

Caltech *News*

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Photo by Bill Varie

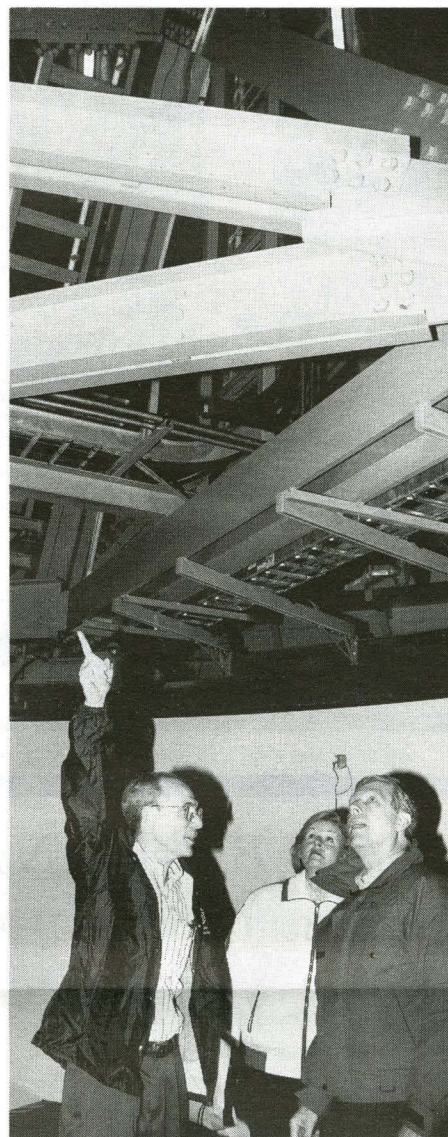
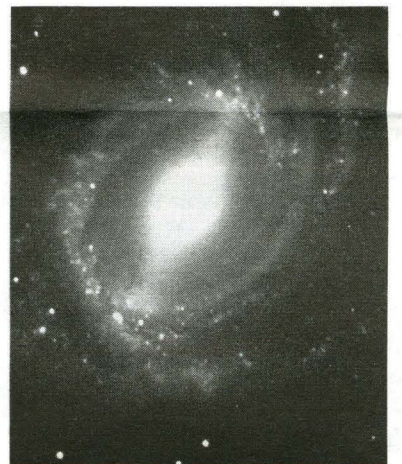


Photo by Bill Varie

Astronomical undertakings: Beneath the massive dome of Keck II, guests listen (photo left), as the traditional kahuna's blessing is delivered by Hawaiian historian and culturist Kapa Maly. In ancient Hawaiian lore, said Maly, Mauna Kea is the home of the all-seeing eye of the sky, who gave birth to the Hawaiian islands and people. Overhead, a more modern origins quest is represented by Keck II's secondary mirror cage, whose mirror collects light that has traveled almost since the dawn of time. A view of the cage from the telescope's pedestal is pointed out by CARA head Ed Stone (left, in middle photo) to Institute trustee Gayle Wilson and her husband, California governor Pete Wilson. Slated to begin full-time operation in October, Keck II saw "first light" in April, when it captured an image (pictured below) of the barred-spiral galaxy NGC 5850, located approximately 150 million light years from Earth.



Two eyes on the skies

In the beginning, there was a scale model of a telescope sitting on a table at a press conference, as Caltech and the University of California announced the start of an unprecedented collaboration to build an unprecedented instrument. A few years later, there was an observatory under construction on a mountaintop, a partially completed mirror of unparalleled size and revolutionary design successfully seeing first light, and then, a new pronouncement, to this effect: It is not good for such a telescope to be alone. We will build another to be its companion. On May 8, that companion—the Keck II Telescope—was dedicated on Mauna Kea, Hawaii, before an audience of about 200 invited guests who had made their way 13,600 feet up to the volcano's summit to breathe thin air and breathe in the heady atmosphere of state-of-the-art astronomy. With speeches by university presidents and the chief scientist of NASA, an island benediction chanted by a Hawaiian kahuna, and the thanks and good wishes of the W. M. Keck Foundation, whose blessings on

the occasion had already taken the more tangible form of almost \$140 million to build the world's two premier ground-based optical and infrared telescopes, the saga of the creation of the W. M. Keck Observatory came to an end. But the larger story in which it is destined to play a prominent role was far from over—and had seldom seemed more promising.

"Today we usher in a new era in astronomy," proclaimed Caltech physicist Edward Stone, as he welcomed the audience of scientists, university trustees and administrators, Keck Foundation officials, and other friends and supporters into the vast dome of Keck II, which now becomes the 10th telescope to perch on Mauna Kea's peak. The director of the Jet Propulsion Laboratory, Stone is also the current chair of the California Association for Research in Astronomy (CARA), the Caltech-University of California partnership that built and now oversees the operation of the two Keck Telescopes. The two universities have now been joined in partnership by NASA, which

contributed \$44 million in construction and operations support during the building of Keck II, and will share in the observing time.

"Already," Stone said, "Keck I has extended our view of the universe back in time to the first few billion years after it began with the Big Bang about 15 billion years ago. With Keck II about to begin operation, what is already an unequalled view of the universe will be greatly expanded."

From the outset, the W. M. Keck Observatory was planned as a twin-telescope facility, and Keck II, located 85 meters away from Keck I, is essentially a clone of its predecessor. Both feature the same 36-segment, 10-meter mirror that has already produced, in the case of Keck I, landmark cosmological observations as well as remarkably detailed views of astronomical phenomena much closer to home. The same mirror that recently enabled scientists to determine that a mere two billion years after the Big Bang the universe was already populated by early ancestors of Milky Way-type galaxies, also gave them an

up-close-and-personal look at the fireworks that ensued two years ago when the pieces of Comet Shoemaker-Levy 9 plowed into the planet Jupiter. When Keck II becomes fully operational later this year, astronomers can anticipate doing more of the same superb science (Keck II will in addition be optimized for infrared astronomy), but they also look forward to the day when the light-gathering power of the Kecks will be combined, for much greater resolution than either can achieve separately. Through a technique known as optical interferometry, the telescopes will be electronically linked to function as though they are part of a single mirror, whose size is equal to the 85 meters separating them. (Research aimed at developing this technology is now under way, partly funded through a grant from NASA.) "Working together," said Stone, "the two telescopes will have the unparalleled capacity to peer back in time to one billion years after the birth of the universe and to search for planets around nearby stars."

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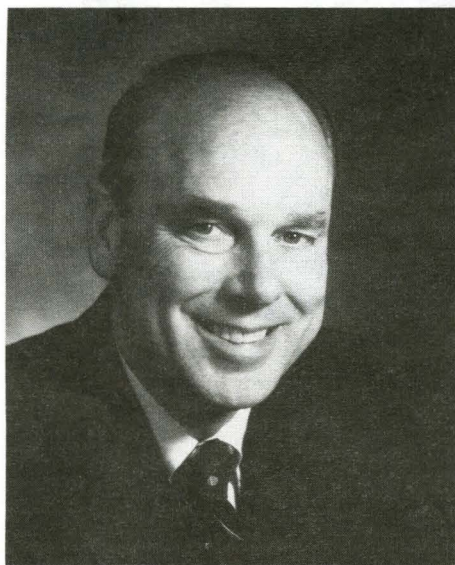
CAMPUS UPDATE

President Everhart announces he will step down next year

President Tom Everhart has announced his intention to step down as president of Caltech on or shortly after September 1, 1997. According to Everhart's May 22nd letter to Caltech faculty, students, and staff, "I will have served a decade as president by that time, and I have always thought that institutions, like people, need renewal: new ideas, new vigor, possibly new directions. In that sense, it is time for a change."

"I am notifying you of my plans now for two reasons," Everhart, 64, said. "First, it is important that there be sufficient time to plan a smooth transition between my term here and that of my successor. Second, a number of Caltech's important goals can be more effectively accomplished if there is no ambiguity about the timing of presidential succession."

"I am proud of this institution, and



Tom Everhart

all that has been achieved during my time here, both on campus and at JPL. Although Caltech, like all research universities, may face uncertain times in the days ahead, we have the traditions, the people, and the facilities to face them with optimism.

"My wife Doris and I have made many friends here during the past nine years, and expect to make more during the year ahead. The support of the Caltech community has been remarkable and we greatly appreciate it. I am looking forward to 1996-97, from frosh camp to commencement."

During his tenure, Everhart has overseen construction of the Keck Observatory in Hawaii, the Beckman Institute, Braun Athletic Center, Moore Laboratory of Engineering, the Fairchild Library, and Avery House, as well as the Campaign for Caltech, which raised close to \$400 million.

Caltech's Board of Trustees will initiate the search process for a new president in the near future.



There's no Caltech rite of spring more traditional than Ditch Day, and for junior Shirley Chen that meant having a whale of a time as she took on a Ruddock House challenge to turn Millikan Pond into a winter scene. While her group of undergrads grappled with a time-travel conundrum, other undergrads launched projectiles, built pyramids, and solved a variety of other puzzles left by seniors, who ditched their classes on May 22.

Caltech Biologist Norman Davidson receives National Medal of Science

Norman Davidson, the Norman Chandler Professor of Chemical Biology, Emeritus, at Caltech, will receive the 1996 National Medal of Science, America's highest scientific honor, from President Bill Clinton at a White House ceremony this summer. The 20th member of the Caltech faculty to be honored with this award, Davidson is one of eight scientists receiving this year's medal, which is awarded periodically in special recognition of outstanding scientific contributions.

"The recipients of these prestigious medals are the nation's champions of research and innovation," said President Clinton in a statement released by the White House. "For their leadership and originality, we honor them with America's version of the Nobel Prize."

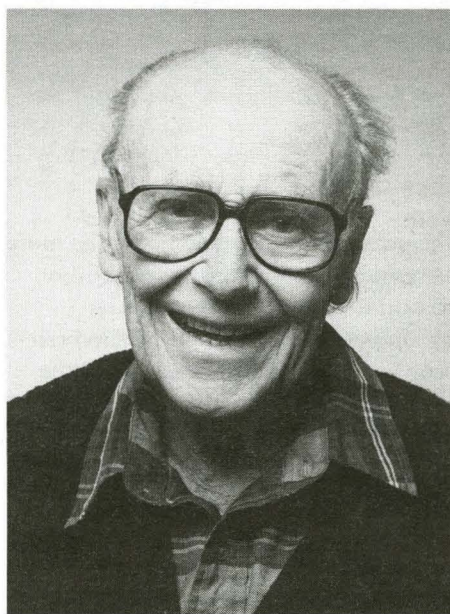
In his research, Davidson developed new techniques for bridging the gap between the physical and biological sciences. He pioneered new methods in physical chemistry, specifically for the study of fast reactions behind shock waves and by flash photolysis. Later, he developed new techniques, including electron microscopy, for genetic mapping and for exploring the informational properties of DNA and RNA. In his current research, Davidson is working on creating methods for studying electrical signaling in the nervous system and the ways in which it changes during learning and the formation of memories.

"I'm proud and delighted about the recognition of my work that the award implies," Davidson said in response to the news. "I always feel that a great deal of my success is due to the creative scientific environment provided by Caltech. Science is nourished here at the Institute and this award is, in large part, a credit to the university."

Calling Davidson's work "not only

very deep, but broad," Caltech's President Everhart hailed him as "a scientist's scientist, always working towards the betterment of science. I am pleased that he has been recognized for his tremendous contributions to chemistry and biology."

Davidson received his PhD from the University of Chicago in 1941. He came to Caltech in 1946 as an instructor in chemistry, became a full profes-



Norman Davidson

sor in 1957, and was appointed Chandler Professor in 1982. In 1989, he served as interim chair for the Division of Biology, and is currently serving as one of its executive officers. A member of the National Academy of Sciences, Davidson was a Rhodes Scholar in 1938, was named California Scientist of the Year in 1980, and was elected a fellow of the American Academy of Arts and Sciences in 1984. He was awarded the Robert A. Welch Award in Chemistry in 1989, and received an honorary degree from the University of Chicago in 1992.

Spring honors blossom bountifully

Yaser Abu-Mostafa, professor of electrical engineering and computer science, has been awarded the 1995-96 Richard P. Feynman Prize for Excellence in Teaching. The honor, presented annually to a professor who has demonstrated "unusual ability, creativity, and innovation in teaching," consists of a \$3,000 prize, matched by an equivalent increase in the awardee's salary. The prize was established in 1994 through a gift by longtime Caltech supporters and President's Circle members Ione and Robert Paradise.

Michael Alvarez, associate professor of political science, has been chosen by the Midwest Political Science Association to receive the Sprague Award for his paper with John Brehm entitled "Are Americans Ambivalent About Affirmative Action?" The paper was considered to be the best delivered at the 1995 meeting to apply quantitative methods to a substantive problem in political science.

Michael Aschbacher, professor of mathematics, was elected vice president of the American Mathematical Society for the 1996-98 term.

Jacqueline Barton, professor of chemistry, has been awarded the Paul Karrer Gold Medal by the University of Zurich. Barton also delivered the Paul Karrer Memorial Lecture in June.

Sloan Fellowships have been awarded to Assistant Professor of Chemistry Erick Carreira, for his study of the design and synthesis of a class of metal complexes whose molecular asymmetry makes them useful in pharmacological research; to Matthias Flach, associate professor of mathematics, for his research in number theory, a branch of pure mathematics with applications to cryptography; to Peter Schröder, assistant professor of computer science, for his work in computer graphics—specifically, in methods for solving the large-scale computational problems of computer graphics; and to Assistant Professor of Chemical Engineering Zhen-Gang Wang, for his research in the structure and dynamics of complex fluids, including polymers, liquid crystals, surfactant solutions, and molecular monolayers. Awarded by the Alfred P. Sloan Foundation of New York for studies in science, technology, economics, and public policy, the fellowships include \$35,000 in unrestricted research funds.

Peter Dervan, the Bren Professor of Chemistry, has been selected by the French scientific society Fondation de la Maison de la Chimie to be a corecipient of its 1996 Grand Prix. The prize, which brings with it 150,000 francs, is awarded for original work in chemistry that benefits life, humanity, society, or nature. Dervan's research is directed toward understanding the chemical principles involved in sequence-specific recognition of double-helical DNA. He

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Nunnally named vice president for Institute relations

J. Ernest "Jerry" Nunnally has been named Caltech's new vice president for Institute relations, succeeding Tom



Jerry Nunnally

Anderson, who announced his resignation earlier this year. Nunnally, who has been at Caltech since 1993 as assistant vice president and director of development and alumni relations, began his new job July 1. As vice president for Institute relations, Nunnally oversees Caltech's offices of Development and Alumni Relations, Government Relations and Community Affairs, Public Events, and Public Relations.

"It gives me great pleasure to announce Jerry's appointment," said Caltech President Tom Everhart in making the announcement to the campus community. "Jerry is well respected and very well regarded by all who have worked with him, and he has contributed strongly to Caltech."

Nunnally came to the Institute from Harvard, where he had been associate director of development, director of school relations, and director of corporations and foundations. Before joining Harvard in 1985, he was director of foundation and corporate relations at Dartmouth, from 1977 to 1985. Earlier in his career, he served as manager of college relations for Continental Illinois Bank in Chicago and as director of development at Dillard University in New Orleans.

Nunnally received his BA degree in 1969 from Dillard University, and he earned a master's of education degree from Harvard in 1984. He serves as a member of the board of trustees of Hampshire College in Massachusetts and is a director of the Pasadena Symphony and a trustee of Pasadena's Polytechnic School. He and his wife, Brenda, have three children—Martin, 20, Adia, 15, and Amanda, 7.

Tom Anderson, Nunnally's predecessor, is leaving the Institute for Harvard, but not in an administrative capacity. After five years at Caltech, during which he oversaw the Institute's extremely successful fund-raising drive, the Campaign for Caltech, and after more than 30 years in university administration, Anderson has, as he expressed it, decided to "step away from a

full-time professional assignment for a time." This fall, he is entering a graduate program at the Harvard Divinity School to pursue a longstanding interest in the influence of religion and ethics on institutions, public policy, and public life. "I have no specific career objectives post degree," says Anderson, "but I am confident something interesting and challenging will come along." Anderson will continue his association with Caltech on a part-time basis, providing regional representation for the Institute.

