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Caltech News

Volume 31, Number 2
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In This Issue

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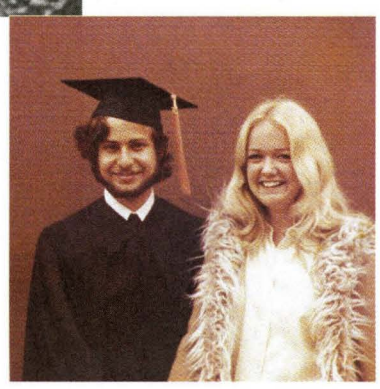
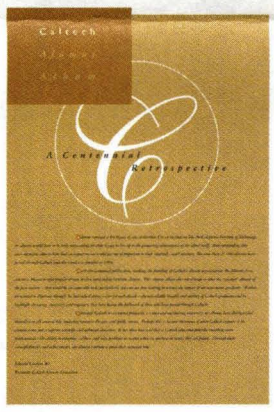


Also in this issue:
A special insert celebrates the alumni centennial; Warren Buffett and Beverly Sills plan to visit; *Caltech News* introduces a "Class Notes" feature; a new back-page poster offers a view of two moons (check out the description on page 19).

ON THE COVER:
Welcome to Caltech: Board of Trustees Chair Gordon Moore, PhD '54 (left), and Feynman Professor of Theoretical Physics Kip Thorne '62 (right), the chair of Caltech's presidential search committee, accompany the Institute's President-Elect David Baltimore and his wife, Alice Huang, into Beckman Auditorium, where Baltimore was introduced on May 13 to the Caltech community.



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Up Front

David Baltimore, winner of the 1975 Nobel Prize for his work in virology, and a leading figure in science and public affairs, has been named Caltech's new president, capping an 11-month search that presents the Institute with its sixth chief executive and first biologist to hold the office. Gordon Moore, PhD '54, chair of Caltech's Board of Trustees, and head of the trustees' Presidential Search Committee, made the announcement on May 13, as he introduced the president-elect to the trustees and faculty. Later that same day, Baltimore met the campus community in Beckman Auditorium, where he spoke eloquently about some of the challenges ahead and, to the thundering strains of the undergraduate signature anthem, "Ride of the Valkyries," pressed the flesh (or fur) with the Caltech beaver.

Baltimore, whose move to campus this fall will give the Institute its 24th Nobel laureate, succeeds Thomas Everhart, who announced his retirement last year after serving a decade as Caltech's president.

"David Baltimore is perhaps the most influential living biologist, and surely one of the most accomplished," said Moore in announcing the appointment. "He is our nation's leader in the effort to create an AIDS vaccine, and he was a major player in the creation of a national science policy consensus on recombinant DNA research.

"In the coming decade there may be rapid and remarkable changes in the relationships between research universities and government, industry, and society," Moore continued. "Dr. Baltimore's wisdom and his proven abilities as an educator, researcher, administrator, and public advocate for science and engineering make him an outstanding choice to lead Caltech through this period of change and into the 21st century. I look forward to working with him to make our Institute even greater in the future than it has been in the past."

Speaking to the large crowd gathered in Beckman, Kip Thorne '62, Caltech's Feynman Professor of Physics and chair of the faculty's Presidential Search Committee, recalled his committee members' enthusiasm upon learning that the trustee search committee—in whose hands the final selection rested—had concurred with the faculty group's choice for the job. Calling Baltimore "an outstanding successor to Tom Everhart, who has so ably led Caltech for the past decade," Thorne said, "Dr. Baltimore's colleagues have described him to us as subtle, perceptive, and keenly insightful about people and complex issues, and as having the mind of a humanist as well as a scientist. Caltech's faculty, students, staff, alumni, and friends will find him a fascinating person with whom to work and from whom to learn."

Said Baltimore, "It is a deep and special honor to be asked to serve as president of Caltech. I am humbled by the faith placed in me by Gordon Moore and the Caltech trustees, as well as by the faculty committee chaired by Kip Thorne. In accepting this offer, I realize that I have accepted the awe-inspiring responsibility to lead a great institution as it adapts to the changing requirements of 21st century America. When one approaches a great institution like this, one can only hope to maintain and perhaps

President Tom Everhart talks with his successor.

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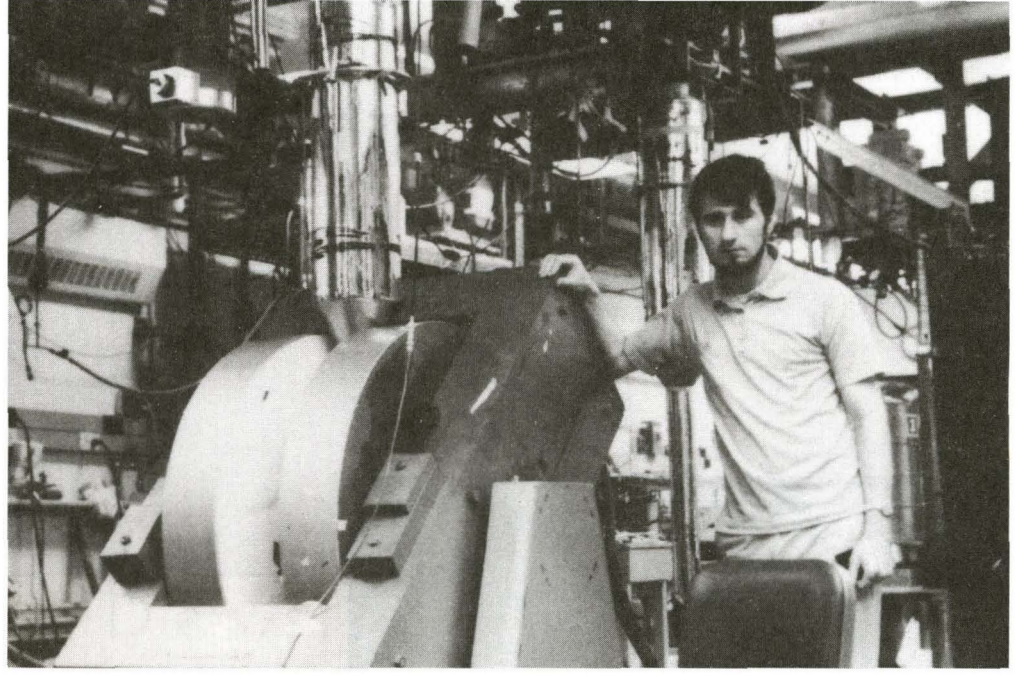
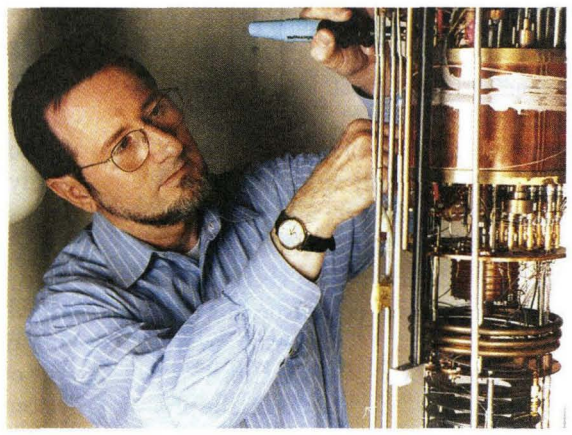


The Guy Who Came in from the Cold



ABOVE: A sleep-deprived Doug Osheroff '67 strikes a pose for posterity beside his cryostat in this picture he took of himself in Cornell's low-temperature physics laboratory in May 1972, shortly after his landmark discovery of superfluid-helium 3, for which he would share the 1996 Nobel Prize in physics. "The haggard expression on my face was quite genuine," Osheroff, who pursues photography in his spare time, noted in his Nobel lecture.

LEFT: The laureate, once more with cryostat, in his lab at Stanford, where he has been a professor since 1987.

For the high school student from Aberdeen, Washington, who had built a 100 keV X-ray machine his senior year in high school and basically breezed through his studies, Caltech came as a blast from a cold wind. "The pressure at Caltech was extreme, and there were times when I wondered how I was going to survive," recalls Douglas Osheroff, who entered the Institute in 1963.

Osheroff did survive, but things got colder still during his senior year, when he started doing research in Caltech's newly revamped low-temperature physics lab and became fascinated with the changeling properties of matter at temperatures very close to absolute zero (0 Kelvin or -273.15161° Celsius). Then came the big chill at Cornell, where, toiling virtually around the clock over a cooling apparatus that he'd designed, built, and painstakingly refined over the course of several years, the fifth-year graduate student discovered a much-sought and famously elusive form of matter. "I still get goose bumps just thinking about it," Osheroff said years later. At the time, he was working at temperatures of roughly 2/1,000 of a degree above absolute zero. Small wonder then that it was an icy-voiced Osheroff who picked up the phone in the wee hours of October 9, 1996, and asked his unidentified caller if he was aware of the time. Sure he was, said the caller. How did Osheroff feel about checking out the low temperatures in Stockholm come December?

"For the discovery of superfluidity in helium-3," Doug Osheroff '67 became the 14th alumnus of Caltech to be awarded the Nobel Prize. The fifth alumni Nobelist (and the first in more than 30 years) to have received his undergraduate degree at the Institute, Osheroff shared the 1996 honor in physics with his Cornell professors and mentors David Lee and Robert Richardson for what the Swedes hailed as a key breakthrough in the study and understanding of low-temperature physics, and one which has contributed numerous new insights to the dynamics and properties of matter at the quantum level.

In the most basic terms, what Osheroff and his colleagues lighted on was a phase transition: the type of change that occurs when, for example, a gas becomes a liquid, or a liquid a solid. These states of matter can be approximately described and understood using classical physics. But when a phase transition occurs in helium liquid at temperatures close to absolute zero, the situation enters the realm of quantum physics and becomes entirely different. The liquid becomes a superfluid: its atoms suddenly lose all randomness and move in a coordinated manner. As a result the liquid loses all internal friction and exhibits delightfully bizarre properties: it can flow upward and out of a cup, flow out through very small holes and—as long as it stays cold enough—spin indefinitely once the container it is in has been set spinning.

Osheroff first became aware of these phenomena at Caltech, where he worked with scientists studying superfluidity in an isotope of helium, helium-4. "I was drawn to the low-temperature work," he recalls, "because it was so counter-intuitive. Who would expect a liquid to flow up and out the top of a beaker? There was also the sense that there was a tremendous amount of new science to discover." As a graduate student at Cornell, he set out to discover it.

Although some of its properties resemble those of superfluid helium-4, superfluid helium-3, which can only be created at a far lower temperature (relatively speaking), has a different and more complicated atomic structure and thus exhibits very special characteristics as a quantum liquid. Unlike helium-4, its transition to a superfluid is described by the same theory that governs what is known as the BCS transition to superconductivity in metals (named for the three theorists—John Bardeen, Leon Cooper, and Robert Schrieffer—who formulated it). It was this transition that Osheroff discovered, after years of work by more senior researchers around the country had proved fruitless.

Says Caltech Professor of Theoretical Physics Michael Cross, a longtime friend and colleague, who first became acquainted with Osheroff when the two worked together at Bell Labs, "Osheroff's breakthrough opened up many different directions of research—from experimental nuclear magnetic resonance (NMR) to the theoretical application of the mathematics of topology that were a major focus of the physics community for many years. As a young graduate student at Cambridge and later at Bell Labs, I was enormously influenced by his superb experiments."

An unusually pure liquid, superfluid helium-3 has served since its discovery as a model system for understanding aspects of complex physics that would be difficult to study and understand accurately with less clean systems. In a remarkable recent experiment, its phase transitions have been used to test a theory about the formation of cosmic strings—immense hypothetical objects in the primordial universe that might have played a crucial role in the formation of galaxies and hence in determining the present-day structure of the cosmos.

After leaving Cornell in August 1972 (he received his PhD in '73), Osheroff spent 15 years at AT&T Bell Laboratories in Murray Hill, New Jersey, extending and expanding on the work he'd done at Cornell. At Stanford, where he joined the faculty in 1987 and is now the J.G. Jackson and C.J. Wood Professor of Physics, his research continues to focus on quantum fluids, and also on the dynamics and properties of glasses and other amorphous solids at ultralow temperatures. He served as chair of Stanford's physics department from 1993 to August 1996.

A member of the National Academy of Sciences, Osheroff has received a number of other prestigious honors in physics, and was among the first batch of MacArthur Foundation "genius" fellowship recipients in 1981. In 1991 he received Stanford's Gores Award for outstanding teaching. On April 20, 1997, 25 years to the day after he made his landmark discovery at Cornell, he was interviewed for *Caltech News* by the paper's editor, Heidi Aspaturian.

Caltech News: I'd like to start with the perhaps inevitable question about how you recall your days as a Caltech undergraduate.

Doug Osheroff: My first year was horrific. When I came into Caltech, my background was not so good. I did okay in physics, but calculus was terrible. My high school didn't offer it—and now here I was having to take calculus exams weekly. I think the first grade I got on one of them was a D. Back in those days, Caltech actually predicted freshman GPAs for entering students, and they would only tell you what they had predicted at the end of the year, and you could then compare it with how you'd done. The policy was never to predict a GPA below 2.7, and I later found out that was what they had predicted for me. I did do better than that, but it was a shock to have to work so hard. In math courses, my grades went up 1/3 of a grade per term, right into my junior year. That year, I took an applied mechanics course, and I can still remember that I got an A+. That made me feel I'd finally done okay in math. But getting there was very, very hard.

How did you manage?

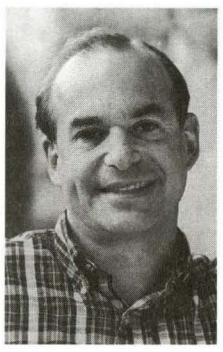
During my first year, I sort of made a decision that to survive I would do nothing but study and get by on 6 hours of sleep a night—which was not a smart thing to do. The second year I said, "Well, things have improved—life has got to be worth more than this—and so I will get 7 hours of sleep (I was always sleepy), but I won't do anything else." And I didn't. But I did quite a bit better, enjoyed

Continued on page 6...

Campus Update

Caltech sends one professor, two alums to NAS

John Schwarz, the Harold Brown Professor of Theoretical Physics, was elected in May to the National Academy of Sciences, bringing to 63 the number of Caltech faculty who are members of the NAS. Election to membership in the NAS, which was established in 1863, is considered one of the highest honors in the American scientific community. Schwarz was one of 60 new members (along with 15 foreign associates) elected this year; total active membership now stands at 1,773.



John Schwarz

Schwarz is one of the founders of superstring theory (and coiner of the name)—a theory that attempts to unite all the particles and forces in nature and explain their relationship to one another. Superstring theory holds that the basic units of the universe are not points but infinitesimally small strings, which exist in 10 dimensions.

He received his AB from Harvard in 1962 and his PhD from UC Berkeley in 1966. After a few years on the Princeton faculty, he came to Caltech as a research associate in 1972, becoming a senior research associate in 1981. He had begun his work on strings in the 1960s, but it was only after coming to Caltech, combining string theory with supersymmetry, and advancing it as a quantum theory of gravity, that Schwarz and a few collaborators gave birth to superstring theory, publishing their first papers in 1974 and 1975. But still it was not until Schwarz's seminal 1984 paper with Michael Green of Queen Mary College, University of London, that superstring theory suddenly excited a flood of interest in the physics community—and even captured the public imagination as a potential "theory of everything." Since then physicists and mathematicians have been wrestling with solving the extraordinarily difficult equations posed by the theory.

Schwarz became professor of theoretical physics in 1985, and in 1989 was named the first Harold Brown Professor of Theoretical Physics. He received a MacArthur Foundation Fellowship (popularly known as "genius awards") in 1987, was elected a fellow of the American Physical Society in 1986, and won the Dirac Medal in 1989. He has held several offices at the Aspen Center for Physics.

Two Caltech alumni were also elected to the National Academy of Sciences this year: Robert Metzenberg, PhD '56, professor of research and biological sciences at Stanford; and Michael Turner '71, professor of astrophysics at the University of Chicago and a scientist at the Fermi National Accelerator Laboratory.

Warren Buffett will present DuBridge Lecture this fall

Here's a sobering thought: if you had invested $10,000 with Warren Buffett in 1956 and stayed with him, you would have $95 million today. But Buffett, who will deliver the 1997 DuBridge Distinguished Lecture, "A Conversation With Warren Buffett," this coming October 21 in Beckman Auditorium, does more than make money. He has raised the art of investing to an almost austere intellectual discipline. Something of a mathematical savant (he can compute odds and add long columns of numbers in his head at surprising speed), Buffett avoids the high-risk speculation that began in the 1960s and peaked in the 1980s; he concentrates on the intrinsic value of a company rather than on what its shares are worth on the market at the moment. Almost as an afterthought, he has amassed a fortune that makes him the "second-richest man in America."

Warren Buffett

Shelby Coffey III, editor of the *Los Angeles Times,* will interview Buffett onstage during the informal conversation. The DuBridge lecture series honors the late Lee DuBridge—longtime president of Caltech and science advisor to President Nixon—and was inaugurated in November 1996 with a "Conversation with Walter Cronkite," the much-honored newsman.

The DuBridge Lecture is free, but tickets are required. Tickets for Buffett's talk will become available to members of the Caltech community (including alumni) on September 3, on a first-come/first-served basis, and may be obtained by contacting Caltech's Office of Public Events at 626/395-4652. For further details and updates, visit the DuBridge Lecture Website: www.caltech.edu/~tickets/buffett.html.

Beverly Sills to give next Michelin Lecture

This famous soprano is known for making opera accessible to ever-expanding audiences. Now she's coming to Caltech.

Not expected to sing but sure to give a user-friendly speech on November 4, Beverly Sills will be the sixth guest in Caltech's James Michelin Distinguished Lecture series, which was established in 1992 "to foster creative interaction between the arts and sciences."

Beverly Sills

Vice Provost David Goodstein, whose office oversees the Michelin series, explains, "We are scientists. The Michelin lectures give us a chance to hear from people in the arts—people who are welcome to talk to us about anything they want to."

The singer and spokesperson whom Goodstein refers to as "a dynamic element in American culture" has yet to title her talk, so it's anyone's guess how she'll relate her three decades of performing in nearly all the world's leading opera houses, her influence on her art form as director of the New York City Opera, and her dedication to charities (for example, chairing the national March of Dimes Foundation).

"Bubbles" has brought youngsters and innovative works to the stage and television screen and introduced American audiences to supertitles (translations projected above the stage for live foreign-language performances).

An advocate of lower ticket prices, Sills may be happy to know that entrance to the Michelin lectures is free. The series was established by New York designer Bonnie Cashin in memory of her uncle, James Michelin, an engineer who had always hoped to attend Caltech.

Tickets for Sills' talk will become available to members of the Caltech community (including alumni) on September 15, on a first-come/first-served basis, and may be obtained by contacting Caltech's Office of Public Events at 626/395-4652. For further details and updates, visit the Michelin Lecture Website: www.caltech.edu/~tickets/sills.html

Gone with the wind

The Navy SNJ version of the AT-6 Texan shown here was one of four World War II planes that flew over the campus in a salute to Caltech's 10-foot wind tunnel as it was officially decommissioned on April 30. The 68-year-old wind tunnel in Guggenheim Laboratory had tested many of the warplanes that helped the Allies win World War II, including the Texan, in 1939, and two of the other planes that flew overhead in tribute.

The four planes buzzed the campus twice at the close of a day-long commemorative ceremony attended by about 200, including former wind-tunnel workers, scientists, and aeronautical engineers, as well as pilots, war veterans, surviving spouses, and aviation buffs who came to campus to bid a fond farewell to the test facility. The photo was captured by Institute photographer Bob Paz, riding in a C-46 Commando transport/cargo plane, as the makeshift squadron flew west directly over the Olive Walk.

The 10-foot wind tunnel was financed by $300,000 from the Daniel Guggenheim Fund in 1926, a sum that covered not only the wind tunnel but the building that housed it (Guggenheim Aeronautical Laboratory) and the salaries of the staff, including that of Theodore von Kármán, who founded Caltech's school of aeronautics. Both von Kármán and his wind tunnel made enormous contributions to airplane design in this country and established Southern California as the aeronautics capital. Almost all of the old Douglas and Northrop planes were tested in the facility.

In later years, after most aircraft manufacturers had built their own wind tunnels, Caltech's facility kept busy with the design and testing of automobiles and supertankers. It also found occasional use in "human experiments," involving bicyclists, skiers, and luge racers. But the four-story tunnel was expensive to keep up and not as efficient as smaller, modern ones. A two-story wind tunnel will replace the 1929 one, sections of which will be parceled out to various museums. The balances will now reside in the Smithsonian, with other portions going to the Fantasy of Flight attraction in Florida, the Los Angeles County Museum of Air and Space, the Western Museum of Flight, and the Heritage of Eagles Museum. ■

Alumni on the Street: Days of Your Lives

When you cast your memory back a few years or a few decades, what's your most vivid memory of Caltech? When you look around at your life right this moment, how did your years at the Institute shape it? Caltech News *wanted to know. So we trolled the mean streets of the information superhighway, posting messages on the Alumni Association electronic bulletin board and littering cyberspace with e-mail; we importuned by telephone, interrupting busy workdays or quiet afternoons of well-earned retirement; we backed unsuspecting alumni against the virtual wall. And some of your answers surprised us.*

Hallelujah, you're a tenor!

One of the most surprising results of our highly unscientific survey was how often Caltech's impact had nothing to do with its scientific or technical excellence, but with the opportunities the Institute offered to discover or develop other interests and talents. "Those who say Caltech is just a 'science school' should think again," says **Samantha Seaward '91.** Seaward, who is now a radiation oncologist at UC San Francisco Hospital, says, "I am most thankful to have gone to a school small enough to allow anyone to get involved with just about any activity"—activities that for her included TACIT (*Bye Bye Birdie*), Chamber Music, Glee Club and Chamber Singers, cheerleading, Interhouse athletics, and tryouts for cross country and swimming. Not to mention classes in modern dance, ancient art, pottery, airbrush and silkscreen, creative writing, weight training, tennis, and badminton. "More importantly," she continues, "the experiences that were opened up to me at Caltech didn't end there. I continue to study Egyptology in my spare time, am currently singing with the San Francisco Choral Society, and badminton has become my favorite sport. Caltech produces graduates who are top-notch scientists and well-rounded human beings."

Reuben "Rube" Moulton '57 is another alum who discovered a talent he didn't know he had while at Caltech. Already an accomplished instrumentalist—piano, organ, saxophone, and clarinet—when he entered Caltech, he showed up at a rehearsal of the Men's Glee Club, simply planning to try out as an accompanist. But then-director Olaf Frodsham (whom Moulton remembers as "a pretty charismatic fellow") had him vocalize "before he knew what was happening to him." "Hallelujah, you're a tenor!" Frodsham exclaimed, and Moulton, who has worked for Pacific Bell for 38 years, has been a tenor ever since, making choral singing a "pretty serious avocation." He sings, records, and travels with the San Francisco Symphony and the Masterworks Chorale, and has appeared as guest soloist with the Pasadena Pro Musica.

"I learned to socialize at Caltech," says **Cecilia Rodriguez Aragon '82,** determined to skewer the myth that "anybody who goes to Caltech is a socially stunted nerd." True, many Caltech students were shy in high school, as was she. But perhaps precisely because of this, she ventures, Caltech students are less slick, more genuine, more likely to reveal their true selves to each other—and certainly more accepting of unconventionality and originality of thought—than students elsewhere. College is naturally a time of life when emotions run high, Aragon notes, and the Caltech experience is particularly intense. Under these conditions, Caltech fosters strong bonds of friendship (and not a few marriages: several of our respondents were married to other alumni).

Ed Gauss '54 has a few typical memories of his four years at Caltech: the lectures of Linus Pauling, the after-dinner stories of Richard Feynman, navigating the steam tunnels. But his most vivid memory is of "the art classes on Saturday morning that Professor Hallet Smith thought we might like." The instructor had brought in a model for a life drawing class, and, as Gauss puts it, "I saw my first naked lady there." Evidently it was an unforgettable experience, since in his retirement Gauss has started a new career—as a sculptor.

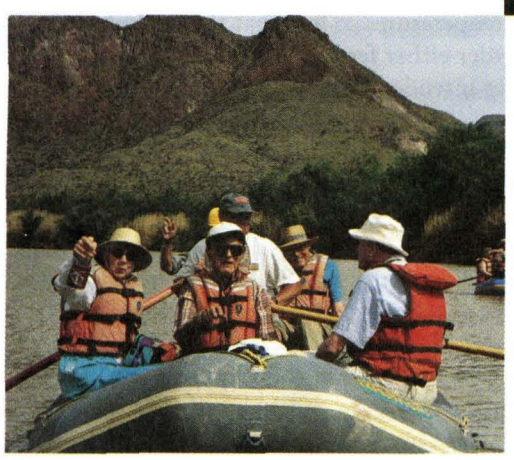
Every day I felt challenged and excited but not overwhelmed

But, of course, what many of you

Continued on page 17...

Alumni

The talk of Taipei in April included an address by Vice President and Provost Steve Koonin '72 on research at Caltech. From left, Tiffany Lee '96, Chung-Yu Mou, PhD '93, and Wen-Jean Hsueh, PhD '93, helped organize the event for alumni living in Taiwan.



Good times on the Rio Grande are shared by (left to right) Marge Pettingall, Chuck Pettingall '39, Jack Cortelyou '34, and Ray Gerhart '39, '40, Eng '42. Bill Muehlberger '49, PhD '54, led the Alumni Association's April travel-study trip to Texas's Big Bend National Park.

On his nationwide tour of alumni chapters, President Tom Everhart spoke to a group in Texas in April that included, from left, Houston's Tom Bjorklund '60, J. Eugene Stones '39, and Esther Stones.

