.O.R.E. He is survived by his wife, Marilyn, and his son, Quentin B. Elliott.

D. F. JAMES McINTOSH, on October 5, 1995. He is survived by his wife, Hedwig.

#### 1943

WILLIAM R. FAIR, of Kentfield, California, on January 19, 1996. He was chairman of the board and cofounder, with Earl Isaac in 1956, of Fair, Isaac and Company, Inc., of San Rafael, California. He retired as president and CEO in 1991, but remained as chairman until his death. He was a member of the American Association for the Advancement of Science, the Operations Research Society of America, the Caltech Associates, the Olympic Club, the Lagunitas Country Club, and the Society of California Pioneers. He is survived by his wife, Inger; three children, Erik, Christian, and Ellen; and a brother, Robert.

#### 1935

PAUL F. GENACHTE, PhD, of New Canaan, Connecticut, on April 17, 1996. He is survived by his wife, Suzanne.

THOMAS W. GRIFFITHS, MS '36, on November 11; he was 83. During World War II he was a lieutenant commander in the Naval Construction Battalions, serving on Guam and Tinian in the Pacific. After the war he worked for Vinnell Steel Company, becom-

#### 40

ROBERT S. MOORE, MS, of San Marcos, California, on December 16, 1995. He is survived by his wife, Julie.

SHIH-I PAI, PhD, of Beltsville, Maryland, on May 23, 1996; he was 82. A retired aeronautical researcher at the University of Maryland, he conducted pioneering studies focusing on the drag and lift of airplanes, space engines, and missiles; his discoveries 40 years ago about the effects of structure on turbulent flow laid the foundation for moving from low-speed aerodynamics through high-subsonic and then supersonic and hypersonic speeds. Helping to define the shifting complexities arising from the interaction of electrical, chemical, and electromagnetic forces involved with such radically MAMORU MASAKI, Ex, of Ojai, California, on February 23, 1996; he was 74. He was a black-belt judoist. He is survived by his wife, Christine; his children, Mark, Geoffrey, Miles, and Roxanne; and six grandchildren.

#### 1945

WILLIAM E. HELLER, MS '47, of Pasadena, California, on September 3. He spent 38 years employed at the "brickyard"—C F Braun & Company, in Alhambra, California—starting as a draftsman and eventually becoming a structural section leader and assistant head of the civil engineering department. Retiring in 1985, he received his "brick." He loved flying and had earned his private pilot's license in 1946, and he helped found the Sierra Madre United Methodist Church in 1955. He is survived by Luce, his wife of 49 years; two sons, John and Andy; a daughter, Marie Kidd; four brothers, John, Jess, Harold, and Ray; a sister, Motie; and six granddaughters.

#### 1946

WILLIAM J. RUSSELL, JR., on June 6, 1996.

W. CLIFFORD TAYLOR, of Phoenix, Arizona, on April 11, 1996. He is survived by his wife, Maybelle.

#### 1947

CARL F. RASMUSSEN, MS '68, of Downey, California, on December 7, 1995. He is survived by his wife.

#### 1948

JOHN W. THOMAS, MS, ENG '49, of Pacific Palisades, California, on February 21, 1995. He is survived by his wife, Olive.

#### 1949

PHILIP HAYWARD, PhD, on April 20, 1996. He is survived by his wife, Olga.

PHILIP A. VAUGHAN, PhD, of San Marino, California, on September 3; he was 72. After a year at Caltech as a George Ellery Hale Fellow, he spent 18 years at Rutgers University as a professor of physical chemistry. He later returned to Pasadena and worked at Vemco Corporation, a manufacturer of products such as drafting equipment and pressure regulators. He is survived by his wife, Betty Alice; a daughter, Christine Hlavka; a son, Philip, Jr.; and a granddaughter, Eileen Rose Hlavka.

