

Caltech News

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Doing the RVT at 13g—From left, Caltech seniors Ben McCall and Al Ratner and test specialist Tim Werner (right) prepare to shake-test a photomultiplier tube that will ride the space shuttle as part of a project to investigate the origin of gamma-ray bursts. The tube's housing, sealed with duct tape, is being bolted to an axial shaker at JPL for a Random Vibration Test that subjects the tube to an acceleration of 13g—13 times the force of gravity—to simulate the shuttle's vibrations during launch. Once in space, the photomultiplier will collect the signals emitted by a gamma-ray-detecting scintillation crystal and pass the data along to a computer.



Undergrad group gets set to catch a few Gs

When the shuttle *Endeavour* roars into space in July 1995, it will carry the Caltech logo in its cargo bay. In September, NASA officially informed a group of Caltech undergrads that their GAMCIT experiment to study an enigmatic source of cosmic radiation known as gamma-ray bursts had a confirmed booking on the shuttle's cargo manifest.

The students who designed and built GAMCIT may also secure themselves a place in the annals of astronomy if all goes as hoped. While gamma ray bursts were discovered in the late 1960s by satellites watching for clandestine nuclear tests, their precise nature and origin remains an intriguing astrophysical mystery. The satellites observed that, like tropical cloud-bursts, torrents of gamma rays would appear and vanish in less than a minute, at a rate of one per day, on average. (They don't reach the ground, thanks to Earth's atmosphere.) These gamma rays are some of the most energetic astrophysical phenomena ever witnessed, but telescopic searches of the bursts' apparent points of origin have yet to turn up anything unusual.

Until the launch of the Gamma Ray Observatory (GRO) in 1991, astronomers had assumed the bursts came from within our galaxy. But the GRO data have shown that the bursts can come from any point in the sky. Since they aren't confined to the galactic plane, their sources must either be very close,

or far enough away to be outside our galaxy altogether. "It's a very high-stakes game," says veteran astronomer Maarten Schmidt, Caltech's Francis L. Moseley Professor of Astronomy. "Either the bursts are a few thousand light-years away, or billions of light-years away. If they're billions of light-years away, they must be from enormously energetic events—perhaps coalescing black holes or colliding neutron stars."

If the bursts originate nearby, they could be generated by binary stars that consist of an ordinary star and a neutron star orbiting each other. Invisible from Earth, the neutron star devours its companion, slurping material from the normal star. The material accretes on the neutron star's surface, compacts under the star's crushing gravity, and eventually detonates in a thermonuclear explosion. When this occurs, a flash might sometimes accompany the burst if the gamma rays hit what remains of the companion star and get reemitted as visible light. To date, however, no one has built a detector capable of seeing both types of radiation at once and thus confirming or refuting one of the local-origin theories.

Now, some 30 Caltech undergraduates are building GAMCIT to do just that. The instrument pairs a gamma-ray detector and a 35-millimeter camera. But solar flares spew gamma rays too, as well as electrons and protons, so GAMCIT will also carry a charged-

particle detector. GAMCIT won't waste film on simultaneous bursts of gamma rays and charged particles, but if the gamma-ray detector trips and the charged-particle detector doesn't, the camera will shoot five exposures of one minute each. A computer will record GAMCIT's position, using data from the Global Positioning System (GPS) satellite network. Orientation data will come from the photo, which should show enough recognizable stars to pin down the direction in which the camera was looking. The computer will also record the burst's arrival time, duration, intensity, and energy spectrum. GAMCIT is what NASA calls a Get-away-Special Canister, or GAScan. GAScans provide a way for small payloads to be sent into space quickly enough that students can design, build, and fly an experiment—and analyze the data from it—in less time than it takes to graduate. GAScans are slightly smaller than oil drums, and can weigh up to 200 pounds. They get stowed in odd corners of the shuttle's cargo bay as space permits. They are self-contained and self-sufficient—GAMCIT gets its juice from 288 size-D batteries.

Of course, you don't just stroll into Kennedy Space Center with a hunk of machinery and say, "Here, fly this." Gamma-ray astronomer John Grunsfeld—former faculty advisor for the project and now a NASA astronaut-in-training—and a small group of students began filing GAMCIT's pre-

liminary paperwork around 1990. Getting into the government mind-set has been an experience in itself. For example, GAMCIT's windowed lid is now a UDMD, or User-Designed Mounting Disk. "We called it a lid, and they flipped," recalls Al Ratner, a senior in mechanical engineering. "They said, 'People will confuse it with our lid.' It was so much more worth it to call it a UDMD than to have people be confused." (GAMCIT will ride in a NASA-supplied canister that also has a lid. But, in fact, NASA doesn't call its lid a lid, either—it's a Motorized Door Assembly, or MDA.) Even so, GAMCIT received its Final Safety Certification last January—the last paperwork hurdle before being assigned a launch date. GAMCIT will be built this term under the eye of technical advisor Daniel Burke, the electronics engineer for high-energy physics. The complete assembly is to be tested this January and shipped east in February.