Alumni Activities

June 21–July 1
Alaska Travel/Study Program, led by Robert Sharp '34, MS '35, the Robert P. Sharp Professor of Geology, Emeritus, and Leon Silver, PhD '55, the W. M. Keck Foundation Professor for Resource Geology, Emeritus.

September 5–6
Opening meeting of the Board of Directors, and committee meetings.

September 26–October 5
Rio Grande del Norte—Geology and Culture of the Rio Grande Travel/Study Program, led by Leon Silver, the W. M. Keck Foundation Professor for Resource Geology, Emeritus.

December 5-6
Meeting of the Board of Directors, and committee meetings.

January 1, 1998
Tournament of Roses Parade.

Osheroff...from page 3

myself more, and learned more science. Then in my junior year I said, "I will get 8 hours of sleep a night, and I'll go out on dates." That last part didn't work out so well, but I did graduate with honors. So, I did okay in the end. But I walked out of Caltech feeling very humble.

Years later, in 1984, Caltech offered me a job on the faculty. And I confided to Ed Stone, who was then the chairman of the division of physics, math and astronomy, that "Ed, you know, I didn't have a particularly illustrious career as an undergraduate." And Ed said, "That's okay, Osheroff, because we're not hiring you to be an undergraduate."

Caltech has always been a sink-or-swim kind of place. At Stanford, for instance, I think the safety net, at least for undergraduates, is much higher. And certainly in my day, the social ineptitude of Caltech undergraduates was legendary. I won't elaborate—I don't think it needs any elaboration. I was in Lloyd House, which I think at that point had ended up collecting many social misfits. Some of these guys were unbelievably arrogant—they just weren't very nice people. And it was interesting—I think every one of them left without graduating. It was hard for me to tell what happened.

Do you have friends from the Caltech years who you still keep up contact with?

There are a number of people, but I'm very bad at remembering names. A lot of physicists have terrible memories. That's why we go into physics, because you can derive everything from first principles. I did have the good fortune to know Ernest Ma, who was one year ahead of me and got me through the problem sets in Feynman physics. He would never tell me how to solve the problems, but would give obscure hints when I got stuck—at least they seemed obscure to me at the time. He's now the chairman of the physics department at UC Riverside, and it was the first place I visited after I came back from Stockholm. There are of course many more, including Ed Groth, Dan McCammon, Ron Peterson, and lots more.

Did the Feynman course have a particular impact on you? Was Feynman teaching it at the time?

I can't say I understood it all, but it was an extremely important part of my education and contributed a lot to the development of my physical intuition. Feynman was teaching the sophomores when I was a freshman, and a team of crack physics professors were struggling to teach the freshmen. But Feynman did give a number of guest lectures. He was of course an exceedingly animated lecturer. You could see how the adrenaline was flowing, because he would nervously pace back and forth. One day, I counted up: he went from one end of the blackboard to the other 43 times during his talk. I have to say, it was very difficult to not be excited about physics listening to Feynman talking about it.

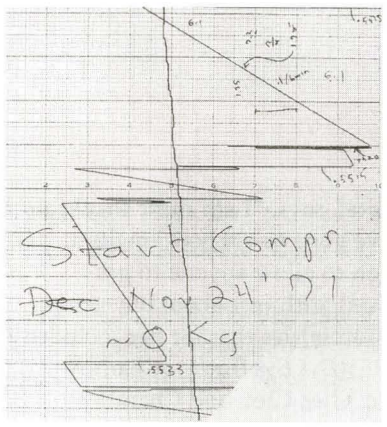
Was it primarily that course that inspired you to make physics your career?

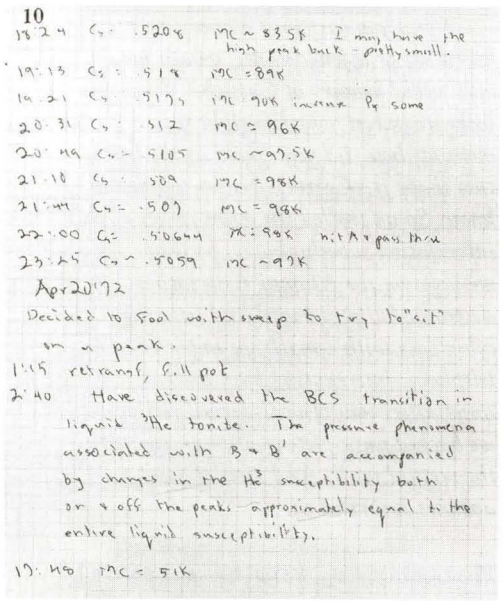
There was more to it than that. I would say that probably the most important thing that happened to me at Caltech was during my junior year. I was very tired, and I could not see the light at the end of the tunnel. And then a student who was working with Gerry Neugebauer on the first infrared star survey came to me and said, "Gerry is looking for another undergraduate to work on this research program with him. Would you be interested?" I wasn't sure, and then he said, "It pays money." I said, sure, why not?

So, I went to work for Gerry. I always tell my students that the first job I ever had was correcting parity errors in punched-paper tape. There can be nothing more inglorious than doing that, but I got very good at it. And then as time went on, I was given more responsibility, and eventually I got to run the telescope and even to help design and build infrared cameras for looking at the center of the galaxy. It was a great experience to discover how satisfying research could be and how different it was from doing endless problem sets.

How did you first become interested in low-temperature physics?

That also happened at Caltech. I was really enjoying the stuff I was doing in the infrared program, but I have always sort of been a tinkerer, and I wanted to be more of a participant in what I was studying, as opposed to being an observer. I wanted to be able to control things. I also wanted to get out of the third term of a senior lab, so I opted to do an independent research project in what was becoming David Goodstein's lab. David was in Rome at the time, so I started working with two other guys who were at Caltech on sabbatical—Don McCullum from UC Riverside and Walter Ogier from Pomona College. They were trying to reach a temperature of half a degree above absolute zero in liquid helium-4. So I started working with these guys, and they wanted me to build a pressure gauge called a McCleod gauge. I built them the most beautiful gauge—I was extremely proud of it—and it didn't work. But in the process, they filled my mind with all the very beautiful and exotic things that happen at low temperatures, and I decided that this was a magical world that needed to be investigated. I was suddenly immersed in this research environment, and that's what hooked me. They lit a fire inside me—this feeling of excitement that one could experience in studying this field. I don't know what I would have done otherwise.




10
18 24 C_s = .5208 mc ~ 835K I may have the high peak back - pretty small.
19:13 C_s = .518 mc = 89K
19:21 C_s = .5173 mc 90K increase P_x some
20:31 C_s = .512 mc = 96K
20:49 C_s = .5105 mc ~ 97.5K
21:18 C_s = .509 mc = 98K
21:44 C_s = .507 mc = 98K
22:00 C_s = .5064 mc = 98K nitA + gas thru
23:45 C_s ~ .5059 mc ~ 97K
Apr 20 '72
Decided to fool with sweep to try to "sit" on a peak.
1:15 retramf, 5.11 pot
2:40 Have discovered the BCS transition in liquid ^{3}He tonite. The pressure phenomena associated with B & B' are accompanied by changes in the He^3 susceptibility both on & off the peaks approximately equal to the entire liquid susceptibility.
17:40 mc = 51K

Osheroff's lab data (left) from the start of his November 24, 1971, run, when he first noted the "glitch" in his cooling-rate curve; and from the middle of the night on April 20, 1972 (below), recording his discovery of superfluid helium-3.

Had you decided to make this your field of study by the time you arrived at Cornell?

Not entirely. But during my first semester there, I attended a colloquium given by Bob Richardson, who was then a new assistant professor. He spoke about a new device called a helium-3/helium-4 dilution refrigerator that could continuously cool samples down to 20 thousandths of a degree above absolute zero. And that just completely blew my mind. I was already working as a teaching assistant for Dave Lee, head of the low-temperature lab at Cornell, and when I got a good look at what was going on in his lab, I said, "sign me up." And that's how I got into low-temperature physics.

What were the circumstances of the discovery at Cornell?

It's a long and technically rather complicated story. It's all written down in gory detail in my Nobel lecture.

Is there a less gory version?

I'll try. After I joined the low-temperature group, I spent my first year apprenticing under a graduate student named Jim Sites. He was married with two kids, so he was absolutely determined that this was going to be his last year. I think he was the only person in Cornell's low-temperature group to get out in four years. So it wound up that when we were running his experiments, we ran two shifts. I got the night shift—from 5 p.m. to 8 a.m. It was better than correcting parity errors in punched paper-tape, though. Several of the techniques that I used in the discovery of superfluid helium-3 I learned from Jim Sites and Bob Richardson. Jim and I built the dilution refrigerator that was later used in the discovery, and he was the first student at Cornell to use Pomeranchuk cooling to study the frozen solid.

Pomeranchuk cooling?

This was a process named for the Russian physicist who suggested it. It depended upon a unique property of the helium-3 system, which is that below about a third of a degree Kelvin, the heat of solidification is negative, so that if you form solid helium-3 from the liquid in thermal isolation, the liquid would cool. This process should continue to temperatures so low that the nuclear spin system in the solid would eventually order either ferromagnetically or antiferromagnetically. This is what Sites intended to study.

So you weren't looking for the transition to the superfluid in the liquid at all?

No, because people had been looking for the transition at that temperature and colder temperatures for more than a decade, and no one had been able to find it. So, the theorists decided that they had been too optimistic. They revised their theories, and the prediction for the transition to the superfluid state went down to about 50 millionths of a degree above absolute zero. At the time I was doing this work, no one had any idea how to get that cold. We were using NMR techniques to study the frozen solid. When Jim left he bequeathed me his cryostat, and during my third year I built a new Pomeranchuk cell that I had designed during my second year, while I was in the hospital recovering from a skiing accident.

In my fourth year, I teamed up with another student, Linton Corruccini, and we used the new cell to study some of the unusual NMR properties of normal liquid helium-3.

As the fall of my fifth year began, I was studying the suppression of the melting pressure at constant temperature due to the application of a large magnetic field. To determine the temperature, I measured the polarization of copper nuclei along the applied field, using NMR techniques. The whole lab shared only one large iron-core electromagnet for doing NMR, and finally another team

A lot of physicists have terrible memories. That's why we go into physics, because you can derive everything from first principles.

that had an experiment ready to go said they thought that I should relinquish the magnet. So I did. But in those days, these low-temperature apparatuses were really, really flaky. My thinking was that I would give up the magnet but would keep my apparatus cold, in case their apparatus failed, in which case they would have to give me back the magnet right away.

I thought that as long as I had to tend this cryostat three times a day, I might as well see how low a temperature I could reach with this cell. I couldn't do NMR-based temperature readings, but the melting-pressure itself was related to temperature in a way that was known down to about 2.7 millidegrees. I figured that I could probably just extrapolate that out to lower temperatures and look to see whether I could actually reach temperatures where the nuclear spins in the solid ordered. Several other students in the lab thought I was just wasting my time, but on November 24, 1971, the day before Thanksgiving, I tried this experiment for the first time.

I was slowly converting the liquid to solid by compressing the liquid–solid sample, and it was slowly cooling. The way this works is that solid helium-3 occupies less volume than the liquid, so compressing the sample encourages it to solidify. Normally, when a liquid freezes, the solid gives up heat to the liquid. But when liquid helium-3 freezes, the solid—which actually has a higher entropy than the liquid—sucks heat out of the liquid, and cools it. So, I was taking measurements of the rate at which this was occurring. And all of a sudden, at what we estimated to be 2.6 millidegrees—which was still above the temperature of 2 millidegrees at which we thought ordering would occur in the solid—there was a very sharp decrease in the rate of cooling. It dropped by about a factor of three. I looked at that and said, "Oh, damn—things are not working right." My assumption was that something had gone wrong with the apparatus. I was kind of disappointed, but I decided to allow the apparatus to precool over the Thanksgiving holiday, and then redo the experiment.

I started again, four days later, and I saw what appeared to be exactly the same decrease in cooling rate. I was pretty unhappy, but then I looked at the pressure, and it was the same to within one part in 50,000 in pressure—a temperature difference of 20 microdegrees—as it had been when I first observed it the day before Thanksgiving. And I thought—wow! *It simply couldn't be a chance coincidence that these pressures are so much the same.* It's much more likely that this resulted from some highly reproducible phase transition within the cell. I think I then went back and forth through this transition a couple of times, and confirmed that it was always at the same pressure. And of course that was very exciting.

So, when the Nobel committee wrote in its citation of your "vigilant eye," this is the episode that they were referring to?

Yes, but the thing is that Bob Richardson, David Lee, and I initially interpreted the phenomenon as a phase transition within the frozen solid, and that's how we wrote it up in the paper that was published in *Physical Review Letters*. No one expected to produce superfluid helium-3 at these temperatures. There were some baffling aspects to what we had found, but we interpreted these as signifying an unusual phase transition in the spin system of the solid. Our paper sailed through the peer review process and was accepted for publication without any problems. As it turned out, the data were all correct, but the interpretation was all wrong.

What is really interesting is that when we realized later that we had actually seen a transition to the superfluid state in the liquid and wrote that up for *Physical Review Letters*, the paper got bounced! The referee basically said that he didn't think there were enough new results there. We appealed to both editors, and they both supported the referee. Eventually it got published, but it took a while.

When did you realize the actual significance of what you had discovered?

It took several months, and several other people were involved. David Lee went to an American Physical Society meeting, where he ran into a guy named John Goodkind, from UC San Diego, who'd spent a great deal of time himself searching for superfluid helium-3. He was the one who pointed out that the change in cooling rate that we'd seen was in fact consistent with a phase transition in the liquid helium-3, not the solid. We'd accounted for these inconsistencies in our paper, but I started to get nervous and said that we should really do an NMR experiment to see just what was going on with the liquid versus the solid. But then we began to have lots of problems with our apparatus. The worst one was when a squirrel tried to jump across one of the high-tension insulators in the power distribution system for Cornell University, and its carbonized body brought down the entire power grid at Cornell. It took more than a month to fix that.

In the meantime, I had built some new cells with new refinements, and I talked to a professor named Michael Fisher, who was a theorist in three departments at Cornell—physics, chemistry, and mathematics—and asked him how he thought solid helium-3 would grow inside a Pomeranchuk cell. Based on what he told me, I designed a new experiment, which allowed me to image the magnetic signal as a function of height in our cell. I used this device in experiments throughout the first half of April, and seemed to see results that supported our earlier conclusions. Then, on the night of April 20, I looked at the very tiny region where we had an all-liquid signal. At the lower temperature transition, the liquid NMR signal dropped by more than a factor of two very suddenly. It was then clear that the transition in question was in the liquid—not in the solid. This was at 2:40 in the morning, and I wrote in my lab book, "Have discovered the BCS transition in liquid helium-3." I would have to say, that was the most exciting moment of my life.

We wound up our experiments at Cornell by mid-July, and I went to Bell Labs and spent the next several years elucidating the nature of these unusual phases. That was a very fulfilling and productive time.

I understand that you got quite involved in outreach science education while you were at Bell Labs. How did that come about?

When I was a kid, there had been this show called Parade of Progress that came through this small logging town where I was growing up. It was sponsored by GM, and it was like a circus that was all about science. You can't really be sure what it is that makes up your mind to be a scientist, but this certainly had a profound impact on me. I also think I had an early predisposition toward science, which both my parents encouraged. I started out at about age 6 tearing apart my toys to get the electric motors out. When I was about 10, I somehow got hold of some old telephone parts, and connected a relay to a 22-volt battery. When I released it, I got a shock. I didn't quite understand what was going on, but I thought it was pretty interesting—it was a mild shock. I packaged this contraption in a duffel bag and took it to school, and pretty soon all my friends were lining up to get shocked by my machine.

The point is that I wanted to share this excitement that I felt for science. And I thought that one way to do that was to give these demonstration lectures in local high schools and grade schools. I'd swallow liquid nitrogen and belch up these clouds of white smoke, or I'd swallow helium so that my voice became all squeaky, and I'd explain the principles behind how these things worked. It was always fun and interesting. I remember that one time I went to a local elementary school, and I talked to the entire sixth grade class. I showed them liquid oxygen, and I picked it up with a magnet. Afterward the teacher came up and said to me, "I just got finished telling my students this morning that oxygen was a colorless, odorless gas; and now you've showed them that it's a blue liquid—why is it blue?" I didn't know the answer. It took me quite a while to find out.

Together again: Osheroff (center) and his Cornell professors David Lee (left) and Robert Richardson (right) display their medals after the Nobel ceremony in Stockholm.

What prompted you to leave Bell Labs for Stanford?

Part of it was that my wife, Phyllis, had been urging me for quite some time to think about becoming a professor. I think she saw me liking to go around and give these demonstration lectures, and felt that I was a born teacher. Then Phyllis, who is a protein biochemist, got an excellent job offer at Genentech in San Francisco, and I applied for faculty jobs at both Stanford and Berkeley. They both offered me positions, and for a number of reasons, I chose Stanford. So, we moved to California.

How did you learn you'd received the Nobel Prize?

The call came at 2:30 in the morning. I picked up the phone, and here's this Swedish accent on my line: "Hello, is this Dooglas Osher-Off?" And I said, "Yes, and do you realize it's 2:30 in the morning?" And he said, "Yes, I know that, but I have a matter of considerable urgency"—or words to that effect. At that point I sort of wondered if my mother, who wasn't well, had gone to the hospital, except that he sounded incredibly cheerful. Then he identified himself as secretary of the Royal Swedish Academy of Sciences, and I knew at once what it was about. All I could say was, "Oh, my goodness. Oh, my goodness." And he said, "I can see, you're stunned."

Were you stunned?

I suppose I was in some sense. Really, all I could think of, as I stood there in my pajamas at 2:30 in the morning, was that my life was changing, and that I had no control over what was happening. My first inclination was to try and get some more sleep, but there was no way I could get off my feet. I kept pacing back and forth, trying to imagine what my new life was going to be like and whether it was one that I would enjoy more than the one I already had. I knew that once you get a Nobel Prize, people will inevitably call you up and want you to do this and do that. Of course, you can simply say, "No. I'm not interested," and more or less continue with the life you used to have. Still, my feeling is that when you're a Nobel laureate, people are interested in what you have to say, and you have a responsibility to be a spokesperson for what you feel strongly about. Even giving talks that will be inspirational to students and young people—these are things

Continued on page 8...

One student wrote, "Osheroff is a typical example of some lunkhead from industry who Stanford University hires for his expertise in some random field."

Osheroff and his wife, Phyllis (above), on their way to Iceberg Lake, in Glacier Park, Montana. An enthusiastic hiker, Osheroff here takes advantage of the park's scenic beauty to indulge in another favorite pastime, photography.

Osheroff...from page 7

the Nobel laureates can do, and that perhaps few other people can do in quite the same way. If you abdicate your responsibility, no one else can do those things.

So, how much has your life changed?

Well, I'm very very busy. Up until this April I was out of town essentially half the time. I've logged, I would say, 65,000 air miles since October 9. It makes it difficult to do the things I tend to think are really important, such as interacting with my graduate students, teaching, and serving on university committees and research panels. I have trouble finding the time to do all that now. One of the first things I did was take a trip to Washington with the other U.S. laureates. Right after the prizes were announced, the National Science Foundation invited us to come participate in a media blitz. The NSF was of course elated that five of the six Nobel laureates in the natural sciences that year were Americans, and that *all of them had been supported by the National Science Foundation*. So, we talked about our work and the importance of supporting fundamental research. Later, we were invited back to Washington as guests of Al Gore to discuss these same kinds of issues.

What did you say to the vice president?

I think I said more than my share, which is to say I kept interrupting other people. We were all gathered around a large table with officials from the NSF, the Department of Energy (DOE), and so forth, and we just went around the table, expressing and discussing our concerns. One of the main points I tried to make is that you don't fund basic research intended to solve some specific need of society, such as cheaper, cleaner energy. You do basic research in semiconductor physics, materials science, surface physics, and perhaps wet chemistry and maybe you'll come up with some breakthrough directly related to solar energy, but it's equally likely that this sort of research will lead to advances in other areas as well. So, you can't take money designated for basic research and at the same time earmark it to solve some specific societal need, because if a researcher isn't allowed to follow his or her nose, there are going to be a lot of missed opportunities. I think, regrettably, that's what is happening with a lot of research today—NASA is a good example.

Do you think you got your point across?

It's hard to say. I think the general consensus is that the period during which I worked for AT&T Bell Laboratories was, in retrospect, a golden era. That started with Sputnik, of course, and the NSF support for research increased regularly over the next three decades. But with the end of the Cold War, the prevailing attitude is that technology is really important for economic competitiveness, so we should really support things that are going to support American industry and not just mankind in general. And that of course is the attitude that has forced a lot of U.S. companies to get out of basic research. It's really unfortunate.

How about your own graduate students? With the changing research climate, are they mostly pursuing careers in science?

Most of them are, but there have been a couple of interesting exceptions. I had one student recently who actually made a reasonably important discovery. He did not even want a postdoc—he went directly off to an investment house and now works for the Chicago Stock Exchange. Another, who got his master's degree in aeronautical engineering after finishing a PhD with me, is making a name for himself as an expert in unconventional aircraft. All the others are doing physics at some level.

Do you have much time yourself to do research nowadays?

No, not directly as I did before. There are basically two things that I don't like about my present position in the university. One of them is writing research proposals. Condensed matter physics has never been funded heavily to begin with, and I'm not the type of person who is very aggressive in getting research funds. The DOE and NSF have been good to me, but the grants are small, by comparison with other areas of physics. So there is a real limit to the number of students and postdocs I can support.

The second drawback is that for most of the year I don't have the time to really work in the laboratory. I define the direction of my research and help my graduate students develop specific strategies and solve problems, but I don't do the work anymore. I'm much more cheerful in the summer, when I actually do have a bit of time to actually design things, solder wires, take data, and so forth. I miss being able to do that a lot.

At the same time, it's tricky, because at Bell Labs, that's essentially all I did. (I was also a department head, but that wasn't an enormous responsibility.) And when I look back on that time, I remember thinking, "I'm just doing this one thing: I'm getting bored." So, there are always trade-offs.

At Stanford you've acquired quite a reputation as a teacher. You teach introductory physics regularly and you won the university's teaching award in 1991. Do you have a particular philosophy of teaching?

Nothing real specific. I always feel that you need to push the students—challenge them, to be more exact—particularly the best ones, so that they don't lose interest. That's part of the Caltech tradition, of course. The other main thing, I think, is that you have to be animated. In a way it's like a good general leading his troops. If you, as the professor, can't show your excitement in what you're discussing, the students are certainly not going to generate any on their own. I feel it's absolutely essential to show a love for what you're talking about.

I should add that I've had my share of bad reviews. The first year I taught at Stanford, one student wrote on the evaluation, "Osheroff is a typical example of some lunkhead from industry who Stanford University hires for his expertise in some random field." I think it's fair to call this a minority opinion, but you can't please everybody. I always hand out my lecture notes before a lecture, and I would say that three-quarters of the students who comment on that say it's a wonderful idea—they really enjoy being able to sit and listen to me talk. The other quarter say that they think it's a terrible thing to do, for whatever reasons. Last year I actually paid someone to enter all the notes on the computer, so that they would be completely legible, and one student said, "All Osheroff ever does is lecture out of his notes in class." At that point, I start to say to myself, "What is it that I'm supposed to do?"

But I really do enjoy teaching. My father was a physician, and I think for him the satisfaction of curing a person, or saving a life, was really what kept him going. Part of what keeps me going is when students come to me, either after having taken my class or sometime later, and say, "You know, your course was really important to me." It happens fairly often, so that part of my ego is fairly well cared for. I'm teaching an entry-level physics course this term, and this past week close to 70 students came to my office hours. Obviously, it represents a tremendous investment of my time, but my attitude has always been that these people are bright, they're Stanford students, someone is paying $30,000 a year for them to come here, and they deserve to see me. The explanation that I just won a Nobel Prize and am expected to travel all over the country just ain't good enough.

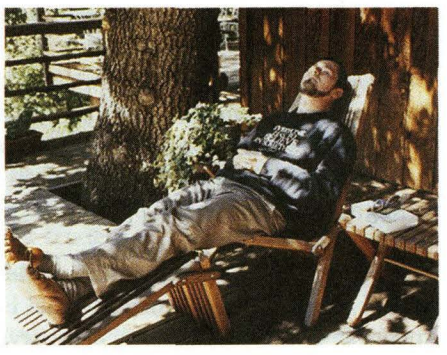
Do you teach other undergraduate courses, aside from introductory physics?

I teach an advanced lab course for physics majors, which is sort of an introduction to research. For the last four or five years, I've also taught what Stanford calls Sophomore Dialogues. One is "The Art of Physical Measurement or Instrumentation." This past year for the first time I designed and taught a course on the "Physics of Photography." In a sense, this goes along with the fact that I'm an experimentalist, and I experiment with everything. That includes my teaching. I like to just come up with something new and see what comes out. I will start with something that I personally enjoy—for instance, I've always considered the art of physical measurement one of the most enjoyable parts of experimental physics—and then I'm interested in seeing the students' reactions.

And, generally speaking, I like young people. I don't have children—I always tell my students that they're my children, and that I'm going to come visit them in my old age.

Do they respond favorably?

Well, they laugh—nervously. ■



Not a cryostat in sight.

The Boomerang Effect

BY HILLARY BHASKARAN

On June 13, Caltech will send about 500 graduates off into the world to continue their education, contribute to society, distinguish themselves. . . . Give 'em a few years, and a bunch will be back.

History tells us that alumni return to Caltech not because they can't find a job elsewhere but because they thrive in this environment. "It's one of the best places for me," says Joe Kirschvink, whose double major in biology and geology evolved into a BS and MS in '75.