Caltech appoints biological sciences advisory council

With the biological sciences emerging as a preeminent area of scientific research at the turn of the millenium, Caltech has established a Biological Sciences Advisory Council to assist the Institute in developing plans and priorities for the future of the biological sciences at Caltech. The council, which is made up of Caltech trustees, long-time supporters, professors, and administrators, will advise the Caltech administration and faculty on various issues related to the success of the Institute's teaching and research programs in the bioscience fields.

The council is chaired by Caltech trustee Camilla Frost, trustee of the Chandler Trust and a director and secretary-treasurer of Chandis Securities Company. Joining her as council members are Gordon Binder, Caltech trustee and chairman and CEO of Amgen; Eli Broad, Caltech trustee, and chairman and CEO of SunAmerica Inc; Peter Dervan, the Bren Professor of Chemistry and chair of the Institute's Division of Chemistry and Chemical Engineering; Joseph Hurley, president of the Ralph M. Parsons Foundation; Mary Johnson, trustee emerita of Scripps College; Steven Koonin '72, Caltech provost and professor of physics; Ronald Linde, PhD '64, trustee and chairman of the board of the Ronald and Maxine Linde Foundation; Mel Simon, the Anne P. and Benjamin F. Biaggini Professor of Biological Sciences and chair of Caltech's Division of Biology; Warren Schlinger '44, PhD '49, past president of the Caltech Associates; Walter Weisman, Caltech trustee and former chairman & CEO of American Medical International; and Gayle Wilson, Caltech trustee and first lady of the state of California.

Caltech staff assisting the council include Tanya Mink, director of principal and major gifts in the Caltech Development Office, and Jerry Nunnally, vice president for Institute relations.

The council was appointed after extensive discussion among Caltech faculty and administration about the Institute's future direction in the biological sciences, and a decision that Caltech should focus, over the next two decades, on two fundamental questions: (1) how a single cell develops into a highly complex, multicelled organism; and (2) how the brain works. These

questions will be addressed in a multidisciplinary framework that builds on Caltech's programs in developmental biology, structural biology, genetics, neuroscience, and cell biology and that emphasizes research in molecular structure, mammalian genetics, biological imaging, behavior, computational biology, and evolution.

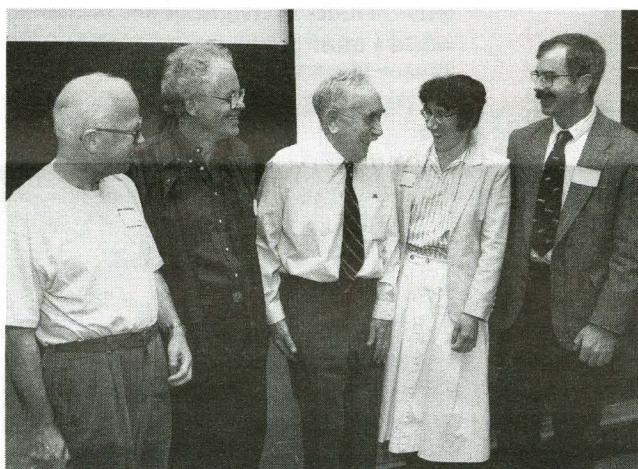
As part of its work, the council will assist the Institute in understanding how this academic agenda and its objectives will be perceived by the public and by potential supporters of research in the biological sciences. The council will meet several times over the next few months, and hopes to conclude its work with recommendations for the Institute by the fall.

At the council's initial meeting in March, President Tom Everhart told members that he was depending on them to provide Caltech with a "reality check" as the Institute prepares to embark on a major new direction. Said Caltech's president, "We want to be sure that what we are doing is not only



Council members at their first meeting. From left, back row: President Tom Everhart, Biology Division Chair Mel Simon, and trustees Eli Broad, Gordon Binder, Wally Weisman, and Roland Linde. Front row: Council Chair Camilla Frost, and Mary Johnson. Not pictured: Peter Dervan, Joseph Hurley, Steven Koonin, Warren Schlinger, and Gayle Wilson.

exciting science, but will also serve the interests of society." He added that Caltech wants to be sure that it has done its homework before it seeks private sources of funding to implement, establish, and sustain its new plans and programs.



Honoring the late Caltech Professor of Mathematics, Emerita, Olga Taussky Todd in an April symposium on campus are former students and her husband: from left, Fergus Gaines, PhD '66 (who journeyed from Ireland); Frank Uhlig, PhD '72; Jack Todd, Caltech professor of mathematics, emeritus; Helene Shapiro, PhD '79; and Philip Hanlon, PhD '81.

Innovative CAPSI program expands into six new California school districts

The Pasadena Center for Improving Elementary Science Education, a collaboration between the Caltech Pre-college Science Initiative (CAPSI) program and the Pasadena Unified School District (PUSD), has announced that their hands-on, inquiry-based science program will be expanded into six more California school districts this year: Bakersfield, Baldwin Park, Hacienda-La Puente, Lynwood, Stockton, and Tulare.

To date, the PUSD-CAPSI collaboration has offered the successful elementary science program in PUSD and the Conejo Valley, California, and the Maui, Hawaii, school districts. In 1994, as reported in the November '94 issue of *Caltech News*, PUSD and CAPSI received a five-year, \$6 million grant from the National Science Foundation to expand the program to 14 more school districts within California. The grant was the largest ever awarded by the NSF in support of improving science education in the public schools.

In the CAPSI program, students are

motivated by their own curiosity and use hands-on experiments to investigate a variety of phenomena. Teachers guide the children's learning with careful questions, and the students keep notebooks of their work. A large component of the program involves professional development for teachers—training them to become knowledgeable facilitators of their students' inquiry-based learning.

"We don't expect to change the way science is taught throughout the entire state, much less the whole country," says Jim Bower, an associate professor of biology at Caltech, who codirects CAPSI with Professor of Physics Jerry Pine. "But we have designed a good model for teaching elementary-school science, and we're happy to be able to share it with other school districts throughout the state. Eventually we hope these methods will be adopted by more districts in California, and will perhaps even spread to other parts of the country."

From Tulsa to the stars: Jim Westphal's had quite the trip

By Hillary Bhaskaran

HELP WANTED: Prestigious institute looking for engineer-scientist who will make profound contributions to research in planetary science, astronomy, geology, etc., advancing to full professorship and leadership roles on the foremost astronomical projects of our time.

REQUIREMENTS: bachelor's degree.

Now, if Jim Westphal had read this ad as a 20-something jug hustler in Tulsa, Oklahoma, he would have thought it was nuts. Then he might have been talked into taking the post. In a sense that's what happened.

But there was no ad to warn him what was in store when, with only a bachelor's in physics from the University of Tulsa and some experience searching out oil fields, Westphal embarked on an adventure that would lead to tenure at Caltech, the job of principal investigator for the Hubble Space Telescope's main camera, and the directorship of Caltech's Palomar Observatory.

Incidentally, the latter position not only includes oversight of one of the world's most productive telescopes (the

mechanical skill, Westphal says, was passed down from his two grandfathers and his father, "a shade-tree mechanic of the first order," who made his living as an accountant for a gas company. As for Jim Westphal's plans for a career, his goal was "to have fun," plain and simple.

To succeed, he decided he'd have to earn some money for college. With help from an uncle in the industry, he got a job with an oil exploration contractor from Tulsa called the Seismograph Service Corporation. Says Westphal, "I was shipped off to the top end of the Texas panhandle where, as they say in the wintertime, there's nothing between you and the North Pole except three or four barbed-wire fences. So I got an additional education in how you survive in such a specialized environment" (which wouldn't hurt once he got to Caltech). As recounted in the book *First Light*, by Richard Preston, Westphal the jug hustler planted a string of geophones, which are like microphones, to pick up sonic vibrations from explosives.

Since college cost "an immense amount of money" (\$255 a year), Westphal continued working nights, weekends, and summers for the Tulsa company. The job did wonders for his electronic and mechanical know-how, and the same company helped him broaden his horizons after graduation. First he was off to Mexico's gulf coast to do well-logging, lowering gamma-ray and neutron instruments into wells that were being drilled and taking measurements to determine whether there was

oil, where it was, and how to set up the well to extract it. Between logging stints, he had the chance to take flying lessons in Mexico City.

But the company lost the well-logging contract and sent Westphal with a team of oil explorers to the isthmus of Mexico, where he camped in the jungle, waded through mud up to his waist, swatted mosquitoes, and watched for slithering reptiles. "I was there for six months, but I didn't see a snake the whole time," says Westphal, sounding disappointed.

But he did find oil, which was concealed within a salt dome under a small island in a river. Unfortunately, the island was also home to the archeological site of La Venta, where most of Mexico's great stone heads were found. As the oil exploration team cut its way through the lush vegetation to survey

the land, many more artifacts were revealed. PEMEX, the Mexican government's oil company, gave archeologists one year to make way for a refinery and numerous wells, so as many of the artifacts as possible were removed from the island.

"I always felt a sadness in having been a partner to finding oil under one of the oldest archeological sites in the western hemisphere," says the explorer. Having "pretty well mined out my curiosity for living in Mexico, though it was really very educational," Westphal headed back to Tulsa toward a future that would place exploration firmly on the path of pure science rather than commercial gain.

During his last few years in industry, he worked as a group leader for Sinclair Research Labs, investigating unorthodox methods for finding oil. In 1960, Westphal's team hired a consultant to lend his scientific expertise to the search. That was Caltech Professor Hewitt Dix, the "father" of exploration geophysics.

During that time, "he and I thought of a nifty way to process seismic data," says Westphal, "before the days of computers that could fit on a desk." They developed an optical technique to do Fourier analysis of the data, which they would record on special film. To continue with the project, they needed two kinds of 16-millimeter movie film, so why not head for the movie capital of the world to finish the job?

Dix, who had \$4,000 to apply toward the research of his choosing, invited his young colleague to take a four-month leave of absence and come to Caltech to build the data processor.

"Well, I thought that was the most incredibly nutty thing," says Westphal. "You see, I had no sense of how independent professors are here. It turns out they're little duchies of their own." He headed west to discover that such freedom not only exists but is also "one of the reasons this place succeeds in such a tremendously effective way."

Waist deep in a different jungle

It was 1961 and "a very dynamic time at Caltech," Westphal recalls. "We were about to go into the business of going to the moon, and science had a tremendous amount of money."

Besides working with Dix, Westphal got to talking with other scientists about a variety of intriguing Institute projects, including the lunar studies that Bruce Murray was pursuing as a research fellow. (Murray later became the director of JPL and is currently a Caltech professor of planetary science and geology.)

Westphal and Murray decided that they could make thermal infrared scans of the moon to determine whether the surface was solid or deeply covered with dust. "People were afraid that the astronauts would get there and would sink down in the dirt and never be seen again," says Westphal. He and Murray



Photo by Jean Westphal

In the above photo, Westphal (left) takes a breather from one of his weekend hobbies of the last decade: filming the inside of Yellowstone's Old Faithful geyser to help Sue Kieffer (PhD '71) model its fluid dynamics. Westphal created a homemade video system to plumb the depths of the geyser for up to 40 minutes at a stretch, before the thermos-protected system overheats. The results can be viewed at the Yellowstone visitor's center and in an IMAX movie about the national park.

200-inch Hale that sits atop Southern California's Palomar Mountain), but it has come with the side job of helping to oversee the Keck Observatory until a full-time Keck director takes over this July. The two 10-meter (almost 400-inch) Keck Telescopes—unprecedented in size and revolutionary in design—are Caltech-UC projects situated atop the 14,000-foot dormant Hawaiian volcano Mauna Kea.

How did Westphal reach such heights? The story of his extraordinary, unsolicited career begins in the late 1940s in Tulsa, Oklahoma. There, the high school student spent his spare time building telescope mirrors. The



J. Hester & P. Scowen (ASU), NASA

After years of work by Westphal et al., the Hubble Space Telescope's main camera is sending back images like this one of an evaporating gaseous globule in the Eagle nebula—a place where stars are born.

leave from Sinclair. "I was in way over my head," he says. But long before the year's leave was up, he had made his home at Caltech. "This was too much fun," he had to admit.

Before long, the senior engineer realized that "everyone who walks onto this campus feels like they're in over their heads—and we all are." The atmosphere pushes people to "get a lot of nifty stuff done," and it reminds Westphal of baseball player Satchel Paige's saying, "Never look behind you 'cause you don't know who's back there a-gainin' on you." Even after all these years, Westphal says, "Sometimes I wake up in the middle of the night and wonder 'Is tomorrow the day they're gonna find me out?'"

Plenty of scientists did find him out. Volcanologists found that Westphal could help them study Mount St. Helens eruptions. Lowenstam nabbed him to build a special high-pressure aquarium for studies of deep-ocean animals. Whether he was dreaming up instruments to track glacial ice flows, record volcanic activity, or capture starlight, Westphal could turn his and his colleagues' ideas into action by building the instruments he had envisioned. Then, he'd often play a big part in the research effort as well.

Astronomers soon discovered that Westphal could create a night-vision camera that, when fitted to the Hale Telescope, would measure the brightness of distant galaxies 20 times more

precisely than the existing technology. In 1973 he built a Silicon Intensified Target (SIT) camera, which produced unprecedented pictures of distant objects in the universe. The pictures captured a range of 1,000 gray tones, compared with the 40-some tones that could be detected using photographic emulsion plates. To test the device, Westphal and Hale astronomer Jerry Kristian took it up to the 200-inch telescope's prime-focus cage. The cage is an observing capsule suspended high at the top of the telescope, where the brightest images can be seen and recorded (see photos below).

As Preston notes in his account of the events in *First Light*, prime focus is meant to hold one person. But "with the help of 10 or 20 yards of Palomar 'Glue' [or strapping tape], Westphal and Kristian installed their night-vision tube, along with a computer, a tape recorder, an oscilloscope, a television monitor, a 10,000-volt power supply, an octopine tangle of power cables, and both of themselves. They aimed the Hale Telescope at the Milky Way, and then they charged the night-vision tube with 10,000 volts of electricity—maximum redline power—and let first light fall into the tube."

The stars that showed up on the monitor didn't look familiar, and Kristian complained that the telescope must be misdirected. But suddenly "they realized they were seeing stars that had never appeared on any star chart [because they were too faint to be seen on photographic plates]. Westphal let out an Oklahoma wildcatter's 'Yaa-hooooooooo!'" and the camera went down in the annals of astronomical history. It's now part of the National Air and Space Museum's collection.

It wasn't unusual to see some everyday household items soldered into Westphal's inventions. In the early

eighties, he built \$300 tiltmeters that could be installed and sacrificed at the fiery eruption site of Mount St. Helens. To insulate and protect each tiltmeter, he surrounded it with Styrofoam pellets and encased it in half of a plastic garbage can.

Like the vastly more expensive tiltmeter that was

sold commercially (at \$6,000 a pop), the new instrument measured changes in ground level that could signal an imminent eruption. The expendable tiltmeters were sensitive enough to replace the higher-tech ones, and they spared scientists the harrowing task of rescuing costly equipment prior to an eruption.

How does Westphal come up with ideas for these inventions? "It's magic," he says. "All of a sudden, the idea just pops up. Who knows how?"

"But what's my job?"

While everyone was finding out that Westphal was a technical wizard, he was still trying to find his footing at Caltech. One day he went to Bob Sharp's office to protest that Caltech was not getting its money's worth out of him. Westphal was unsettled by a discussion he had just had with Professor of Physics Robert Leighton, in which the two had sketched out a solution to an optics problem. In the process, Westphal saw that Leighton, in a matter of minutes, had grasped concepts that would have taken him months to fathom.

"When people can stand up at the blackboard and do what Leighton just did," he told Sharp, "I think I ought to go back to Tulsa. I'm learning, but painfully slowly." Sharp's response was to tell his own story: "I'm a rock banger, and the only technical tool I have is a rock hammer. I go up to Owens Valley and bang on rocks from glaciers, and I can tell which are older just by the way they sound. I don't know how it works, but I can hear the difference. I'm sure there are people on campus who know all about how it works, but they're busy keeping up with their stuff." Westphal got the message, but he had one lingering concern.

"I guess you need to tell me what my job is," he said. "You guys just seem to let me do anything that happens to be fun."