Naturally, there's no guarantee that GAMCIT will solve the riddle of the gamma-ray bursts' origins, but that's life. "These are the most mysterious objects in astronomy right now," says Schmidt, who became GAMCIT's faculty advisor after Grunsfeld's departure. "I can think of no other object where the uncertainty in distance is a factor of a million."

CAMPUS UPDATE

Major grant to support biology division growth

Caltech has received a \$1.2 million grant from the Howard Hughes Medical Institute (HHMI) to support undergraduate teaching and research programs in the Division of Biology. One of 62 grants that HHMI has given to universities this year, the funds will be used to update undergraduate courses in cell and molecular biology, genetics, neuroscience, and chemistry; to purchase new equipment for those courses; and to support 24 SURF (Summer Undergraduate Research Fellowship) students over the next four years.

Caltech will also renovate the laboratories serving these classes, using \$300,000 in funds from other sources.

According to program director Charles Brokaw, professor of biology, Caltech's undergraduate laboratories need to be expanded because the number of students taking biology classes has doubled in the last five years. "Biology has been growing in importance relative to other sciences," says Brokaw. "Another element is that Caltech has been admitting more women in recent years, and the fact is that a high percentage of female science students major in biology."

The HHMI grant to Caltech will support the purchase of state-of-the-art equipment to outfit the Institute's cellular and molecular biology laboratory, which is currently being completely redesigned and enlarged by one third its present size. These renovations will support a new cellular and molecular biology curriculum.

"The curriculum changes were something we had already planned, but the grant allows us to make major changes in a short period of time," says Brokaw.

The grant will also support the expansion of Caltech's neuroscience program. "Neuroscience has been very popular with students," says Brokaw. "With this grant we are going to equip a new lab in the basement of the Beckman Institute with the latest in neuroscience equipment."

Lastly, according to Brokaw, the grant will be used to purchase new microscopes, "in order to improve both their quantity and quality," and will fund the purchase of major pieces of equipment for the several chemistry classes that biology majors take.

"This grant will also reach beyond the biology division to students in other fields," says Brokaw. "Chemistry is buying a mass spectrometer for its

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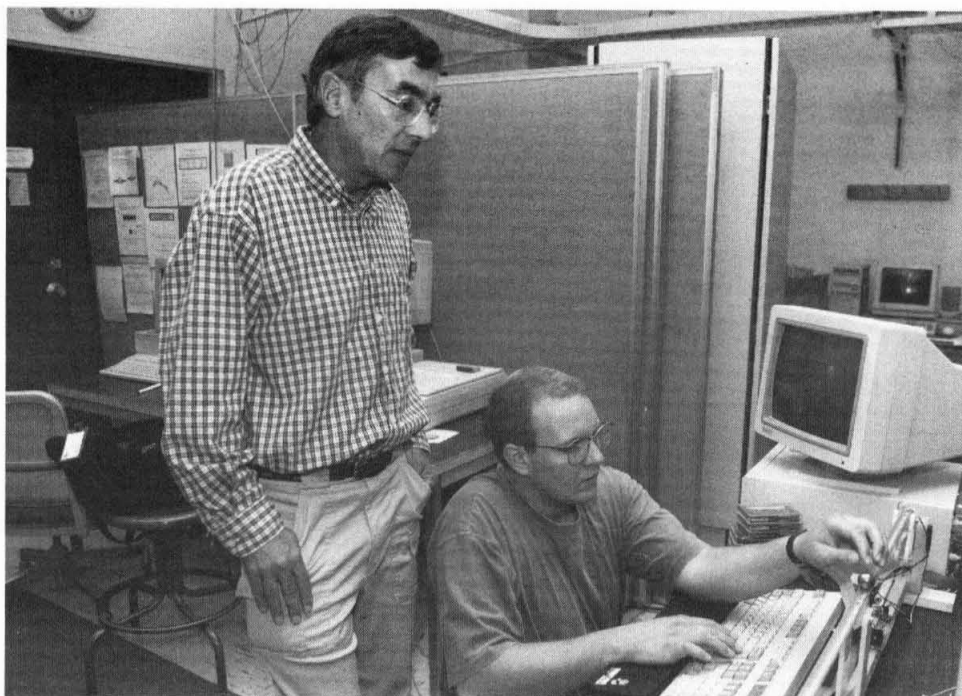
New Caltech engineering center will focus on biomachines

Sensors that can alert a car's braking system to an impending crash and telephones that can distinguish between many speakers during a video conference call may one day be as common as air-bags and Touch-Tones are today, thanks to research that will soon get under way in Caltech's newly established Center for Neuromorphic Systems Engineering. The Institute has received a five-year grant of \$11 million from the National Science Foundation to set up the center, where Caltech researchers will work closely with their counterparts in business and industry to design and develop devices that possess one or more of the humanlike senses of sight, hearing, taste, smell, and touch. The creation of such "biological machines" could have "an impact on our lives comparable to that of the microprocessor," says Professor of Electrical Engineering Rod Goodman, who will serve as the center director.