"There's a particular nature that needs to be nurtured in a science-intensive environment," says the geobiology professor. "You can be creative. You can have original ideas. But you never know where you can run with your ideas until you're in that environment." Inspired by Caltech professors Heinz Lowenstam and Gene Shoemaker, the latter a two-time Techer ('47, MS '48), Kirschvink has developed his ideas into novel research on how the earth's magnetic field helps orient organisms such as migrating birds.

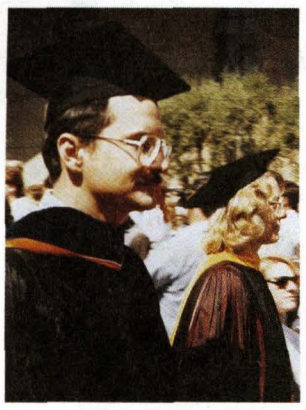
Between his undergraduate and professorial days, "to take a break from Caltech," he did a Watson Fellowship in Australia and graduate work at Princeton. Then in Japan, he met Atsuko Kobayashi, and they were married just before he joined the Caltech faculty in 1981. The Institute obviously had a strong pull on Kirschvink family members, because Joe's sister Cathy ('82, MS '82) and Cathy's husband-to-be, Dave Dowling ('82, PhD '88) joined the Beaver brigade. The tradition continued when Atsuko Kirschvink received her Caltech master's degree in '91 and became a research engineer in geobiology.

Joe Kirschvink returned to his roots with a broader perspective. Now, for example, he can see "dramatic differences between the capabilities" of someone from a large place like Stanford or Australia National University and those of a Caltech student. "You can give Caltech students a problem involving a hairy mathematical relationship, and they'll do much better. I hate to be chauvinistic about this. However, students at Princeton can zap out term papers much faster. The content may not be as good, but they'll be phrased better. At Caltech, we need to work on literacy to learn how to communicate our work. I write all the time, and all of my core classes are term-paper classes."

Julia Kornfield '83, MS '84, returned in 1990 with a PhD from Stanford. Why? "For the people," says the associate professor of chemical engineering. In the process, she had to overcome her feelings of intimidation. "I was terrified to come back." But "if you want to teach and work with great people, nothing compares to Caltech. The students are wonderful, and the admission standards are so high. The faculty aren't bad to work with either, although I didn't really know that at the time I decided to return." In her new role, she says, "I was surprised. I didn't expect to be taken seriously by my colleagues, since I was coming back as a young nobody. But even in faculty meetings, I really felt like I was being heard."

Kornfield gets to know her graduate and undergraduate students better here than she might elsewhere, thanks to the Institute's small size. "No other university I'm aware of has this caliber of students and such small classes"—which are good for faculty like her who are bad at remembering names, she adds. "I didn't fully appreciate the small class size until I came back." Active in campus issues as an undergrad, Kornfield remains very involved in student life, serving on numerous faculty-student committees and, of course, marching in commencement. She missed only her first of seven because she was "too intimidated to walk."

PERSPECTIVES ON PRANKS AND PRODUCTIVITY

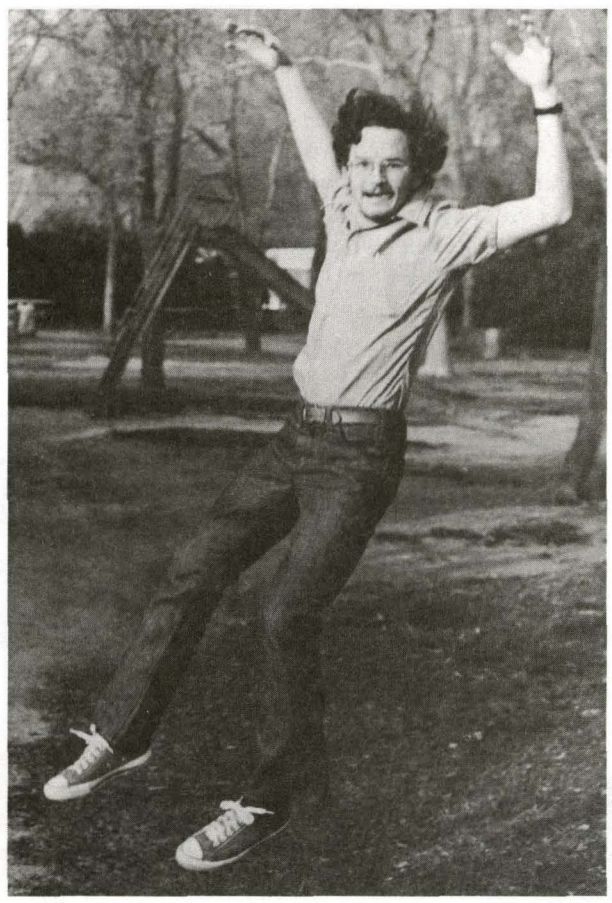


Professor Kirschvink marches with the faculty down Beckman Mall in his sister's (and brother-in-law-to-be's) 1982 commencement. Jocelyn Keene, member of the professional staff in physics, is at right.

As Kirschvink interacts with students, he gets that déjà vu feeling. "I understand the problems they're going through and have seen the same issues, like complaints about food service," he says. "I've also seen it worse." The faculty associate for Page, Ricketts, and Avery Houses still goes back for dinner with the troops.

While giving thanks for the improved cuisine, Kirschvink laments how "a more litigious society" has put a damper on that favorite student pastime: pranks. For instance, what some may consider an improvement to the Hollywood sign in 1987 "turned into a $10,000 lawsuit. That wouldn't have happened in the '60s."

Professor of Physics Ken Libbrecht '80 agrees that, while the larger community appears so intolerant of mischief-making these days, "my impression is that everyone here likes a good prank. I do think that those of us who were undergraduates here tend to be more interested in undergraduate life, on average, probably because we know more about it, having lived



Up in the air about where to go after commencement? 1975 graduate Joe Kirschvink expanded his horizons and then landed a faculty job at Caltech.

it ourselves." But that's not to say alums are angling to be roped into, say, Ditch Day activities. Nor do they feel they are singled out as targets.

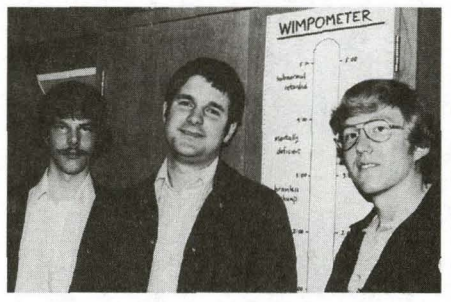
"You're not asking me to set myself up for pranks?" asks Kirschvink cautiously, but then mentions that he is surrounded by "a zillion" Ditch Day clues each spring. "My lab gets pasted with notes and all sorts of things."

"Since I have a lab, I've lent equipment one or two times," says Libbrecht. "But faculty aren't particularly involved." As for traditions like ponding, it's not just alums like Chemistry Professor Nate Lewis (BS and MS '77) who get tossed into Throop pond, Libbrecht points out. It also happens to Harry Gray, the Arnold O. Beckman Professor of Chemistry. "I think it goes along with teaching Chem 1."

Libbrecht's view of Caltech history has been relatively short-term compared with those of Bob Sharp '34, MS '35, the Robert P. Sharp Professor of Geology, Emeritus; and Ed Lewis, PhD '42, Nobel laureate and Thomas Hunt Morgan Professor of Biology, Emeritus. Yet Libbrecht has shared their experience of becoming colleagues with former teachers as well as classmates. As one of the first SURFers, he participated in the Summer Undergraduate Research Fellowship program under the supervision of physicist Steve Koonin '72. He returned in 1984 to see Koonin rise from the ranks of fellow faculty member to vice president and provost. The search for Caltech's next president would be led by fellow alum-turned-faculty-member Kip Thorne '62, the Richard P. Feynman Professor of Theoretical Physics.

Hot on Libbrecht's heels, his Page House roommate Sterl Phinney joined the growing number of returning physicists in 1985. And classmate Kerry Vahala '80, PhD '85, who never left Caltech, joined the applied physics faculty one year later.

Everyone can rattle off a handful of names of Caltech grads-turned-colleagues. Based on their list, they hypothesize about particularly "productive" classes and divisions. "Here's an interesting statistic," says Koonin. "In the '70s from Lloyd House, there was me, Nate Lewis, Joe Kirschvink, Julia Kornfield, and Geoff Blake. Maybe it was something in the water."



Did their experience as Page House roommates and 1980 Ditch Day cohorts prepare seniors Sterl Phinney (left) and Ken Libbrecht (right) for their Caltech faculty days? It didn't seem to hurt them or Doug Whiting (center), who is now vice president of STAC Electronics.

Speaking of Lloydies, Blake, PhD '86, took a leave of absence after his freshman year, imagining he'd be back at some point but unsure of when that would be. He wanted "a broader college experience" in anticipation of having a career in science. The associate professor of cosmochemistry freely admits that his choice was influenced by the fact that "there were eight women in my class of 220." Blake doesn't regret his choice, he adds, "because I met my future wife at Duke." The basketball fanatic also "camped out in tents two days before Carolina games" and roomed with musicians and artists. He has had success bringing that breadth of experience to students as a resident faculty member in Avery House, and he and his family have been invited to live there again next year.

While Blake's undergrad connection is hard to trace (his PhD is the only degree listed in the directories), everyone seems to know Kornfield's alumni

Continued on page 16...

Caltech Alumni and Their Association: Reminiscences and Recollections

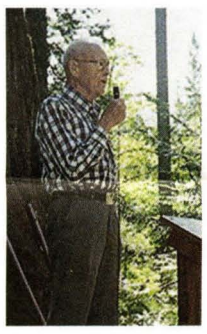
BY TED COMBS '27

In 1907 the trustees of Throop Polytechnic Institute decided to get out of the elementary-school business. Gone too, they decided, would be the business school, the teacher-training program, and the high school. Only the college would remain, offering courses in science and technology, and conferring bachelor of science degrees in electrical, mechanical, and civil engineering. President James A. B. Scherer had the challenge of moving the Institute upward to nothing less than excellence.

He had some history to work with, however. Consider the records of Throop graduates such as James Gaylord '02, who finished his schooling with an MS in electrical engineering at MIT, and went on to work for Southern California Edison Company. In 1932 he became chief electrical engineer for Los Angeles' Metropolitan Water District.

Then there was Joseph Grinnell '97, whose specialty was ornithology. He hiked the mountains north of Pasadena, studying birds. Grinnell identified a previously unknown species of pygmy owl, which he named *Geococcyx californiaus: glaucidium gnoma*. Latin students will deduce correctly that Grinnell named the owl for a social club he had just joined—the Gnome Club. In 1908, Grinnell became director of the California Museum of Vertebrate Zoology at UC Berkeley.

So, while President Scherer had his work cut out for him, the students were already leading the school in the right direction—toward a world-class institute of science and engineering. But World War I interrupted the plans of many, students and civilians alike. Scherer threw himself into war work. He established the Student Army Training Corps, which provided intensive training, including the construction of trenches and sandbag barricades among the orange trees where the Athenaeum and the south student houses now stand. President Scherer was proud to point out that Throop graduates served in the armed forces in significant numbers and that 20 percent of all alumni had received commissions. One, Charles Wilcox '15, shot down three enemy airplanes and was honored with the Croix de Guerre.



In 1991, Combs "unearthed the fact that Caltech owned 20 acres of giant sequoia trees south of Yosemite. In September 1991, with me at the microphone, and with the help of Le Val Lund '47, we named the five giants on the property for Institute President Robert Millikan, scientists George Ellery Hale and Arthur Amos Noyes, Trustee Arthur Fleming (who gave the land to Caltech), and Founder Amos Throop."

Back on campus, students found time to formalize the Alumni Association. The members wrote a charter, which provided for chapters, and elected Virgil Morse '14 Association president. (Morse remained an active Association member until his death in 1991.)

THROOP BECOMES CALTECH

In 1920, Scherer put the final cap on his vision for the school when, with distinguished research scientists George Ellery Hale and Arthur Amos Noyes, he changed the name of the school to the California Institute of Technology. Scherer made the announcement at a weekly assembly in front of the Institute's 337 students. The distinguished title lasted only seconds until a student shouted out, "Let's hear it for Caltech!" "Oh, please don't abbreviate it," said Scherer, according to Institute Archivist Judith Goodstein's book, *Millikan's School*. But Scherer was ignored.

The new Caltech needed a school song. Manton Barnes '21, an electrical engineer by education and a musician of no mean talent, was inspired to compose "Hail C.I.T.," which has not only endured, but has become the school alma mater:

In Southern California with grace and splendor bound,
Where lofty mountain peaks look out to lands beyond,
Proudly stands our Alma Mater, glorious to see;
We raise our voices proudly, hailing, hailing thee.
Echoes ringing while we're singing, over land and sea,
The halls of fame resound thy name, noble C.I.T.

The Alumni Association had 191 members who would often get together for homecoming festivities (usually to attend a football game and yell "to Hell with Oxy"), as well as to help out with Exhibit Day, an occasion where alumni and undergraduates would visit high schools to stimulate interest in Caltech. Commencement in 1924 added 88 new alumni, including nine PhDs and three MSs. The annual meeting of the Alumni Association was held on commencement day.

In 1926, the alumni, flush from a successful football season as undergrads in which they had beaten Stanford and USC, returned to campus to play football against Tech's second-string team. The alumni team, coached and captained by Mike Brunner '25, won, 19 to 17. It seems that the alumni had gained a few pounds, for it was reported in the *Tech* that the alumni team presented "the greatest display of beef since the final barbecue of Rancho San Pasqual."

During World War I, students traded in their study time for marching and rifle practice. Photo courtesy of the Caltech Archives.

In 1930, the Institute's trustees and administration decided it was time to provide on-campus student housing. At that time, many students lived in one of five off-campus fraternities: the Gnome Club (Kappa Gamma), Sigma Alpha Pi, Pi Alpha Tau, Pharos, and Gamma Sigma. The Old Dorm, left over from World War I, had rooms available, but most of the rest of the students lived off campus in residences made available through the housing office. With the removal of the orange grove on the southeast corner of campus for building the Athenaeum, the administration decided there was room for student houses between the Athenaeum and Throop Hall.

Fraternity members, particularly the alumni, were incensed. Alumni had had an active role in fraternity life. They helped in tutoring, provided dates for dances, encouraged athletics and campus activities, and provided employment for new graduates. They held their traditions dear and questioned the future of practices such as the required coat and tie at dinner; everyone standing until the president was seated; and the brief social period after dinner, sometimes with music and singing, that was followed by an all-quiet study period.

The administrators invited student-body president Bob Lehman '31 to head a student committee to study housing programs on other campuses. Committee members visited all of the Ivy League schools and many other campuses across the U.S., and went overseas to Oxford and Cambridge. Because the goal was to make sure that the new houses developed a climate for students' social and cultural

During his Caltech years, Ted Combs '27 became a yell leader, won a letter in track, developed his skill as a debator, and was elected Gnome Club president as well as editor of the *Big T*. After taking several jobs upon graduation (engineering jobs were scarce), Combs settled into the lumber industry. During World War II this expertise was tapped when he was assigned to the undersecretary of war in Washington to streamline wartime construction contracts, work that also took him to the European and Pacific theaters. After several positions, ending as vice president of engineering for Zero Manufacturing Company, Combs left working life to pursue personal interests, one being Caltech. Good friend Lee DuBridge asked Combs to become secretary to the Board of Trustees (which made him an officer in the Caltech corporation) and executive director of the Associates, positions Combs held until two years past the mandatory retirement age. Now married to Viva O'Haver, Combs stays busy visiting his nine grand-children, five great grandchildren, and many friends, and traveling and writing. This article, part of a longer manuscript (originally edited by Edward Hutchings), was edited and adapted for publication in *Caltech News* by Betsy Woodford.

Caltech

Alumni Album

A Centennial Retrospective

Alumni represent a key legacy of any institution. For an institution like the California Institute of Technology, its alumni would have to be truly outstanding for their legacy to live up to the pioneering achievements of the school itself. And outstanding they are—Institute alumni have had an impact on our world far out of proportion to their relatively small numbers. No more than 21,000 alumni have passed through Caltech since the school was founded in 1891.

With this centennial publication, marking the founding of Caltech's alumni organization, the Alumni Association is pleased to offer profiles of some of these outstanding Institute alumni. This alumni album does not attempt to select the "greatest" alumni of the past century—that would be an impossible task, particularly since we are just starting to witness the impact of our more recent graduates. Rather, we wanted to illustrate through 20 individual stories—two for each decade—the remarkable breadth and quality of Caltech graduates and to highlight the energy, creativity, and ingenuity that have become the hallmark of those who have passed through Caltech.

Although Caltech is considered primarily a science and engineering university, its alumni have distinguished themselves in all areas of life, including business, the arts, and public service. Perhaps this is because the essence of what Caltech imparts to its alumni is not just a superior scientific and technical education. It has often been said that a Caltech education provides something more fundamental—the ability to recognize, address, and solve problems no matter where in our lives or society they are found. Through their accomplishments and achievements, our alumni continue to prove that statement true.

Edward Lambert '82
President, Caltech Alumni Association

Frank Jewett '98

Caltech Archives Photo

Frank Jewett

A century ago, when Frank Jewett went to Caltech's forerunner, Throop Polytechnic Institute, getting to school was probably harder for him than getting through classes. Jewett lived with his family five miles away and traveled to school first on horseback and later on a high-wheel bicycle. Not surprisingly, transportation was one of Jewett's original interests, but a chance encounter steered him to a career in the telephone industry.

After graduating from Throop in 1898, Jewett got his PhD at the University of Chicago and then taught physics and electrical engineering at MIT from 1903 to 1904. During Jewett's first term at MIT, he was introduced to a visiting engineer from the American Telephone and Telegraph Company; he made such a good impression that he was hired away when his contract expired the following year.

When Jewett went to work for AT&T as a transmission engineer, the longest-distance phone call anyone could make was between Boston and Chicago. One of Jewett's first tasks was to help create the first transcontinental telephone line in time for the opening of the Panama-Pacific Exposition, held in San Francisco in 1915. Jewett's major contribution was helping design a repeater that would amplify speech waves over a long-distance line. He appealed for help on the project from Robert Millikan, then a physics professor at the University of Chicago and a friend of Jewett's from his Chicago days. Millikan, who would come to Caltech a few years later, helped Jewett recruit several graduate students from his lab.

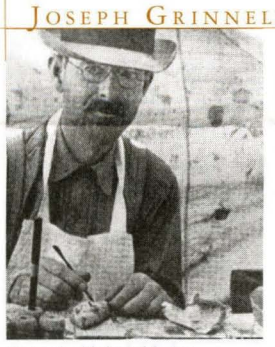
During World War I, Jewett served as a lieutenant colonel in the Signal Officers' Reserve Corps, helping develop the radio telephone and other technical equipment. He was in charge of adapting the wireless telephone to aircraft, which took six weeks to accomplish, and was awarded the Distinguished Service Medal in 1919 for his work in communications during the war.

Jewett quickly rose through the ranks at AT&T and then at the Western Electric Company, the manufacturing arm of the Bell System. He was named chief engineer of Western Electric in 1916 and vice president and director in 1921. Under Jewett's leadership, a radio broadcasting wire network was established in 1923. When Bell Telephone Laboratories was created in 1925, he became its first president, in charge of AT&T's research and development operations. In 1927, Bell Labs demonstrated television transmission by both radio and wire lines, and within the next few years, it developed a coaxial cable system for television broadcasting. Studies of waveguide transmission in the early 1930s at Bell Labs led to the development of radar.

Communications facilities were greatly expanded during Jewett's association with the Bell System. The year Jewett joined AT&T, there were fewer than two million telephones in the nation, but during his 40 years with the Bell System, nearly 20 million telephones were added. In 1940, Jewett became chairman of the board of Bell Labs. When he retired in 1944, any Bell System telephone in the United States could be connected with telephones in almost any other country.

During his career, Jewett served on many government advisory boards. In 1923, he was appointed chairman of the Division of Engineering and Industrial Research of the National Research Council, and in 1933, he was named to President Roosevelt's Science Advisory Board. In 1939, he was elected president of the National Academy of Sciences, a position he held until 1947. Jewett, whom Millikan once called "probably the most distinguished graduate of the Institute," died in 1949. An obituary in *Nature* said, "Those working under his direction did so, not only because his direction was good, but also because it was a labour of love for the leader. He gave an extraordinary example of how to manage men and how to weld together teams of persons (even difficult personalities) into efficient units." ■

Joseph Grinnell '97



Cooper Ornithological Society

Joseph Grinnell, preparing specimens in the field, c. 1915.

When Joseph Grinnell attended Throop Polytechnic Institute exactly a hundred years ago, he explored the rugged foothills of the San Gabriel Valley with the same zeal with which today's undergraduates surf the Internet. He brought home from his travels not data, but something bulkier and more tangible—birds, flowers, and lizards.

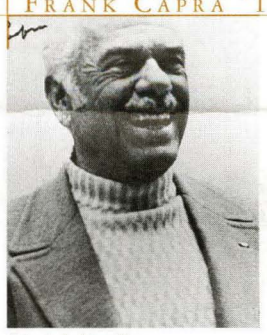
Born in 1877, Grinnell was raised on an Oglala Sioux reservation in the Dakotas, where his father was the government physician; this boyhood "quickened his senses," his wife Hilda, also an ornithologist (and Throop graduate), later wrote, and served him well as a field naturalist. At Throop he studied biology, receiving careful scientific training from botanist Alfred James McClatchie, and spent every free moment roaming the still-wild local terrain, observing the flora and fauna, particularly birds; at eighteen he had published a definitive list of the birds of Pasadena. After his third year at Throop he sailed up the coast to Alaska, where he also collected and classified birds. After graduation he taught at Throop's secondary school and continued his exploration of California and its rich biota. He was the youngest-ever Fellow of the American Ornithologists' Union, and a prolific and much-admired writer.

In his later years, as he witnessed the loss of the West's wildlands, he became an eloquent and prescient conservationist.

Grinnell was more than a taxonomist, though dozens of species of birds, mammals, wildflowers—and a Sierran lake—are named after him. And he was more than a meticulous observer, though his methodical field notes are to this day a model for biologists. He was a naturalist in the tradition of Darwin, speculating creatively about the interrelationships of species and their environments: the adaptive function of geographical differences in birds' coloration, or the role of insects in promoting soil fertility. Grinnell wondered how, for example, since acorns roll downhill, California's oaks could ever colonize slopes and mountainsides—and then he noticed the local jays burying nuts for their winter stashes. The jays, he realized, were the means by which acorns moved upslope.

Today, on the cusp of another century, neither Pasadena nor Caltech bears much resemblance to what Grinnell knew; Pasadena is fuller of people and emptier of other species, and ornithology, zoology, botany, and herpetology won't be found in Caltech's current course catalog. Though he died in 1939, Grinnell was fundamentally that quintessential nineteenth-century figure, the gentleman naturalist. But his work demonstrated the timeless qualities of good science: presented with the same data—the natural world, everyone's backyard—he simply saw it more clearly, and thought about it harder, and better, than other people. ■

Frank Capra '18



Caltech Archives Photo

Frank Capra, in the 1960s.

Before movies became overrun with special effects, they were primarily stories about people, and no one could tell those stories on screen better than Frank Capra. From the mid-1930s through the 1940s, Capra was one of the world's most influential film directors. His movies, which often championed the common man's—and woman's—battles against bureaucracy and adversity, resonated with much of the nation during the Depression and World War II. Today, they continue to be widely appreciated and are viewed as classics of American cinema.

Capra's biography reads like a typical Capra script. Born in Italy, he moved with his family to California in 1903 when he was six years old. He had six siblings, and seven more died before the age of one. His father was an orange picker, and Capra helped support his family by holding down three jobs while paying his way through what was then Throop Polytechnic Institute, from 1915 to 1918. One of the jobs, a four-hour shift with the Pasadena Power Plant, began at 3:30 a.m. After receiving his bachelor's degree from Throop and then serving in the Army, Capra held a series of odd jobs, including banjo player and door-to-door salesman, before landing a job as a writer for Hal Roach and Max Sennett. He eventually talked his way into directing, starting first with silent films.

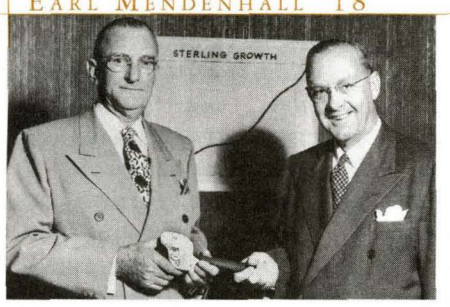
Capra moved to Columbia Studios in the late 1920s, and his films helped turn it into a major studio. At Columbia, he became the first director to have his name listed above the title of his pictures.

His classic 1946 film, *It's A Wonderful Life*, which he also co-wrote, has, for many years, been traditionally shown on television during the Christmas season. Capra's other well-known films include *It Happened One Night* and *Mr. Smith Goes To Washington*. Capra won four Oscars for best director—three for features and one for a documentary—and continued making movies until 1961. In a 1972 interview in *Caltech News*, Capra said, "People don't understand why I can make films but am not doing it. The answer is because I've made them. I've made them as well as I can, and I don't think I could improve on the kinds of films I made, so it's time to move on." That same year, Capra gave his 14-acre ranch in Fallbrook to Caltech. Capra Ranch has since been used by research groups, trustees, and many other members of the Caltech community.

Capra, who often thought of returning to Caltech for his PhD, credited the Institute with helping him make the transition from silent films to talkies. "I knew all about sound waves from freshman physics," he said. When given a lifetime achievement award in 1982 from the American Film Institute, he said, "The art of Frank Capra is very simple: it is the love of people." Capra died in 1991. ■

'10s and '20s

Earl Mendenhall '18



Carl Johnson (left), the president of Sterling Electric Motors; Mendenhall (right) was vice president and general manager.