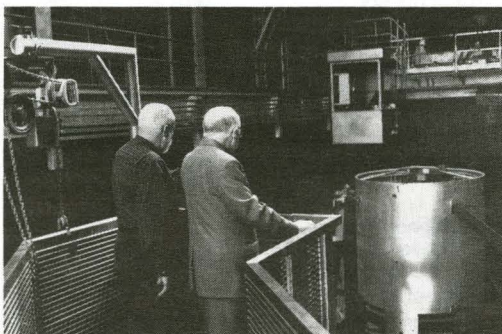
"Your job," said Sharp, "is to decrease research resistance. I don't care who you work with—whether it's an astronomer, a biologist, a chemist—but if you can help them do their research more efficiently, or in some new way, that's the proper thing for you to be doing."

"I've lived by those words ever since," says Westphal. "When someone walks in this door and says, 'Hey, do you know how to do thus and such?' a little switch goes flip, 'hey, it's job time.'"

By 1971, Westphal's job had taken

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Westphal (left) and Jesse Greenstein, DuBridge Professor of Astrophysics Emeritus, look toward Palomar's prime-focus cage, while assistant supervisor Mike Doyle (lower left) joins Westphal in the cage itself.



would later identify lunar areas that they knew were rocky because they retained heat, just as a sidewalk retains heat better than sand does. "So it seemed unlikely that these were merely pinnacles of rock sticking up out of 3,000 feet of dust. It just isn't the way things work."

While he got his feet wet in that project, Westphal was also sharing his deep-sea diving pictures with Heinz Lowenstam, then professor of paleoecology and now deceased. Lowenstam was excited about the clarity of the pictures that Westphal had achieved using a flash photography technique he had developed before the days of underwater flash photography. "That was the last I saw of my slides for two years," says Westphal, while his colleague put students to work counting the marine organisms in each frame. Regarding Westphal's inventiveness, Lowenstam told one interviewer, "he is phenomenal."

Word of what Westphal was doing came to the ear of the geology division chairman. "A month before I went back to Sinclair," says Westphal, "I got a call from Bob Sharp—the nicest man I think I've ever met—who was officially my boss. He said, 'You've been having a lot of fun here, haven't you?' 'Yes, sir, that's a fact,' I said, though it's kind of a shameful thing to admit."

"Well, we like your style of fun, and we'd like you to come back and go to work for us," said Sharp, to which Westphal replied, "You people are crazy, you must have too much money to spend." Sharp pleaded sanity and offered Westphal \$1,000 per year more than Sinclair was paying him, and the die was cast.

He was nervous about the Caltech job and merely applied for another

Puzzle champ pieces together life of work, play

By Hillary Bhaskaran

Wei-Hwa Huang would rather play with puzzles than work. He'll gladly fly off to a foreign country to ace an international competition and sample exotic cuisine, when he *could* be getting a jump on course work and eating room-made noodles in Ricketts House.

Now the junior in computer science has reached the top of the puzzle pyramid. In October, Huang was named the Individual World Puzzle Champion at a competition in Brasov, Romania.

His quick, clever solutions to 63 "logic, observational, and arrangement puzzles" also helped the U.S. team win its first team title in the four years that the competitions have been held. (The games are sponsored by various companies in the host countries.) In past years, Huang has attended world championships in the Czech Republic and Germany, placing second and sixth, respectively, while the U.S. team placed second.

At the latest contest, Huang and his competitors had to figure out what tricks were required to solve each problem. They were handed one problem that looked like a crossword puzzle, but the 40-plus participants had to realize that words must zigzag down the page rather than go straight down in order to complete the pattern correctly. "Some of them were just nasty," says Huang, who "did much better than others" at solving the zigzag one and is thankful for the partial credit he received on it.

All this sounds pretty competitive for a guy who chose Caltech over other schools because "there seemed to be a lot of competition going on" at Harvard, Princeton, and MIT. And indeed he has found that, at Caltech, there's not competition between students—"it's so darn hard that everyone loses." Even when it comes to the gaming life, competition is secondary for Huang.

After winning the world championship, he told the *Los Angeles Times* that, beyond the thrill of victory, he was especially happy to get his hands on new puzzles.

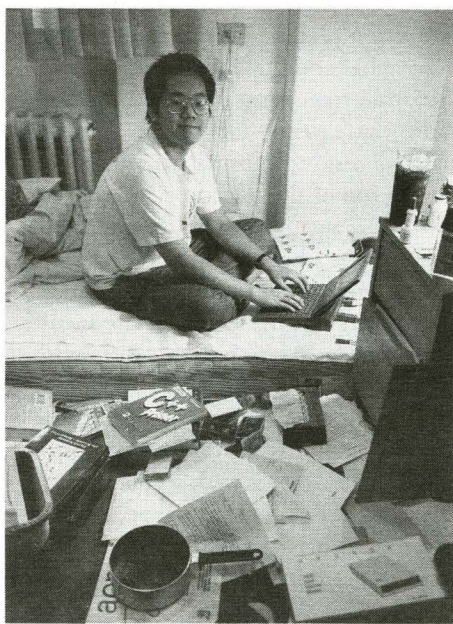
That's because Huang is a puzzle collector. He has drawers and shelves full of the things, a World Wide Web page that directs people to more, and a bunch he's made up himself, including the one printed at right.

Huang's growing collection plays a part in preparing his mind for future challenges. By getting exposure to many genres, he says, "you're faster to attack a new problem of the same sort." That's "experience," and it's essential to puzzle wizardry.

Then there's ingenuity. "You can't rely on it," but you can try to apply it when it comes. Some people have techniques to encourage it, says Huang, like sitting in certain positions or letting their minds go blank. He might just stare at a problem, or go away, or walk around.

To explain how experience and ingenuity work in practice, Huang invokes a series of letters: O-T-T-F-F-S-S. An

old challenge asks what the next letter would be. If you're not familiar with such a problem, you need a flash of ingenuity to solve it, says Huang. (That's why a good puzzle writer aims to create puzzles "like no one has ever seen.") But, if you know from experi-



Huang's Ricketts venue gives a drawer's eye view of what, in their spare time, puzzle champs do.



ence to consider each letter as the first in a word, you can figure it out—by doing an exhaustive mental search.

That's the part where you need an analytical mind, says Huang. As you use trial and error, your search is "most efficient if you don't try the same thing twice." Huang pieces these ingredients together into a winning strategy.

When faced with a number of problems in a competition, he considers: "What gives the best time-to-point ratio?" You have to choose between hard problems worth more points and easier

After a little searching, Wei-Hwa Huang digs up a homemade puzzle and gives us a few notes on how to solve it (based on "Battleships," from GAMES magazine, and Argentinian puzzles):

- There are 12 ships hidden on the three visible faces of the cube. As pictured below the cube, the ships include one four-part battleship, two three-part cruisers, three two-part destroyers, and six one-part subs.
- Each number alongside the cube represents the number of squares in that "row" that contain ship parts, and is repeated on the other side of that row for your convenience.
- Two ships will never occupy adjacent squares, even if the two squares only touch at a point or across a face boundary.
- Ships never bend across a face boundary.
- The contents of some squares have been revealed to help you. Wavy lines designate water, circles identify subs, squares represent a central part of a ship, and oblong semi-circles designate a bow or stern.
- Check your answers on page 13. Good luck!

ones worth less.

"I try to attack the ones that I anticipate will take a lot of time first," says Huang. "Those don't usually yield good results if you wait until time is almost up to start on them." Then you risk leaving one half solved, and, "ideally, when time is up, you've just finished a problem." Huang cautions that, with some problems, you may sit there five minutes thinking you almost have the answer. "It's important to know when you're stuck and to move on."

Huang's passion for puzzles started in elementary school. "Then there wasn't much distinction between puzzles and things you do in school," he says. Take this problem: Persons A and B have four apples, B and C have six, and A and C have eight. How many apples do A, B, and C have all together?

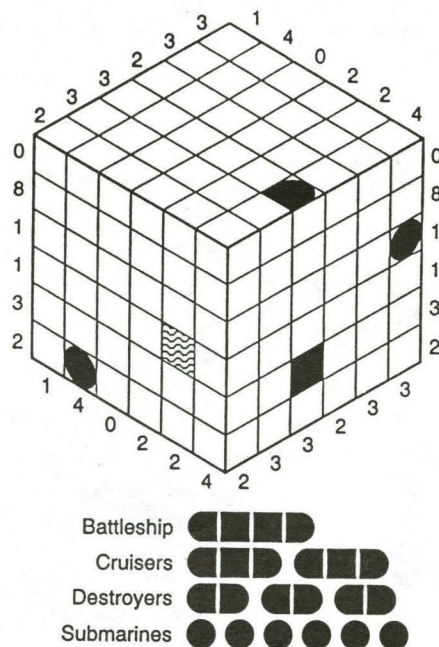
"The solution is trivial with algebra," Huang points out, "but when you don't know that, it's an interesting problem to figure out how to solve the problem. People invented math so there would be less puzzles—so there would be ways to solve problems. That has its drawbacks, but it also advances society."

As Huang got older, and the distinction between puzzles and schoolwork "started diverging," he says, "I found myself preferring puzzles." His mother kept him well supplied with game books.

His preference never caused a problem until he got to Caltech. "Before, my classwork was never hard—now it's hard." Attending the last competition caused Huang's grades to take a dive, so when he's asked what's next for a puzzle king, he has conflicting thoughts.

All things being equal, he says, he might be interested in designing games—even higher-tech ones like pinball machines—as a career. "But all things are not equal." There's another, perhaps more attractive, option of having a computer-science career that makes lots of money, then buying expensive toys.

"If I focus on my grades, my career will have more openings. I have to keep reminding myself of that." Still, that doesn't stop Huang from offering the campus a puzzle challenge as he himself heads off toward the pinball machines below Ricketts House.



Jim Westphal

Continued from page 5

him up the academic ladder to serve as a senior research fellow and Hale Observatories staff associate, and then as an associate professor. He had 32 scientific papers and 11 patents to his name. That number would eventually rise to 91 articles and 15 patents as Westphal took infrared pictures of planets, measured redshifts of remote galaxies, and helped map the first known gravitational lens.

He was obviously still having fun in 1976, because when he learned that he had been granted tenure, the new full professor thought, "Now they've really done themselves in. They'll never get rid of me now."

Says Rich Terrile, one of Westphal's graduate students at the time, "It's a real credit to Caltech that they'd recognize intellectual brilliance over academic credentials... Jim is a genius." The fact that he was made a professor without being a PhD fits with his character, adds Terrile. "Jim likes to tweak the system."

Now an astronomer at JPL, Terrile lives by a number of so-called "Westphal pearls of wisdom" that he collected while at Caltech. During their many observation runs at Palomar, the professor-student team experienced plenty of equipment failures and cloudy nights, and they saw plenty of astronomers throw fits as a result. "Jim told me that 'if something goes wrong,' as it so often does in astronomy, 'you always have two choices: you can get mad and then fix it, or you can just fix it. Now how would you rather try to fix something—mad or calm?' It was clear when he said it that it applied to much more than astronomy."

On the one thing that couldn't be fixed in the world of ground-based astronomy—the weather—Westphal advised acceptance. He also advised Terrile not to spend such nights collecting rotten data, as many people did. "'Don't put [trash] in the ice cream,' he would say."

Up in the air with Hubble

Westphal would need all his pearls of wisdom to tackle his next challenge: working with JPL and NASA on the Hubble Space Telescope. He was lured into the mammoth project in 1977 by a solid-state detector less than an inch in diameter. The bait was called a CCD (charge-coupled device), and JPL and Texas Instruments were developing it to use in the Galileo spacecraft's camera to take pictures of Jupiter.

Westphal and Jim Gunn, then an astronomer at Caltech, recognized the CCD's potential in ground-based astronomy. When it came to collecting light for astronomical photography, this tiny silicon device would go way beyond Westphal's SIT camera and the conventional vacuum tubes and photographic film of the time. The two Jims wanted to get their hands on some of these rare CCDs to make an extremely light-sensitive camera for the Hale

Continued on page 12

Keck II

Continued from page 1

Achieving such prodigies of vision and partnership on the part of telescopes seems to have required, to say the least, an equal measure of both qualities on the part of individuals and institutions. With regard to the latter, University of California President Richard Atkinson, commented favorably on the ability of Caltech and the University of California to transcend their history as sometime scientific rivals and work together toward a common goal of unrivaled significance. "If either institution had tried to build them alone," he noted, "Keck I and II would never have happened." As for "the many people who were essential to making this incredible telescope a reality," Atkinson singled out former UC President David Saxon, "who recognized back in the 1970s that astronomy was on the brink of major advances," and who, by committing university resources to research on the feasibility of building a new generation of telescopes, had helped set into motion the events that ultimately culminated in the Keck project.

Caltech President Tom Everhart also indulged in a bit of institutional history, noting that the Keck Observatory represented Caltech's second pioneering effort to build the world's most powerful optical telescope. The first of course had been the 200-inch Hale Telescope, completed in 1948 on Palomar Mountain in an undertaking considered similarly daring in its day. "No one had ever cast such a large piece of glass—many believed it was impossible," Everhart reminded his audience. UC astronomer Jerry Nelson's innovative segmented-mirror design for the Keck had been greeted in some quarters with equal disbelief, Everhart said, but the principles underlying it had been triumphantly demonstrated with Keck I—a tribute both to Nelson and to the two universities who, before they banded together to build the Keck Observatory, had already collaborated in the education of its future project scientist. (Nelson '65 went on to earn his PhD from UC Berkeley; he's now professor of astronomy at UC Santa Cruz.) Everhart also alluded to the major role played in the project's early stages by the Institute's then-provost Rochus (Robbie) Vogt, and noted that Vogt's daughter Nicole—who had entered Caltech in 1984 when her father was laying the groundwork for the Keck Observatory—would now be using the facility as a UC astronomer. "Rarely," said Caltech's president, "has a father had the opportunity to contribute to his daughter's work in such a magnificent way."

And never before had a private foundation made so large a gift to support a scientific project as had the W. M. Keck Foundation, under the leadership of its former chairman, Howard Keck. (It is for Keck's father, the founder of Superior Oil, that both the Keck Foundation and the Keck Observatory are named.) "For 12 years the Keck Foundation has supported this development here," said the chair of Caltech's Board



The Keck Telescopes I and II (foreground) on the summit of Mauna Kea.

of Trustees Gordon Moore. "Now that's short compared with the 15 billion years we can look back, but it's a long time in a human career." Moore appeared to have one very particular human career in mind when he added, "We certainly have the generosity of the Keck Foundation to thank—and the personal commitment of Howard B. Keck, without whose vision, foresight, and perseverance these telescopes would never have been built."

Keck, who had been present at the dedication of Keck I in 1991, was unfortunately absent from its sequel, due to illness. He was, however, able to watch the ceremony from his home, thanks to a satellite link that beamed the proceedings to a number of venues, including the Caltech campus. So, he was able to learn firsthand that from this day forth, there would not only be two Keck telescopes canvassing space, but also a permanent Keck presence in space. As the dedication ceremony drew to a close, Gordon Moore and Clair Burgener, chair of the UC Regents, unveiled a plaque commemorating the fact that Asteroid 5811, discovered in 1988 by JPL astronomer and asteroid-tracker Eleanor Helin, had been officially named Asteroid Keck, "in honor of the man, the family, and the foundation." And, one might have added, the observatory. "Ladies and gentlemen," announced Stone, by way of a finale, "the Keck II Telescope." As the onlookers watched, 150 tons of steel and glass rising eight stories high began slowly to revolve about them, as did the 10-story dome itself. The assemblage then headed down Mauna Kea's slopes for lunch, leaving Kecks I and II, and their eight mountaintop confederates to feast on the universe.

Speaking just moments earlier of Howard Keck, Robert Day, the current chairman of the Keck Foundation, had declared that "Howard likes to take risks and he likes to win." He was, to Day's knowledge, "the only man ever to win both the Kentucky Derby and the Indy 500." What had Keck won by spearheading the creation of the W. M. Keck Observatory? The answer, it might be said, is the 15-billion-year question. **Heidi Aspaturian**

Honors

Continued from page 2

shares the prize with Professor Claude Helene of France's National Museum of Natural History.

Mory Gharib, professor of aeronautics, has been elected a fellow of the American Society of Mechanical Engineers.

Michael Hoffmann, the James W. Irvine Professor of Environmental Science, has been honored as a Distinguished Lecturer in Environmental Chemistry by the São Paulo State Foundation of the University of São Paulo in Brazil, and by the Hebrew University in Jerusalem.