#### 1950

JOHN T. MOSICH, of Covina, California, on January 25. He received his MS in aeronautical engineering from UCLA in 1962 and worked in the aerospace industry, contributing before his retirement to the creation of the mechanical arm for the Space Shuttle. He was a member of the American Institute of Aeronautics and Astronautics, the Caltech Alumni Association, the UCLA Alumni, and the Gnomes. A sportsman and a lover of the outdoors, he was an avid tennis player and hiker, and he and his wife spent much time on the trails of the Sierra Nevada, Switzerland, and Banff, Canada, and, world travelers, enjoyed several weeks in the spring and fall in Maui. A private pilot, Mosich flew his family to Canada and Northern California for vacations. Despite being diagnosed nine years ago with myelofibrosis, a rare bonemarrow disease, he remained active until just a

#### 1953

ROLF D. WEGLEIN, MS '54, of Los Angeles, on November 7. A research chemist credited with more than 90 published papers and invited lectureships, he was a consultant in private practice for the past 15 years, during which he pursued the development and application of acoustic microscopy and acoustic micrometrology to nondestructive industrial evaluation. He spent the major portion of his professional career doing applied research in the aerospace industry, particularly in the areas of electromagnetism and microwave electronics and acoustics. He is survived by his wife, Ruth.

#### 1954

BRUCE H. MORGAN, MS, of Annapolis, Maryland, on May 29, 1996; he was 64. He was a retired associate professor of physics at the U.S. Naval Academy. After receiving his master's degree in physics at Caltech, Morgan earned a law degree from the George Washington University. He worked for Westinghouse Electric Corporation in Baltimore, and then was with the academy for 35 years, before retiring in 1992. He was a member of Phi Beta Kappa, the American Association of Physics, and the Maryland Bar Association, and he was an active member of the First Church of Christ, Scientist, in Annapolis. He enjoyed reading, music, gardening, boating, and volunteering for literacy and human rights. He is survived by two daughters, Julia Morgan-Leamon and Elaine Morgan Levit; a brother, Paul; a sister, Marian Ramsey; and three grandchildren. His wife, Olivia, died in 1989.

#### 1955

VINCENZO M. CESTARI, MS '55, of Wellesley Hills, Massachusetts, on March 31, 1996; he was 67. A retired investment analyst and executive, he had earned an MBA at Harvard in 1960. He began his career as an economic analyst in 1963 with Honeywell, Inc., then from 1968 to 1970 was fund manager and senior research analyst at Eaton & Howard Inc., and from 1970 to 1977 was vice president of Endowment Management & Research Corporation. He ended his career as vice president of the Boston Co., retiring in 1989. He was a member of the Financial Analyst Federation and the Boston Security Analysts' Society. He is survived by his wife, Alice; a son, Peter; a daughter, Luisa; a granddaughter; and two brothers. Giovanni and Amedeo, and a sister, Rosanna Dughiero, all three of Italy.

#### 1960

ROBERT C. THOMPSON, PhD, of Goleta, California, on December 10, 1995. He is survived by his wife.

#### 1969

WILLIS G. WATROUS, JR., MS '71, of Eugene, Oregon, on September 19. Early in his career he was a supervising engineer at Intel Corporation, but then he earned his medical degree from UC San Francisco and became a board-certified orthopedic surgeon. In recent years he acquired four patents in both the medical and semiconductor fields. He enjoyed hiking, gardening, reading, and spending time with his family, and he was a host father for three foreign students, two from Japan and one from Norway. He is survived by Merrill, his wife of 25 years; his daughter, Malena; his parents, Willis and Barbara; and his sisters and brother, Ellen, Barbara, and John.

## Robert Leighton 1919–1997

Robert Leighton '41, PhD '47, Caltech's William L. Valentine Professor of Physics, Emeritus, and a renowned pioneer in numerous areas of physics and astronomy, died on March 9 after a long illness. A three-time Institute graduate, he had been a Caltech faculty member for 50 years.

Widely known for his innovative design of scientific instruments such as the Caltech Submillimeter Observatory (CSO) on Mauna Kea, Hawaii, Leighton was active in many areas of physics and astronomy during his career. His work over the years spanned solid-state physics, cosmic-ray physics, the beginnings of modern particle physics, solar physics, planetary photography, infrared astronomy, and millimeter- and submillimeter-wave astronomy.

"In the latter four fields, his pioneering work opened up entirely new scientific areas of research that subsequently developed into vigorous scientific communities," said Charles Peck, PhD '64, professor of physics and chair of Caltech's Division of Physics, Mathematics and Astronomy. "All of us who knew Bob Leighton deeply admired him, and we will miss him."