Earl Mendenhall once backed a car all the way up Fair Oaks Avenue. No, it wasn't a prank, like the water balloons he and other Throop Polytechnic Institute students sometimes hurled from the balcony of Gates; it wasn't boyish high spirits, like the pitched orange-throwing battles waged periodically in the grove that in 1918 still covered most of the Throop campus. It was an engineering solution. Mendenhall was driving a date home from a dance, and on the steep slope of Fair Oaks the gas in the borrowed car's front-mounted tank kept dipping below the feedline. Buy gas? Or drive backward? Mendenhall's course was clear.

He brought the same quick wits to a more high-profile problem when a local manufacturer, Carl Johnson, won a government contract to produce motors to operate electrical equipment at the Panama Canal. The contractor was unsure about meeting the government's specifications, so he turned to his friend Royal Sorensen, a professor of electrical engineering at Throop, and Sorensen turned to a bright young student named Earl Mendenhall. Mendenhall helped Johnson successfully design the motors, and the ad hoc collaboration became a lifelong partnership when the two men plus Allen Adams formed Sterling Electric Motor Company—an association that has been described as "revolutionizing the electric motor industry." Improvements by Mendenhall and associates in the design of electric motors became the standard for the industry. Alone or with collaborators, Mendenhall secured multiple patents for inventions as disparate as an enclosed motor now used in the food industry, and a submersible pump used extensively in agriculture. (A Russian-made copy of one of his inventions was found washed up on the Oregon coast in 1948, confirming the Sterling Company's global influence.)

As a boy in rural California, Mendenhall had ridden alongside his big brother making service calls for the local light and power company. He became fascinated by the new field of electrical engineering, which in those days had nothing to do with today's "double e" of microcircuits and computer chips. Rather, it was enterprise on a grand scale—municipal power systems and electric motors to fuel an energetic new century. From an early age, then, Mendenhall knew he wanted to be an electrical engineer. "I knew exactly what I wanted to do," he told an interviewer in 1981, when the Caltech Archives recorded his oral history, and he never changed his mind "one bit." And when the family moved to Los Angeles, "everyone told me," he recalled, "that the place to go for electrical engineering was Throop Institute." So even though USC was a 15-minute bike ride from his home, and Throop two hours by streetcar, he rose at six every morning to arrive at the corner of Lake and California in time for his first class at Throop. He wasn't disappointed. Not only did Throop have the most up-to-date equipment and a companionable, first-rate faculty, but its reputation drew occasional visits from luminaries like Thomas Edison, who was driven around campus in an open touring car during Earl's junior year.

Mendenhall found his experience at Throop so inspiring that soon after he graduated he served as president of the Alumni Association, from 1921 to 1922. His time at Throop was "one of the highlights" of his life. "No wonder I took four hours a day out of my life running back and forth on the streetcar. It was worth it." ■

Arnold Beckman, PhD '28

Arnold Beckman

There are few scientists who have played as significant a role in academia, industry, and philanthropy as Arnold Beckman. Coming from extremely humble beginnings, Beckman has achieved remarkable success. Not only did he make discoveries that revolutionized science and go on to build a company that became one of the giants of industry, but his generosity has also enabled thousands of scientists and engineers to pursue their goals.

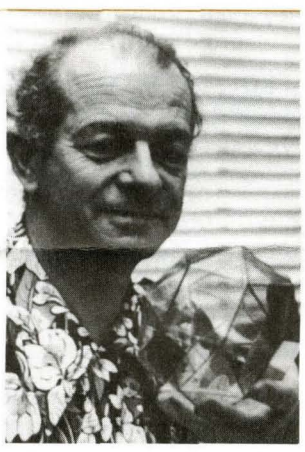
The son of a blacksmith, Beckman grew up in Cullom, Illinois, and became interested in chemistry as a young boy. For his 10th birthday, his father built him a laboratory in a shed, and in high school, Beckman took college-level chemistry courses. After a stint in the Marines, Beckman attended the University of Illinois, receiving his BS degree in chemical engineering in 1922 and his MS degree in physical chemistry the following year. He came to Caltech in 1923, took a two-year break to work for Bell Telephone Labs, and received his PhD in photochemistry in 1928. He became a Caltech instructor that year and an assistant professor the following year.

In 1935, Beckman developed a pH meter to measure the acidity of lemon juice in a citrus-processing plant. The device became an indispensable tool for analytical chemists in many fields, and the same year that it was introduced, Beckman founded a company to market it that would later become Beckman Instruments, Inc. In 1940, he developed two other products that simplified tedious laboratory procedures—the Beckman DU Spectrophotometer, which automated chemical analyses, and the Helipot, a variable resistance device that became an essential component of radar systems during World War II. Also in 1940, Beckman left the Institute to devote full time to the development of scientific devices. Beckman Instruments soon became one of the world's largest manufacturers of scientific and medical instrumentation. In 1982, it merged with SmithKline Corporation. Beckman was vice chairman of SmithKline Beckman from 1984 to 1986 and became chairman emeritus of Beckman Instruments in 1988.

Throughout his lifetime, Beckman, along with his wife Mabel, who died in 1989, has provided unequaled support to institutions of higher learning throughout the nation. The Beckmans provided the funds for four buildings on the Caltech campus and have supported the Institute in many other ways. In 1980, his friends endowed the Arnold O. Beckman Professorship of Chemistry at the Institute in his honor. A Caltech trustee since 1953, Beckman served as board chairman from 1964 to 1974, when he was named chairman emeritus and a life trustee.

Among the many prestigious awards that he has received are the National Medal of Technology and the National Medal of Science. During Caltech's centennial celebration, Harry Gray, the Arnold O. Beckman Professor of Chemistry and the director of Caltech's Beckman Institute, said, "Dr. Beckman is a role model for many of us here. He is one of the great scientists of the 20th century...just a towering figure. You could never write enough about him." ■

Linus Pauling, PhD '25



Linus Pauling contemplates "one of his favorite solids," the structure of the iron-containing protein ferritin.

When F. Scott Fitzgerald said American lives had no second acts, he clearly hadn't met Linus Pauling. Pauling's life encompassed more than nine decades, as well as two Nobel Prizes and enough adulation and scorn, drama and plot turns, for two triple-features running simultaneously.

The man who has been called "the most original and creative mind in chemistry of the 20th century" was a high-school dropout who attended Oregon Agricultural College before earning a PhD in chemistry in 1925 from Caltech, which was to be his home for nearly forty years. In the mid-1920's, physicists were just beginning to explore the new quantum model of the atom. An understanding of the theory's implications for chemistry, plus training in X-ray crystallography, gave Pauling an almost intuitive sense of molecular structure—of "which atoms liked to sit next to each other," as James Watson said in *The Double Helix*. Pauling's investigations into the bonds that held atoms together in molecules resulted in his 1939 landmark book, *The Nature of the Chemical Bond*, and a Nobel Prize in chemistry in 1954.

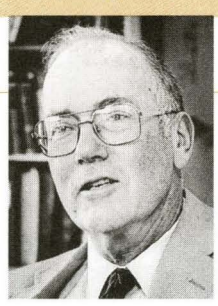
Pauling's interest in biology and genetics began in the late '20's under the influence of Thomas Hunt Morgan, and that interest deepened as his studies of molecular structure led him to the complex molecules of biology. In 1951 he and his lab worked out the crucial idea of the alpha-helix, a long coil of amino acids that is a common structural motif in proteins. His studies of the hemoglobin molecule made him suspect—correctly—that a genetic defect in the formation of the molecule underlay sickle-cell anemia; he continued to wonder about a genetic basis for other illnesses, and undertook an exploration of the nature of the structure of DNA. (His solution—a triple helix—was wrong, but his hot breath on the necks of Watson and Crick probably hastened their discovery.)

Somehow Pauling found time to pursue political activism. After World War II, he circulated a petition against nuclear testing that was signed by more than 11,000 scientists, and once worked up an appetite for dinner with President Kennedy by picketing the White House. These activities won the attention of both the Nobel Committee, which awarded him his second Nobel, the Peace Prize, in 1962, and the anticommunists of the McCarthy era. Although Pauling simply declined to answer the questions of the California congressional committee, to President DuBridge he denied any association with the Party.

Pauling had become chairman of Caltech's Division of Chemistry in 1936; and while his genius and his generosity toward younger colleagues were recognized, his management style provoked tensions. In 1958 he was asked to step down from the chairmanship. Although Pauling was disappointed, his break with Caltech did not come until he won the Peace Prize, when he felt that his achievement was slighted by the Institute. In 1963 he left to pursue his interest in biomedical research, including, controversially, the uses of vitamin C. There was an eventual rapprochement, and he returned to Caltech for a celebration of his 85th birthday, and then again for his 90th.

Pauling was brilliant, charming, audacious—and seemingly incapable of compromise. Nevertheless, as the late James Bonner said when Pauling died in 1994, "he earned the respect of other scientists by being incredibly smart, incredibly inventive, and mostly right. Not always right, but mostly." ■

Charles Townes, PhD '39



Charles Townes

When Charles Townes was a boy on his family's farm in Greenville, South Carolina, he was a tinkerer, a fixer of broken machines and an inventor of new ones cobbled together with spare parts. In fact he and his older brother became so competitive in ingenuity that their father had to bring his lawyerly skills to bear, issuing what the young Townes called a "patten" to settle sibling disputes about who had invented something first. The "patten" cost a nickel.

Townes and his brother Henry also were keen naturalists; Townes says he considers science to be "in one way or another the study of the universe," and for him the outdoors was his first inspiration. He still remembers sitting on a rock in the Blue Ridge Mountains as a college student, reading his physics text's section on special relativity—and deciding Einstein's logic was faulty. After lunch he persevered and was persuaded, and many years later his invention, the laser (for light amplification by stimulated emission of radiation), was used to confirm special relativity, timing with unprecedented precision the velocity of light and showing that it remained constant regardless of the motion of the observer.

Townes retained his boyhood proclivity for tinkering, and in fact claims that growing up on a farm is the best preparation for experimental physics, since it gave him "a feeling for how things work," on a cosmic as well as an immediate scale. At Caltech he worked with W. R. Smythe on the separation of stable isotopes of oxygen, nitrogen, and carbon and on determining the spin of some of the isotopes. But first he had to make sense of, repair, and then modify an intricate apparatus—a tangle of glass tubing, vacuum tubes, and gas flames for boiling mercury—he had inherited from a previous student, Dean Wooldridge, PhD '36. (The "W" in TRW, Wooldridge later became Townes's friend and collaborator at Bell Labs.)

In the days before World War II, Townes recalls, physics was still relatively obscure to the general public. He had to explain to his friends that it was "sort of like chemistry, and sort of like electrical engineering, but somewhere in between." But during the mid-30s, when Townes was doing his doctoral work at Caltech, the discipline was rapidly acquiring some glamor—partly owing to the rich cast of characters gathered at the Institute. Millikan was here, as well as Willy Fowler and Linus Pauling; Robert Oppenheimer shuttled between Berkeley and Caltech, an army of very bright students trailing perpetually in his wake. It was heady company, and Townes stresses that, while he learned much from the excellent and supportive faculty, impromptu conversations with his peers were equally crucial to his career. In fact, he thinks social interaction and the serendipitous conversation are generally underestimated in the popular conception of science: "Ideas, inspirations, and opportunities come as often from the people one happens to meet as they do from some sort of special vision."

During World War II, Townes designed radar systems and navigation devices, and later he characteristically "recycled" the now-obsolete military shortwave radar, using it to investigate the microwave portion of the electromagnetic spectrum, between the shorter infrared and the longer radio waves. Eventually, his inspired tinkering resulted in the maser (microwave amplification by stimulated emission of radiation), powered by the vibrations of ammonia molecules flowing through an electrostatic field. But when he and A. L. Shawlow pushed the idea on to still shorter waves, creating a similar device that used light instead of microwaves, the laser was born. And while the maser has been of far-reaching importance to science—for example, it forms the core of one type of atomic clock, the most accurate timing device ever created—it is the laser that has transformed society, with applications to everything from surgery to supermarket price-scanners.

For his investigations into what has become known as quantum electronics, and specifically for his invention of the maser and the laser, Townes shared the 1964 Nobel Prize in physics with Russian physicists Aleksandr Prokhorov and Nicolay Basov. Three years later, Townes became a professor at Berkeley (he is now professor emeritus there), where his investigations into radio and infrared astronomy led to the discovery of complex molecules like ammonia and water in the interstellar medium, as well as evidence of a gigantic black hole in the center of our galaxy.

Perhaps because his atomic clock mastered time, Townes himself seems relatively impervious to it. On the eve of his 82nd birthday, he continues his research and is finishing an autobiography. Like *Making Waves* (AIP Press, 1962), his forthcoming work interweaves physics, vivid memory, religious convictions, and personal philosophy, in one more attempt to figure out "how things work." ■

William Pickering '32, MS '33, PhD '36

Bill Pickering, with his wife, Inez, thanks the emperor of Japan after receiving the Japan Prize in 1994.

Bill Pickering never went into outer space, but with his help, the United States sent spacecraft to all of the planets in the solar system except Pluto. As director of the Jet Propulsion Laboratory for 22 years, Pickering transformed the facility from a developer of missiles for the Army into a NASA flagship dedicated to the unmanned exploration of the moon, the planets, and interplanetary space. He was such an inspiration and driving force behind the laboratory that he became known as "Mr. JPL."

Growing up in a small town on New Zealand's South Island, Pickering became interested in science at boarding school in Wellington, where he and a friend built the school's first shortwave radio in 1925. After a year at Canterbury College in Christchurch, Pickering headed to Caltech at the encouragement of a great uncle, a retired civil engineer. At Caltech, Pickering received his BS in 1932, his MS in 1933, and his PhD in 1936, all in physics. His mentor was Robert Millikan, with whom he worked after receiving his doctorate, investigating high-energy particles called cosmic rays. As part of his work in the late 1930s, Pickering developed electronic telemetering techniques, so that data could be transmitted from Geiger counters sent 100,000 feet above Earth in balloons.

In 1940, Pickering became a Caltech assistant professor in electrical engineering (he would be named associate professor in 1945 and professor in 1947), and in 1944, at age 33, he went to the newly named Jet Propulsion Laboratory as a section chief developing radio telemetry systems for missiles. Pickering oversaw development of the Army's first long-range, liquid-propelled, supersonic missile, called Corporal. He stopped teaching at Caltech in 1950 to work full time at the lab, and was soon put in charge of the Sergeant solid-propellant missile project. In 1954, Lee DuBridge, then Caltech's president, appointed Pickering JPL's director.

Several years later, JPL's focus turned from missiles to space exploration. Pickering's long record of successful achievements in space began in January 1958 with Explorer 1, the first U.S. satellite to orbit Earth. In response to an urgent plea from the Pentagon, Pickering and JPL managed to get Explorer ready only 83 days after the Army was given the go-ahead, and only 120 days after the Soviet Union put the first Sputnik into space. Under Pickering's leadership, JPL achieved one milestone after another. Among the lab's many firsts were Mariner 2's flyby of Venus in 1962; Ranger 7's mission in 1964, providing the first close-up pictures of the moon; Mariner 4's first close-up photographs of Mars in 1965; and Surveyor 1's soft landing on the moon in 1966.

In running JPL, Pickering has said that his main role was organizing superb engineering teams and effectively answering questions from Congress. He retired in 1976, and when asked to explain his longevity at JPL, he said in his typical wry manner, "I guess things were going all right and they left me there till I got old enough to kick out."

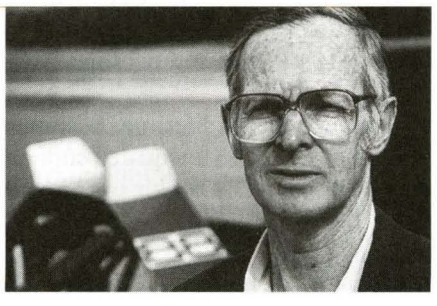
In the late 1970s, after leaving JPL, Pickering briefly taught at Caltech, established an applied engineering research institute in Saudi Arabia, and formed a consulting firm in Pasadena. In 1984, he formed Lignetics, Inc., a company that manufactures fuel pellets out of sawdust. The firm has plants in Idaho and Missouri, and is constructing a new facility in West Virginia. Among the many honors he has received, perhaps the most prestigious are the National Medal of Science, awarded by President Ford in 1975, and the Japan Prize, the Japanese equivalent of the Nobel Prize. It was awarded to Pickering in 1994. ■

Paul MacCready, MS '48, PhD '52

An interesting study could be done of the number of important inventions that have been inspired by either a bet or a debt. Take the Gossamer Condor. This ultralight aircraft was launched by a $100,000 debt its creator, Paul MacCready, owed a friend. When MacCready happened to note that the Kremer Prize for human-powered flight had reached £50,000 in 1976—and that at the then-current rate of exchange, £1 = $2—inspiration was born.

Most of us wouldn't automatically think, hmm, maybe I'll win the Kremer Prize to pay off my debts. But MacCready knew something about airplane design. Not only did he have a PhD in aeronautics (and an MS in physics) from Caltech, but he had a passionate interest in sailplaning; in fact, while a graduate student at Caltech he became the U.S. National Sailplaning Champion. But to build the Gossamer Condor he had to forget most of what he'd learned about sailplanes and resort to simpler models: hang-gliders and hawks. It was his observation of the speed and lift of the hawks that soared and banked above the foothills of the San Gabriel Mountains that gave him his crucial inspiration—keep weight constant, but increase wingspan.

Since MacCready knew that frequent crashes would be inevitable during the development of the Condor, it was built to crash—in other words, to be easy and cheap to repair. Toy wheels were used for takeoff; the leading edges of the wings were made of corrugated cardboard. And MacCready and his team learned something from each crash and made appropriate alterations: parts that never broke, for example, were replaced with weaker but lighter parts. (This is not, he points out, the way to develop airliners.) On August 23, 1977, Bryan Allen piloted the Condor around a "Kremer Course" near Bakersfield, California, thus securing the prize.



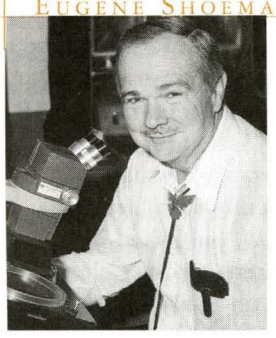
Paul MacCready in front of the GM Sunraycer, which he helped develop.

The Condor was retired—to the National Air and Space Museum—but the debt was not. Unfortunately, MacCready had had to use part of the prize to pay off the cost of building the plane, so he was forced to win another Kremer by building the Gossamer Albatross, which Allen piloted across the English Channel. He also built a solar-powered aircraft, whose pilot had to weigh in, like a jockey, at under 125 pounds. (Unfortunately, humans "strongly resist being miniaturized," MacCready says.) Like many important technological innovators, he seems to have found a way to play and get paid for it, though his "playing" is of a particularly refined sort. And MacCready credits Caltech with, among other things, flexibility. Caltech allowed this kind of creative play and offered opportunities for the wide-ranging multidisciplinary background he needed. As a graduate student he also studied cloud physics, for example, and consulted frequently with Caltech's meteorological department—which was disbanding at the time, but moved en masse as a private consulting company. At the same time, Caltech gave him a sound education in the basics, and if you have a good grasp of the fundamentals, MacCready says, you can adapt to a quickly changing world.

His company AeroVironment develops such adaptive technology—"doing more with less," creating designs that both incorporate engineering efficiency and address environmental concerns. Recently, for example, the company collaborated with GM on the solar-powered Sunraycer vehicle and on the EV1 electric car. Bob Stempel, former chairman of GM, says, "The Sunraycer was one of those great projects that opened our eyes toward what we can do with relatively little energy."

But MacCready and AeroVironment aren't through playing. "No matter what's happened up till now," he says, "there're even more exciting things in the works." ■

Eugene Shoemaker '47, MS '48



Gene Shoemaker

In an attempt to understand the mysteries of Earth, Gene Shoemaker looked to the moon. He initiated the systematic investigation of lunar geology, and through his combined studies of the moon and ancient Earth craters, Shoemaker pioneered the field of astrogeology. In collaboration with his wife, Carolyn, he has become one of the most successful comet hunters in the world.

After high school in Los Angeles, where he developed an interest in radioactive minerals, Shoemaker went to Caltech, receiving his BS in 1947 and MS in 1948, both in geology. He then worked for the U.S. Geological Survey in Colorado, mapping uranium-bearing formations and exploring for uranium deposits. While thinking about the rocket tests then being conducted at White Sands by the Jet Propulsion Laboratory and a team under Wernher von Braun, he suddenly realized that men would soon be going to the moon, that geologists would be likely astronauts, and that he would like to be the first in line for the job. Although failure of his adrenal glands would later keep him from fulfilling his dream, his interest in the moon never waned.

Since many scientists believed that volcanoes had caused the craters on the moon, Shoemaker decided to study volcanic structures on Earth, an investigation that occupied much of his time in the 1950s. In 1960, the year he received his PhD in geology from Princeton, Shoemaker shared in an important discovery at Meteor Crater near Flagstaff, Arizona. By means of a detailed geologic investigation of Meteor Crater, he demonstrated how the crater was formed by impact. Then, with colleague Edward Chao, Shoemaker found coesite—a high-pressure form of silica that could only have been formed by a strong shock produced by the impact. Next, he used similar evidence to show that the 25-km diameter Ries Basin in Germany was an impact crater and in the process founded the field of astrogeology, the study of what happens when a piece of rock or ice hits a planet.

Shoemaker was convinced that Earth has been peppered with impact craters, but that they have been largely erased by erosion. The next logical step was to analyze the craters on the moon, a more pristine body where the record of bombardment is better preserved and where the history of impact might be traced back several billion years.

In 1960, Shoemaker established a lunar geological time scale based on deciphering a stratigraphic sequence of deposits on the surface of the moon. He then began a 10-year program to map the geology of the lunar surface using photographs taken from Earth, telescopic measurements, and images from spacecraft. During that time, he served as co-investigator on the Ranger program, principal investigator for the television camera on the Surveyor missions to the moon, and principal investigator for field geology on the early Apollo landings. As part of his Apollo duties, Shoemaker was responsible for helping to prepare the astronauts to conduct geological field work on the moon. He took them to Meteor Crater and initiated their crash course in geology. The evidence gathered from the NASA missions led to a detailed understanding of the bombardment of the moon by particles ranging from micrometers to tens of kilometers in size.

While pursuing his lunar studies during the 1960s, Shoemaker also taught and conducted research at Caltech, first as a visiting professor and research associate. He joined the faculty in 1969 as chairman of the Division of Geological and Planetary Sciences and professor of geology. He served as chairman until 1972.

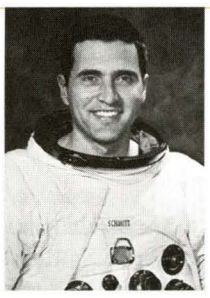
Shoemaker, who was named to the National Academy of Sciences in 1980, left Caltech in 1985 to focus on his studies of impact craters, asteroids, and comets. "I had satisfied my pedagogical urges, and realized that there were a whole lot of fish that I wanted to fry," Shoemaker says. His observing team, which includes his wife, Carolyn, has discovered several thousand asteroids and 33 comets since 1982. One of the group's most famous discoveries was Comet Shoemaker-Levy 9, which it found in 1993, and which crashed spectacularly into Jupiter in July 1994.

Today, a scientist emeritus with the U.S. Geological Survey and a member of Arizona's Lowell Observatory, Shoemaker, 69, continues to hunt for asteroids and comets and to analyze impact craters. One of his remaining scientific goals, he says, is to determine accurately the rate at which craters are produced over time by asteroid and comet impacts, and to establish how the rate has varied and why, which should help clarify Earth's geological history and perhaps help predict its future. "I'm an historian of Earth," says Shoemaker, who credits much of his career to his early years at Caltech, particularly his work under Richard H. Jahns, then an associate professor of geology. "I got superb training in geology with a heavy focus on field geology. I still consider myself a shoe leather, rock-knocking field geologist." ■

Harrison Schmitt '57

As part of a course he teaches at the University of Wisconsin, Harrison ("Jack") Schmitt delivers a lecture called "A Field Trip to the Moon." And Schmitt is one of the few human beings with the undeniable credentials to discuss this topic, since as an astronaut with the Apollo 17 mission, he once scuffed his feet through moondust. He thus became the one and only Caltech alumnus—not to mention the only scientist and the last of twelve humans—to walk on the moon. Afterward, Schmitt ascended again, this time into the chambers of the U.S. Senate, thus becoming the one and only Caltech graduate to achieve that distinction. Schmitt credits Caltech with providing "opportunities that few, if any, other colleges can match," and he has surely seized those opportunities; in addition to his careers as astronaut and senator, he has been a geologist, pilot, administrator, businessman, writer, and college professor.

Schmitt had already seen a great deal of the world before he viewed all of it, in the round, from a distance of



Harrison Schmitt keeps the memories, but not the suit.

400,000 kilometers. He came to Caltech from New Mexico; won a Fulbright to study in Oslo; earned a PhD at Harvard in 1964; received his Air Force jet pilot wings in 1966, and his Navy helicopter wings in 1967. While working for the U.S. Geological Survey in Arizona, he was selected for the Apollo scientist-astronaut program, where he organized lunar science training for the Apollo astronauts, managed much of the hardware and procedures for lunar surface exploration, and oversaw the final engineering preparation of the Apollo Lunar Module Descent Stage.