Jeffrey Hubbell, professor of chemistry and chemical engineering, has been named recipient of the Clemson Award of the Society for Biomaterials, presented in May at the 5th World Biomaterials Congress in Toronto.

Jonathan Katz, assistant professor of political science, has been awarded a 1996 Haynes Foundation Faculty Fellowship to pursue his research project entitled "Why Did the Incumbency Advantage Grow in U.S. Congressional Elections?"

Caltech faculty Daniel Kevles and Nelson Leonard and Senior Trustee Ralph Landau have been elected to the American Philosophical Society, America's oldest learned society, founded in 1743 by Benjamin Franklin. They were recognized both for significant contributions within their own fields, and for a broader range of interests. Kevles, the J. O. and Juliette Koepfli Professor of the Humanities, was cited for work that "blends the history of science with general history, knowledge of the past with understanding of the present, and scholarship with broad human sympathies." Faculty Associate in Chemistry Leonard was recognized for "pioneering work on biologically important molecules, first as a synthetic organic chemist, then as a biochemist . . . In both areas he has shown great originality and creativity." Landau was recognized by the Society as "an enormously energetic and intellectually vital person [who has had] at least four careers"—chemical engineer, entrepreneur, philanthropist and supporter of academic life, and active contributor to academic life. Currently, he serves on the faculty of engineering at Stanford.

Julia Kornfield, associate professor of chemical engineering, has been awarded the 1996 John N. Dillon Medal for Research in Polymer Physics by the American Physical Society.

Nobel Laureate and Thomas Hunt Morgan Professor of Biology, Emeritus, Ed Lewis has been selected as Scientist of the Year by Achievement Rewards for College Scientists (ARCS), a national volunteer organization that fosters excellence in education and fur-

nishes financial assistance to needy, talented students in the sciences. Lewis will speak at the November ARCS luncheon, at which over 60 scholarships and fellowships will be awarded.

Nobel laureate and Arthur Amos Noyes Professor of Chemistry Rudy Marcus has been awarded an honorary degree by the University of North Carolina at Chapel Hill.

Professor of Political Science Richard McKelvey has been awarded the Rochester Distinguished Scholar Medal from the University of Rochester in acknowledgment of scholarly achievements that present to new PhDs a model of "a career of eminence."

Assistant Professor of Chemical Engineering Richard Murray has been selected to receive one of 34 Young Investigator Awards given by the Office of Naval Research. The Young Investigator Program helps support research by recent exceptional PhDs by providing recipients with up to \$100,000 per year for 3 years; the program supports work in such diverse fields as acoustics, ceramics, pure mathematics, and electromagnetics. Murray will use the award to continue his research into high-performance aircraft.

Gerry Neugebauer, the Robert A. Millikan Professor of Physics, has been awarded the 1996 Henry Norris Russell Lectureship of the American Astronomical Society.

The Pasadena City Planning Division has recognized Professor Emeritus of Economics Robert Oliver, along with other former Pasadena Planning Commissioners, for his volunteer efforts in the city of Pasadena.

Thomas Palfrey, professor of economics and political science, has been selected as a Fellow of the Econometric Society.

Excerpts from the curriculum of Caltech's innovative telecourse *Project MATHEMATICS!* have been selected by the Eisenhower National Clearinghouse for Mathematics and Science Education for inclusion in a CD-ROM video that will be distributed to 25,000 schools nationwide. Project MATHEMATICS! is directed by Tom Apostol, professor emeritus of mathematics.

John Roberts, Institute Professor of Chemistry, Emeritus, and lecturer in chemistry, has been awarded an honorary Doctor of Science degree by the Scripps Research Institute.

FRIENDS

Caltech establishes J. Stanley Johnson Professorship

Through a bequest from the estate of J. Stanley Johnson '33, MS '34, the founder of several companies, who died in December 1994, Caltech has established an endowed professorship in the area of business economics and engineering management. A faculty committee headed by Paul Jennings, professor of civil engineering and applied mechanics and former Caltech provost, has been appointed to search for and recruit candidates for the position, which may include a combination of a full-time faculty member and visiting faculty.

The J. Stanley Johnson Professorship and Endowment Fund will be under the aegis of the Division of Engineering and Applied Science, and the designated faculty will focus on practical aspects of entrepreneurship, business and engineering management, and the role of business in society. These were subjects that were of great concern to Johnson, who often cited as a principal influence Horace Gilbert, a longtime economics professor at Caltech, who died in 1990. Through his graduate course in business economics, which, in his words, tried "to bridge the gap between engineering and business," Gilbert prepared students for the business world. Many of his students eventually became top executives.

In a 1994 letter to Caltech Board of Trustees Chair Gordon Moore, Johnson wrote, "Horace had hundreds of loyal admirers who felt that his course had been of important help to them, and I am one of them." After receiving his master's degree in mechanical engineering, Johnson first worked for the Southern California Gas Company. The research work that he had done in his graduate year at Caltech resulted in his giving a talk and publishing a paper in the *Journal of the American Welding Society*. As a result of this paper, he was hired as a research engineer at Taylor Forge & Pipe Works in Chicago. Upon his return to Southern California in 1938, he founded and became president of Holly Manufacturing Company, which developed and manufactured furnaces. Among the series of companies he later cofounded were Burner Devices Corp., Arcadia Metal Products Co., and A.S.D. Corp.

"Stanley was devoted to Caltech," says Johnson's wife Mary. "But he always felt that it was important that scientists and engineers should under-

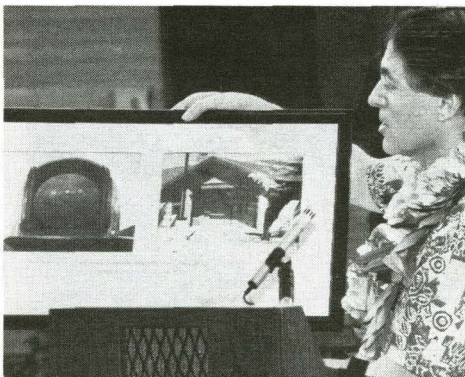


Photo left: Longtime Institute supporters William and Georgina Gimbel were joined by Doris Everhart and about 100 other celebrants in Hilo, Hawaii, this past February, as they hailed the dedication of a new Caltech building bearing the Gimbels' name. Made possible by a generous gift from the couple, the facility now serves as the scientific and administrative headquarters for the Caltech Submillimeter Observatory on Mauna Kea. **Photo right:** Telescope and headquarters are displayed by CSO Director and Caltech Professor of Physics Tom Phillips during remarks at the ceremony.

stand the ambiguities of the relationships between people and businesses."

The new professorship isn't the first time the Johnsons have committed themselves to spurring interest in business at Caltech. In 1978, the couple gave \$60,000 to the Institute to establish a student investment fund, adding \$5,000 the following year. Through this fund, now in its 18th year of operation, students get practical experience in buying and selling securities. Mary Johnson, an alumna and trustee emerita of Scripps College, had earlier established a similar fund at her alma

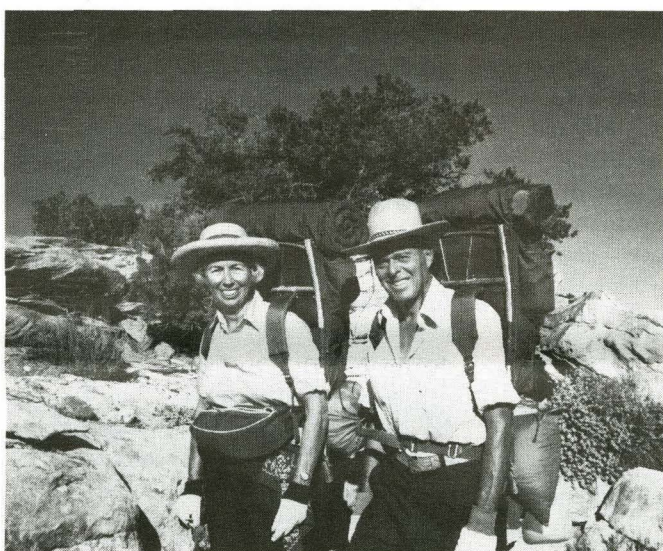
interests, the professor may also teach courses at Caltech. The search for the professor is in progress and an appointment is expected soon.

"We are extremely grateful for the Johnsons' support over the years and, in particular, for the generous bequest from the Johnson Family Trust," said Caltech President Tom Everhart. "With the recent active interest in entrepreneurship and technology transfer among Caltech's faculty and students, a professorship in business and engineering management makes perfect sense. Stan Johnson was passionate about

bringing back business courses to Caltech, and it is a testament to his remarkable inspiration and perseverance that we will offer such studies once again."

The Johnson family has actively supported Caltech for many years. Stan Johnson was a life member and director emeritus of the Caltech Associates. Mary Johnson has been a life member of the Associates since 1959, is a member of the board of

the Associates, and is also a member of the President's Circle. The Johnsons, avid hikers, took many trips with alumni groups, the Associates, and the President's Circle. Their two sons, Donald and Robert, are also life members of the Associates. On several occasions, the Johnsons provided funds to renovate the Athenaeum. Mary Johnson was recently appointed to the Biological Sciences Advisory Council (see story, page 3) by President Everhart.



Forgers of new paths in many walks of life, Mary and Stan Johnson on one of their frequent hiking trips.

mate. The Caltech student investment fund, which donates up to five percent of its assets each year to student activities, is now managed by 10 students, and is worth approximately \$265,000.

Before his death, Johnson also funded a four-year professorship at Harvey Mudd College, to teach management of technology-based companies. As part of the arrangement, depending on mutual

ASSOCIATES' EVENTS

July 15, *Caltech Tour for New Members and Associates with Prospective Members.*

July 27, *Northern California Associates Luncheon*, at the home of Gordon and Betty Moore.

August 5, *Caltech Tour for New Members and Associates with Prospective Members.*

September 7, *Day Trip to Big Bear Solar Observatory*, led by Hal Zirin, professor of solar astronomy.

September 12-21, *President's Circle Trip to Switzerland*, led by Brian Wernicke, professor of geology. Followed by optional add-on tour of Burgundy, France, September 21-26.

October 31-November 3, *Associates Trip to Williamsburg, Virginia*, with Andrea Goldsmith, assistant professor of electrical engineering, and Ellen Rothenberg, professor of biology.

November 15-17, *President's Circle Weekend Trip to Imperial Valley, California*, led by Kerry Sieh, professor of geology.

For more information about the Caltech Associates, call the Associates' office at 818/395-3919.

Fairchild Foundation gives \$2.5 million for postdoctoral research

Caltech has received an award of \$2.5 million from the Sherman Fairchild Foundation to support postdoctoral researchers in physics and astronomy. The gift, which extends over eight years, will support six scientists in theoretical physics or astrophysics, five in observational optical-infrared astronomy, and two in experimental physics, astrophysics, or radio astronomy. The first group of Sherman Fairchild Scholars will begin their term at the Institute this fall.

In physics and astronomy today, a newly minted PhD is seldom considered fully ready for a long-term position. Many recent doctoral graduates therefore spend a few years gaining research experience in a postdoctoral position, working under the guidance of

an experienced scientist.

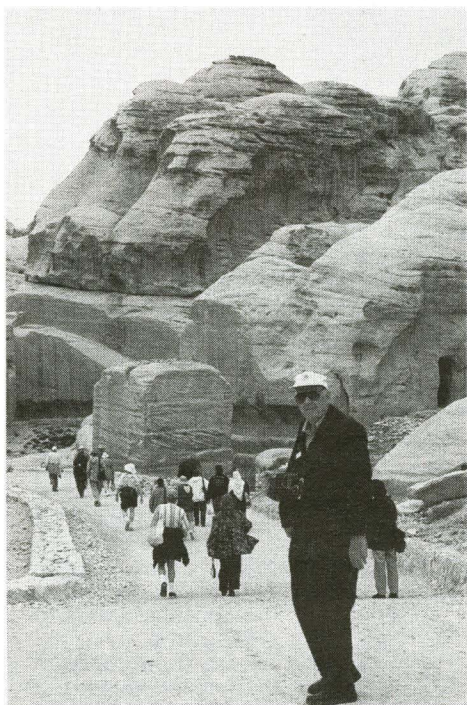
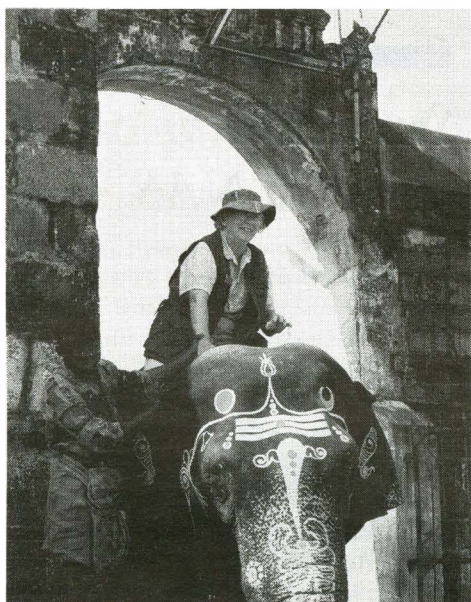
"This award will allow us to bring the very best new PhDs to Caltech as Sherman Fairchild Postdoctoral Scholars," said Charles Peck, professor of physics and chair of Caltech's Division of Physics, Mathematics and Astronomy. "Postdoctoral scholars bring to our campus new ideas, unexpected initiatives, and wonderful opportunities for cross-disciplinary research. They are our future leaders in academia, industry, and government, and may well turn out to be future members of Caltech's faculty or future Nobel laureates."

The Sherman Fairchild Foundation was incorporated in 1955 by Sherman Mills Fairchild, inventor of the Fair-

child aerial camera; chairman of Fairchild Camera Instrument Company and of Fairchild Hiller Corporation; owner of Fairchild Recording Equipment Company; and a director of IBM. When Fairchild died in 1971, he left most of his estate to the foundation.

The foundation has been a longtime supporter of Caltech and has made many notable grants to the campus. Among them are funds for the Sherman Fairchild Distinguished Scholars Program, which serves as a model for the enrichment of the academic environment through visits from eminent scientists and engineers, and the Sherman Fairchild Library of Engineering and Applied Science, which is currently under construction.

Annals of the Associates



From ancient monuments in New Delhi to space science in Bangalore, from the biblical byways of Jerusalem to the political landscape of the present-day Middle East, it's all in a season's sojourn for the Caltech Associates. In February, members of the Institute support group joined Professor of History and India specialist Peter Fay for a historical and cultural exploration of the Indian state of Rajasthan, well known to Fay from his many trips to the subcontinent. Joined by noted Indian naturalist and conservationist Sri Raj Singh, the group took in the sights and sounds of New Delhi before embarking on a two-week trip through India's "camel country"—a land of vast plains, walled medieval cities, bustling villages, and striking works of art and architecture. An optional add-on visit to Bangalore and Madras included a special tour of India's Space Agency, hosted by Caltech alumnus and former JPL director Sir William Pickering, hailed by his Indian colleagues—many of them former students—as the "guru" of India's space program. In March, a President's Circle trip to the "Lands of Pharaohs and Prophets" brought Associates, led by Caltech Professor of Anthropology Thayer Scudder, to Jerusalem, where they toured the city's incomparable landmarks, visited the ruins of Masada overlooking the Dead Sea, and received a special briefing on Mideast affairs from Caltech alumnus and former Israeli defense minister Moshe Arens. The mingling of ancient and modern continued with a seven-day cruise through the Red Sea, with stops at Jordan's unique red-rock city of Petra; the Sinai Peninsula port of Sharm El Sheikh; Luxor and the Valley of the Kings in Egypt; and with tours of Cairo, Memphis, and the pyramids.

Travelers' Tales:

Clockwise, from top of page: Marge Leighton, the wife of Valentine Professor of Physics, Emeritus, Bob Leighton, makes a monumental entrance in Bangalore; and Robert Anderson '42 appears to be putting his many years as a geologist to good use as he surveys the astonishing Jordanian city of Petra, carved into the sheer face of the cliffs. In Bangalore, the former head of India's Space Agency S.S.R. Valluri, PhD '54 (left), and colleagues extend a warm welcome to William Pickering '32, PhD '36 (with glasses), and Inez Pickering (foreground) and tell their visitors, "Without Dr. Pickering [whose affiliation with India's scientific community dates back to the 1930s] and Caltech, India would have no space program." More alumni meetings mark the occasion in Jerusalem, as Israel's former defense minister, Moshe Arens, MS '53 (at podium), joins Robert Henigson '48, MS '49 and other President's Circle members for dinner and discussion of Mideast politics and security issues. And what Associates trip, however memorable, would be complete without a commemorative group photo? This one was taken at the Palace Hotel in Udaipur, in the heart of the northwest Indian state of Rajasthan.