Caltech's new center has been funded through the NSF's Engineering Research Center (ERC) program, which was established in 1985 to link engineering and scientific endeavors in areas where fundamental engineering advances would enhance U.S. competitiveness. Each ERC is expected to work in partnership with industry to help turn basic knowledge and technological advances into concrete industrial applications. Along with the NSF grant, the center has received \$500,000 from the California Agency for Trade and Commerce.

Of the 20 ERCs that have been funded nationwide since 1985, Caltech's is only one of three new centers established this year and will be the first to focus on the design and development of "sensing machines." (The word "neuromorph" comes from Greek and means literally "neural form.") The center's work will build on research that has been under way for nearly a decade in the Institute's program for computation and neural systems. Established as an option in 1986, CNS is a unique multidisciplinary effort in which researchers from biology, engineering, computer science, and a number of the applied sciences have collaborated to design and build artificial neural networks—silicon arrays whose information assimilation and processing capabilities are modeled on those of biological systems.

"The NSF wanted a neural networks center, and Caltech has demonstrated for the past several years that we have a thriving, interdisciplinary program at the forefront of this field," says Goodman. The new center will focus on the engineering aspects of neural networks,



Professor Rod Goodman and electrical engineering graduate student Dave Babcock position a ball on a beam in preparation for an artificial neural network learning run, in which the apparatus will literally discover through a humanlike (or seallike) process of trial and error how to correctly balance the ball.

particularly on the coupling of neural nets to VLSI (very large scale integration) circuit technology, a field pioneered by Carver Mead, Caltech's Gordon and Betty Moore Professor of Engineering and Applied Science. Close to 50 researchers, including as many as 30 graduate students, are expected to work in association with the center, which will be headquartered in Caltech's new Moore Laboratory of Engineering, once construction of that building is completed next year.

In addition to Goodman and Mead, professors involved with the ERC include CNS faculty Yaser Abu-Mostafa, professor of electrical engineering and computer science; John Hopfield, the Roscoe G. Dickinson Professor of Chemistry and Biology; Christof Koch, associate professor of computation and neural systems; Pietro Perona, assistant professor of electrical engineering; and Demetri Psaltis, professor of electrical engineering.

Research that will be covered by the ERC includes the development of vision-sensors, texture-analysis systems, and chemical-sensing devices, among other fields of study. CNS researchers already have several such devices in various stages of development. One team, headed by Mead, is readying the prototype of a silicon retina that has the ability to grasp the relationship between the distance from an object and the time to impact. Another research group is working to develop a silicon "ear" capable of localizing sound. A third collaboration, between Goodman and Assistant Professor of Electrical Engineering Yu-Chong Tai, is investigating ways to marry neural chips to microdevices with the aim of creating what Goodman refers to as an "intelligent skin"—a system of micro-sensors and actuators that can monitor and compensate for the drag created by the flow of air vortices over airplane wings.

"The potential applications of such devices," says Goodman, "appear to be almost unlimited." For example, a silicon retina able to calculate time-to-impact could be mounted on the front end of an automobile and used in conjunction with an antilock braking system to provide more efficient—and timely—braking. A silicon ear that can distinguish one speaker's location from

another is likely to find widespread use in telecommunications and human-computer interaction. Researchers in the CNS program and elsewhere are also looking at ways to design chemical sensors that could ultimately render drug- and explosive-sniffing dogs obsolete. Equally sensitive "tasters" and "sniffers" may one day replace the costly and not always terribly efficient monitoring systems used in such areas as air-quality control, industrial-solvents manufacturing, and chemical processes analysis.

The job of the ERC won't be to manufacture such devices, but to develop the theoretical and technical tools that will enable industry to bring these and similar products to market. "Although extremely promising, the technology for designing machines with sensory capabilities is in many ways still in its infancy," says Goodman. "We can do the science and engineering that drives the development of these devices, but actually bringing them to fruition depends heavily on having industry help, both in terms of defining research directions and providing funding."

In its initial phase, expected to start within the year, the center will actively seek one collaborator from each of five major industrial areas: automotive manufacturing, chemical processing, telecommunications, general manufacturing, and consumer electronics. An additional 30 to 40 companies are expected to sign on as partners in various capacities.