A renowned teacher, Leighton edited The Feynman Lectures on Physics into their printed form and wrote a highly influential text, Principles of Modern Physics. In addition, he coauthored, with Caltech physics professor Rochus (Robbie) Vogt, a set of problems to accompany the Feynman Lectures.

Leighton made his scientific mark in 1948 with his first publication, which concerned the specific heat of face-centered cubic crystals, but he had already been drawn into Caltech's pioneering cosmic-ray group, led by Nobel Laureate Carl Anderson. In 1950 he made the first observation of "strange" particle decays after the initial discovery of two cases in England in 1947. Over the next seven years, he elucidated many of the properties, such as mass, lifetime, decay-modes, and energies, of several of the new particles.

In the mid-1950s, Leighton became interested in the physics of the outer layers of the sun, and developed Döppler-shift and Zeeman-effect solar cameras that were applied with great success to the investigation of solar mag-



Physicist Robert Leighton in his Caltech office in the 1970s.

sive infrared telescope. He and Caltech physics professor Gerry Neugebauer used it to produce the first infrared survey of the sky. This survey revealed an unexpectedly large number of relatively cool objects, including new stars and dying supergiant stars, and set the stage for much of the subsequent work in the field of infrared astronomy.

In the mid-60's Leighton was the team leader at JPL for the Imaging Science Investigations on the Mariner 4, 6, and 7 missions to Mars and played a key role in guiding the development of JPL's first digital television system for use in deep space. Earlier in his career he had also designed and built equipment that was used to make images of the planets. These were considered the best images of the planets until the era of space exploration with probes began in the 1960s.

In the 1970s, Leighton's interest shifted to the development of large, inexpensive, highly sensitive radio dishes that could be used to pursue studies in millimeter-wave interferometry and submillimeter-wave astronomy. The "Leighton Dishes" that he designed and built as a result of this research are now in use at both the Owens Valley Radio Observatory (OVRO) and at the CSO on Mauna Kea.

After earning his PhD, Leighton joined Caltech's faculty in 1947 as a research fellow. He was named assistant professor in 1949, associate professor in 1953, and full professor in 1959. He was appointed the Valentine Professor of Physics in 1984 and became emeritus professor the following year. A member of the National Academy of Sciences and numerous other professional societies, Leighton also served as division chair of Physics, Mathematics and Astronomy from 1970 to 1975. Leighton is survived by his wife, Marge Leighton of Pasadena; his former wife, Alice Leighton of Seattle, Washington; their two sons, Alan of Bochum, Germany and Ralph of Tiburon, California; and two grandchildren, Ian and Nicole, both of Tiburon. Memorials may be made to the Los Angeles Library Foundation at 630 West 5th Street, Los Angeles, California 90071. A Memorial service open to the campus community will be held on June 2, at 4:30 p.m. in the Athenaeum.

few weeks before his death. He is survived by Beverly, his wife of 49 years, and by his daughters, Susan Dakey and Louise Mosich.

#### 1952

THOMAS E. FERINGTON, MS, of Wheaton, Maryland, on September 8; he was 69. After receiving his master's in chemistry from Caltech, he went on to earn his doctorate from Princeton. He was an assistant professor of chemistry at the College of Wooster, in Ohio, before going to work for the W. R. Grace research facility in Clarksville, Maryland, in 1961. The holder of patents in polymer chemistry and the author of several books, he retired in the 1980s. He was active in the peace movement during the 1960s, and he was a member of the Sandy Spring Friends Meeting. He is survived by two daughters, Judith Strenio and Esther Ferington; four grandchildren; and his former wife, Marie.

netic and velocity fields. With the Zeeman camera, he and his students produced high-resolution maps of the complicated patterns of the sun's magnetic field. Even more striking were his discoveries of a five-minute oscillation in local surface velocities and of a "super-granulation pattern" of horizontal convection currents in large cells of moving material. These solar oscillations have subsequently been recognized as internally trapped acoustic waves, opening up the field of solar seismology, subsequently pursued by Caltech physics professor Kenneth Libbrecht '80.

In the early 1960s, Leighton developed and fabricated a novel, inexpen-

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