Knapp Fellowship Fund endows new graduate fellowship in engineering

A new graduate fellowship in engineering has been endowed at the Institute through a gift of nearly \$695,000 from the estate of Pearl Knapp Briscoe. Now totaling more than \$1.1 million, the Robert T. and Pearl Knapp Fellowship Fund will provide financial aid to engineering graduate students, with preference given to those whose fields of study are mechanical engineering and/or hydraulics.

The fellowship is named after Robert Knapp, a former Caltech engineering professor who died in 1957, and his wife, Pearl, a prominent Los Angeles psychologist. She established the fellowship in 1988, the year of her death, to honor her first husband. Her second husband, Charles Briscoe, a retired Southern California Gas Company executive and a life member of the Caltech Associates, took a personal interest in the fellowship and was instrumental in administering the sale of the estate's assets that funded the fellowship.

The Knapp Fellowship Fund fills a great need at the Institute, says Paul Jennings, professor of civil engineering and applied mechanics, who worked closely with Knapp Briscoe on establishing the fund. Adds Jennings, who is a former Caltech provost and a past chairman of the Division of Engineering and Applied Science, "Graduate fellowships are a high priority and were a campaign goal that we didn't quite meet, so this fellowship is particularly important."

Robert Knapp came to Caltech as an instructor in mechanical engineering in 1922 and received his PhD here in 1929. Named assistant professor of mechanical engineering in 1930, he rose through the academic ranks to become professor of hydraulic engineering in 1950. Widely known for his work in hydrodynamics, Knapp was the supervisor of Caltech's Hydraulic Machinery Laboratory, whose research figured prominently in the construction of the Colorado River Aqueduct. He also developed the Caltech Hydrodynamics Laboratory.

Pearl Knapp Briscoe received her bachelor's and master's degrees and her PhD in psychology from UCLA. She was the chief psychologist for the Los Angeles Psychiatric Service from 1949 to 1957, and the chief psychologist at Cedars-Sinai Medical Center from 1958 to 1972.

In establishing a fellowship at Caltech, Knapp Briscoe said she was partly inspired to do so by the invaluable experience her husband Robert Knapp received when a one-year fellowship enabled him to spend 1929 studying in Europe. The benefits of this fellowship were enormous, she noted, "because of the opportunities to see laboratories and meet the men who were active in all kinds of research."

Since 1992, partial Knapp fellowships have been awarded to six graduate students. The first recipient of a full Knapp Fellowship is Alastair Preston, who received his BS in civil engineer-

ing at Canterbury University in New Zealand and is now working toward a Caltech PhD in either civil or mechanical engineering. "I'm interested in fluid mechanics, especially computational fluid dynamics," he says. "I'm interested in how you can set up mathematical equations and solve them to describe real-life situations—from flows in jet turbines to waves breaking on the shore."

Trustee Stan Rawn extends Alumni Fund challenge to second year

In 1994 Caltech President Tom Everhart challenged alumni to demonstrate their support for the Institute by increasing the Alumni Fund participation rate to 50 percent by June 30, 1997. Gifts to the Alumni Fund provide the Institute with the flexibility to address some of its most pressing needs, including scholarship aid and seed money for innovative faculty research. In 1994/95 the alumni responded strongly: turning around an eight-year decline, they raised their level of support from 31 to 37 percent, an increase that represents participation by 1,246 new donors. As of May 15, 1996, alumni had surpassed last year's outstanding results.

To help the Fund achieve the 50 percent goal, Stan Rawn '52, MS '53, a generous Caltech trustee, provided a \$350,000 challenge grant for the 1995-96 fund year. Under its terms, for every whole percentage point increase over last year's results—37 percent served as the baseline figure—the Institute will receive \$50,000. When the results as of June 30 are tallied, the value of each individual alumni's contribution will be substantially leveraged by factoring in funds accessed through the Rawn challenge.

July 1, 1996, marks the beginning of a decisive 12 months for the Alumni Fund. Stan Rawn has agreed to provide another \$350,000 in challenge grant funding. In order to reach the 50 percent participation goal, those generous alumni who brought the Fund to a base of over 40 percent in 1995/96 must all give again in the coming year. In addition, new donors are needed to step forward and help meet the continuing challenge. Every gift from a donor will have a significant impact on whether the Fund successfully meets President Everhart's goal of 50 percent alumni participation and takes advantage of Stan Rawn's challenge grant.

To join the more than 6,000 generous alumni who have already shown their commitment and support for the Institute this year, please call the Alumni Fund at 818/395-6323.

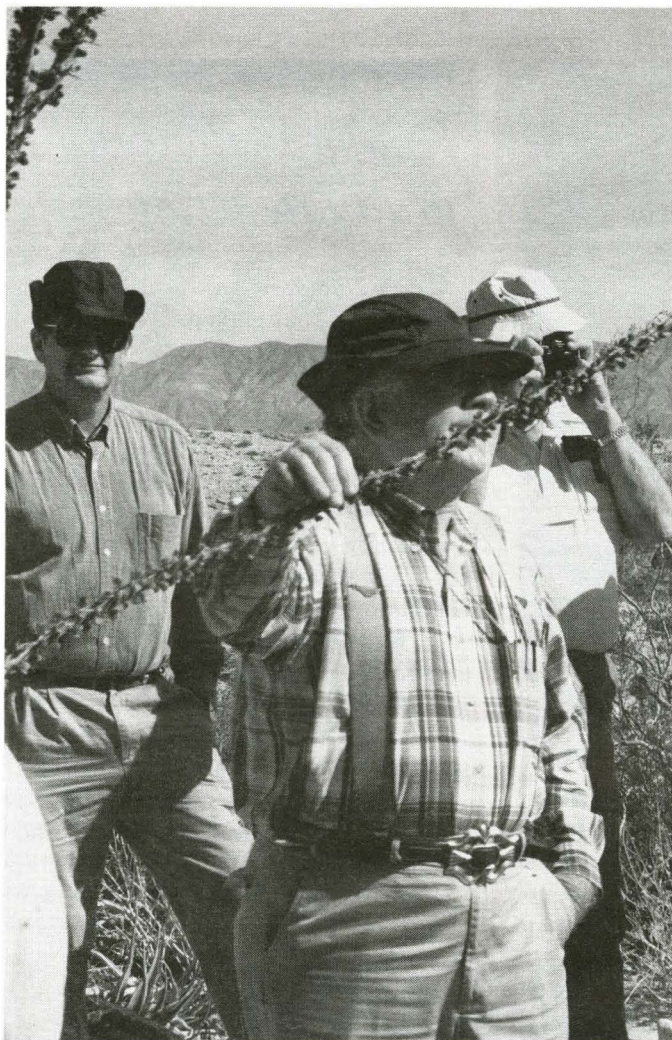
ALUMNI

Check it out: channel-surfing the chapters

Rumor has it that Caltech's alumni chapters are launching their own cable channel. And why not? The fact is, anyone wielding that Big Remote in the Sky could have seen an array of recent chapter programs that gave *Nova*, not to mention *The X-Files*, some stiff competition. Where else on the dial could audiences celebrate the end of Galileo's six-year interplanetary journey this past December with a tour of Jupiter, led by JPL mission scientists? The Chicago, San Diego, and Orange County chapters did just that; their guides were Galileo Project Manager William O'Neil (Chicago, Orange County) and Galileo Science Manager Robert Mitchell (San Diego), who described the orbiter's two-year future itinerary. And what action-adventure flick could surpass the daring exploits of Galileo's gallant entry probe? The probe plunged into Jupiter's roiling atmosphere and for 57 minutes relayed information about the structure and composition of the solar system's largest planet, before being incinerated into oblivion.

Seattle channel-surfers might have gained some insight into the plucky probe's last moments when Hans Hornung, the Institute's C. L. "Kelly" Johnson Professor of Aeronautics and director of Caltech's Graduate Aeronautical Laboratories (GALCIT), spoke to the city's alumni chapter about the heating of orbital vehicles during reentry into Earth's atmosphere. He talked about how GALCIT's research with a facility designed to simulate flows over bodies at reentry conditions is providing new insights into the "many interesting phenomena" that occur at such high speeds and temperatures.

Viewers wishing to look at Earth from the heavens, rather than at the heavens from Earth, also had their choice of technologies, from the most recent—SAR, or Synthetic Aperture Radar—to the traditional—a handheld camera (held, however, by the hand of a Shuttle astronaut.) In Washington, D. C., Diane Evans, deputy manager for the Science and Information Systems Office at JPL, described how SAR's infrared imaging system enables it to "see" where the human eye cannot—beneath dry sand and through forest canopies—and to "sense" the moisture content of soils, vegetation, and snow. The most advanced civilian radar ever built flew aboard two Space Shuttle flights in 1994, and its data are being analyzed to help assess the environmental health of the planet. In Houston, William Muehlberger '49, PhD '54, professor of geological sciences, emeritus, at the University of



Caltech Professor of Aeronautics Tony Leonard '59 (left) listens as fellow alum and W. M. Keck Foundation Professor for Resource Geology, Lee Silver, PhD '55, describes the ocotillo, a native plant of the low desert of Southern California. Forty alumni and guests took part this past March in the Association's second travel/study program to experience, explore—and enjoy—the geology, flora, and fauna of the Salton Sea area and the Anza-Borrego State Park.

Texas at Austin, talked about his experiences teaching Shuttle astronauts how to recognize and photograph various geologic, oceanographic, meteorologic, and environmental features from space—from deltas and coasts to volcanoes and major fault zones. The aim of developing this elite corps of shutterbugs is to generate high-quality photos of Earth that will benefit many fields of research.

The New Mexico chapter looked even closer to home—inside the human body—when Caltech Professor of Biology Ellen Rothenberg spoke to the group on "information processing in the immune system." She described how cells of the immune system mobilize their protective response against invaders, first by learning to recognize foreign molecules, then by assessing the level of threat, and finally by communicating with one another via chemical messengers called "cytokines" in order to coordinate an appropriate defense.

A very different type of biology—the nurturing of young minds—was the topic when Associate Professor of Biology Jim Bower made back-to-back appearances before the Seattle and Portland chapters, speaking on "Scientists and Science Education Reform: Myths, Methods, and Madness." Bower, who is also codirector of the Caltech Precollege Science Initiative (CAPSI), talked about the program's innovative hands-on approach to teaching science in grades K through 12 and speculated about the nature of science education in the next century. Through a grant from the National Science Foundation, the science-teaching model pioneered by CAPSI in Pasadena is now being introduced into selected school districts throughout California.

The Seattle chapter also presented its own "hour of power"—if by power one means movers, shakers, and protean intellects—when it played host to University Archivist and Caltech Faculty Associate in History Judith Goodstein. Goodstein, the author of *Millikan's School*, a history of Caltech, spoke

about some "big thinkers" at the Institute who played a key role in shaping not only Caltech's postwar teaching and research agenda, but America's entire postwar scientific enterprise. Her talk dealt with, among others, Institute president Lee DuBridge; physicists Richard Feynman, Robert Bacher, and Robert Christy; astrophysicist Jesse Greenstein; and biologist George Beadle.

Those in alumni circles who preferred to think small—*really* small—could do so by catching Axel Scherer on the San Francisco channel. The Caltech professor of electrical engineering and applied physics discussed his research in micro- and nanofabrication—work that is leading to new techniques both for improving the performance of devices and for exploring new physical phenomena.

And finally, what respectable cable channel would close out its programming schedule without giving subscribers a taste of the latest scandal? "My career in scientific fraud began some decades ago," confessed Caltech Vice Provost David Goodstein in a tell-all encounter with members of the Tri-State chapter. Goodstein, who is also

Alumni and alumni-to-be met, mingled, and munched at the Annual Senior Barbecue, held in April by the Alumni Association and Alumni Fund to honor the Class of '96.



Seven alumni elected to NAS

Seven Institute alumni were elected this past April to the National Academy of Sciences—one of the highest honors that can be bestowed on an American scientist. The Caltech graduates, who together constitute more than 10 percent of the 60 new NAS electees, are Roger Chevalier '70, the W. H. Vanderbilt Professor of Astronomy at the University of Virginia, Charlottesville; Robert Clayton, PhD '55, the Enrico Fermi Distinguished Service Professor, department of chemistry and geophysical sciences, the University of Chicago; Charles Cox '44, professor emeritus at Scripps Institution of Oceanography, UC San Diego; Yuh Nung Jan, PhD '75, investigator with the Howard Hughes Medical Institute and professor of physiology and biochemistry at UC San Francisco; Jerry Nelson '65, professor of astronomy at UC Santa Cruz; Alvin Tolstrup, PhD '50, senior scientist at the Fermi National Accelerator Laboratory (Fermilab); and George Zweig, PhD '64, senior fellow at Los Alamos National Laboratory.

professor of physics and applied physics as well as the Institute's Frank J. Gilloon Distinguished Teaching and Service Professor, regaled Tri-State alumni with the details of how he embarked on his crooked course while developing, in response to federal regulations, formal procedures for handling any instances of scientific fraud that might arise at Caltech. The experience has taught him that while "science is self-correcting, in the sense that a falsehood injected into the body of scientific knowledge will eventually be discovered," science nevertheless "needs active measures to protect itself."

Might science, in other words, be destined to develop its own V-chip? Stay tuned for the next edition of the Caltech Chapter Channel.

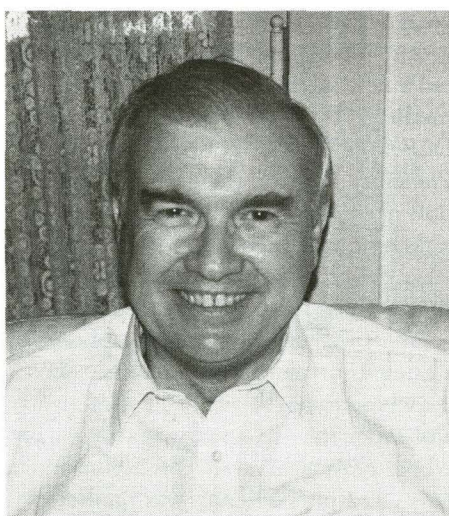
Another centennial milestone

By Frank Dryden '54, MS '57

In 1991, Caltech celebrated its first centennial, thereby marking the 100th anniversary of the start of classes at Throop Polytechnic Institute. In 1897, one year after the first bachelor's degrees were awarded to graduates of Throop, an alumni association was formed. This group continued until June 7, 1915, when 13 graduates of what had become Throop College of Technology banded together to form a new alumni association for the purpose of creating a perpetual bond of friendship between all alumni. The name of the college was changed to the California Institute of Technology in 1920.

Fifteen years later, in 1935, the Caltech Alumni Association was formally incorporated in the state of California, and its purposes were expanded to assisting the Institute by supporting and advancing the cause of higher education. Based on the humble beginnings of 1897, this coming year marks the 100th anniversary of the origin of the Caltech Alumni Association. Our goal is to use this commemorative year as a means to reach out to all alumni and to celebrate the achievements of alumni through the last 10 decades.

A centennial committee has been established this year, chaired by Ed



Frank Dryden

Lambert '82, vice president of the Association, with the charge of finding appropriate ways to celebrate all alumni (not just those in the Association), to offer the Institute a venue through which it can continue to show support for and appreciation of its alumni, and to strengthen Institute-alumni bonds. The committee has focused on plans in four areas:

- Developing a multimedia presentation showing what the world might be like without the contributions of Caltech alumni (à la Frank Capra's *It's a Wonderful Life*).
- Profiling the achievements of one alumnus/alumna per decade who has made outstanding contributions in a variety of fields, or one per class year as representative of the scope of alumni achievements.

- Holding appropriate celebrations both at Caltech and around the country at alumni chapter gatherings.

- Preparing special publications or media releases promoting the centennial and the achievements of alumni.

Although you will be hearing more about centennial events in future mailings and issues of *Caltech News*, recent developments included the kickoff announcement of the coming of the centennial year at this year's Alumni Seminar Day and during commencement activities. We are also planning a feature that will utilize a centennial brochure and a video/web site, and will include information on a few alumni from all classes.