While partnerships between university engineers and private businesses are nothing new, the kind of hand-in-glove relationship between industry and academia that the NSF envisions for its engineering research centers does represent a departure—one that reflects the realities of today's science-funding scene and the growing emphasis the U.S. government is placing on research that directly enhances American competitiveness. As federal sources of funding become scarcer, academic research centers that can both advance America's prospects in the international market and ultimately become self-sufficient through reliance on private support are likely to become increasingly common. Goodman anticipates

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NSF grant to Caltech will plant SEED statewide

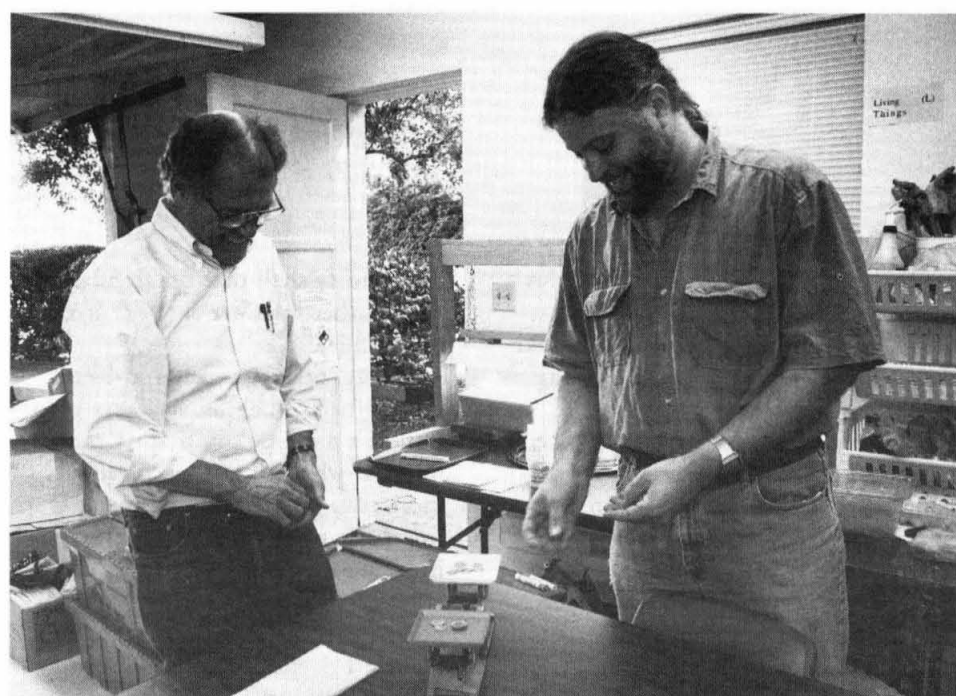
The Caltech Precollege Science Initiative program (CAPSI) has received a six-year grant of \$6 million from the National Science Foundation (NSF) that will enable it to expand its innovative approach to teaching elementary school science into selected school districts throughout California. Heading up the Caltech project, which will be officially known as the NSF Center for Teaching Enhancement Coordinated with District-Wide Reform, are Professor of Physics Jerry Pine and Associate Professor of Biology Jim Bower, the codirectors of CAPSI.

The NSF grant to CAPSI is among the first and is certainly the largest that the foundation has ever made to promote and improve science education for public-school students. The grant reflects a new agency emphasis on getting professional scientists more involved in upgrading the quality of precollege science teaching in the United States.

"The federal government is very serious about the need for universities to take the lead in supporting these efforts," says Bower. He and Pine have been active in this area since 1984, when they first collaborated with the Pasadena Unified School District to develop the Science for Early Educational Development program, better known as Project SEED. From a pilot program in a few elementary schools, SEED has grown into the much broader CAPSI effort, which encompasses science education at all grade levels. Meanwhile, the SEED science curriculum has become standard in grades K-6 throughout Pasadena and has also been adopted by the Conejo Valley school system in Ventura County as well as by the school district on the Hawaiian island of Maui. While programs somewhat modeled on SEED have sprung up in other parts of the country, the new NSF-sponsored center will represent the first effort to systematically introduce the program's methods into schools throughout a single state.

Says Bower, "We can't, and don't, expect to transform the entire state, much less the country as a whole. What we can do is design a model that others can use to transform much larger parts of the state's program—and ultimately, perhaps, to extend these reforms beyond California into other parts of the country."

The terms of the NSF grant call for the SEED program to be moved into 14 selected school districts in California over the next six years, at a rate of two to three schools a year. The districts will be selected from an applicant pool of about 50 districts, each of which has a minority student enroll-



A \$6 million grant from the National Science Foundation means that CAPSI directors Jerry Pine (left) and Jim Bower are playing with more than just small change—and in fact may herald big changes in the way science is taught in California's public schools. The scale is one of CAPSI's many teaching aids.

ment of at least 30 percent and is prepared to put up funding, which will be matched by CAPSI, to implement and support the program. Pine, Bower, and CAPSI Executive Director David Hartney have just begun soliciting proposals from potential participants. They expect to phase SEED into the first two new school districts next summer.

"We plan to establish a SEED pilot school in each district and let that school serve as a model for the rest of the district," says Bower. "We used this approach in Pasadena, Ventura, and Maui, and our experience with it has been very successful."

Since its inception ten years ago, two key features of SEED have been the use of science kits especially designed to make science come alive for young students, and the active role of Caltech researchers, alumni, and other professional scientists in working with and training the program's teachers.

"Essentially SEED invented the first system for involving working scientists in the development and support of science teachers, and this has been absolutely crucial to the program's success," says Bower. "We will continue to emphasize this relationship in each new district by identifying scientists from academia or industry, or both, who are willing to make a long-term commitment to the program and its goals."