In 1972, as a member of the Apollo 17 mission to the moon, he landed in the moon's deep Valley of Taurus-Littrow, where, surrounded by 7,000-foot mountains, he was able to view the moon's geology "in three dimensions," as he expresses it. The valley yielded surprising riches, including the famous "orange soil," volcanic debris from deep inside the moon. That discovery had consequences that were both personal—teaching him "to always search for the unexpected"—and scientific, roiling the ongoing controversy over the moon's origin. (Captured? Or split off from Earth? Captured, Schmitt says firmly.)

Back on Earth, Schmitt organized and directed both NASA's Scientist-Astronaut Office and its Energy Program Office, and in 1975 he was elected as United States senator from New Mexico. "It was extremely rewarding," he says—a crash course in political science—but "not productive, compared to the work of scientists and engineers." As chairman of the Subcommittee on Science, Technology, and Space, Schmitt was among the first to call attention to problems that weren't seriously addressed for many years: most notably, the relentless depletion of, and dependence on, fossil fuels. After his term in the Senate, he served on a number of presidential commissions, including the President's Foreign Intelligence Advisory Committee. Currently he's a business and technical consultant in Albuquerque, and teaches "Resources from Space" at the University of Wisconsin.

Schmitt's unique experience has given him both a keen sense of Earth's finiteness and a particularly broad perspective on how to deal with its limitations. "Take a look at the solar system," he says. "How do you make use of its resources to expand our species' possibilities?" As the general session speaker at the Alumni Association's 1992 Seminar Day, he spoke with animation about what he called, in homage to Ray Bradbury, the "Chronicles Plan": fusion energy resources from the moon—and a permanent settlement on Mars by 2010 (five years later he's added about five years to that estimate). ■

Moshe Arens, MS '53

Moshe Arens

As Israel's defense or foreign minister for much of the turbulent 1980s and early 1990s, Moshe Arens had a reputation as a hard-liner who nevertheless tried to ease tensions with the Palestinians. He reached out to Arab leaders on the West Bank, prohibited soldiers and Jewish settlers from using excessive force in controlling hostile crowds, and was the first Israeli defense minister to attend Christmas Eve festivities in Bethlehem. In a region where agreements are regularly broken, Arens was known as a man of his word. Shortly after his appointment as foreign minister in 1988, *Time* magazine quoted a U.S. official as saying, "It (is) tough to strike a deal with Arens. But if you have a deal, it sticks."

But before Arens was a government minister, he was an engineer. Born in Lithuania in 1925, Arens immigrated with his family to the United States in 1939, fleeing the Nazi Holocaust. The experience fueled his interest in Zionism, starting when he was a teenager in New York City. After serving in the U.S. Army Corps of Engineers during World War II, he received a bachelor's degree in mechanical engineering from MIT in 1947. Arens moved to Israel in 1948 during the Arab-Israeli war, helped organize pro-Israeli groups in North Africa and Europe, and briefly lived on a kibbutz before returning to the United States in 1951 to study jet propulsion at Caltech. He received his master's degree in mechanical engineering in 1953 and began his doctoral studies at the Institute before leaving to work in the aircraft industry. With a wife, a young son, and another child on the way, Arens says that he couldn't afford to stay in school.

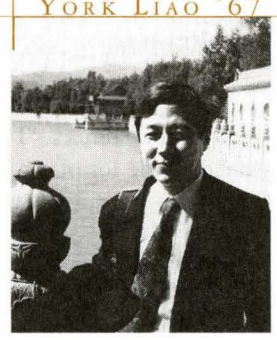
He returned to Israel in 1957 to teach aeronautical engineering at the Technion—the Israel Institute of Technology. In 1962, Arens became vice president of engineering at the Israel Aircraft Industry, directing the development of Israel's fighter and civil aircraft programs and the development of its missiles.

With a reputation for helping to build the Israeli Air Force into a formidable military presence, Arens was encouraged to enter politics by leaders of the conservative Herut party. Elected to the Knesset in 1974, Arens planned to serve for only one 4-year term, but then the Likud bloc, which included the Herut party, was voted into office, and Arens was named chairman of the Defense and Foreign Relations Committee.

In early 1982, he resigned from office when then Prime Minister Menahem Begin appointed him Israel's ambassador to the United States. As ambassador, he met often with senators and congressmen, helping to persuade them to approve $550 million in military aid to allow Israel to begin producing a new generation fighter plane—the Lavi. Following the massacre in September 1982 of Palestinian refugees in Beirut's Sabra and Shatila camps, Arens was named defense minister, serving until 1984, when he was named minister in charge of minority affairs. When the Israeli government decided to cancel the Lavi fighter program in 1987, he resigned from the government in protest. He returned the following year, however, as Israel's foreign minister, serving until 1990, when he again was named defense minister. When the Likud party was voted out of power in 1992, Arens decided to leave government service for good. "I had been in politics for 18 years, and never intended it for my life's work," Arens says. "I thought I'd do it for four years and then return to industry. After 18 years, that was enough."

Since leaving government, Arens has written a book called *Broken Covenant: American Foreign Policy and the Crisis Between the U.S. and Israel*, published in 1995. He also serves on several corporate boards in Israel. Arens credits Caltech with helping him to develop intellectually. "Caltech taught me analytical thinking and how to approach problems," he says. "It was a powerful influence." ■

York Liao '67



York Liao at the Imperial Gardens in Hong Kong.

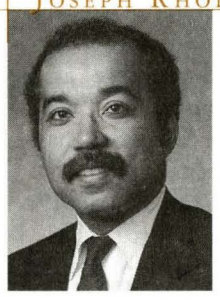
York Liao receives Monday's e-mail in Hong Kong; Tuesday's, Wednesday's, and Thursday's in Malaysia; and Friday's in China. Yet if everything had gone according to plan, he would be securely planted in a Hong Kong university, teaching and quietly going about his research. Instead, he is Executive Director of Varitronix Ltd., one of the first—and still one of the leading—LCD (liquid crystal display) manufacturers in the world, with manufacturing facilities in all of these countries.

Luckily, Liao likes disparate cultures, something he didn't know about himself until he came to Caltech from Hong Kong for a BS in the late 1960s. It was, he says, "one of the most memorable periods of my life": his first trip overseas, his first exposure to a foreign culture (to several foreign cultures, actually, given the international character of Caltech's student body), and his first encounter with what he calls "frontier science." Liao went on to receive his MA and PhD in applied physics at Harvard, where his research dealt in part with the electro-optical properties of liquid crystals—a field that, in the late 60s, was merely a "scientific curiosity," he says. After graduate school he took a year off from research, working for the United Nations as a simultaneous translator, and then settled into what he assumed would be his life, teaching in the department of electronics at the Chinese University of Hong Kong and continuing his research into liquid crystals. "Not in my wildest dreams did I think what I did was useful," he told *Reader's Digest* in a recent article, "Asia's Cool Companies," that included Varitronix.

But when wristwatches suddenly began to feature LCDs, he and a colleague who had more of a business background recognized that Liao's "scientific curiosity" did indeed have commercial applications. "It was entirely fortuitous," he says—and not, perhaps, altogether welcome: like a swimmer entering murky waters, Liao edged into business gradually and tentatively, hanging onto his teaching position for another six years before committing entirely to the new venture. In 1978 he cofounded Varitronix, which continued to be research driven, making up in ingenuity what it lacked in production and marketing experience. The company now concentrates on manufacturing relatively small quantities of LCDs tailor-made to specific needs: airport and railway-station departure and arrival boards, navigation instruments, missile controls, and even a hand-held terminal for placing long-distance telephone bets on horse races. Liao reckons Varitronix makes an average of one new product a day, and today's limited application is sometimes tomorrow's industry standard. Like LCDs on wristwatches.

And Liao has become a much more savvy entrepreneur: while Varitronix is still based in Hong Kong, much of its manufacturing has moved to sites in Malaysia and southern China. Thus his nomadic existence. And thus his businessman's sanguine attitude about Hong Kong's imminent change in political regime, which he describes as "almost a nonevent." For businesses, he says, many of which are already entirely integrated with China, the change will be largely symbolic. "It's like a couple who's been living together for 20 years. When they finally get married, it's not a big deal." ■

Joseph Rhodes '69



Joseph Rhodes

When Joe Rhodes came to Caltech in 1965, his goal was to become a scientist, but he left as one of the nation's most influential student leaders—an experience that propelled him toward a career in government. Trying to change institutional policies was one of Rhodes's interests even before college. Growing up in Pittsburgh, he refused to attend his high school football games and tried to get the school to eliminate sports altogether, since he felt that the inner-city school emphasized sports at the expense of scholarship.

At Caltech, he was determined to concentrate on his studies, but his friends in Blacker House encouraged him to run for president of ASCIT during his sophomore year. To do this, the rules had to be changed, because up to that time only juniors and seniors were allowed to run for president. Rhodes won and was the first ASCIT president to be elected in successive years.

After graduating from Caltech, Rhodes was selected as a Harvard Junior Fellow, studying the history of racism in Victorian England, but his research was continually interrupted by political commitments. In 1970, because of his contacts at HEW, Rhodes became the only student to be appointed to President Nixon's Commission on Campus Unrest, largely formed to investigate the killings at Kent State and Jackson State. Many of his friends vowed never to speak to him again if he served. "I thought, 'People are getting shot up. I want to try to do something so no one else gets killed,'" recalled Rhodes. He immediately found himself battling Vice President Spiro Agnew when he told a *New York Times* reporter that his aim on the commission was to find out whether "the president's and vice president's statements are killing people." Both *Newsweek* and *Time* covered this incident and reported that Agnew had demanded Rhodes's resignation. Rhodes remained on the commission, because, according to *Newsweek*, the president wanted to maintain a wide range of views.

Two years later, officials from his hometown encouraged him to run for the Pennsylvania state legislature. He won and served as a state representative from 1972 to 1980. He said that two of his principal achievements in that job were the passage of juvenile protection and organized-crime laws, for which he wrote the original bills. In 1976, the Ford administration sent him to South Africa to gather information following the Soweto riots. The highlight of this trip was spending several days with antiapartheid activist Steve Biko, who was murdered by South African security forces a few months later.

In 1980, after Rhodes ran for the U.S. Senate and lost in the primaries, he decided to take a break from politics. From 1980 to 1987, he worked for Westinghouse in its corporate planning department. He served as deputy secretary of commerce in Pennsylvania in 1987 and, in 1988, was appointed to the Pennsylvania Public Utility Commission where, he says, he usually found himself fighting for consumers. His term expired in 1995, and last year he formed a consulting firm focusing on the utility industry. He said he may venture back into politics again, a career that he said never would have happened without the Institute. As a Caltech student, says Rhodes, "I learned how to serve a constituency with honor, to deal with adversity, and to be disciplined." ■

'70s and '80s

David Ho '74

David Ho

As *Time* magazine's 1996 Man of the Year, for AIDS research that may have turned the tables on the devastating disease, David Ho has become instantly famous. But along with the accolade came the implication that he is destined to find an AIDS cure. Ho, 44, says that the recognition has been extremely gratifying, but adds, "Sometimes it feels like the weight of the world, at least in regards to AIDS, is on my shoulders."

Born in Taiwan, Ho moved to Los Angeles with his family when he was 12. Physics and mathematics were among his passions in high school and, after spending his freshman year at MIT, he transferred to Caltech aiming to study those disciplines. But he was quickly turned onto biology in his junior year when he took an introductory biochemistry course taught by then-Caltech professors Lee Hood and Bill Wood. Ho had always thought that biology was mostly about memorization, but they showed him how to learn biology through problem solving, a skill that would become invaluable in his AIDS research. He received his BS in biology in 1974.

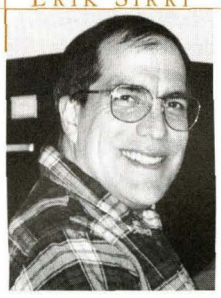
After medical school at Harvard, Ho returned to Los Angeles to do his residency in internal medicine at Cedars-Sinai Medical Center. It was there, as the chief medical resident in the early 1980s, that Ho began seeing patients, particularly gay males, who were dying from infections that would later be identified as resulting from AIDS, and began his long association with the disease.

Throughout his biomedical career, Ho has focused on how the HIV virus, which causes AIDS, works, and his research has yielded some remarkable discoveries. He was the first scientist to show that the virus grows in long-lived immune cells called macrophages, and among the first to show that it could not be transmitted through saliva. In 1990, after being named director of the Aaron Diamond AIDS Research Center in New York, he helped demonstrate that HIV never lies dormant but is feverishly active in newly infected individuals from the beginning. It was this discovery—which he says was made largely by using mathematical reasoning to figure out how fast HIV replicates and decays in different cells—that dramatically changed the way doctors treat their HIV-positive patients. While doctors originally concentrated on treatments in the latter stages of the disease, when symptoms are more prevalent, they now focus their attention on it early, when the immune system is still working.

Last year, Ho made headlines when he reported that by treating patients with a group of new drugs called protease inhibitors, he may have eliminated the virus from the blood and other body tissues. "We've been able to control replication, and I think we can extend it over two years. Next we want to see if we can eradicate it. I don't know yet which way it will fall, but a lot of answers will come out in the next two years."

Ho says that in some ways, being named Man of the Year is premature, since the battle against AIDS is far from over. Nevertheless, it's gratifying to have helped improve his patients' lives, he says, and encouraging to have a scientist, rather than the usual awardee from politics, recognized in this way. "It's also been great from a different perspective," says Ho. "I am an immigrant, and many people are telling me how proud they are to have another immigrant recognized in this way. Many immigrants, including scientists, contribute every day to this country. That's something that I hadn't considered before." ■

Erik Sirri '79



Erick Sirri

Erik Sirri grew up hearing about the space program from his father, who worked for NASA and JPL. Those seductive full-color pictures from the Mariner and Surveyor missions had him hooked, and by the time he entered college his future was clear: he would study at Caltech and he would become an astronomer. And soon he was on his way to fulfilling his destiny, earning his BS in astronomy in 1979.

So why is he currently the chief economist of the Securities and Exchange Commission? Well, Sirri didn't want to be a university astronomer, and he realized—"surprisingly late," he says—that outside of academia the job prospects for astronomers were pretty scarce.

So after Caltech, Sirri went on to receive his MBA from UC Irvine, and his PhD in finance from UCLA. Before joining the SEC, he was an assistant professor of finance—at the Harvard Business School, from 1989 to 1995, and at Babson College from 1995 to 1996. And although he left science, science never quite left him: like many Caltech graduates who have made their careers in other fields, he notes that the problem-identifying, -analyzing, and -solving skills he honed at Caltech applied to his new career. That analytical training, he says, "has repeatedly given me useful insights into my work" as the commission's senior advisor on major economic policy issues. Sirri also heads the Office of Economic Analysis, an independent executive agency responsible for assisting the commission in establishing regulatory policy.

Sirri is still posing and answering research questions, as an astronomer might—and as he did while a professor of finance. But for a member of a government agency, there are significant differences in how those questions are defined and answered, and in the consequences of the answers. Researchers in academia, he says, define their own problems, working alone or in collaboration with one or two others. But the SEC is more like a big company—people work within teams—and there are no laboratory conditions here. The "data" have the messy intractability of the real world.

Take, for example, the problem of how best to design a system for trading stocks. Should the transactions be simultaneous? Sequential? Anonymous? These are questions, says Sirri, that have been posed by researchers like Caltech's Charles Plott, Harkness Professor of Economics and Political Science; in fact, Sirri remembers Charlie Plott's Friday-evening experiments, which recruited Caltech students as players in experiments designed to answer exactly such questions. But in the real world, Sirri notes, "anonymous" traders may move in the same social circles and guess each other's identity from subtle cues. Still, Sirri and the SEC have to make policy based on their best answers, and the effects of that policy propagate outward from the financial community to all of American society—and beyond.

It's a lot of responsibility. Luckily, Sirri has his team at the SEC to support him. And a group of old friends, which he calls the other lasting legacy of his time at Caltech. Caltech, more than any other group of which he's been a part, has provided him with friendships that have lasted through the years. He's not sure what it is about the Caltech experience that forges such long-lived friendships, but he suspects it's the shared rigors of a Caltech education—or, as Sirri jokes, "solidarity in the face of a common enemy." ■

Arati Prabhakar, MS '80, PhD '85

When Arati Prabhakar accepted her PhD from Murph Goldberger in the spring of 1985, she became the first woman to earn a doctorate in applied physics from Caltech. Not surprising for a woman whose mother used to begin her sentences, "When you get your PhD. . ." What was surprising was that Doctor Prabhakar then veered off the path of academia, eventually accepting President Clinton's appointment as Director of the National Institute of Standards and Technology (NIST), an agency of the Department of Commerce whose primary mission is to work with industry on civilian technology that will spur economic growth.

Prabhakar was born in New Delhi but moved with her family to the United States as a small child. She earned her BS and MS in electrical engineering from Texas Tech University, and had every intention of staying in academia. But during her graduate studies at Caltech she began to chafe at the tight focus of academic research, and to think for the first time of another sort of work. "My time at Caltech wasn't happy, but it was important," she says now; "it showed me what I didn't want to do." And it pointed the way toward what really interested her—technology that made a practical difference; casting a wide intellectual net rather than a narrow one. "Caltech was the crucible that formed me—professionally—in an essential way," she says, and she credits her adviser with encouraging her in her search for career fulfillment, and with accepting her decision to leave academia. "He saw a PhD as something that should open doors, not limit choices." And Caltech continues to respect her decision; in 1995 she was named a recipient of the Distinguished Alumni Award, the Institute's highest honor.

Arati Prabhakar

When she left academia for Washington—first for the Office of Technology Assessment, then the Defense Advanced Research Projects Agency (DARPA)—Prabhakar continued to break new ground. Her appointment as head of NIST marked a new direction both for the agency and for her personally: as the youngest person, the first woman, and the first trained engineer, to head NIST, she was expected to guide the Institute through a reorientation that would include raising the profiles of the Advanced Technology Program (ATP) and the Manufacturing Extension Partnership (MEP), both joint government-industry efforts that entail the forging of unprecedented collaborations. ATP funds high-risk, enabling technology projects on a cost-shared basis in companies that range from innovative start-ups to major established firms. The program's overall aim is to facilitate promising technological efforts that are beyond the reach of individual private investment. MEP provides access to information and expertise for the nation's smaller manufacturers, to help them make changes that will allow them to compete in the global marketplace.

Never one to shy away from challenges, Prabhakar has just recently taken on two: parenthood—her daughter was born on January 20—and a new job in California. She's in the private sector this time, as senior vice president and chief technology officer at the Raychem Corporation, a leading materials science company, where she will direct the company's worldwide research and development of products for electronics and telecommunications. So the installment of Prabhakar's life as wunderkind Washington policy-maker is ending. But, as she says, "the ending is just the beginning of a new chapter." ■

William Gross '81

Bill Gross

It used to be that Bill Gross started a new company every time he got a new idea for one. That seemed to happen every couple of years, as Gross would start a new business and exit another. But apparently, Gross couldn't form companies fast enough to keep up with his brainstorms, because he recently started a new firm just to generate and promote ideas. If it seems like Gross has a short attention span for business, his peripatetic tactic has also made him one of the nation's most aggressive entrepreneurs, whose latest venture was likened to a "pit crew to put companies swiftly on track" in a February cover story on Gross in *Inc.* magazine.

Gross's career in business began in high school when he built a kit to convert solar power to electrical and mechanical energy and sold the plans for $4 each in *Popular Science* magazine. This earned him enough money to go to Caltech in 1977. During his freshman year, he built a pair of stereo speakers in the student shop. When his friends heard how much better they were than commercial brands, Gross started a cottage industry making speakers on campus. With knowledge gained from acoustical engineering courses, Gross designed cylindrical speakers that had less hiss than box-shaped ones, formed a company called Gross National Products (GNP), and opened a Pasadena store selling stereo systems, including his speakers. He took a hiatus from school after his sophomore year to build the business, which paid his way through his final two years of college.

In 1984, three years after he graduated, Gross started a new venture, designing business software. His simplified version of the spreadsheet software known as Lotus 1-2-3 was such a hit when Gross showed it off at a computer trade show that Lotus bought the program and hired Gross to write software. Gross sold GNP and went to work for Lotus.

In 1991, six and a half years later, with his son David starting kindergarten, Gross noticed a lack of quality in educational interactive software programs for children, and decided to make his own. He left Lotus to form Knowledge Adventure, an innovative developer of educational software, primarily for children. He quickly produced a series of successful products, such as Dinosaur Adventure and Science Adventure, and signed a joint development deal with Steven Spielberg.

In September 1995, Gross turned over Knowledge Adventure's daily operations to his brother Larry '83, so that he could concentrate on starting new companies. In late 1995, Gross formed Idealab, which he calls a creative capital firm. Designed to give entrepreneurs the seed capital, know-how, and a wide range of other services to get their companies off the ground, Idealab is primarily focused on incubating Internet ventures. With $5 million in start-up funds provided by a small group of investors, including Spielberg and actor Michael Douglas, Idealab has already helped launch 20 companies, including 15 based on Gross's ideas. One of those, CitySearch, is an on-line information service that provides consumers with information on retail establishments and community programs.

While Gross remains chairman of Knowledge Adventure, it was bought last year by CUC International, a marketing company, for approximately $100 million. Asked whether Idealab will be his last experiment, Gross says, "I feel like this is my Sistine ceiling, or something that I will work on for many years and try to leave behind the most perfect thing I can." Although that sounds a lot like something he once said about Knowledge Adventure, Gross adds, "What I feel we are really inventing here is not a 'particular' company, but a methodology for inventing companies." ■

Lounette Dyer, MS '87, PhD '91

Lounette Dyer

Maybe that different drummer Caltech graduates march to is Lounette Dyer. She has certainly tapped out an original, polyrhythmic soundtrack for her own life. Dyer is, as you may have guessed, an accomplished and prize-winning percussionist. She is also a mathematician and computer scientist—and a successful entrepreneur. As cofounder, vice president, and chief technical officer of the Cogit Corporation, which develops software for "data mining" massive corporate databases to find patterns that can be used for competitive advantage, Dyer was recently profiled by *Forbes* magazine as one of the young movers and shakers of the Silicon Valley—a Woman of the Valley, as the magazine termed it.

Dyer's unique beat started early. A gifted math student, she baffled her blue-collar hometown of Muskegon, Michigan; her 10th-grade typing teacher scolded her for dropping his class to take a college-level calculus course at a nearby community college. "You'll be able to make good money typing when you graduate," he advised her. And when she entered Western Michigan University, she was the first person from her working-class family (father Sam was a barber, mother Bonnie a factory worker) to attend college, graduating in three years with a BS in computer science and math (and a minor in music performance). She received her PhD in computer science from Caltech in 1991. Caltech, Dyer observes, is notable for its encouragement of multidisciplinary studies, and for Dyer this meant that she could pursue both her loves: music and computer science. Working with adviser Carver Mead she devoted her research to an exploration of sound synthesis, musical-instrument modeling, speech recognition, and auditory modeling.

In the years since she left the Institute, Dyer has thought hard about how her career decisions were shaped by what she considers unique aspects of the Caltech experience. One was the Institute's emphasis on mentoring. "It was almost an apprenticeship program," she says, and it was partly her relationship with Mead, himself both an academic and an entrepreneur, that inspired her and gave her the confidence to start her own company (she took a leave of absence from her graduate studies to get the work experience she would need). Dyer also was struck by Caltech's commitment to new ideas and to questioning. "In most other top-tier schools," she says, "graduate students are given a problem, whereas at Caltech most grad students are given the problem of finding a problem!"

This ingenuity makes successful entrepreneurs as well as first-rate scientists; it also makes great employees for start-up companies like hers, where the first thing that needs to be done is to figure out what the problem is. Half of Dyer's first group of software engineers were Caltech graduates: "We would not have been able to get the core technology for our company off the ground without a few Techers!" ■

Ari Kaplan '92

Ari Kaplan

Like all die-hard baseball fans, Ari Kaplan is into statistics, with one big difference—he invents them and, in the process, is changing the way baseball conducts its business. As a high school student in New Jersey, Kaplan hypothesized that baseball statistics often didn't tell the truth about a player's effectiveness. At Caltech, he decided to do something about it.

Following his freshman year in 1989, Kaplan was awarded a Summer Undergraduate Research Fellowship to develop better baseball statistics. The most notable result was his Reliever's Effectiveness ratio, which better reflects a relief pitcher's performance than the traditional gauge called the Earned Run Average.

In short, Kaplan divides the number of runners on base when the reliever enters the game and who then score, by the number expected to score. The resulting ratio better reflects a relief pitcher's performance than does the ERA, in which all inherited runners who score are charged to the pitcher who put them on base in the first place.

President Tom Everhart attended Kaplan's presentation of his results on SURF Seminar Day in 1989, and invited him to discuss his research with the Institute trustees at their annual retreat. Trustee Eli Jacobs, then owner of the Baltimore Orioles, was so impressed by the presentation that he hired Kaplan on the spot to work for the team the following summer in 1990. Kaplan developed statistics and improved the team's computer system so that the manager and coaches could immediately access information on players rather than wade through piles of scouting reports. Kaplan worked for the San Diego Padres in the summer of 1991 and, after he graduated from Caltech in 1992, he was hired by the Montreal Expos, developing its computer system from scratch, and helping the team improve the way it scouts and drafts players.

Kaplan, 27, now divides his time between his job as an Oracle database designer and as a consultant to six major-league baseball teams. Most teams, Kaplan says, are in the Dark Ages when it comes to using technology and information to run their operations. "When you base trades and multi-million-dollar decisions on players' statistics, you had better have the best information," Kaplan says.

Kaplan is quick to note that his computer work for baseball is actually just one stop on his way to his lifelong dream—to become the general manager of a major-league baseball team. As Kaplan pursues that goal, he says, he is looking forward to continuing to advance the field of major-league baseball, and is excited about meeting the challenges that lie ahead. ■

Caltech Alumni Album

Produced by the Office of Public Relations and *Caltech News*

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development, and because the fraternities already had successful social programs in place, Lehman's committee, with great reluctance, recommended that the fraternities be closed and their members moved into assigned houses.