Since the success of this project will depend on the level of volunteer effort to help put it together, we will need your help. Please let the Alumni Association Office know what has happened in your life or in the lives of alumni you know, that might be of general interest. If the program comes together as planned, we will use it at chapter gatherings around the country as part of our ongoing effort to keep all alumni informed about their classmates and what is going on at the Institute.

A highlight of the alumni centennial year will be a 100th Birthday Ball next spring. This will include a program and dance, and we hope to entice you to visit the campus for that weekend. More details will follow.

Plans are also under way to develop some special features for Alumni Semi-

nar Day '97, as we approach the end of our centennial year at graduation time. If you have any thoughts on how this celebration can be used to enhance communication with, and appreciation of, all Caltech alumni, or if you have time to help, call or write the Alumni Association Office and let us know.

ALUMNI ACTIVITIES

June 24–July 3, Alaska Travel/Study Program, led by Robert Sharp '34, the Robert P. Sharp Professor of Geology, Emeritus, and Leon Silver, PhD '55, the W. M. Keck Foundation Professor for Resource Geology.

October 6–21, China and the Yangtze River Travel/Study Program, led by James Lee, associate professor of history.

For more information on Association activities, please contact Judy Amis at 818/395-6594 for foreign travel/study programs, Arlana Bostrom at 818/395-8363 for domestic travel/study, local, and chapter programs, and Patsy Gougeon at 818/395-8366 for Seminar Day/Reunion Weekend programs.

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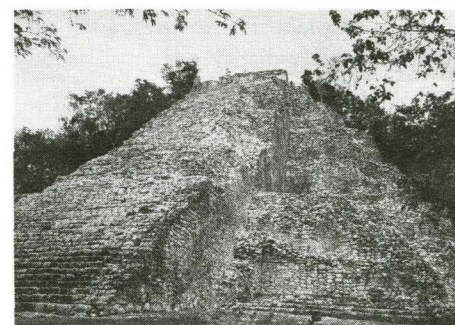
OVER \$38 MILLION WORTH OF POSITIONS HANDLED THIS YEAR

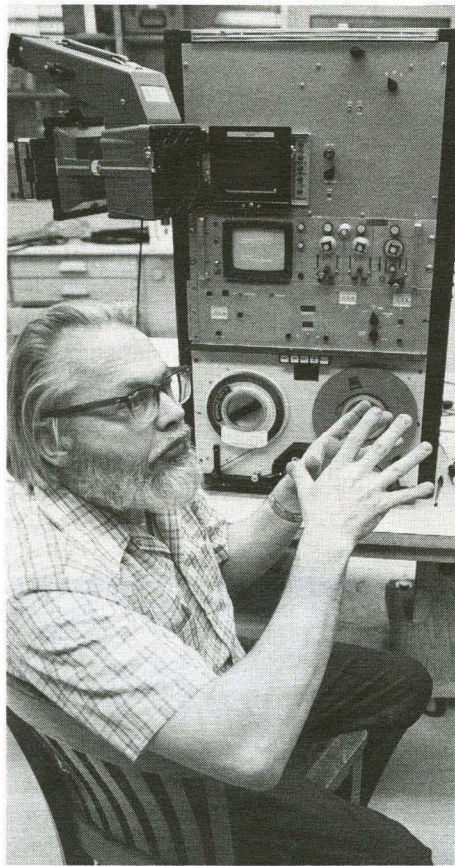
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Elated if a bit short of breath, participants in the Association's recent travel/study program to the Yucatán are definitely long on smiles as they reach the top of the ancient Mayan pyramid at Cobá (pictured at right). Clockwise, from left: tour guide Wig-gie Andrews (in cap); Margaret Schaefer; Deedee Rechtin; Dave Wilson, PhD '58; Sonya Onderwyzer; Bill Schaefer, tour leader and Caltech senior research associate in chemistry, emeritus; Kathy Merten; Ulrich Merten '51; Eb Rechtin '46, PhD '50; Dwight Schroeder '50, MS '63; Alumni Association Executive Director Judy Amis; and Marty Wilson.





Westphal in 1974 with an electronic data system for the Silicon Intensified Target camera that he and Kristian built for the Hale Telescope.

Jim Westphal

Continued from page 6

Telescope. However, as Westphal puts it, the folks at JPL were "sure as hell not going to hand any over to a couple of mad astronomers after spending millions of dollars to develop them."

So Westphal and Gunn kept track of the technology and, in the process, found themselves recommending CCDs for use in the main camera then being planned for the Hubble Space Telescope. The Space Telescope would orbit the earth far above the planet's obscuring atmosphere, allowing light to reach its 94-inch mirror unimpeded. Between the light-gathering abilities of the telescope and the light-recording abilities of a CCD-based camera, the orbiting observatory would be able to zoom in on planetary features, such as Pluto's recently discovered satellite, or scan the distant universe for galaxies that were forming when the cosmos was only one-fifth its present age.

Next thing Westphal knew, Gunn was encouraging him to be principal investigator for what would come to be called the Space Telescope's Wide-Field and Planetary Camera (WFPC), commonly referred to as the Wiffpik.

"You be PI and I'll help," Gunn said. "No, you be PI and I'll help," said Westphal. Both of them were hands-on innovators whose "style was to go into the shop with an engineer, a machinist, and an electroniker" and have at it. In contrast, the Wiffpik would be built in a JPL clean room with only the most space-worthy components (i.e., no plastic garbage cans), and with the inventors "watching from the sidelines as the JPL pros worked their magic."

Westphal was willing to make a list of people who would be needed for this hypothetical venture. If enough of them agreed to join the team, Westphal

told Gunn, he would be PI. "I thought those people were smarter than we were and would decline."

Everyone accepted. NASA chose the Wiffpik proposal in an open competition, and the Caltech-JPL team was in business for what everyone thought would be five years.

But the Hubble project was much bigger than Wiffpik. It encompassed the telescope plus six science instruments (of which Wiffpik was one). This was mega-science, with big delays, big bureaucracies, and big cost overruns to match. To further complicate matters, the Shuttle program was grounded after the *Challenger* disaster, forcing the Hubble to wait until 1990 to be launched. And there was the major postlaunch disappointment when a serious flaw in the telescope's main 94-inch mirror required Westphal's team to use its *flawless* camera to diagnose the problem.

A mistake in the testing equipment at Perkin Elmer, the mirror's manufacturer, had resulted in a telescope that couldn't bring astronomical objects into clear focus. Images could be improved by computer manipulations, but what the Hubble needed in order to meet all its science objectives was something akin to eyeglasses.

Already there was a second Wiffpik planned to replace the first, in case it failed. The schedule was stepped up and the challenge was now to build Wiffpik II with corrective mirrors that could exactly compensate for the telescope's flaw. At this point, Westphal's job was to pass on all the Wiffpik I knowledge to the Wiffpik II leader (JPL's John Trauger) and get back to being a scientist.

The good news was that, even as the Hubble hobbled along, Westphal and Gunn fulfilled their original goal of getting CCDs into ground-based observatories—not only at Palomar, but also at most major observatories in the United States and Chile. First coupled with a CCD camera in 1977, the Hale's 200-inch mirror obtained the light-collecting power that a 2,000-inch mirror would have using photographic plates. (CCDs are now in all modern video cameras and some 35mm cameras.)

For their work on Wiffpik, Westphal's 12-person science team earned 320 hours of observation time on the Hubble Space Telescope. "That was our payment for 17 years of whatever you'd like to label it." And what would he label it? "It was messy," with innumerable hours spent in meetings across the country. "I'll tell you what it was: it was 1,600,000 frequent flyer miles on American Airlines."

What would the scientists do with their payment: take all their pictures with the Wiffpik I, or save a number of hours in hopes that the Wiffpik II would "really happen" and would correct the telescope's flaw? "We gambled on the success of Wiffpik II and saved 200 some hours to use on it," says Westphal.

"And that's what we're merrily doing. Almost every day I get a cassette

with new data—it's unbelievably gorgeous. The Space Telescope has spotted a new satellite orbiting Saturn." As predicted by Peter Goldreich, Caltech's DuBridge Professor of Astrophysics and Planetary Physics, the gravitational pull of this moon and other known and unknown satellites shepherd the planetary debris orbiting Saturn into the sharp-edged rings that we observe.

Westphal eagerly pulls out photos of a number of very faint, far away galaxies whose images have been stretched and intensified by a large nearby galaxy whose gravitational field is acting like a lens. The phenomenon was predicted by Einstein in his general theory of relativity, and it was first witnessed through ground-based telescopes about 15 years ago, by a team that included Westphal. "But this has just got to be the most fabulous picture ever taken of these things," he says. "When this picture came in, I put it under Kip Thorne's door [Thorne is the Feynman Professor of Theoretical Physics] with a note saying, 'If you ever have any doubt about gravitational lenses, here's your proof.'"

"In the blankest piece of the sky, we can now see galaxies. The fainter they are, the more 'torn up' they are, and now we know it's because they're merging. Scientists have been waving their arms, predicting this for years, but now everyone seems amazed that they were right." For someone who once told a *New York Times* reporter that "one of our pleasures is when we ruin a theory or two," Westphal sounds pretty pleased about the confirmations.

Down to Earth at Palomar

While the mysteries of the cosmos are being confronted, one final mystery of Westphal's career must be solved. In 1991, about to be liberated from his leadership role on the Wiffpik project, Westphal was in a prime position to set his future course. He had just been awarded a MacArthur Fellowship to the tune of \$360,000. The fellowships are popularly referred to as genius awards.

What would he do with his fame and fortune? His colleague Jim Gunn, who had previously won a MacArthur, advised Westphal to do the opposite of what he had done. Gunn felt he had failed to jump on a great opportunity when it presented itself. So he told Westphal, "Go and find your favorite palm tree, and sit down and decide on the widest spectrum of things that you're prepared to do."

Westphal sought out some shade in Fiji and, within five minutes, realized that the spectrum of what he was prepared to do was "way too broad to con-

template." He decided to focus on what he was not prepared to do. "I shall not be principal investigator of anything," he vowed. "I shall not be chairman of anything, or the director of anything, or sit on a committee of anything." The mystery is, why did he break his vow?

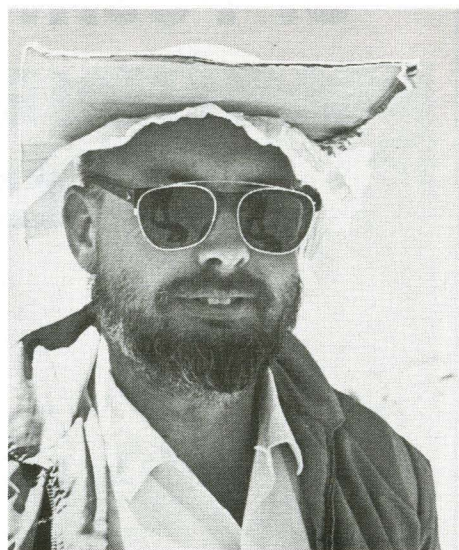
Two years later, Westphal was merrily following the rules he had set out for himself, when Nick Scoville, professor of astronomy and director of the Owens Valley Radio Observatory, walked into Westphal's office and shut the door behind him. "Oh God, now what," thought Westphal. Scoville told him he was on the short list of candidates for the directorship of Palomar. "The answer's no," said Westphal. "You can't say no," countered Scoville. "I just did," argued Westphal.

Within 45 minutes, Westphal was talking to the search committee, trying to recommend someone else. Soon "the pressure started coming." He talked to astronomers and other colleagues around campus. "They really did want me to do the job," says Westphal, who has always had great respect for the "real astronomers," calling himself an amateur astronomer to this day.

The biggest reason why Westphal broke his vow and became director of Palomar—"ultimately, with nobody forcing me"—is that it was payback time. "Given my history, and how I came here, it's very, very difficult to tell Caltech that you won't do something when you're finally convinced that you might be of service to them."

Now just over two years into the job, Westphal is finding that the directorship is even more about "decreasing research resistance" than were his previous jobs. "It's about allowing astronomers to do more astronomy in better ways, and new ways." He adds that "in this job, there are lots of different talents one has to develop—or fails to develop! There's an awful lot more sociology involved in dealing with people. . . . It has been enlightening."

Westphal signed a three-year contract rather than the standard five-year one. "We'll see how it goes," says the professor who has a knack for attracting adventure.



In La Silla, Chile, where starlight reaches telescopes through thin air, sunlight tests the range of Westphal's ingenuity.

Photo by John Irwin

PERSONALS

1940
ROBERT OSBORNE COX, of Fort Lauderdale, Florida, has been named the winner of the 18th annual Charles F. Chapman Memorial Award, created by the national association of the boating industry and by *Motor Boating & Sailing* magazine to honor "individuals or groups in the marine industry who have made outstanding contributions to the sport of boating for the benefit of the recreational boating industry and boating public." He received the award during the New York National Boat Show, in January, and donated the \$1,000 prize to the Marine Boat Museum, which has one of the largest collections of small antique boats, a hobby of Cox's. The chairman of Lauderdale Marina, the world's largest Boston Whaler dealer for the past five years, Cox is a founder and former president of the Marine Industries Association of South Florida, the former chairman of the marine advisory board of the city of Fort Lauderdale, a founder and past chairman of the Ship-yard Museum in Clayton (now the Antique Boat Museum), and a founding member of the first Fort Lauderdale International Boat Show, considered the largest such show in the world. He served as the mayor of Fort Lauderdale from 1984 to 1989 and on the City Commission from 1969 to 1989, the longest tenure on record. Cox is currently in Guatemala consulting on a marina project designed to be part of a new luxury resort. Then he will travel to Genoa, Italy, to represent the Marine Industries Association of South Florida at an international show.

1955
ALFRED A. BARRIOS, of Los Angeles, has received the Cancer Federation's Leslie Ralston Brusky Prize, presented March 2 during a meeting at the federation's national headquarters in Banning, California. The prize comes with a \$1,000 cash award. A psychologist, Barrios operates his own center in Culver City, California, and is the author of *Toward Greater Freedom and Happiness*. He is the developer of Self Programmed Control, a technique for helping individuals prevent and fight not only psychological problems but physical illnesses such as cancer, and he lectures widely and works with individuals and institutions who utilize his therapeutic approach as an adjunct to traditional cancer treatments.

ROD SUPPLE was among tourists who survived a deadly blizzard while trekking in Nepal last November—44 died in Himalayan avalanches, and landslides set off by the storm, the by-product of a cyclone in the Bay of Bengal. A resident of Santa Rosa, California, Supple is a retired engineer.

1956
DANG DINH ANG, MS, PhD '58, founding president of the Ho Chi Minh City Mathematical Society and longtime professor of mathematics at Ho Chi Minh City University, turned 70 on March 16, and in his honor his society and the Vietnamese Mathematical Society organized an international conference, "Analysis and Mechanics of Continuous Media," held December 27–29, 1995, in Ho Chi Minh City, Vietnam. The introductory talk was given by his friend Don H. Tucker, professor of mathematics at the University of Utah, and also in attendance was CHARLES W. VAN ATTA, PhD '65, professor of engineering sciences and oceanography at UC San Diego. In 1960, Ang assumed the chairmanship of the department of mathematics at the University of Saigon, where he modernized the curriculum, introduced topics such as topology, modern algebra, and functional analysis, and instituted the graduate-level certificate of Mathmatiques Approfondies, which was also open to gifted undergraduates. He remained chairman until 1975, when he became director of the laboratory of analysis, a position he held until April 1995. A researcher in several areas of applied analysis, Ang has

authored or coauthored more than 100 publications and is currently advising seven doctoral students. From 1983 to 1992, three students completed doctoral programs with him, one of whom won a Humboldt Fellowship and another of whom was appointed assistant professor at a U.S. university. During his career he has also been senior research fellow in aeronautics and then geophysics at Caltech, associate geophysicist at UCLA, visiting professor of mathematics at the University of Utah, the University of Paris 13, and the Mauro Picone Institute of Applied Mathematics in Rome, and DFG Visiting Researcher at the Institute of Mathematics of Berlin Free University, and he has lectured at Cambridge and other European scientific centers. He and his wife of 46 years, Minh Thi, have two sons and three daughters, all of whom have gone on to careers in medicine and academia.