Finding scientists willing to lend their time and expertise to such an undertaking should be easier now than ten years ago, when Pine and Bower first planted the idea of SEED among their colleagues. "A lot of scientists felt that getting involved in grade-school teaching had nothing to do with 'real' science," says Bower. He adds that perceptions are changing as more real scientists become aware that precollege science education is almost nonexistent in many schools, and as the federal government nurtures projects like SEED with greenbacks. He expects it will be a learning experience for everyone involved, as Caltech takes the lead in "piloting a new mechanism for science education reform."

Campus establishes Office of Technology Transfer and names first director

Technology transfer, which has been around at least from the time that Prometheus stole fire from the gods and gave it to the Greeks, has in recent years been looked on with growing fondness by university officials, who view it as one way to bring warmth to what has become academia's increasingly chilly economic climate. Caltech has now established an office of technology transfer and has named Lawrence Gilbert, patent administrator for Boston University, as its first director. In his new position, Gilbert will seek out potential markets and avenues of application for Institute-based inventions, with the aim of increasing revenues for Caltech. Gilbert, who will work closely with Caltech's patents and licensing director, Michael Keller, arrives on campus in December.

In the past Caltech has successfully marketed campus-developed products largely by relying on researchers to bring their finished inventions to the attention of the patents and licensing office. In addition to encouraging this kind of activity, Gilbert will actively work to identify inventions with commercial potential while they are still in development on campus. He will also seek out and establish relationships with companies that might be interested in sponsoring Caltech research.

"Fundamentally, Larry Gilbert's role will be to take ideas that arise in Institute laboratories out into the commercial world where they can be successfully marketed to benefit society and,

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New Caltechers join CARA

Two new Caltech faculty members have joined the board of the California Association for Research in Astronomy (CARA)—the joint committee of Caltech and the University of California that oversees the W. M. Keck Observatory on Mauna Kea, Hawaii. The new CARA members are Professor of Physics Charles Peck, the recently appointed chair of the Division of Physics, Mathematics and Astronomy; and James Westphal, professor of planetary science, who is the new director of Palomar Observatory. Peck and Westphal both succeed Howard Hughes Professor and Professor of Physics Gerry Neugebauer, who held the dual titles of PMA division chair and Palomar director until stepping down from both positions earlier this year.

The current chair of the CARA board (a rotating position) is Edward Stone, director of JPL and Caltech's newly named David Morrisroe Professor of Physics.



Thirty-six years after Martin Luther King, Jr., visited Caltech, his daughter Yolanda gave a free public lecture to a crowd of almost 300 in Ramo Auditorium. During her two-day October visit, the actress/producer/lecturer shared her dream of America as a place where diversity is "actively embraced." She dined with student leaders, lunched with faculty members, and met with Caltech's one-year-old multicultural task force, headed by Sharyn Slavin, assistant vice president for student affairs. At an American politics class, Lecturer Wendy Wall (left) and students asked King (right) about her family life in the Civil Rights era.

Caltech Island: Is this orientation for real?

By Hillary Bhaskaran

No school is an island, entire of itself, the poet John Donne might have said. But each fall, Caltech suspends that reality and whisks its new students off to a remote corner of Catalina Island.

Here they attend what is traditionally referred to as Freshman Camp. It's Caltech's three-day orientation for entering freshmen and undergraduate

looms less than a week away. But this morning, Caltech's entering students are focusing on name tags with colored dots—if they're focusing on anything at all.

"I think a pink dot means that the last letter of your first name is a consonant," says freshman Emily Jennings, who has a pink dot on her name tag along with a light blue one. (She is later proven correct in her assessment.) The light blue dot means you're a Caltech student, most people agree. The black dot on selected name tags poses the most mystifying challenge, leading some to concoct theories about birthdays or birth places that black-dot bearers may have in common.

The "dot game" has been devised by the dean's office and the Caltech Y as an icebreaker. If students walk around and coax enough strangers into divulging their life stories, the persistently sociable student may eventually find out that the black dot signifies new students who lettered in a high-school sport, the green dot denotes students from outside the continental United States, and so on. The socializing doesn't always go both ways, though, because the most dedicated code-crackers divulge the least. They have their eyes set on winning fame and a modicum of fortune when the game cards are scored at camp.

But games are only a small part of the camp experience. They're

sandwiched between the more serious lectures and discussions that students attend once they reach the island. In just a handful of hours, the freshmen will begin their formal introduction to life at Caltech: a life where the male-to-female ratio is about 4-to-1, where high-school valedictorians may find themselves ranked in the bottom half of their college class, and where ethical behavior is ruled by the Caltech honor system.

While male-to-female undergraduate ratios weren't even calculated at Caltech until 1970, the honor system has been a topic of camp discussion since at least 1946, when the Institute began hosting the off-campus orientation program (see the timeline on page 5). As a good many alumni will recall, the student-administered code of ethics states that "No member of the Caltech

community shall take unfair advantage of any other member of the Caltech community."