With the advent of on-campus undergrad housing, the Old Dorm was no longer needed for undergrads, so Millikan arranged for Lehman and his family to move in and establish a residence for graduate students. Upstairs were the bedrooms and downstairs was a makeshift gym. Nearby were a barber shop, the Greasy Spoon eatery, and a meeting place for the Throop Club. Willy Fowler, PhD '36, and 1983 Nobel laureate, was one of the residents.

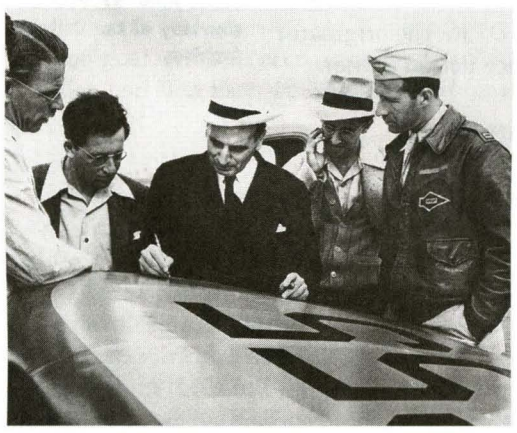
The Alumni Association finally felt able to start its own publication, the *Alumni Review*, in June 1937. Albert Atwood, Jr., '32, MS '33, was the founding editor of the magazine, which had a small format and no illustrations. "That issue was funded by a $150 grant from the Association," says Atwood, "and, as I recall, I went $45 over budget." His classmate, William Pickering '32, PhD '36, furnished an article on research into atoms and cosmic rays. George Rice III '31, whose family owned the George Rice & Sons printing firm, was made assistant editor. (The *Alumni Review* became *Engineering and Science* in 1943.)

In 1938, Clarence Kiech '26 realized that alumni had maintained a keen interest in campus events and current research and teaching. He thought, what better than a one-day refresher course? Kiech found the administration and faculty receptive, and organized a committee that planned the first Alumni Association Seminar Day.

Caltech goes to war again

As a captain in the reserve, I was called to active duty on November 1, 1940, and thus I resigned from the presidency of the Alumni Association (a title I had just acquired). By the fall of 1941, 56 alumni were on active military duty. Students did their bit for the war effort, too. Fred Selleck '49 recalls the members of one Army reserve group at Caltech who, after receiving the Army's promise that they could remain in college, were inducted a short four months later. The inducted students were marched off through the streets of Pasadena in a parade headed by Robert Millikan, who remarked that he had already led two other student-inductee parades.

One big excitement on the campus in 1936 and succeeding years was the design and construction of the 200-inch Hale Telescope. Several alumni were involved in this great effort, including Bruce Rule '32, who was the mechanical and electrical engineer of the project; Sinclair Smith '21, PhD '24, a member of the Mount Wilson Observatory staff who worked on the controls until he died of cancer; and Mark Serrurier '26, who designed an unconventional support structure that was extraordinarily rigid and lightweight, which has been adopted worldwide in modern telescopes. Due to the war, the polishing of the mirror ground to a halt, and Caltech students and faculty turned their attention to rockets.



The rocket research group makes final plans for the first jet-assisted-takeoff flight in 1941. From left are Clark Millikan, PhD '28; Martin Summerfield MS, '37, PhD '41; Professor Theodore von Kármán, head of the graduate aeronautical laboratories (GALCIT); Frank Malina, MS '35, MS '36, PhD '40; and pilot Homer Boushey.

An early military need was for a proximity fuse that would detonate a missile close to its target. Charles Lauritsen, his son Tommy '36, PhD '39, Seth Neddermeyer, PhD '35, John Streib '36, PhD '41, Robert Becker PhD '41, and Willy Fowler all worked on artillery rockets that used solid propellants. The rockets were designed on campus, powder was produced in bunkers in Eaton Canyon, and testing was done at Goldstone. Metal parts were made in Los Angeles-area machine shops, the number of which reached 400 at the peak of production.

The method developed by Carl Anderson '27, PhD '30, for firing rockets from aircraft and the design by Ira Bowen, PhD '26, of a nose cone that enabled a missile to penetrate water instead of skipping off its surface, stimulated instant interest by the armed forces in Caltech's expertise in developing specialty rockets. During testing, Caltech's designs proved so successful that the military would demand more rockets before industry could gear up to make them. So Caltech found itself in the manufacturing business. One run was for 60,000 units, small by military demands, but overwhelming to Caltech capabilities. Willy Fowler, Charles Lauritsen, Bruce Sage, PhD '34, Frederick Lindvall, PhD '28, and Vic Veysey '36 helped to produce the armaments. By the end of the war, Caltech had produced more than one million rockets, which the Navy funded at the rate of $2 million a month.

No description of Caltech's involvement in World War II would be complete without mentioning Irving Krick, PhD '34. Krick, the first Caltech PhD student

Continued on page 12...

Highlights from 100 years of alumni history

1895—The first students graduate from Throop University—all are from the training programs, none from the college.
1896—The first AB degrees are awarded to Diantha Haynes and George Doty. Throop Polytechnic Institute's football team defeats USC 22–0.
1897—The first Alumni Association is founded for Throop Polytechnic Institute. On March 9, the Gnome Club is started as a social club.
1898—Two alumni associations exist—one for the college and one for the commercial school.
1907—A total of 20 alumni have graduated from Throop by this year.
1915—Due to the reorganization of Throop Polytechnic Institute into Throop College of Technology in 1913, alumni meet to formalize the Alumni Association and to provide for chapters.
1917—The first MS degree is awarded to Paul Manning in chemistry.
1920—Roscoe Dickinson earns the first PhD, also in chemistry.
1921—An influx of alumni join the faculty of the newly named California Institute of Technology. The first Southern California Alumni Association chapter is formed.
1924—Robert Millikan, head of the Institute, starts the Associates.
1926—Roscoe Dickinson is the first alumnus to join the professorial faculty.
1931—Undergraduate houses Dabney, Fleming, Blacker, and Ricketts are built and opened.
1937—The Alumni Association publishes its first magazine—Alumni Review.
1938—The first Alumni Association Seminar Day is held.
1942—Membership in the Alumni Association tops 1,000.
1943—The alumni magazine becomes a monthly instead of a quarterly and its name is changed to Engineering and Science.
1948—Palomar Observatory is opened and used to map the northern sky.
1954—William Pickering '32, PhD '36, is appointed director of JPL.
1956—Philip Conley '56 becomes the first Caltech student to be awarded three letters in each of three major sports.
1960—Three more student houses are built: Lloyd, Page, and Ruddock.
1962—Winnett Student Union is built.
1964—Arnold Beckman, PhD '28, is the first alumnus elected chair of the Board of Trustees. Beckman Auditorium opens.
1966—For Caltech's 75th anniversary, the first Distinguished Alumni Awards are given.
1967—The first issue of Caltech News is published in April. Alumnus Chester Carlson '30 gives funds to complete Noyes Laboratory.
1968—Frank Borman, MS '57, a member of Apollo 8's crew, makes the first manned flight around the moon.
1971—Simon Ramo, PhD '36, and his wife, Virginia, fund Ramo Auditorium in Baxter Hall.
1972—Harrison Schmitt '57 becomes the first scientist to walk on the moon.
1973—The first female undergraduates receive their diplomas: Deborah Chung (also MS '73), Stephanie Charles, Sharon Long, and Flora Wu.
1974—The Arnold and Mabel Beckman Laboratories of Behavioral Biology are completed.
1985—Ruben Mettler '44, PhD '49, is elected chair of Caltech's board of trustees.
1989—Beckman Institute is dedicated; Paul Jennings, PhD '63, is appointed Caltech's provost. The U.S. Postal Service issues a stamp commemorating Chester Carlson '30, the inventor of Xerography.
1991—Caltech celebrates its centennial with President George Bush as commencement speaker.
1994—Gordon Moore, PhD '54, is elected chair of Caltech's board of trustees.
1995—Steven Koonin '72 succeeds Jennings as Caltech's provost.
1996—The Gordon and Betty Moore Laboratory of Engineering is dedicated.

Malina, Smith, and Tsien decided to design a workable rocket engine, funding the work from their own pockets.

in meteorology, who went on to found the Institute's meteorology department, and not only trained more than 675 military meteorologists who came to Caltech during the war, but he and his weather forecasts also played a part in picking the dates for the Allied invasions of North Africa and Normandy.

The Jet Propulsion Laboratory

Large, high-altitude rockets were also being studied at this time, by researchers who were working in aeronautics. Frank Malina, MS '35, MS '36, PhD '40; Apollo Smith '36, MS '37, MS '38; and Hsue-Shen Tsien, PhD '39, were working on wind-tunnel design when they decided to design a workable rocket engine—funding the work from their own pockets. They were working in the basement of Guggenheim, when, unfortunately, there was an explosion. It did no structural damage, but filled the building with nitrogen tetroxide—a corrosive vapor that immediately rusted every susceptible surface. Theodore von Kármán, then head of the aeronautics laboratory and Malina's faculty advisor, of course said "Out!" And the team moved to the Arroyo Seco.

On March 4, 1954, the men of Dabney, having raised the most money in an ASCIT-sponsored charity drive, were rewarded with a formal dinner, courtesy of faculty members. Taking their serving duties seriously are, from left: Linus Pauling, PhD '25, chair of chemistry and chemical engineering; designated headwaiter George Beadle, chair of biology; Norman Davidson, currently Chandler Professor of Chemical Biology, Emeritus; and Harvey Eagleson, professor of English.

Malina's group eventually designed and successfully tested a liquid-fuel motor. In 1940 the Army Air Corps became interested in the research, and the group, now with an official name—the Jet Propulsion Research Project—worked on developing solid-propellant rocket engines that could lift airplanes more quickly from short runways. Archivist Goodstein writes in her book that von Kármán and Malina wanted to use this army contract as a springboard to establish a Caltech-owned Jet Propulsion Laboratory, but Caltech's trustees declined to do so—"JPL remained an army research and development laboratory until the late fifties when it was transferred to NASA and embarked on a new career as the center of America's unmanned space program."

Malina was the first of several Caltech alumni who served as JPL directors. The second was Louis Dunn '36, PhD '40. Pickering '32, PhD '36, served as director for 22 years, from 1954 to 1976. Other alumni leaders in this historic revolution in aeronautics and jet propulsion were Homer Joe Stewart, PhD '40, and the Clauser twins, Francis and Milton, both '34, PhD '37.

The DuBridge years

Lee DuBridge succeeded Robert Millikan as Caltech president in 1946 and wrote in *Engineering & Science*, "I am already proud of Caltech alumni. I was proud of them even before I came to the Institute. I have met them in my travels and duties in recent years through the length and breadth of this country. In every case I have found them to be men of ability and vision—men who hold the highest respect of their colleagues and their communities. No institution could have a greater asset than such a fine alumni body."

During the DuBridge years, the dedication and helpfulness of alumni on behalf of Caltech reached a new level. One example is the recruiting meeting with Los Angeles–area high-school principals, which was arranged by Howard Lewis '23, and attended by him, President DuBridge, and Professor L. Winchester Jones, registrar and director of admissions. Jones then traveled to alumni chapters in Chicago, New York, Schenectady, Boston, Philadelphia, and Pittsburgh to outline ways in which alumni could be of assistance in securing the best students for Caltech.

After eight years of fund-raising through the Alumni Fund, the Alumni Swimming Pool was dedicated in 1954 and Caltech students were flying high.

In 1949, the Alumni Placement Committee established the Placement Consultant Service. Approximately 100 alumni in Southern California counseled Caltech students on courses of study and employment opportunities.

This support of the Institute became an institution itself with the founding of the Alumni Fund in 1947. Under the energetic leadership of Charles Varney '22, the fund grew, having the goal of providing recreational and athletic facilities for students. It took eight years, but in 1955, the Alumni Swimming Pool was dedicated.

Of this new alumni–Caltech relationship, Alumni Association President Howard Lewis wrote, "A great and fundamental change has taken place in our own conception of our reason for existence and in our relationship with the Institute . . . now we are recognized as a member of a great team, composed of the trustees, the Associates, the administration, and the faculty, working for the growth and advancement of Caltech." The Alumni Scholarship, first established in 1922 and apparently not continued, was renewed in 1954, when the Alumni Board set aside $15,000. Over the years, the money has grown so much that in 1993 it was possible to give five awards to students.

Charles Newton, DuBridge's public-relations man, had a big influence on the Alumni Association during this time. Newton realized that the Association was being run as a gentlemen's club. Gradually, Newton formalized the situation, hiring a journalist as editor for *Engineering and Science* (Ed Hutchings) and initiating professional money-raising techniques. The roster, which had been a card file in a shoe box, was transferred to a mailing machine. Thanks to Newton, the Association was growing up.

Fundraising and friends

In 1958 Caltech announced "the most ambitious undertaking in the history of the Institute"—a campaign to raise $16.1 million in new capital funds. The alumni pledged to raise $1 million. Led by Frank Bumb '51, MS '52, chairman of the Alumni Steering Committee for the development program, the alumni donated $1.3 million.

Everyone was saddened to learn of the death in 1965 of Royal Sorensen, head of electrical engineering at Throop and then Caltech, from 1910 until he became professor emeritus in 1952. He had influenced the lives of more students than anyone else, not only as a dedicated teacher, but also with his involvement in the athletic program—he was the perennial speaker at the football banquets. His greatest pride was in the achievements of his students. One brilliant group in the thirties included Simon Ramo, PhD '36, the R of TRW; Dean Wooldridge, PhD '36, mastermind of the U-2 spy plane, leader in the intercontinental ballistic missile program, and the W in TRW; Louis Rader, PhD '38, creator of the GE electric computer; Gilbert McCann '34, PhD '39, an authority on lightning and lightning protection; Barney Oliver, PhD '40, head of research at Hewlett-Packard and developer of many of the company's key products; and John Pierce '33, PhD '36, the originator of satellite communications, and science fiction author.

Bruce Rule '32. Photo courtesy of the Caltech Archives.

The Alumni Association matures

About 1965 I had been lured back to campus to start a corporate-relations program when President DuBridge announced the start of another fund-raising campaign. As the campaign took shape I was asked to head the alumni effort. Six busy people studied our status and goals, and analyzed alumni as to classes, geographical distribution, and leadership potential. It quickly became obvious that the Association had the potential to come of age with an executive director and its own office. A committee led by William Nash '38, PhD '42, studied the situation and recommended that yes, the alumni could support an executive director and, yes, we should initiate a newspaper to be circulated to all alumni.

At this same time, Don Clark '29, PhD '34, who had served as secretary to the alumni board, stepped down after 23 years of devoted service.

Clark had been a stalwart of the Alumni Association and his presence would be sorely missed. He was one of the few men who could wear three hats at the same time, not only efficiently but comfortably. At Caltech he served as professor of physical metallurgy, director of placement (predecessor to today's Career Development Center), and secretary of the Alumni Association. Efficiency and organization were two of Don's strongest points. A man who could handle a staggering amount of work, Clark never forgot anything, never lost anything, and never threw anything away.

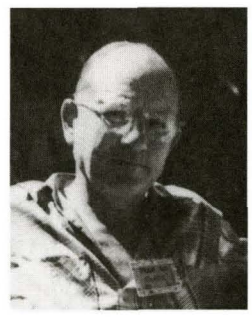
Clark served one two-year term as director of the Alumni Association, and for four years was editor of *E&S*, but his main contribution to the alumni was as secretary. He took the job for one year—in 1946—and finally stepped down more than 20 years later. He helped plan all events, assisted committee members and the board in carrying out the details of their work, and attended monthly board meetings (keeping a spectacularly detailed set of minutes). He handled all correspondence on alumni matters, and kept in touch with the chapters.

Our new executive director stepped in to fill the void left by Clark's departure. He was Jim Black, a former assistant city manager, who beat out 85 other candidates for the job.

Clark never forgot anything, never lost anything, and never threw anything away.

President DuBridge had for some time wanted to give special recognition to alumni of high achievement—an event appropriate for Caltech's 75th anniversary celebration in 1966. Because Caltech did not give honorary degrees, it was decided to present Distinguished Alumni Awards—the equivalent of honorary degrees, but restricted to alumni.

At first we thought that the Institute would recognize six to ten Distinguished Alumni, but as nominations came flooding in, it was decided to honor a larger initial group—23. A similar number was also honored in 1967; thereafter, the numbers were smaller.



Don Clark '29, PhD '34. Photo courtesy of the Caltech Archives.

To honor the new Distinguished Alumni, a black-tie banquet was staged on October 25, 1966, at Pasadena's Huntington Hotel. President DuBridge, beaming with pride over Caltech's children, stated, "It was clearly a presumptuous action we took, when we decided to pick from 9,906 alumni, 23 who attained rather special distinction. No one denies that we could easily have found 23 more who also deserved recognition. But these 23 are all men of whom any institution would be proud. And we are proud of them." He then introduced each one, read their citations, and presented the certificates and medals.

In 1967 Ruben Mettler '44, PhD '49; William Nash, Jr.; and Richard Schuster '46 led the way for alumni contributions to Caltech's capital campaign. By April 1968, nearly $3.5 million—more than a quarter of the campaign total—had come from alumni.

The 1970s and 1980s

Alumni were in big demand on campus in 1971. W. Morton Jacobs '28 was the incoming president of the Associates, succeeding John McMillan '31. The commencement speaker was NASA head James Fletcher, PhD '48, talking about the challenges of space exploration. J. Stanley Johnson '33, MS '34, oversaw the dinner celebrating the 55th anniversary of the Caltech Y. Seminar Day that year had a large turnout—1,480 alumni, family members, and friends.

Not to be outdone by other big events, the Alumni Association Board thought it was time to establish a Half Century Club. Their first event celebrated the reunion of the class of '21. Alumni President Reuben Moulton '57 observed that whereas the Association had originally been a social and nostalgia-preserving group, it was becoming an organization whose major purpose was to help to support Caltech. He also observed that, in general, engineers and scientists were not held in as high a regard as they had once been, creating a need for increased communication and promotion. Moulton himself, though, had pretty good communication skills—that year 70 percent of the graduating seniors joined the Association.

Caltech's 1972 Science for Mankind fund-raising drive exceeded its $70.4 million goal. Alumni accounted for $11.7 million of the total. Si Ramo, Rube Mettler, and Ben Earl '44 were honored for their leadership in the campaign.

Alumni House

When Carel Otte, MS '50, PhD '54, took over the position of Association president in 1979, he and the other board members became convinced that the association needed a central facility—one large enough to accommodate the office, Placement, and the Alumni Fund, with room for expansion.

Reaching an agreement wasn't easy. An Institute-owned two-story house at 345 South Hill Avenue had good potential, but needed considerable rehabilitation. The cost was estimated at $100,000. The Institute insisted that the work be done at alumni expense, but it was willing to lease the building to us for $1 per year. Alumni had to raise the needed funds entirely outside the Alumni Fund.

Carel & Co. went to work. His position with Union Oil required him to make frequent visits to the East Coast. One of his first calls was on Jim Glanville, MS '46, Eng '48, a Caltech trustee. Glanville's pledge for $5,000 kicked off the drive, soon followed by a contribution from Ben Earl. The fraternities funded the Gnome Room and the Sigma Room. Meanwhile, costs rose to nearly $200,000. Phil Reynolds '58, MS '59, and Jim Workman '57, MS '58, became personally involved in the preparations, devoting untold hours to the need for more funds, and to such projects as making the rear garden suitable for outdoor entertaining. At long arduous last came the grand opening in September 1980.

That same year, the Alumni Association honored three loyal friends: Robert Sharp '34, MS '35, tour guide extraordinaire; Jesse Greenstein, cosmic explorer; and Ned Munger, a prolific speaker at chapter meetings. Sharp, already an alumnus, was presented with a testimonial resolution that included twelve "whereases" recognizing his accomplishments and contributions during 50 years of friendship, service, sage advice, humor, and wisdom. Greenstein and Munger were named honorary alumni.

In 1982, tales of alumni were told through print in *Legends of Caltech*, a comprehensive record of student pranks put together by Willard Dodge, Jr. '44, MS '47, Reuben Moulton '57, Harrison Sigworth '44, and Adrian Smith '70, and published by the Alumni Association. It did so well that a second volume, *More Legends*, was published in 1989.

The Alumni Fund continued to do well. Alumni Association President Arne Kalm '56, MS '57, brought his own way of doing things to the selection of fund volunteers in 1983. In a corollary to the Peter Principle, Kalm said, "In a volunteer organization, it is availability, not necessarily competence, that counts." Whatever his formula, the campaign that year did well—$924,014 was raised from 4,655 alumni.

Time for a vacation

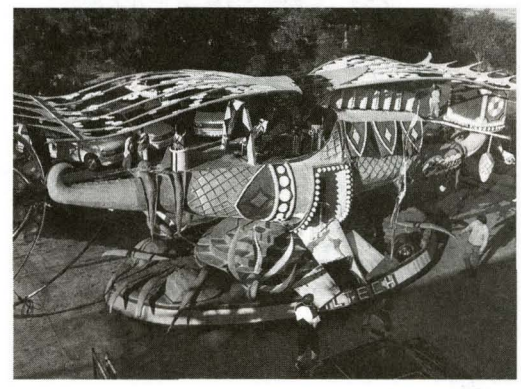
Travel/study programs, especially geology trips, have long been popular with alumni. Bob Sharp, along with Leon Silver, PhD '55, Clarence Allen, PhD '54, and others, has been so deeply involved that trips are virtually his second career. To date, Sharp has led trips to Hawaii, Owens Valley, Yosemite, Alaska, Bryce and Zion National Parks, Death Valley, and Iceland. Geology has not been the sole focus of travel/study programs. Shakespeare festivals, the Galápagos Islands, rivers in Europe, and the Yucatán have all been visited by inquisitive Caltech alumni. In recent years, shorter and less costly programs have been added to the schedule in response to a plea from younger alumni.

The modern Association

In 1991 Caltech had a big milestone coming up—its centennial. A steering committee was established, and I offered to be liaison between the alumni and the Tournament of Roses Association for Caltech's Rose Parade float. This resulted in my once again being elected to the board—49 years after having served as president.

The float project needed all my available time to select a theme and a float builder and to ensure the involvement of students. After the design was complete, alumni joined a swarm of other Caltechers in decorating the float. The result will long be remembered—a time machine, the most intricate float in the parade that year. Its main feature was a Rube Goldberg machine that involved a cuckoo clock, a teeter-totter, a row of falling books, and a chute with apples—one of which fell on Sir Isaac Newton's head. The title of the float was "For Every Action a Reaction." Alumni Association president Mike Boughton '55 accompanied the float down Colorado Boulevard, dressed in a beaver costume.

Learning that others were boasting of the number of times that they had played football in the Rose Bowl, we researched Caltech's record. From 1923 to 1967, the varsity played there 96 times and the frosh played 4 times, for a total of 100 Rose Bowl appearances. We hope that this is the record.



Caltech's entry into the 1991 Tournament of Roses Parade, created in commemoration of the Institute's centennial, was designed in part by students in a special class—Mechanical Engineering 100. A bevy of beavers, otherwise known as Caltech alumni, students, staff, and faculty, accompanied the float down the parade route.

In conjunction with the centennial was another fundraising effort—The Campaign for Caltech. Hugh Colvin '36 made a challenge offer of $3 million for matching donations to the Alumni Fund. Reunion classes also made important gifts: 1943 gave $51,047; 1948, $140,090; 1958, $42,030; 1963, $15,510; 1968, $41,990; and 1983, $13,538. The class of 1941, celebrating its 50th reunion, raised $114,392—the largest reunion class gift ever. That year, as part of the Campaign for Caltech, five named professorships were given by alumni: Warren Schlinger '44, PhD '49, Richard Dickinson '52, Allen Puckett, PhD '49, Martin Summerfield, and George Van Osdol '34. Alumni donated a total of $106 million to the campaign.

Gary Stupian '61, Alumni Association president in 1991, a scientist with Aerospace Corporation and a computer expert, initiated an alumni e-mail program and established user groups on the Internet just for Caltech alumni. The Association joined the information superhighway.

In 1997, there are about 19,000 living alumni, 7,000 members of the Association, and 15 chapters. Thirty-seven percent of alumni belong to the Association. Taking care of us are the Alumni Association staff: Judy Amis, Arlana Bostrom, Karen Carlson, Kerry Etheridge, Patsy Gougeon, Laura Reimann, and Lisa Winiecki, who handle travel/study programs, Distinguished Alumni Awards, division reunions, undergraduate admissions support, student/faculty/alumni relations, Seminar Day, Alumni House, and membership records.

Continued on page 14...