1957
RUBE MOULTON writes: "I retired from Pac Bell in September of '95 (after over 38 years), and am enjoying having some additional time to explore the internet and other interesting things. I hope to do a bit of part-time management consulting or contract work, but frankly have enjoyed simply not working at all for the past several months. My e-mail address is rbmoultn@slip.net. I am still very much involved in choral singing in the Bay Area, which all started with my involvement with Olaf Frodsham and the Caltech Glee Club! Our daughter, Vicki, is apparently a chip off the old block, and is the alto soloist/section leader at Lewinsville Presbyterian Church in McLean, Virginia. She also sings with the Washington Singers, a small choral group in Washington, D.C."

1959
DONALD M. WIBERG, MS '60, PhD '65, retired in July 1994 to emeritus status as professor of engineering and applied science and professor of anesthesiology at UCLA, where he started in 1965. While there he was elected a fellow of the IEEE and had Fulbrights to Denmark in 1976 and Norway in 1983. During 1995, funded by an IEEE Congressional Fellowship, he was Iowa Democratic Senator Tom Harkin's legislative analyst for defense appropriations, arms control, energy, and related areas. He and his wife, Merideth, now reside in

Long Beach, California, and his younger son, KENNETH C. WIBERG '93, works for Douglas Energy in Placentia, California.

1963
RICHARD E. PETERSON, of Lubbock, Texas, writes, "In September 1995 my wife and I went to Estonia where I was keynote speaker in a conference (held in Tallinn and Tartu) on the tornado research of Johannes Letzmann (who worked in Estonia during the years between the world wars). Over the last 23 years I have had the good fortune to pursue studies on severe windstorms as a part of the wind engineering research group at Texas Tech." Peterson is chairman of the department of geosciences and professor of atmospheric science at Texas Tech University.

1965
VIRGINIA TRIMBLE, MS, PhD '68, professor of astronomy at UC Irvine, has been elected to the board of directors of Sigma Xi. Also, this spring she begins a three-year term on the board of directors of the Astronomical Society of the Pacific.

1966
PO KEE WONG, Eng, of Somerville, Massachusetts, has been appointed a Professional Development Provider by the Massachusetts department of education. A teacher at Charlestown High School and the owner of Systems Research Company, he is a senior member of the American Institute of Aeronautics and Astronautics, has six U.S. basic patents granted and pending in areas related to physics, mathematics, engineering, and high technology, and has published papers on topics ranging from wave propagation to satellite tracking.

1974
H. MAX IRVINE, Eng, has been designated emeritus professor of civil engineering at the University of New South Wales, Sydney. He is founding director of a specialist engineering consultancy, Structural Mechanics and Dynamics, which is involved in an extensive range of projects in Australia, New Zealand, Southeast Asia, and the Middle East. He specializes in structural dynamics and earthquake engineering. He is also a visiting professor at Imperial College, London, and the University of Hong Kong, and he continues to be actively engaged

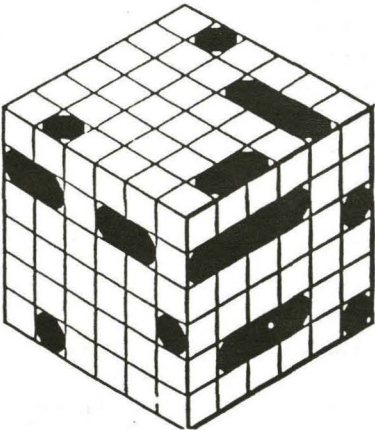
in setting up midcareer training programs for officials from Indonesia's public service.

1977
BEN S. FREISER, PhD, professor of chemistry at Purdue University, has—almost exactly 20 years after winning the Herbert Newby McCoy Award at Caltech in 1976, for graduate research in chemistry—won the Herbert Newby McCoy Award given by the School of Science at Purdue, for outstanding contributions to science. "Ben 'The Real McCoy' Freiser," he writes, "has been on the chemistry faculty at Purdue since 1976."

WING KAM LIU, MS, PhD '81, professor of mechanical and civil engineering at Northwestern University, received the Gustus L. Larson Memorial Award of the American Society of Mechanical Engineers (ASME International) at its International Mechanical Engineering Congress and Exposition this past November in San Francisco. The award is given for outstanding achievement in mechanical engineering within 10 to 20 years following graduation. Liu joined the faculty of Northwestern in 1980 as an assistant professor of engineering and became full professor in 1988. Specializing in applied mechanics, he has made fundamental contributions to nonlinear finite element methods and has developed new reproducing kernel and wavelets methods for solving mechanics problems. His techniques have been applied in manufacturing processes, safety analysis of nuclear reactors, seismic analysis, and probabilistic fracture and fatigue problems. The editor of 10 books, he has had more than 200 papers published and currently serves as associate editor for the *ASME Journal of Pressure Vessel Technology* and *ASME Journal of Applied Mechanics*. He has been a consultant to Argonne National Laboratory, Grumman Aerospace Corporation, Mitsubishi Heavy Industries, and Battelle, among other organizations. An ASME Fellow, he has received the Society's Melville Medal (1979) and Pi Tau Sigma Gold Medal (1985). He also received the 1989 Thomas J. Jaeger Prize from the International Association for Structural Mechanics in Reactor Technology, and the 1983 Ralph R. Teetor Educational Award of the American Society of Automotive Engineers.

1978
R. JEFFREY BLAIR writes: "I expect to graduate from the University of Hawaii in May 1996 with an MA in English as a Second Language (= applied linguistics). My wife (Yoko), two children (Michael and Melissa), and I will be moving back to Nagoya, Japan, where I will be teaching at Aichi-Gakuin Junior College."

1979
SANGTAE KIM, MS '79, Wisconsin Distinguished Professor at the University of Wisconsin–Madison, was appointed chair of that school's chemical engineering department July 1, 1995. His research interests are fluid mechanics, rheology, suspensions, protein dynamics, applied mathematics, and parallel computing, and his awards and honors include an NSF Presidential Young Investigator Award (1985), the Allan P. Colburn Lecture (University of Delaware, 1989), a Romnes Faculty Fellowship (1990), and the Robert W. Vaughan Lecture (Caltech, 1991). "Keeping us ranked a step above Caltech's chemical engineering department," he writes, "continues to remain a major preoccupation for me. :)"



Here's the solution to Huang's contribution (see page 6).

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Keep us informed so we can keep your fellow alums informed. Send us news about you and your family, about a new job, promotion, awards—anything you'd like to see printed in the Personals section of *Caltech News*. Return this coupon and any additional materials to *Caltech News*, 1-71, Pasadena, CA 91125.

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NEWS _____

1983
TZE KIN IP writes that, after graduating from Caltech, he completed his MD/PhD at Brown University. "Since then I have gone on to finish my residency in internal medicine at the University of Pittsburgh Medical Center as well as a couple of years of post-doctoral research at the Children's Hospital in Pittsburgh and West Penn Hospital. I am currently a fellow in cardiology at the Johns Hopkins Medical Institution. On a more personal note, I have been married to Bettina Franz now for almost 10 years and have three active, well-behaved kids: Renita (8), Arista (4), and Zachary (1). I would love to hear from any old Caltech classmates."

1984
JEFFREY S. BANKS, MS, PhD '86, professor of economics and of political science at the University of Rochester, has received the National Academy of Science's award for excellence in scientific reviewing. Awarded at the academy's 133rd annual meeting in Washington, D.C., on April 29, it carries a \$5,000 prize. Given to Banks for his "influential reviews of work on the theory of games of incomplete formation, theory of automata, and the theory of repeated play games as they apply to political relationships, as well as for his extensive editorial work," the award was established by Annual Reviews, Inc., and the Institution for Scientific Information, in honor of J. Murray Luck. In 1989, Banks received an Alfred P. Sloan Foundation Research Fellowship, and a National Science Foundation Presidential Young Investigator Award.

1985
MICHELLE WALTERS COSTA writes, "On January 14th of this year my husband, Tom, and I had our third son. Steven Peter Costa joins big brothers Michael (4) and David (2) to make our home a happy and noisy one. During what little free time I can find, I have been pursuing a new career—writing. I have had two articles published, one by a local magazine and the other by the *Washington Post*."

RAYMOND SCOTT HUDSON, PhD '91, a radar astronomer and electrical engineering professor at Washington State University, has had the asteroid 5723 Hudson named after him by the International Astronomical Union, recognizing his pioneering work using radar images to determine the shapes and rotation of asteroids. According to his coinvestigator, JPL's Steven Ostro, "Hudson's techniques improve asteroid orbit prediction by several orders of magnitude, and open the door to an array of scientific studies of these small Earth-crossing bodies." Hudson is one of a group of scientists interested in discovering, observing, modeling, exploring, and possibly deflecting such asteroids. As Hudson points out, "The probability that civilization will be devastated by the impact of an asteroid or comet during the next century has been estimated at one in a thousand."

JOHN F. MCGOWAN, of Mountain View, California, writes that he received his PhD in experimental particle physics from the University of Illinois at Urbana-Champaign in January 1993. "I now work for CompCore Multimedia optimizing and implementing MPEG-1 and MPEG-2 digital audio and video compression algorithms on the PC and other computer platforms," he says. "MPEG-1 is a digital audio/video standard that can store 72 minutes of video on a standard CD-ROM. MPEG-2 is the compression scheme used in the Digital Versatile Disc (DVD) standard. I have also worked on a Microsoft Windows user interface for our MPEG-1 player. CompCore's customers include Hitachi, NEC, Packard Bell, ATI, Cirrus Logic, Matrox, and Network Computing Devices (NCD). MPEG is one of the more mathematically sophisticated technologies that I have seen in the 'real world.' I'm actually able to use the mathematical knowledge that I acquired at Caltech and in graduate school. I am currently living in the San Francisco Bay Area, thoroughly spoiled by the best climate of any-

where I have lived or visited. I've become a regular hiker and have explored most of the many parks in the Bay Area. I am looking for hiking companions since most of my friends don't share my enthusiasm."

1992
BERNARD ROUSSET-FAURÉ, MS, and his wife, Sabine, announce that their son, Antoine Emmanuel Rousset, was born on January 16. Although permanent residents of France, the family is currently living in Burbank, California.

JOHN WISSLER, PhD, a major in the U.S. Air Force, writes, "We're back in Colorado at the U.S. Air Force Academy, where I'm an assistant professor of aeronautics and deputy director of the academy's aeronautics lab. I was promoted to major two years ago, then left New Mexico for a year's hiatus at the USAF's staff college in Alabama. Beth and the kids are fine and we all miss Caltech. We should be in Colorado three or four years."

OBITUARIES
1927
CHARLES L. GAZIN, MS '28, PhD '30, of Richmond, British Columbia, on December 23, 1995; he was 91. He served as curator of vertebrate paleontology at the Smithsonian Institution from 1932 to 1969. Predeceased by his wife, Elizabeth, he is survived by a son, Chester; two daughters, Margaret and Barbara; and many grandchildren and great-grandchildren.

1928
ROBLEY D. EVANS, MS '29, PhD '32, of Scottsdale, Arizona, on December 31, 1995; he was 88. A nuclear physicist, he became director of the Radioactivity Center at MIT in 1935. In 1938, he persuaded MIT to build the first atom smasher, the Markle Cyclotron, which generated radioactive isotopes for biological and medical research. His initial research of workers exposed to radium while painting luminous numbers on instruments, published in 1941, set a standard for maximum allowable lifetime dose still used today, and after World War II he helped establish the regulations governing the medical uses of radioactivity. With Dr. James Howard Means of Harvard Medical School he pioneered ways to use radioactive iodine to diagnose and treat hyperactive thyroids. In the 1940s and '50s he used radioactive calcium and iron in nutritional studies that later became controversial. Evans defended the studies, saying that "you can use tiny amounts of radioactive materials and trace drugs or minerals in the body with substantially no effects from the radiation." In 1990 he won the Enrico Fermi Award, the highest scientific award given by the Department of Energy. He is survived by his wife and onetime colleague, Mary, and three children from his first marriage: two sons, Richard and Ronald, and a daughter, Nadia Hill.

1930
GEORGE L. REYNOLDS, of Duarte, California, on July 20, 1995; he was 87. He was a forest engineer for 25 years and a church business manager for 25 years. He is survived by a son, Don; a daughter, Carolyn Gillespie; a brother, William; a sister-in-law, Margaret Poggione; a sister, Harriet Phillips; eight grandchildren; and ten great-grandchildren. His wife, Esther, died April 26, 1995.

1931
ALBERT T. CRAWFORD, of Downey, California, on November 7, 1995. He retired from Shell Oil in 1970, after serving 31 years. He also served in the Army Chemical Corps Reserve, attaining the rank of major. After retiring, he did volunteer work for the retarded, the Red Cross, and hospitals. "He loved Caltech and the Gnome Club." He is survived by his wife, Valera.

1932
ROBERT L. SHERMAN, Whittier, California, on January 2; he was 85. In 1934, he joined American Potash and Chemical Corporation, in Trona, California, where he remained for the next 35 years working in engineering, research, and administrative positions. He was also the first president of the Home School Association of Searles Valley and served as president of the Kern County Council of the Boy Scouts of America, from whom he received the Silver Beaver Award. A dedicated Rotarian, he joined the China Lake Club in 1952, in its second year, and served a term as president. He shared his hobby of astronomy with the community as well, at one point reporting to the American Association of Variable Star Observers, a group of astronomers under the direction of Harvard University. In 1969 he was transferred to Whittier, where he worked at Kerr McGee Research Laboratory until his retirement in 1973. In Whittier, he was a member of the Rotary Club and the East Whittier Amateur Radio Club, and he directed the Former Tronans Club from his residence for 19 years. He also performed computing consulting for industry and tax consulting for H&R Block and Security Pacific Bank, and served individual clients until 1995. He is survived by Augusta, his wife of 62 years; a son, George; a daughter, Barbara; seven grandchildren; and four great-grandchildren.

1933
DONALD K. OLSON, of Mount Baldy, California, on March 3; he was 88. A lifelong member of the First Presbyterian Church of Alhambra, he served as a trustee and ordained elder as well as a choir member. He is survived by his wife, Frances; his four sons, Peter, Eric, David, and Jim; his three daughters, Karen, Kristin, and Kandi; 16 grandchildren; and four great-grandchildren.

1935
LEWIS B. BROWDER, of Carpinteria, California, on December 11, 1994. While at Caltech he worked with Carl Anderson, and S. H. Neddermeyer of Stanford, gathering data on cosmic rays with a cloud chamber mounted in a trailer at Pike's Peak, Colorado. He began his career with the research laboratories of the L.A. Gas & Electric Co., followed by the Geophysical Engineering Corp. of Pasadena, where he worked both with a seismic field crew and at the company's lab, helping design variable-gain amplifiers. He then became technical advisor to the Walt Disney Studios camera department, where he assisted in the making of special sound and optical sequences for *Fantasia*, including the first pictures of the replication of an amoeba. He also returned to Caltech as a research assistant in physics, developing electronic gear for the generation and measurement of low-frequency earth currents. In 1940, he moved to Lockheed, where he participated in a number of developments, including the first powered, twin 50-caliber machine-gun turret for bombers, and a theoretical study for a proposed jet-engine design. After World War II he went to work for Westrex Corporation, where he was responsible for developing and designing recording systems for motion-picture sound tracks and made possible the high quality of some of the most memorable music in movies. He took a leave from Westrex for active duty with the Armed Forces Special Weapons Project, where he undertook the planning of instrumentation for the first continental tests of nuclear weapons at the Las Vegas-Tonopah test site. Returning to Westrex as a project engineer, he designed a self-contained film projector and sound-film reproducer that could be operated and viewed by a single individual, greatly simplifying the task of film editing. After serving as assistant manager of Aerojet's missile guidance group, he spent much of his subsequent career with Bell & Howell, beginning as a member of the research staff at Consolidated Electrodynamics Corporation, which was later acquired by Bell & Howell as its research arm. His work focused on motion-picture recording and reproduction, and, after retiring, he contin-

ued in this field as a research consultant, his skills serving the needs of the military and NASA, among others. While with Consolidated Electrodynamics he took a year's hiatus to join Thomas Ware of International Minerals & Chemical Corporation as scientific advisor to the president of the United States, and undertook Ware's responsibility for assessing the impact of a planned underground nuclear explosion near the corporation's potash mines at Carlsbad, New Mexico. By questioning the Atomic Energy Commission's methods of risk assessment, Browder brought about a reappraisal of the experiment. The level of the explosion was reduced, and the company was compensated for the removal of its personnel from the mines as a safety measure. Even with the reduced explosion, as it turned out, a fissure developed at the surface, and mine walls seven miles away were significantly displaced. Browder is survived by his wife and three daughters.