Today, before their island-based indoctrination begins, students get a taste of their new community as they find out what it's like to travel with more than 230 fellow freshmen. During the journey to Catalina, everyone is introduced to a novel baggage-check system. It basically consists of one person after another throwing almost-identical sleeping bags and luggage into huge mounds—first under the buses and then into a roped-off section of the boat—and walking away.

With this system, it's not necessary to find one's own bags throughout the journey. Often it's not even possible. At each point along the way, a person simply grabs a couple of bags of unknown origin and carries them to the next point. Somehow, all the bags and people reach the final destination more or less intact. (There were a few unclaimed bags that went to lost and found, but we'll assume that they rejoined their owners eventually.)

Seeing the baggage system "at work" for the first time, historian Alison Winter observes that "it's like an honor code for luggage." (Perhaps not yet fully accustomed to the honor system, or canny enough to avoid the lengthy retrieval process, the new assistant professor was occasionally seen carrying and stowing her own luggage.)

As the boat approaches Catalina that first day, the passengers are treated to a panoramic view of their camp away from campus. The YMCA's Camp Fox is nestled in a cove on the eastern side of the island, 5 miles northwest of the tourist destination of Avalon. Cabins dot the open areas, and hills rise up on three sides to insulate the cove from all trappings of civilization (besides the few found herein).

Some Caltech staff members and upperclass students are already ashore, having been sent ahead on an express boat "to secure the beachhead," as Dean of Students Rod Kiewiet puts it. They're now setting up the audio sys-

tem for the lectures that follow close on the heels of lunch.

As the students head for their bunks, the rumor that their cabins have roofs but no walls is confirmed. And as everyone heads to lunch, the rumor that the first meal always consists of vulcanized grilled-cheese sandwiches is also confirmed. But everyone is famished and the food quickly disappears, putting those campers who come from families with many siblings at a distinct advantage. Compared to past decades when the food was "just disastrous," says Professor David Wales, "it's much better now." The mathematician has been lucky enough to sample camp cuisine since the mid seventies—as associate dean of students, dean, and now master of student houses.

Today's students find another Frosh Camp veteran dining with them and even waiting tables. Gary Lorden, professor of mathematics and vice president for student affairs, might have picked up his busboy skills as a new student in 1958. (Incidentally, he also performed his Liberace impersonation that year in the camp talent show, where he was "discovered" by the Caltech Glee Club. Lorden has subsequently revived his act at numerous Glee Club concerts and has played accompaniment at camp talent shows to the present day.)

Getting their days in the sun

There's something ironic about coming to an island paradise of sorts for an orientation to Caltech. Students have left behind the smog and haze of their newly adopted city of Pasadena to be welcomed under clear blue skies. They're about to begin one of the most rigorous educational programs in the world, yet their first lectures are conducted in a leisurely manner on lawns, at an amphitheater, and on the floor of a lodge. Here there are stimulating discussions without assignments, or tests, or note-taking.

The only activity that involves a set of rules and a deadline is a design contest, which calls on students to

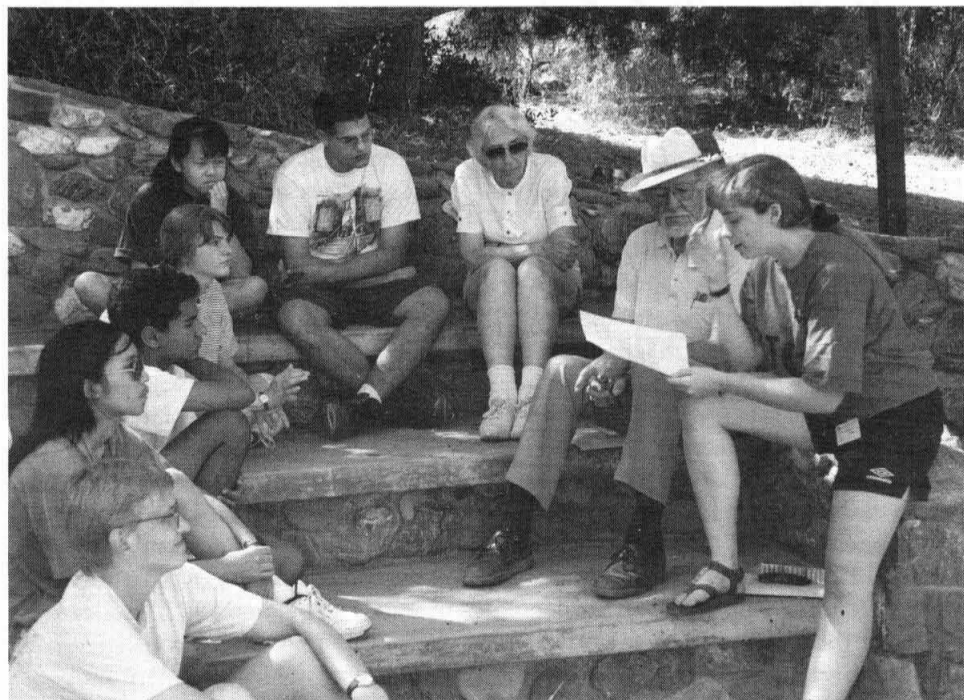


This is the voyage of the Catalina Monarch. Its three-day mission: to introduce students to a new life and a new civilization, to boldly go where most every freshman has gone since 1971.

transfer students. Organized by the office of the dean of students, Frosh Camp is designed to help prepare newcomers for their four-year odyssey before they're actually subjected to the pressures and distractions of life at the Institute.