The Alumni Association and the future

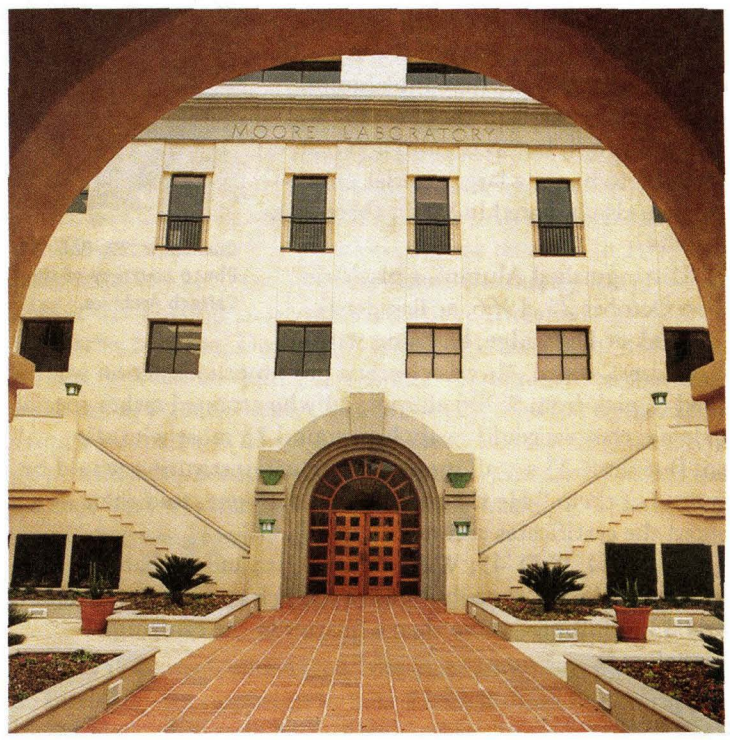
By the time Caltech celebrates its 150th anniversary in 2041, it will have awarded nearly 40,000 degrees and there will probably be more than 30,000 living alumni. Assuming that smallness and excellence continue to be the Institute's goals, the campus, faculty, and student body will have expanded only nominally. JPL will have mapped the solar system. The Keck Telescopes will have discovered many phenomena previously only imagined. Research on campus will have contributed greatly in the fields of science and engineering. Classes will still be small and instruction will be modernized. Students will arrive at Caltech eager to engage in research. They will find, as past Caltech students have, that the world is full of unknowns.

Author's note: When I was asked to write the history of the Alumni Association I thought it would be a pushover. Thinking that the Association had been founded eight years before my arrival in 1923, I thought I had witnessed most of the history myself. But needing a few supplementary references I went to Institute Archivist Judith Goodstein asking to see the records on the Association's history. Her reply was a shocker: "There aren't any."

What she meant was that any information was buried in catalogs, student newspapers, presidential papers, Institute publications, and records stored in the basement of the Alumni House. I found out in an old Throop Bulletin *that an alumni association existed in 1897! This year, we celebrate our centennial.*

This account would not have been possible without the good memories and reviewing skills of Al Atwood '32, MS '33; Ed Bryan '54; Peter Mason '51, PhD '62; Fred Selleck '49; Vic Veysey '36; Bill Whitney '51; Don Wilkinson '48; John Gee '53; Carel Otte, PhD '54; Harry Sigworth '44; and Professor J. Kent Clark, Caltech professor of literature, emeritus.

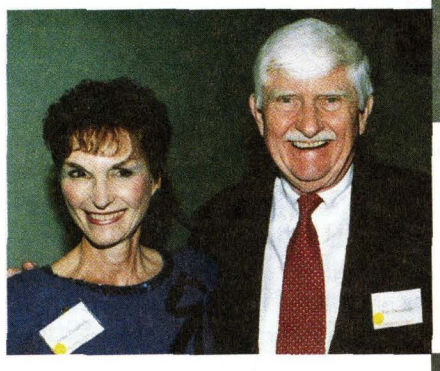
It is likely that this history will be updated from time to time—I encourage you to send in comments and reminiscences.—T. C. ■



Dedicated in 1996, the Moore Laboratory of Engineering, a gift from Board Chair Gordon Moore, PhD '54, and his wife, Betty, is the latest of many buildings on campus that have been funded by alumni. (See Highlights, page 11, for the complete list.)

Friends

LEFT: David Russell followed in his parents' footsteps when he recently joined the Associates. Offering her congratulations is his mom, Pat, a life member of the Associates, former president of the Los Angeles City Council and representative of the Sixth District, and member of the President's Circle. Russell's dad, the late William Russell, was an alumnus (MS '47, PhD '50).



LEFT: Ray Destabelle '52, MS '53, and his wife, Anne, enjoy the Associates' New Member/Provost's Circle dinner in February. The Destabelles, who have joined the President's Circle, were among a record number of new Associates members.

RIGHT: Don Stewart '47, who has been collecting Caltech memorabilia (in showcase) for only slightly longer than he has been volunteering for the Alumni Fund, is being honored on June 14 with a Staff Appreciation Award, in recognition of his 31 years of service to the fund. Since his start as a caller in 1966, Stewart has consistently recruited volunteers every year for the Alumni Fund and for alumni phone nights. Currently, Stewart is serving as reunion class gift chair for the class of 1947's 50th reunion, for which he recruited a committee of 17 and shepherded them through the process of calling their classmates to publicize the reunion and raise the money for the class gift.

Gifts by Will

Caltech trustee Howard Vesper and his wife, Frances, have left Caltech the majority of their estates, totaling over $3,000,000. The funds will be added to the Howard G. and Frances B. Vesper Scholarship Fund to provide financial aid to undergraduates who demonstrate outstanding academic potential, leadership ability, and financial need.

Howard Vesper received his BS in chemical engineering from the Institute in 1922. That same year, he was hired as a research chemist by Standard Oil Company, now Chevron, where he spent his entire career, retiring in 1967 as director and vice president. He also participated for several years as a civilian consultant to the former Research and Development Board in the Department of Defense. Vesper died in 1995.

The Vespers were members of the President's Circle of the Caltech Associates, which they joined in 1958. Howard Vesper became a Caltech Trustee in 1954 and a Life Trustee in 1974. In addition, he established the Howard G. Vesper Trophy for basketball in 1950, which is awarded annually.

Class Notes

Our new alumni class-notes section debuts with the undergraduate class of '44, the only one to get its column in by deadline. Our thanks to scribe Paul Winter. Other class agents are also working hard (we think) on gathering news of their classmates, and we hope to have many more classes represented in the next issue, as this new feature gets rolling. So if your class agent is listed below, let him or her know what you've been doing. If an agent for your class isn't listed here, how about volunteering to be one? To learn more about the project, write Kent Frewing at 455 Noren Street, La Canada Flintridge, CA 91011-2756; phone him at 818/354-6780; or e-mail him at h.k.frewing@jpl.nasa.gov. The Association is also working to set up a similar network for alumni who received their graduate degrees from the Institute. In the meantime, if you have news to share and no class secretary, please send a Personal to the Caltech Alumni Association, Caltech 1-97, Pasadena, CA 91125.

1944
Compiled by Paul H. Winter
859 S. Orange Grove Blvd.,
Pasadena, CA 91105-1738

This is my fifth year of "retirement" here in my small office in the Physical Plant building on the Caltech campus. As a non-staff-member, I do small building-related structural design projects and review large projects by outside consultants for Caltech and monitor my stock portfolio on computer for myself. The computing center, bookstore, gym, and Athenaeum are nice perks. Betty and I celebrated our 50th anniversary this year and continue to enjoy activities on campus as well as the symphony, chamber music, plays, dinner with friends, and our involvement in church. And, in my new capacity as "Class Notes" secretary for the class of '44, I've been catching up on alumni news from around the country. Please keep writing; I look forward to hearing more from you in the near future.

Tway Andrews writes that he and Joyce shuttle between their home in Arcadia and their condo in Rohnert Park (just south of Santa Rosa). They like the area up north, which is close to their two daughters and two granddaughters. There is also a monthly lunch group of "Techers" that meets in the area and includes **John Nelson** and **Win Hughes**. They have just returned from a tour that included New Orleans and then a cruise to Cozumel, Grand Cayman, and Jamaica.

"Retirement is tough!" reports **Bill Bair** from Pasadena. "Have enjoyed Alumni trips to China and Egypt. We climbed the Great Wall and viewed the terra cotta soldiers at Xian. Egypt included the pyramids, Abu Simbel, and the temples of Karnak and Luxor. Currently I am a member of the Alumni Seminar Committee, president of the Pasadena Schools Credit Union, and past president of the Pasadena City College Retirees Association. Hikes to Echo Mountain, the CIT track, and Braun Gym keep me in trim, and a new computer keeps me on a steep learning curve."

Meanwhile, **Barton Beek** writes that he's "still practicing as a corporate finance lawyer in Newport Beach, California, working mainly for upstarting hi-tech companies. I sail and race Star boats and row around the bay. Often see **Wheeler North** at the Kerckhoff Marine Laboratory, where I keep my rowboat and which is three doors from my house. Wheeler claims to be retired, but seems to be at the lab every day and most evenings."

Checking in from San Marcos, California, **Jay Borden** says, "I have really retired! My wife and I have moved to a retirement community in San Marcos. I fill the time by volunteering: I tutor 7th and 8th grade math in private school and shelve books for the local public library. Total retirement takes some getting used to!"

More news comes from **Ross Buchanan**, who finally fully retired several years ago from his consulting work and lives in Fullerton, California. He and his wife travel often and have cruised around the world, as well as taking a recent cruise to South America. They enjoy visiting their two children and four grandchildren in Boston as often as possible.

Ben Earl writes that he's "continuing to work at our employee-owned design/construction company in Pasadena, taking vacations to San Luis Obispo and Oregon to visit our four children, ten grandchildren, and one great-grandchild. Spent several days recently in Palmilla, Baja California, with classmates **Larry Hudson** and **Tom Hudson** and **Bill Gulley** '45, playing golf with **Ned Gates** and **Jack Wilson**, who attended Caltech in their senior years."

Bob Lester retired from JPL in 1992, lives in Pasadena, and for a time continued doing work evaluating proposals for the Technology Reinvestment Program. Now fully retired, he is doing some traveling and has a trip to Kenya coming up in July.

Harry Moore sends word that his "primary activity is managing a 325-tree avocado grove in Falbrook, California, where I manage to lose money each year. Since we have a guest house, we can also be called 'Inn Keepers' and have achieved our goal of getting away from the big city—having spent our working life in New York. 'Eat avocados'—they are good for you."

And bringing us up to date on his activities, **Fred Morris** reports that "following a career in the international telecommunications industry and a stint in Washington working in the White House, I took responsibility for an established international telecom carrier, introducing competition in technical offerings and services. For the past decade, I have enjoyed consulting assignments and investment opportunities through Tele-Sciences Associates. Nancy and I will soon move our residence to Spanish Bay in Pebble Beach, California, and will be celebrating our 50th wedding anniversary. We continue our interest in and support of Caltech as lifetime members of the Associates, the President's Circle, and the Alumni Association, and look forward to classmates and friends visiting us at Spanish Bay."

Bob Parks' retirement to Balboa Island, California, sounds like a very active one. Sports include skiing, tennis, flying, hiking, and windsurfing. He maintains a close relationship with JPL and a strong interest in cosmology and science in general. He is a member of the board of directors of the San Juan Capistrano Research Institute and is consulting with the Universities Space Research Association in Maryland on an earth-orbiting astronomy mission. This is his last year of a three-year term on the CIT Alumni Association board.

From Washington, D.C., **John Rempel** writes that for the past three-and-a-half years, he's been working with the Office for Counterproliferation and Nuclear, Chemical, and Biological Assessments in the Department of Defense. He and his wife travel about once a year, and have recently returned from a two-week trip to Spain. The Rempels have three children—"two in California and one across the river in Maryland, and we manage to see them all fairly regularly. Don't believe I've walked on campus since 1944. That's on my current wish list. Unfortunately, none of my family lives anywhere near Pasadena anymore."

And **Harrison Sigworth** apparently finds retirement a restorative experience, to judge by these comments: "After 38 years with Standard Oil, Mary and I retired in 1985 to her family's old summer home in Idyllwild, California—a sleepy mountain community (population 3,000, and elevation 5,300 feet). Rebuilding the house was a great year's work and a sad day when finally finished. We then bought the house next door for our four children and families when they visit, and converted the four-car garage to a shop, where I have restored a 1911 Model T Ford, and a 1929 Model A Ford 'woody' station wagon. I have also built five small gasoline-powered cars for our eleven grandchildren. This year Mary and I celebrate our 52nd anniversary."

Class Agents

1934
J. Albert Romoli
3226 Waverly Dr., Los Angeles, CA 90027

1937
Joseph J. Peterson
1823 N. Michigan Ave., Pasadena, CA 91104

1938
Robert Davidson
1329 Beachmont St., Ventura, CA 93001

1944
Paul Winter
859 S. Orange Grove Blvd., Pasadena, CA 91105-1738

1945
Donald Tillman
10605 Argents Hill, Las Vegas, NV 89134

1948
Tom Tracy
3803 Darwin Dr., #188, Fremont, CA 94555-3337

1957
James Workman
7937 Fordham Road, Los Angeles, CA 90045

1958
Jonathan Tibbitts, Jr.
4215 Ridgeway Dr., San Diego, CA 92116

1959
Philip Harriman
4410 Glenridge St., Kensington, MD 20895-4256

1964
Spicer Conant
R.R. 4, Box 140, Hedgesville, WV 25427-9320

1970
William Bradley
950 Laguna Rd., Pasadena, CA 91105

1974
Peter Beckman
3116 16th St., Apt. B, Bakersfield, CA 93301

1975
Richard Gruner
3163 Colby Ave., Los Angeles, CA 90066

1976
Phil Naecker
1115 E. Woodbury Rd., Pasadena, CA 91104-1335

1977
Ed Rea
230 Wilton Ave., Palo Alto, CA 94306

1978
Rebecca Rea
230 Wilton Ave., Palo Alto, CA 94306

1979
Stan Cohn
8033 Tripp Ave., Skokie, IL 60076-3247

1980
Susan Fuhs
517 Loma Dr., Hermosa Beach, CA 90254-4649

1981
Eric Korevaar
5771 Lodi St., San Diego, CA 92117-1143

1987
John Beck
4004 Briarglen Dr., San Jose, CA 95118-1803

1994
Won Bang
840 S. Saratoga Ave., D105, San Jose, CA 95129

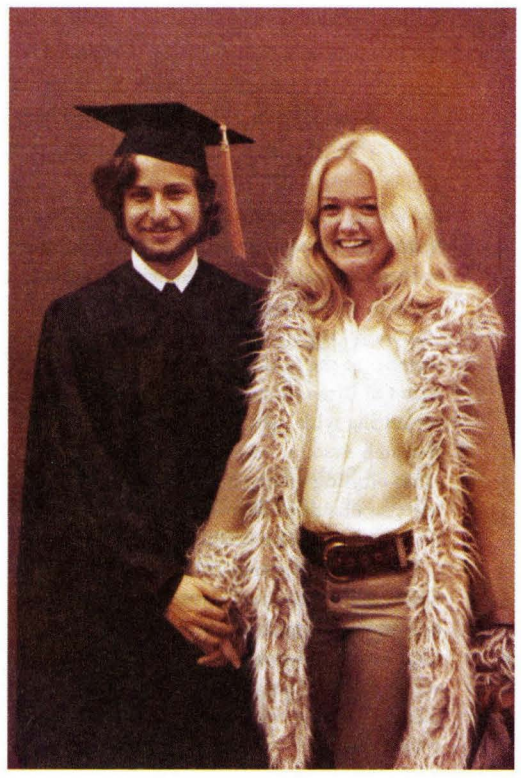
1995
Tobé Corazzini
1058 Fremont St., Menlo Park, CA 94025

Alert readers will note that this issue of *Caltech News* boasts not only a new look but also a new area code for dialing numbers on campus. As of June 14, 626 replaces 818 for Caltech and much of the San Gabriel Valley. Those who forget and dial the old prefix needn't worry; both prefixes will hold good through the end of 1997.

Boomerang...from page 9

status. That may be partly due to the fact that she's the first female undergraduate to return as a faculty member.

Ram Basu '84 knew Kornfield in their undergraduate days, but he didn't live in Lloyd. There may have been something in Blacker House's water too. For one thing, Basu and his friend John Fill '81 came back to work as Caltech staff members—Basu as a PC systems manager and audience services coordinator in Public Events, and Fill as a health physicist in Safety. Basu could put his biology degree to work testing what in Blacker's environs made it "the House of Usher," the place where everyone "came to dinner dressed as ushers" for whatever was playing on campus that night. He joined the culture, taking on more supervisory roles by his sophomore year. After carrying the germ with him to Silicon Valley and back to the L.A. area, a stop-gap "one-year" job back at Public Events turned into a career.



And who is this? Hint: the photo was taken at his 1972 graduation with his future wife, Laurie.

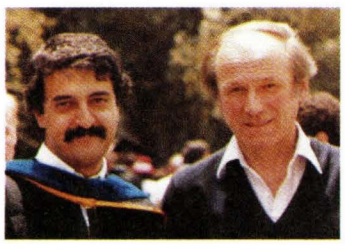
"For the first three years, it was very strange. I had the same students working for me that I had gone to school with. It got less odd as I got older and they got younger." But it got more odd to walk through Blacker, which Basu says was no longer the house of usher, and where "people would look at me like, 'Who the hell are you?'" Houses notwithstanding, Basu likes the fact that he recognizes 60 percent of the "little community" that is Caltech.

Koonin shares that sentiment. "Having grown up here, I feel like I know this place in my bones. Perhaps that helps me to manage a bit better." Even as an undergraduate, "I had the sense I was going to come back." Advised to go away as a grad student, to gain an outside perspective, he came back as a faculty member and won a teaching award from the students his first year. He attributes it to his youth and to having a "sense of what the undergraduates knew."

PhD recipients are also advised to go away after graduation, at least for a while. "It's a disadvantage starting out as a young kid," says Koonin. "Perhaps there's a tendency for everyone to think of you as a student, but now seeing that from the other side, I think that fades quickly. You just don't want to come back in the shadow of your advisor."

Decisions, decisions

Anatol Roshko, PhD '52, attended Caltech in a different era. He came from the University of Alberta with an undergraduate degree and experience as a lecturer in math and engineering. Intending to return to his native Canada to teach or work as an engineer after graduation, he found that the opportunities there were limited, especially in aeronautics. "More than that, I had been hooked on research, and, for aeronautics, Caltech was the place to be." So when postdoc and faculty appointments came along, he was more than happy to stay.



Anatol Roshko (right) has made the Techer trek numerous times, first marching as a PhD candidate and here in his student Morteza Gharib's 1983 commencement. Now that Gharib has joined the faculty, the two march as colleagues.

"Quite a few people from the early days stayed on," says Roshko, the Theodore von Kármán Professor of Aeronautics, Emeritus. "Later, Caltech developed the philosophy where it tried not to immediately hire its own PhD graduates." However, adds Roshko, "after they've been out and laundered, it's not a problem." One of his students, Morteza Gharib, PhD '83, returned five years ago as professor of aeronautics after distinguishing himself at UC San Diego.

"I always recommend this as a great place to be," says Roshko. "But now so few opportunities come along to work here." He also recommends the postdoc period as a prime time to build the research foundation needed to distinguish oneself in a field. Even though his Caltech-to-Caltech transitions have been smooth, "life gets to be considerably more hectic" by the time non-research activities are added for faculty members.

Anneila Sargent, PhD '77, has climbed the Caltech "research ladder" from postdoc to executive director of the Owens Valley Radio Observatory (OVRO). She also chairs NASA's Space Science Advisory Committee. For her research into the birth of stars and planetary systems and galactic dynamics, she says, Caltech's resources—the millimeter-wave array at OVRO and the Keck and Palomar telescopes—have made it "too exciting to leave."

Like Koonin, Sargent feels there are disadvantages to staying at the place where one gets a PhD. "There are always people—not everyone, but some—who refuse to see any evolution from the time you were a student. This can be very frustrating. Researchers probably find themselves in a more vulnerable position than faculty who have acquired tenure, she thinks. How would she advise students in similar situations? "Leave early on if it's at all possible. Returning after even a short absence as a postdoc or grad student can make a difference."

"I often look back and wonder what life would have been like if I'd gone into industry or to another university," says Roshko. "But I have no doubt I did the right thing."

"I couldn't be happier," says Vahala, professor of applied physics and three-time Techer. Having considered advice to try out another school, he turned down Stanford and MIT to remain at Caltech. "For me the selection was based on my desire to work with a specific research group, not to attend a different university or to see another part of the country." Vahala worked with Amnon Yariv, the Martin and Eileen Summerfield Professor of Applied Physics, on the subject of laser noise for his thesis research.

Vahala is one of the few active faculty members to have crossed the Caltech commencement stage three times. The verdict is still out as to who has marched down the aisle the most times, although Kirschvink votes for Bob Sharp. But Vahala is off to a good start. Since he stopped collecting degrees, he has marched in at least the last four commencements and plans to march this year.

"Each year, I appreciate commencement more and more. It's a very powerful day—an opportunity for Caltech's faculty to recognize not only the achievements of the graduates but also the support and sacrifices made by their families to get them here."

In a salute to Caltech's graduates, the Institute has invited its alumni to march in this year's graduation procession and to celebrate a century of alumni achievement. Come June 13, they'll join classmates and faculty and classmates-turned-faculty in that down-the-aisle déjà vu. ■

LEFT: Julia Kornfield attends a 1982 student-faculty conference in her undergraduate days.
ABOVE: Having migrated to the faculty, Kornfield (right) devotes much of her time to students.

How many degrees have Techers earned?

BS only	8,035
MS only	3,948
PhD only	3,038
Ex only	248
Eng only	198
BS/MS only	969
BS/MS/PhD	270
BS/MS/Eng	41
BS/PhD	231
BS/Eng	12
BS/MS/Eng/PhD	6
MS/PhD	1,579
MS/Eng	172
MS/Eng/PhD	14
Eng/PhD	7
Cert only	71

Alumni on the street...from page 5

remembered most vividly were those "ah-hah!" moments—often facilitated by a particularly inspiring faculty member—that confirmed, or clarified, the scientific paths you had chosen. For **Dawn Meredith MS '84, PhD '87**, now professor of physics at the University of New Hampshire, a couple of key notions came into focus during her second summer. "Professor Steve Koonin had hired me to write some of the code for his book, *Computational Physics*," she remembers. "Every day I felt challenged and excited but not overwhelmed by the job. Up till that point my computer programming skills had been minimal and my debugging skills were nonexistent. That summer I learned that code could be written clearly and checked for correctness. I had not known before how to check my code. Learning that skill changed programming from a precarious (and therefore unhappy) experience to a delightful, educational one. I also learned a lot of physics that I thought that I knew. For example, seeing a quantum wave function that was not an eigenstate trying to squeeze into a potential well made the point about eigenstates and boundary conditions clear in a way that I had not seen before. Programming those codes I was able to see the details and the big picture hidden in the equations."

Derek Woolverton '89, director of an Arizona software company, remembers as a freshman becoming fired up with an inspiration and hoping to schedule a brief visit to talk with his teacher about it. Instead, the professor instantly put aside his work to discuss the idea at length. "I always felt respected," Woolverton says, "by those who taught and guided me in my search for knowledge." And for **Jim Cutts, MS '67, PhD '71**, now a program manager at JPL, a memory lingers of the trip led by Gene Shoemaker to Arizona and southern Utah in the winter of 1966. "Shoemaker's work on the impact origin of meteor craters, which I had learned about at school in England, originally led me to Caltech. And here he was, with characteristic exuberance and flair, standing on the rim of Meteor Crater, lucidly describing the evidence that led to this conclusion."

The great Rialto Theater massacre

Of course, no reminiscences about Caltech would be complete without a couple of world-class pranks. **Clay Smith, BS '38, MS '40, PhD '43**, now sedately retired, seems to have been involved in more than his share—though he claims not to have masterminded any. There was the night, for example, when some fellows from Ricketts drove by the Rialto (a grand Art-Deco movie theater in South Pasadena) in a 1922 Lincoln limousine, and "fired" into the crowd, "hitting" some confederates who slumped to the ground, oozing ketchup onto their white shirts. The South Pasadena Police, who were not present, were not amused. They explained, Smith reports dryly, that "had they responded with their customary alacrity, someone might have been hurt." And **Andrew Hsu '89** was the victim of a more typical and less elaborate prank: for reasons that are now obscure, he was handcuffed to the roof of Firestone, where his "friends" brought him the necessities of life: bread and water—and his math homework.

Jim Duderstadt, MS '65, PhD '68, president emeritus and University Professor of Science and Engineering at the University of Michigan, has a somewhat unique take on Caltech pranks, since as president of the University of Michigan he accompanied his football team to the Rose Bowl five times—and "each time," he remembers with a grin, "the game was sabotaged by a Caltech prank." Three were especially notable: one year the famous scoreboard switcheroo ("Caltech 38; MIT 9") was perpetrated; one year an explosive charge meant to set off a balloon was found buried in the turf before the game; and one year the now gun-shy Duderstadt thought he detected a laser flashing from the nearby mountains. "But it was just a parabolic mirror of some sort," he recalls. And as his comments below indicate, Duderstadt doesn't hold a grudge against his alma mater.

The nurturing of essential singularities

So how do alumni on the street sum up their time at Caltech when they look back? Jim Duderstadt is in a position to make some overall assessments of institutions of higher learning, both as former president of the University of Michigan and as director of the Millenium Project, which looks at ways to deliver education in the 21st century. He says Caltech successfully creates an environment for "the maverick." The Institute, he comments, is "unique in its ability to attract, tolerate, and nurture what might be called the 'essential singularities' among students, what Carver Mead calls 'the exponential end of the curve.' Very few institutions do this," he adds. "Contrast it to MIT, which is much more middle-of-the-road." Many alumni valued the Institute's combination of small size and distinguished and stimulating faculty. Jim Cutts recalls "the opportunity of being exposed as a graduate student in Geological and Planetary Sciences to a faculty who were accessible, stimulating, and encouraging to my aspirations," and **Lothrop "Bud" Mittenthal '48**, an applied mathematician for Teledyne whose specialty is cryptography, also looks back on plenty of informal faculty-student "bull sessions" (he remembers J. E. Wallace Sterling and Linus Pauling as "particularly stimulating"). And he notes that Caltech has benefits even beyond the "instrinsic value of its education," opening doors through its sheer prestige.