1936
MINOR L. FAHRMANN, MS '37, of Westfield, New Jersey, on May 14, 1995; he was 79. From 1937 to 1981, he worked in California, Iran, and Perth Amboy for the Chevron Oil Company, as an engineer and as manager of operations for the eastern division. He was a member and, in 1969, president of the Woodbridge Rotary Club. He was also a member of the Monsignor Watterson Council No. 1711 of the Knights of Columbus in Westfield. He is survived by his wife, Antoinette; four daughters, Antoinette, Virginia, and Carolyn, and Margaret Potter; and two granddaughters.

STUART R. FERGUSON, of Corona Del Mar, California, on November 12, 1995; he was 81. After receiving his degree from Caltech, he did graduate work at the University of Michigan and UCLA. During his engineering career the firms he worked for included Disney, Lockheed, Northrop, Douglas, and Hughes. At Disney, he worked on *Fantasia* and *Pinocchio* and with both Roy and Walt Disney. Howard Hughes hired Stuart personally to provide design help for Hughes's new helicopter venture. Over the years Stuart also worked on Project Apollo, the F-104, the B-1, and the stealth bomber. He is survived by his son, Robert; his daughter-in-law, Diana; and his grandson, William. Stuart's wife, Betty, predeceased him in 1995.

1938
EDMOND F. SHANAHAN, of Los Angeles, on May 29, 1994. He is survived by his wife.

1940
LLOYD T. GOODMANSON, MS '41, of Poulso, Washington, on August 8, 1993. He is survived by his wife, Elinore.

1941
WILLIAM L. INGERSOLL, MS '42, of Kentfield, California, on December 23, 1993; he was 73. During World War II he served as a lieutenant in the U.S. Navy, in the South Pacific. He also earned a degree in naval architecture from the University of Michigan. After leaving the service he moved to San Francisco, and then he and his family moved to Kentfield in 1951. He spent 34 years with Standard Oil of California and with Chevron Chemical, working in engineering and management. He is survived by his wife, Phyllis; a daughter, Cheryl; a son, William; a sister, Arlene Jensen; and three grandchildren.

JOHN M. RICHARDSON, of Malibu, California, on February 17; he was 77. After graduating from Caltech, he received his PhD at Cornell. His several employers included Bell Laboratories, Hughes Aircraft Company, the Ramo Wooldridge Corporation, Hughes Research Laboratories (where he was chairman of the theoretical physics department), and the Rockwell International Science Center, where he worked for 25 years and retired as a member of the technical staff. After retiring, he served as a research scientist with the electrical engineering

department at UC Santa Barbara. An expert in nonequilibrium thermodynamics and statistical mechanics, he made important contributions to mathematical inversion techniques, which he applied to inverse scattering and to detection and tracking. He also advanced the theory of pattern recognition. Over a number of years, and especially during the past few years, he made significant contributions toward the invention of a new class of rotary positive displacement pumps, compressors, and expanders, and their application to gas turbine-like engines. "He will be dearly missed by his many friends." He is survived by his wife, Betty; a son, James; two stepchildren, Jana and James Dexheimer; grandchildren Jason and Renee Richardson and Sean Dexheimer; and a sister, Georgia Westdahl.

1942

ROBERT A. COOLEY, PhD, of Bonita, California, on October 26, 1995; he was 79. As an undergraduate in chemistry at UC Berkeley, he discovered a new isotope of cesium, and while at Caltech he worked with Arnold Beckman. During World War II he served in the Navy, planning, developing, and installing harbor defense equipment at Los Angeles Harbor, eventually becoming executive officer of the Naval West Coast Harbor Defense School, and finally serving in Europe and Japan; at one point he worked with Linus Pauling. After the war, Cooley taught at the University of Missouri and was a consultant to Olin Matheson Corporation and the Naval Ordnance Laboratory in White Oak, Maryland. In 1956 he founded Propellux Corporation and bought a 100-acre farm in Illinois to manufacture devices to activate explosives. Chromalloy Corporation later bought the company, and Cooley became vice president and a member of the board. He also founded Fuel Cell Corporation in St. Louis and was a research and development manager with Monsanto Corporation. In 1968 he and his family moved to Bonita, where he became a research and development supervisor with Rohr Industries in Chula Vista. He also founded Aerospex Corporation, to develop ceramic dies for titanium aircraft parts. He was chairman of the St. Louis section of the American Rocket Society, vice chairman of the Wood River American Chemical Engineering Society, and editor for the St. Louis American Chemical Society. He was involved in civic affairs in both Illinois and California. He is survived by his wife, Faith; two sons, Robert and Kenneth; and a daughter, Laurel.

1944

DEAN R. CHAPMAN, MS '44, PhD '48, of Saratoga, California, on October 4, 1995; he was 73. A research professor of aeronautics and astronautics at Stanford, he was a pioneer in the use of supercomputers to model air flow around aircraft. Internationally recognized for his work, he received awards from both NASA and the American Institute of Aeronautics and Astronautics and was elected to the National Academy of Engineering in 1975. During World War II he spent two years with the Navy, stationed at Moffett Field and assigned to Ames Aeronautical Laboratory (then NACA), later the Ames Research Center. After receiving his PhD he returned to Ames, where he remained until joining the Stanford faculty in 1980. He became director of astronautics during the '70s. At Stanford his research efforts focused on computational turbulence and hypersonic flow—he participated in the formation of the Center for Turbulence Research and served on the center's steering committee until his death, and worked with other faculty toward the development of a substantial departmental program in hypersonics. The research project that perhaps challenged him most was his work on the origin of tektites, extremely ancient round, glassy objects found in Southeast Asia and Australia. Tektites examined by him at the British Museum reminded him of shapes created in an Ames wind tunnel during research into how to protect spacecraft from the severe aero-

dynamic heating of hypervelocity flight; he recognized features suggesting tektites had been shaped by the heat and aerodynamic forces of entry into the earth's atmosphere. Tektites have been the subject of scientific controversy for over 100 years, and his own conclusion was that they were the result of a large meteorite impacting the moon and forming the crater Tycho. Molten ejecta captured by the earth's gravitational pull entered the atmosphere as cold, rigid bodies and received their final sculpturing during their high-speed flight. In the end, he donated his tektite collection to the Smithsonian. He is survived by his wife, Marguerite; a daughter, Anita Hirsch; a son, Donald; three grandchildren, Rebecca, Sarah, and David; a brother, Tom; and a sister, Carmen Benson.

MAURICE E. FORD, JR., of Irvine, California, on August 21, 1995. He retired in 1990 as vice president of Bayle Engineering, Inc., and continued as an independent consulting engineer until his death. He is survived by his wife, Marilyn; six children; and 11 grandchildren.

1946

F. BARTON BROWN, MS, of Apple Valley, California, on June 6, 1995. Prior to attending Caltech, he had worked as a design engineer for several companies and spent World War II on active duty with the U.S. Army's Ordnance Department, attending schools on antiaircraft fire-control equipment—including optics and a special 10-week course at Bells Labs—and serving for 26 months in the South Pacific in command of the 253rd Antiaircraft Ordnance Company. After receiving his master's degree, Brown worked as a research engineer on the staff of Caltech's Hydrodynamics Laboratory, where he was in charge of constructing the Navy high-speed water tunnel. He retired as chief research engineer at Kobe Inc. His professional memberships included Sigma Xi, the American Society of Mechanical Engineers, the Solar Energy Society of America, the Society of Petroleum Engineers, and the American Petroleum Institute. He is survived by Mary, his wife of 53 years.

BERNARD E. DETHIER, MS '47, of Blue Hill, Maine, on February 22, 1995; he was 68. He served as a lieutenant in the U.S. Navy, and after receiving his master's degree from Caltech earned his PhD at the Johns Hopkins University. He taught meteorology and climatology at Cornell University for 30 years, retiring in 1988 as professor emeritus. He served as Maine's state climatologist until his death. He was a member of Sigma Xi and the American Association of State Climatologists, and a fellow and professional member of the American Meteorological Society, and he served as director of the Northeast Regional Climate Center and chaired numerous scientific and research programs. After his retirement to Maine he continued his lifelong interests in weather phenomena, world history, and carpentry. He is survived by Merrily Ann, his wife of 19 years; four children, Kathryn Borchard, Suzanne Rogers, Michele Dethier, and Vincent Dethier; two stepchildren, Theresa James and Michael Lee; 10 grandchildren; a sister, Frances Cannon; and a brother, Gerard Dethier. He was predeceased by his brother, Vincent Dethier.

WILLIAM G. MISNER, of Long Beach, California, on December 26, 1993. He is survived by his wife.

1947

HARRY P. BRUEGGEMANN, of San Marino, California, on November 4, 1995; he was 75. A distinguished professional in the field of electro-optics, in the motion-picture, aerospace, and photocopy industries, he held 17 patents, was the author of three books, and published many papers in technical journals. After graduating from Caltech, he became technical director of Cinecolor Corporation and then chief engineer at Pathé Laboratories, and then he worked in the area of optical design at Aerojet, Tridea, and Marquardt. Finally, he worked for 17 years at

Xerox, specializing in advanced concepts in imaging and laser-scanning systems. He received several honors and awards for significant achievement, including the Silver Award for the number of his patents. He was an ardent amateur astronomer, and his picture of a total eclipse, taken during a recent cruise to South America, was published in *Sky and Telescope*. He is survived by his wife, Mary Louise; four children; seven grandchildren; one great-grandchild; and a brother and two sisters.

EDWARD A. FLANDERS, MS, of Lake Tahoe, Nevada, on July 3, 1995. He is survived by his wife, Doris.

DAVID P. SHOEMAKER, PhD, of Corvallis, Oregon, on August 24, 1995; he was 75. A Guggenheim Fellowship took him to the Institute for Theoretical Physics, Copenhagen, Denmark, in 1947, and he served as a senior research fellow at Caltech 1948–1951. Appointed assistant professor of chemistry at MIT in 1951, he rose to full professor in 1960. In 1970 he became professor of chemistry and chairman of the chemistry department at Oregon State University, stepping down as chairman in 1981 and becoming professor emeritus in 1984. He served on many committees and delegations and as chairman of several, and he was coauthor of *Experiments in Physical Chemistry* and coeditor of *Acta Crystallographica*, published by the International Union of Crystallography, from 1964 to 1969. He was a fellow of the American Physical Society and the American Association for the Advancement of Science and a member of the American Chemical Society, the American Crystallographic Association (serving as president in 1970), the International Union of Crystallography (serving as a member of the executive committee from 1972 to 1975), Phi Beta Kappa, and Sigma Xi, among others. He is survived by his wife, Clara, and a son, Robert.

1950

ADAM F. SCHUCH, PhD, of Albuquerque, New Mexico. A retired staff member and alternate group leader of the Los Alamos National Laboratory's low-temperature-physics section, he was a registered professional engineer of the state of New Mexico, a fellow of the American Chemical Society, the American Physical Society, and the American Institute of Chemists, and a member of Tau Beta Pi and Sigma Xi. During World War II he served in the Asiatic-Pacific and European Theaters of Operation, retiring with the rank of lieutenant colonel; he was buried at the Santa Fe National Veteran's Cemetery with military honors. He is survived by his wife, Gretchen; a sister, Edith Ewald; a brother, Frank; and numerous nieces and nephews.

NORRIS D. WHITEHILL, of Los Angeles, on June 7, 1994. He worked on a secret project at Lockheed during World War II, and in later years he helped design a skateboard axle. He donated his body at death to the UCLA department of anatomy. He is survived by a cousin, June Kelley.

1952

JAMES O. JEPSON, MS, of Redmond, Washington, on September 20, 1994. He is survived by a son, Robert.

KARAMCHETI KRISHNAMURTY, MS, PhD '56, of Tallahassee, Florida, on December 31, 1993; he was 70. A native of Gajapatinagar, Andhra Pradesh, India, he spent most of his professional life at Stanford, retiring as professor emeritus. He thereupon joined Florida State University as dean of the College of Engineering, stepping down in 1992 to return to his love of teaching. During his career, he trained more than 50 doctoral students, and he produced two books and over 100 articles. "He was a gifted scientist and teacher. He was also gifted with a talent for laughter, for friendship, for enjoyment." He is survived by two daughters, Indira Karamcheti and Girija Karamcheti.

1965

WILLIAM G. SPRING, of Santa Barbara, California, on March 17, 1993; he was 49. He is survived by his mother, Theresa, and by two children, Crystal and Erhan.

1967

RICHARD L. RUSSELL, PhD, of Pittsburgh, on September 9, 1994. He was professor and assistant chairperson of the department of biological sciences at the University of Pittsburgh. After receiving his doctorate from Caltech, he went to the Medical Research Council, Cambridge, England, as a postdoc, then returned to Caltech as an assistant professor of biology in 1970. He joined the Pittsburgh faculty as associate professor of biological sciences in 1976. His research career focused on using the nematode worm to model the nervous system. He was supported by grants from the National Institutes of Health for 17 years, published more than 40 research articles, served as a member of an NIH study section from 1980 to 1984, presented over 70 invited seminars or lectures at other universities and at national and international symposia, was an active member of the Center for Neuroscience at Pittsburgh, and trained a number of graduate students and postdocs. He became assistant departmental chairperson in 1991 and led a reevaluation of the department's undergraduate curriculum. This resulted in the establishment of new majors and enhanced research opportunities for undergraduates. He helped obtain a Howard Hughes Medical Institute grant for enhancing undergrad biological-science education, and organized a successful HHMI undergraduate research-fellowship program. He had taught in the freshman Foundations of Biology series since 1981, and had recently taught the Honors College sections of that course. Involved in community service, Russell served for five years as commissioner of the Dynamo Soccer recreation league, for which, in 1993, he received the first annual Marjory S. Eisenman Community Service Award from the Squirrel Hill Urban Coalition. An avid runner, he completed the Pittsburgh Marathon four times. Other interests included gardening, photography, computers, and travel. He is survived by his wife, Barbara Attardi Russell, PhD '71, associate professor of medicine and cell biology and physiology in the University of Pittsburgh Medical Center; four children, Daniel Russell, David Russell, Kerstin Arusha, and Laura Attardi; his mother, Elizabeth Russell; his father, William Russell; his stepmother, Liane Russell; and two brothers, a half-brother, and a half-sister.

1991

ERIC R. ANDERSON, of Bellingham, Washington, on July 13, 1995, of undiagnosed diabetes; he was 26. A participant in the 3/2 program, he attended Reed College 1986–89, receiving his BA in physics from Reed and his BS in engineering and applied science from Caltech. He lived and worked in Bellingham after graduation, working part time as a network administrator for Brown & Cole Stores while also managing a restaurant full time. In early 1995 he started working as a computer consultant for a local company. While he enjoyed working with computers, his real love was flying—he received his private-pilot's license at age 17. He also enjoyed fishing and boating. He is survived by his parents, two brothers, his grandparents, a niece, and a nephew.

1992

ERIC M. CANDELL, of Somerville, Massachusetts, on May 15, 1995; he was 25 and a student at Rensselaer. He is survived by his father, Donald.

1993

NATHAN A. FREI, of Seattle, on January 22, of cancer. He is survived by his wife, Diana, BS '93.

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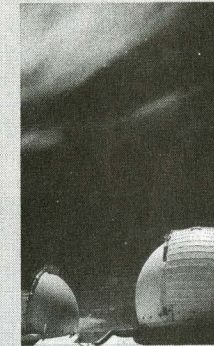
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In this issue



The Keck II Telescope dedication atop 13,600-foot Mauna Kea has participants seeing double.

Page 1



For his outstanding contributions in chemistry and biology, Norman Davidson is awarded the National Medal of Science.

Page 2

"You people are crazy," was Jim Westphal's response back in the '60s to a job offer from Caltech. Thirty years later, the Institute's still crazy about Jim Westphal.

Page 4

His prowess at solving puzzles has made Wei-Hwa Huang '97 the world's reigning puzzle champion. How does he do it? That may be one puzzle even he can't solve.

Page 6