It begins on a Wednesday. An alarm goes off at some ungodly hour, calling students to a feast of muffins and Dramamine on the Olive Walk. The menu is dictated by the approaching boat ride that will speed (and sometimes slosh) the students to their island destination. Although the focus may be on the current crop of students, the administrators and faculty members in attendance are downing the Dramamine as well, with fond memories of past excursions floating through their minds.

It's a hazy morning in late September, and the specter of college classes



Discussing what may be the most time-honored topic of Freshman Camp, senior Jenny Cornack (right) asks Professor John Roberts, his wife, Edith, and a group of freshmen to give their input on hypothetical infractions of the honor code.



Rumor has it that the grilled hamburgers were cooked in advance, but the setting makes up for any culinary curiosities.

Photos by Hillary Bhaskaran

build miniature boats that can safely transport toy figures through water, faster than anyone else's boat. The project isn't even required, but teams of students get right to work on it during their free time.

Freshman Meg Crocker recounts that her group's boat, *The Frog*, went undefeated until the quarter-finals. It then came up against *Maybe It Will Work*, which Crocker says "only worked one time, and that was the time it beat us!" But she adds, "I met really cool people who are also interested in building things and solving problems."

With only one optional assignment during these last days of freedom, there's no need for students to pull an all-nighter (unless one's roommates snore too loudly, and even then, people can pull their mattresses out onto the open field by the beach and sleep under the stars). Plenty of students choose to stay up late into the night, whether debating hypothetical violations of the honor code that were presented earlier in the day, or slam-dancing at the alcohol-free party on the last night of camp.

"I think Freshman Camp is awesome," says entering student Alejandro Ortega. "It gives us a chance to meet other freshmen in a really good atmosphere. In the houses, we're kind of separated, but at camp we have to all be together."

Student Emily Jennings thinks camp is a pretty realistic orientation, as well as a good way to meet students, professors, and staff. "True, it's on an island far away, but it really introduces you to the types of people you'll be spending the next four years with and gives you an idea of what to expect."

One thing that surprises a number of students at camp is that they encounter professors with free time on their hands. Whether the profs are milling around outside or sitting at one's breakfast table (or even waiting tables), they're available to talk to students at leisure.

And there is some leisure time. It's squeezed in between the mandatory

sessions, and it might be devoted to going on a geology field trip or taking a peaceful boat ride around the cove. Or there's the option of just hanging out and "talking about off-the-wall things," says Jennings. "A group of us argued about a physics problem for about an hour," she adds.

Getting serious

It's during the mandatory orientation sessions that students get the largest dose of the reality that awaits them at Caltech. As part of an introduction to freshman classes, an "unbiased" professor briefs students on an offering in his department. "Math 5 is a great class," says David Wales. The mathematician goes on to say that students can identify him by his Mickey Mouse hat or his bald head because he tore his hair out studying the same calculus material during his college days. "But I learned it," he concludes.

Well, maybe the students need one of their own to speak the whole truth. Senior Zack Berger does something of the sort when he discusses the possibilities beyond introductory classes in biology. "If you really want to screw yourself over—I mean, broaden your horizons and challenge your imagination—then you can take an upper-level course in your first year," he advises.

While similarly sage advice may still resonate in the minds of students from years past, one topic of Frosh Camp will be new to all but this and last years' freshmen. A session on AIDS education was added to the orientation curriculum in 1993.

On the second day of Frosh Camp '94, guest speaker Katrina Hammonds, who has worked with the All Saints AIDS Service Center and gives presentations throughout the L.A. area, arrives by helicopter just in time to address the "A" and "B" groups of students. (Groups "C" through "F" are in sessions on either the honor system or the "challenges and choices" of student life, and will rotate and meet with either Ham-

monds or Sue Bunker, director of the Caltech Y, during a different time slot.)

Hammonds immediately captures everyone's attention by presenting a flier on "101 ways to make love without doing it." As the session becomes more and more interactive, participants yell out their favorite suggestions. "Give diamonds," encourages one student. "Do homework together," says an administrator planted in the audience (it's the dean of students, Rod Kiewiet). Someone else suggests a sort of ménage-à-Internet, and Hammonds concludes that there are numerous ways to "inter-face" without being at risk. After talking values, she talks protection because, as she says, "It's likely that most of the people in this room will have sex at least once in their lives."