Cecilia Aragon, who is a member of the U.S. Aerobatics team, attributes part of her success to "confidence I learned at Caltech. It was competitive," she acknowledges, but she learned "not to be afraid of competing. People helped each other; they were willing to share their knowledge, so it didn't matter whether you lost that day. Maybe you'd win the next." For her, that emotional resilience in the face of stiff competition is one of Caltech's lasting legacies. ■

Caltech alumni who have received the National Medal of Science

1963
John Pierce '33, PhD '36

1969
Wolfgang Panofsky, PhD '42

1970
Allan Sandage, PhD '53
Saul Winstein, PhD '38

1974
William (Willy) Fowler, PhD '36
Linus Pauling, PhD '25
Kenneth Pitzer '35

1975
Sterling Hendricks, PhD '26
William Pickering '32, PhD '36
E. Bright Wilson, PhD '33

1979
Donald Knuth, PhD '63
Simon Ramo, PhD '36

1982
Charles Townes, PhD '39

1983
Walter Munk '39, MS '40

1986
H. Richard Crane '30, PhD '34
Bernard Oliver, PhD '40

1988
George Housner, PhD '41

1989
Arnold Beckman, PhD '28
Harden McConnell, PhD '51
Eugene Parker, PhD '51
Robert Sharp '34, MS '35

1990
Edward Lewis, PhD '42
John McCarthy '48
Edwin McMillan '28, MS '29

1991
Folke Skoog '32, PhD '36
H. Guyford Stever '41

1992
Eugene Shoemaker '47, MS '48
Howard Temin, PhD '60

1994
Ray Clough, MS '43

Alumni winners of the National Medal of Technology

1985
Harold Rosen, MS '48, PhD '51
Allen Puckett, PhD '49

1987
Joseph Charyk, MS '43, PhD '46

1988
Arnold Beckman, PhD '28

1989
Alvin Tollestrup, PhD '50

1990
Gordon Moore, PhD '54

1991
James Duderstadt, MS '65, PhD '68
David Thompson, MS '78

Caltech Alumni who have won a MacArthur Foundation Fellowship

Astronomy
James Gunn, PhD '66
Jack Wisdom, PhD '81

Biology
Sharon Long '73

Chemistry
Mark Wrighton, PhD '72

Genetics
Ira Herskowitz '67
Matthew Meselson, PhD '57

Geology
Charles B. Archambeau, PhD '65
Raymond Jeanloz, PhD '80
Susan Werner Kieffer, MS '67, PhD '71
Michael C. Malin, PhD '76
Paul G. Richards, MS '66, PhD '70

Physics
Douglas Osheroff '67
Stephen Wolfram, PhD '80
George Zweig, PhD '64

Statistics
Bradley Efron '60

Personals

1951
ROBERT W. MADDEN, of Hampstead, Maryland, writes, "After retiring from NSA and having many fascinating positions there, it is comforting not to travel the world over. My wife Davida and I have spent a few years restoring an ancient farm in Carroll County, Maryland."

1955
SALVATORE P. SUTERA, MS, PhD '60, professor and former chair of the mechanical engineering department at Washington University in St. Louis, has been installed as the university's first Spencer T. Olin Professor of Engineering and Applied Science. He served as chair of mechanical engineering for 25 years, and he is now moving on to guide the creation of a new program for undergraduates in biomedical engineering. His acceptance address was titled "Training Engineers for the Age of Biology: Will Biomedical Engineering Become the Paradigm for Engineering Education in the 21st Century?" During his tenure at Washington, he has focused his research efforts on biomechanics and biorheology, contributing to the understanding of blood flow in microcirculation, flow-induced trauma to blood in artificial organs, and the mechanical properties of the red blood cell in health and disease.

1966
DOUGLAS C. WHITE, MS, has formed a new company, Profitpoint Solutions Inc., "to help companies in the process industries achieve and sustain continuing value from their computer and communication investments." After receiving his MS from Caltech he went on to earn an MA and his PhD at Princeton, all in chemical engineering. He was employed by Metromation, Inc., and Caltex Petroleum Corporation, and in 1979 he joined Setpoint Inc., a company involved in advanced manufacturing automation and information technology, serving as its president from 1993 until its acquisition by Aspen Technology Inc. in 1996. He served at Aspen as senior vice president for automation technology.

1967
NAVIN C. NIGAM, PhD, vice chancellor at the University of Roorkee, India, writes that he assumed his current position in October 1996, moving to Roorkee—his alma mater (BE '58)—from Goa University. In November, Roorkee entered the 150th year since its founding in 1847 as the first engineering institution in India, and it is now in the midst of a year of sesquicentennial celebrations. Nigam mentions that Caltech's George W. Housner and Don E. Hudson spent some time at the university in the late '50s, launching its earthquake-engineering program. He has also been elected president of both the Association of Indian Universities and the Indian Society of Earthquake Technology and was reelected vice president of the Indian National Academy of Engineering, which completes its first decade next month.

1973
PAUL YANCEY has been selected to hold the first Carl E. Peterson Endowed Chair of Sciences at Whitman College, in Walla Walla, Washington. Endowed by the late Whitman alumnus and longtime Walla Walla Valley resident Carl E. Peterson, the chair is for a seven-year, renewable term and both funds the recipient's salary and provides an annual stipend. Yancey received his PhD in marine biology from the Scripps Institution of Oceanography, UC San Diego, and joined the Whitman faculty in 1981. In 1988 he was appointed a Paul Garrett Fellow, an honor extended to Whitman assistant and associate professors who have demonstrated excellence in teaching and professional activities, and in 1994 the college awarded him the Lange Award for Distinguished Science Teaching. The author of numerous publications, Yancey's research has included extensive tests on a drug that could eliminate the severe eye complications from which many diabetics suffer.

1978
MARGARET MARSHALL, of Bethesda, Maryland, writes to report the birth of her daughter, Sophia Rebeka, on July 28, 1996. Marshall is a pediatrician and medical researcher.

1982
TRICIA STODDARD, MS '88, writes, "Bruce Friedman and I were married in the backyard of the home of Viva and TED COMBS (BS 1927) on September 8, 1996. We honeymooned in the eastern German countryside, with a trip to Leipzig for the world premiere of the Stockhausen opera, 'Freitag aus Licht.' Bruce was off for three weeks playing trumpet with The Platters' tour of Japan (smoke got in his eyes . . .) and is now back in his 7th grade ESL math classroom in Lynwood, CA. I am settling into my new position at Hughes Space and Communication in El Segundo, being responsible for satellite propulsion systems and components. (I have legally kept my name, but socially we are known as Bruce and Tricia Friedman.)"

PERRY G. WALKER, of Charlottesville, Virginia, writes that he and his fiancée, Denita Gardner, are happy to announce the birth of their first child, Brandon Malik Walker, on October 23, 1996. Employed by Du Pont Lycra®, Walker is operations manager for North American legwear.

1983
MARY (HEINRICH) GLOVER, of Florissant, Colorado, writes, "This past summer we moved even further into the mountains. We built a house on almost 12 acres. Since the last time I remember writing, we've had another little boy (he's already 2 years old.) I now have three stepdaughters (12, 14, and 17) and two little boys (2 and 4). I'm still working at getting my photography business to be a paying proposition so that I can continue to stay home with the boys."

JEFFREY YU, MS '84, PhD '88, and CATHERINE HAYES '85, PhD '90, of Northridge, California, report that their first child, Margaret Clare Hayes Yu, was born February 5. "She is thriving, and her parents are enjoying every minute (except the very loud ones). Jeff took the month of February off to be with the family; Cathy intends to return to work in May." Jeff is a group supervisor at JPL, and Cathy is a senior analyst with XonTech.

1986
TAYLOR W. LAWRENCE, of Alexandria, Virginia, has been appointed staff director of the Senate Select Committee on Intelligence. After graduating from Caltech, he received his master's and PhD degrees in applied physics from Stanford, and has since held several top-level Pentagon research jobs mostly centered on developing reconnaissance technologies, including unmanned aerial vehicles. He most recently served as deputy director of the Defense Advanced Research Projects Agency's Information Systems Office.

1988
SHEIKH IMRAN HAMEED, who also holds a BA in physics from Reed College as part of the 3-2 program, returned to his native Pakistan after graduating and entered the banking industry, first with Citibank and then, since 1991, with American Express Bank. In 1994, after getting married, he moved to London, where he is currently working in the bank's Correspondent Banking Group.

MARK A. PORTER, vice president for video server development at Oracle Corporation, writes, "Chyrise Broyer and I were very happily married on March 22 in Woodside, California. Now that the wedding craziness is over, Chyrise will be concentrating again on her new equine sports therapy business, and we'll both be putting in a lot of time to build our post and beam house in the redwoods."

1991
MARC W. ABEL, of Columbus Ohio, has founded Unshredder, Inc., a "developer of technologies for recovering information from shredded material seized by law enforcement agencies. He also serves as a consultant to the fluorochemical industry and sings frequently in locally produced operas and operettas."

■

Up Front...from page 2

expand its greatness. I look forward to working closely with the faculty, the Caltech Board, the very able administration, and the many other employees of Caltech and JPL to maintain and increase Caltech's remarkable strengths in science, engineering, and the humanities. Together we shall face the changes that are occurring, and together we shall take advantage of the opportunities provided by those changes to strengthen Caltech.

"The next decade promises to be an exciting one for the sciences," Baltimore added. "Brain science is coming to the fore in biology, astronomy has powerful new tools, major questions in physics are being approached with new tools, rocks will be coming back from Mars, to name but a few areas of opportunity. Caltech and JPL are positioned to play a major role in many of the advances in science and engineering. To lead Caltech during this time is a great privilege and I look forward to the coming years with excitement."

Currently the Institute Professor at MIT, Baltimore received the Nobel Prize for physiology or medicine in 1975, at the age of 37, for his role in the discovery of reverse transcriptase, an enzyme that permits retroviruses to replicate. This achievement had profound implications for understanding cancer and, later, AIDS, since HIV is a retrovirus. (Baltimore shared the Nobel that year with Howard Temin, PhD '60, and Renato Dulbecco, a Caltech faculty member from 1953 to 1963.) During the 1970s, he also played a pivotal role with several other eminent biologists in creating a consensus on national science policy regarding recombinant DNA research, establishing research standards that are followed by the genetics community to this day.

More recently, Baltimore has been a major figure in Washington as chairman of the National Institutes of Health AIDS Vaccine Research Committee. In accepting the presidency of Caltech, Baltimore noted that he will continue to pursue his chairmanship responsibilities "with unabated vigor," and that the Caltech trustees "have agreed with enthusiasm that I should continue to devote myself to this activity."

Baltimore, 59, was born in New York City. He earned his BA from Swarthmore and his PhD from Rockefeller University. After postdoctoral work at MIT and three years as a research associate at the Salk Institute for Biological Studies in La Jolla, he joined MIT's faculty in 1968 and was named a full professor in 1972. He was founding director in 1982 of MIT's Whitehead Institute for Biomedical Research, and served as director until 1990, when he became president of Rockefeller University. He resigned from the post 18 months later, in the midst of a controversy that stemmed from his support of research collaborator Thereza Imanishi-Kari, who had been charged with scientific misconduct but whose scientific integrity Baltimore had resolutely defended. Last year, after the case had gone on for a decade, the Research Integrity Adjudications Panel of the Department of Health and Human Services exonerated Imanishi-Kari.

Baltimore remained on the Rockefeller faculty until 1994, when he returned to MIT as the Ivan R. Cottrell Professor of Molecular Biology and Immunology and the American Cancer Society Research Professor. He was named Institute Professor in 1995.

Baltimore is married to Alice Huang, a noted biologist and dean for science at New York University. The couple has a daughter, Lauren, who recently graduated from Yale and now works in New York City.

■

Obituaries

1922
JAMES T. KENNEY, SR., Ex, of Cleveland Heights, Ohio; on October 16, 1992. He is survived by his wife, Elizabeth.

1929
PHILIP G. MURDOCH, PhD '32, of Lynnwood, Washington, on March 21; he was 89. He was a member of Phi Beta Kappa. For a time research professor of chemical engineering at Texas A&M University, he later in his career formed and headed the process fundamentals laboratory at Dow Chemical. He was also an award-winning author of numerous technical papers. He is survived by Margaret Ellen, his wife of 58 years; a son, Jeffrey; two granddaughters, Megan and Courtney; and a daughter-in-law, Pamela.

KARL W. WESTLUND, of Port Hueneme, California, on February 22, 1996. He is survived by his wife, Marjory.

1931
RUSSELL L. BIDDLE, PhD, of Delray Beach, Florida, on September 17, 1995; he was 92. He is survived by his wife.

1933
ARTHUR J. DOWNIE, Ex, of Williams, Oregon, in December 1994. He is survived by his wife.

1934
JAMES D. DAVIS, of Covington, Louisiana, on December 26, 1996; he was 85. A longtime employee of Shell Oil, he joined that company's Norco, Louisiana, refinery in 1952 and helped oversee the refinery's expansion. He retired as process superintendent in 1972. He received civic awards for his work in Norco, and was well-known as a civic activist in both the St. Charles and St. John the Baptist parishes. He is survived by his wife, Denise; a son, James; a daughter, Paula Prat; a foster daughter, Charlene MacLure; and nine grandchildren and eight great-grandchildren.

ORIN H. SHOEMAKER, of Oceanside, California, on December 11, 1996. He is survived by his wife, Janet.

1935
DANIEL H. MILLER, of Arch Cape, Oregon, on October 5, 1996; he was 80. A leader in the electrical industry, he was vice president of the Square D Company and subsequently president of ITE Imperial Corporation. After residing in Los Angeles, Portland, Seattle, and London over the course of his career, he retired to Palm Springs and Arch Cape. He was a lifelong subject of Stanford psychologist Louis Terman's "Study of Genius." Predeceased by his wife, Natalie, he is survived by two sons, Jeremy and Jeffrey, and by three grandchildren.

1936
JOHN L. NOLLAN, MS '37, MS '38, of Inglewood, California, on January 12; he was 82. With master's degrees in mechanical and aeronautical engineering, he spent 45 years in research and development with North American Aviation (later North American Rockwell). He is survived by Betty, his wife of 55 years; two sons, Michael and James; and five grandchildren.

1937
MELVILLE A. DIKE, MS, of Carmel, California, in April 1996.

1938
JAMES W. VAN HORN, of Vestal, New York, on March 28, 1995. He is survived by a son, James H.

EDWARD L. WEINBERGER, of Palo Alto, California, on January 23; he was 78. After graduating from Caltech, he received his MBA from Stanford. A certified public accountant, he owned an accountancy practice in Palo Alto that served individuals and small businesses. He was also a founding member of Temple Beth Am in Los Altos Hills, serving as its treasurer. He is survived by his son, Mark; a daughter, Kathy; and two grandchildren.

1939
HODGE S. TAYLOR, JR., MS, of Doylestown, Pennsylvania, on September 28, 1996. He is survived by his wife, Joyce.

1940
EDWIN P. HARTMAN, MS, of Santa Rosa, California, on December 31, 1996; he was 91. He spent most of his career with the National Advisory Committee for Aeronautics (NACA), which in 1958 became the nucleus of NASA. Starting in 1940, he spent 20 years as NACA's western coordinator, and then in 1960 went to Australia as a NASA senior scientific representative; there, he helped coordinate the early space-vehicle tracking program, work that NASA acknowledged with a certificate of appreciation. He retired in 1964 and during retirement wrote *Adventures in Research*, a history of the first 25 years of the NASA Ames Research Center. He is survived by his wife, Jean; his daughter, Joan Fellers; and two grandsons.

PIERRE M. HONNELL, MS, of Phoenix, Arizona, on August 31, 1996. He is survived by his wife, Claire, and by two daughters, Paula Ashley and Celia Dionne.

1941
GEORGE B. HARR, of Vista, California, on March 15.

1942
LAWRENCE A. HANSON, JR., of Sherman Oaks, California, on March 25; he was 76. During World War II and the Korean War, he served in the Navy, working on the design and development of rocket engines at the Bureau of Aeronautics, in Washington, D.C., and rising to the rank of lieutenant commander. Following his naval career, he continued to work on rocket design at North American Aviation. Always interested in science and mathematics, he spent some of his later years developing a guitar microtonal tuning system using 34 tones per octave. He is survived by his wife, Mary; a daughter, Christine Thornton; and two granddaughters.

1944
W. DAVID HINTON, JR., of Ketchum, Idaho, in September 1995.

ROBERT E. LAUTERBACH, of Lynchburg, Virginia, on May 10, 1996; he was 74. A graduate of the Navy's V-12 program during World War II, he served as a radar officer in the Pacific. After graduating from Caltech, he joined General Electric as a design engineer, working on the company's early TV receiver. After a leave of absence during which he obtained his MBA, he became manager of sales for GE's Visual Communications Products Department, and later transferred to the company's Mobile Communications Marketing Department, where he served as manager of systems and technical services. He retired after 39 years with the company. He is survived by Kathryn, his wife of 44 years; two daughters, Karen Lauterbach and Linda Timberlake; a son, Robert; a sister, Beverly Vogler; and six grandchildren.

PHILIP F. LOW, MS, of West Lafayette, Indiana, on January 14; he was 75. After graduating from Caltech, he received his PhD in soil chemistry from Iowa State University, and he served as professor of soil chemistry at Purdue University from 1950 until 1992. He also taught in China, visiting that country several times and being named honorary professor at Zhejiang Agricultural University in Hangzhou. He was a recipient of, among other honors, Purdue's Herbert Newby McCoy Award in Science, Sigma Xi's Research Award, and the Distinguished Member Award of the Clay Minerals Society. He was a fellow of both the Soil Science Society of America, serving as its president in 1972–73, and the American Society of Agronomy; served on the council of the Clay Minerals Society; and was elected to the National Academy of Sciences. A member of the Church of Jesus Christ of Latter-day Saints in West Lafayette, he served in several district and regional positions. He is survived by Mayda, his wife of 54 years; two sons, Philip and Martin; four daughters, Rosanne Smith, Jeannine Nielsen, Lasca Renee Low, and Lorraine Branham; a sister, Gwendolyn Riches; and a brother, Maurice.

JOHN G. WILLIS, CAVU, of Kingston, Oklahoma, on May 31, 1996. He was one of a group of students during World War II who received certification after completing an accelerated training program in meteorology, and who referred to themselves as Ceiling and Visibility Unlimited. He is survived by his wife, Sue.

1947
HAROLD COMLOSSY, of Whittier, California, on July 16, 1996. He is survived by his wife, Ann.

JOHN A. GRAF, MS, of Melbourne, Florida, on April 28, 1996. He is survived by his wife, Bettye.

EARL W. MCLAUGHLIN, Eng, of Silver Spring, Maryland, on December 22, 1995.

LELAND P. ROBINSON, MS, of Roseville, California, in May 1996.

WILLIAM T. RUSSELL, MS, PhD '50, of Marina del Rey, California, on January 9; he was 76. A former aerospace executive, he spent more than 30 years with Ramo-Wooldridge Aerospace Corporation, later TRW, retiring as vice president in the early 1980s. Also a Sierra Club mountaineering leader, Russell was an instructor in rock climbing, safety, and navigation. He is survived by his wife, Pat, former president of the Los Angeles City Council, and council representative for the Sixth District; two sons, Steven and David; a daughter, Mercedes Talley; two sisters, Mercedes Smith and Patricia Blasche; and three grandchildren.

CHARLES B. SHAW, JR., of Westlake Village, California, on April 27, 1996.

1952
ROBERT H. GRAFF, of Endwell, New York, on September 4, 1996; he was 65. A Professional Engineer, he had retired from General Electric after 40 years. He is survived by Phyllis, his wife of 42 years; two daughters, Karen Gross and Melinda J. Graff; a son, Lawrence; and eight grandchildren.

1953
JOHN E. LEIB, MS, of San Diego, California, on November 11, 1996. He is survived by his wife, Buddie.

1964
PHILIP C. PETERS, PhD, of Seattle, Washington, on April 11, 1994.

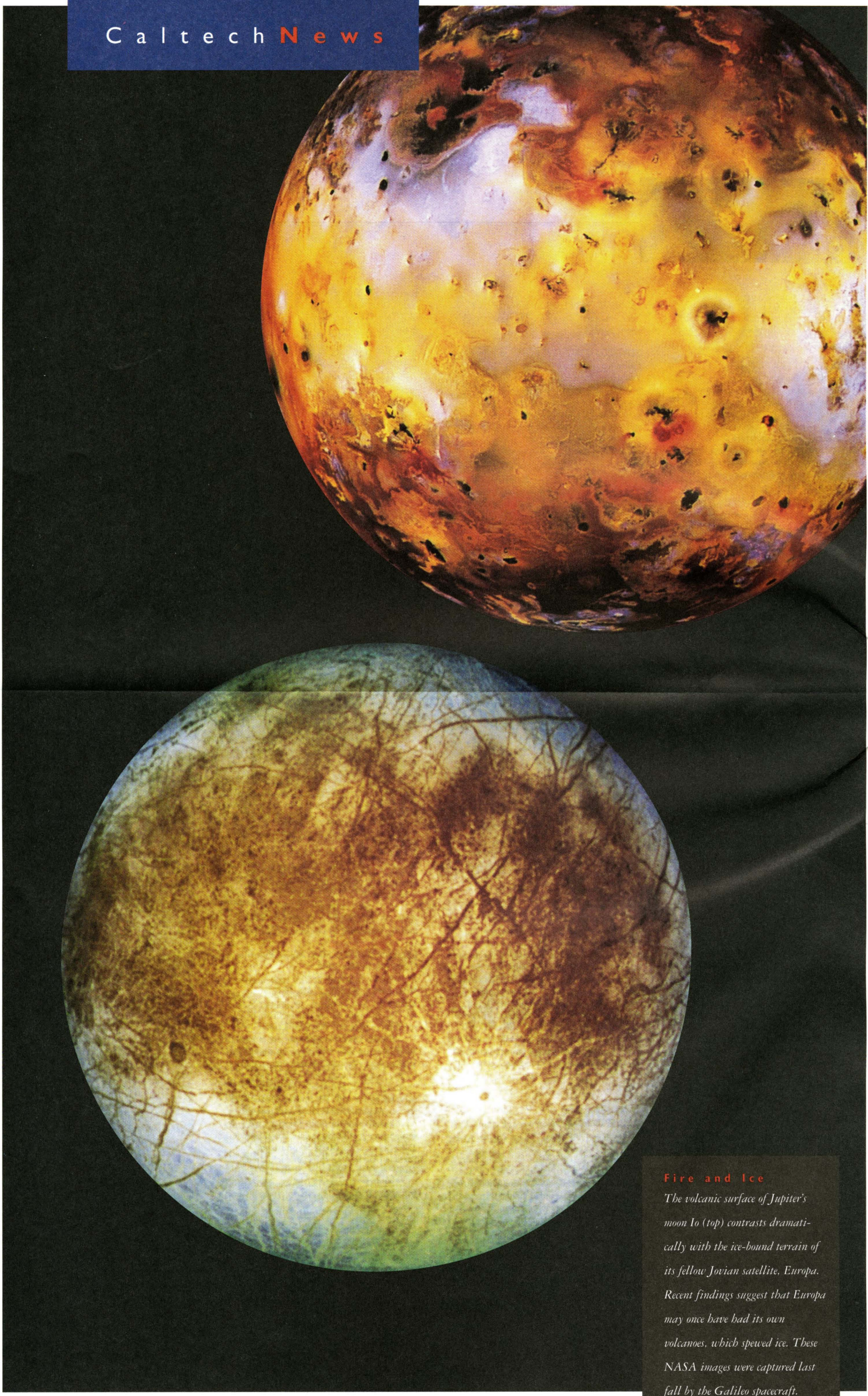
WILLIAM J. SMITHEY, Eng, of Newbury Park, California, on March 20, 1996. He is survived by his wife.

1968
GREGORY G. PIHOS, of Thousand Oaks, California, on August 7, 1996. After graduating from Caltech, he earned his MS in meteorology at UCLA, and he worked as a meteorologist and also as a computer programmer, most recently at JPL. He is survived by his mother, Virginia.

PHOTO FINISH: The back page shows Jupiter's moons Io and Europa, imaged in September 1996 by the Solid State Imaging System aboard the Galileo spacecraft. The most volcanic body in the solar system, Io is seen in a high-resolution picture taken at a distance of about 487,000 kilometers (302,000 miles) and centered on the side of the moon that always faces away from Jupiter (the north pole is at the top). The color in the image is composed of data taken in the near-infrared, green, and violet filters and has been enhanced to emphasize the extraordinary variations in color and brightness that characterize Io's volcanic face. The black and bright red materials correspond to the most recent volcanic deposits, probably no more than a few years old. The active volcano Prometheus is seen in the right-center of the disk.

The image of Europa, showing the moon's approximate natural color, was taken at a range of 677,000 kilometers (417,900 miles). The dark brown areas represent rocky material derived from the interior, implanted by impact, or from a combination of interior and exterior sources. Bright plains in the polar regions (top and bottom) are shown in tones of blue. Long, dark lines are fractures in the crust, some of which are more than 3,000 kilometers (1,850 miles) long. The bright feature containing a central dark spot in the lower third of the image is a young impact crater some 50 kilometers (31 miles) in diameter. The latest data from Galileo suggest that liquid oceans may lurk beneath Europa's icy surface, a finding that, if confirmed, would boost the odds that Europa could host some form of life.

Launched by NASA in October 1989, Galileo entered orbit around Jupiter in December 1995 and is conducting detailed studies of the giant planet, its largest moons, and the Jovian magnetic environment. JPL's Torrence Johnson, PhD '70, is the mission project scientist.



Fire and Ice

The volcanic surface of Jupiter's moon Io (top) contrasts dramatically with the ice-bound terrain of its fellow Jovian satellite, Europa. Recent findings suggest that Europa may once have had its own volcanoes, which spewed ice. These NASA images were captured last fall by the Galileo spacecraft.