In the same session, students learn about the science of AIDS from UC Irvine's Andrea Tenner. At one point, Kiewiet adds a few comments, encouraging the students not to tune out any of the expert advice that they're getting at camp. Remember, he says, "when people get preachy with you, give 'em a break." Quoting some words of wisdom that President Everhart has been known to pass along, Kiewiet adds, "There are two ways to learn about the world: through education and experience. Education is what you get when you read the fine print. Experience is what you get when you don't."

So education is what the students continue to get throughout the three days: in sessions about student life with staff from Caltech's Counseling Center; in discussions about cultural diversity, campus safety, the honor system, and the house system; and in small groups with professors. But on the last evening at camp, they have the chance to make light of it all during the talent show.

Getting silly

Kicking off one of the favorite traditions of camp, Berger plays "Ride of the Valkyries" on the banjo until he is

Freshman Camp milestones

1919: Frosh Camp has its humble beginnings in an evening reception for freshmen, sponsored by the Caltech Y. Within two years, upper-classmen initiate a one-day freshman retreat on campus, which evolves into camping trips to sites near San Dimas and Crestline.

1940: The Y-sponsored orientation has grown into a three-day event at Camp Arbolado near San Jacinto. Foster Strong, future dean of freshmen, reports his dismay that attendance is optional and costs the students money.

1946: The Institute assumes management of the orientation program, under the direction of Strong, and makes attendance mandatory and free of charge. At Camp Radford in the San Bernardino Mountains, students meet Robert Millikan, discuss the honor system, sing songs, and play mountain golf.

1957: Students produce a pickup talent show, forerunner to the modern-day extravaganza, with the help of Richard Feynman on bongos.

1967: Six women attend Camp Radford even though Caltech is still three years away from admitting female undergraduates. The women are participating in a research project on air pollution and are auditing classes at the Institute.

1970: This year marks a failed attempt to hold orientation on campus. Whether the location has been changed because of deteriorating conditions at Camp Radford, uncertainty over where to house 31 new female students, or a desire to introduce the students to their local surroundings, the experiment reaffirms the value of geographic isolation when it comes to keeping students—and professors—from straying.

1971: Frosh Camp is shipped off to Catalina to stay (well, almost).

1979: While Camp Fox undergoes some repairs, orientation is moved to Thousand Pines Camp in the San Bernardino Mountains for one year.

1980 to present: The Catalina tradition continues.

(Sources: *Alumni Review*; *Engineering and Science*; *Caltech News*; Ray Owen, professor of biology, emeritus; and Strong's oral history in the Archives.)

Continued on page 8

FRIENDS

Associates hear from new NSF director

Newly appointed National Science Foundation Director Neal Lane was the guest speaker at the Annual Dinner of the Caltech Associates, held September 29 at the Athenaeum. Lane, a professor

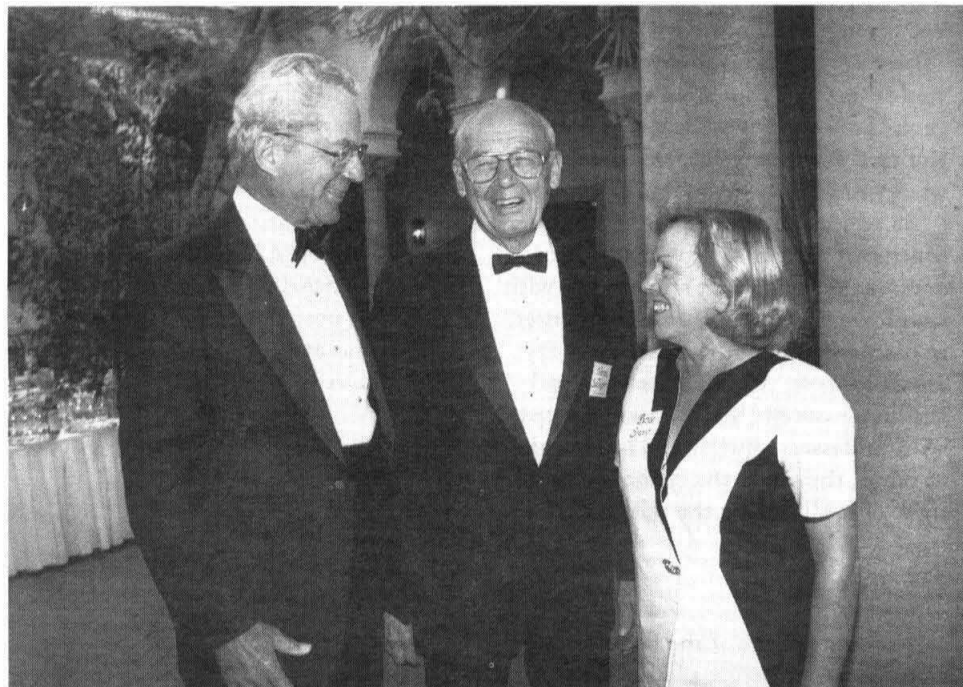
of physics at Rice University until he assumed the six-year NSF position last year, spoke to the Institute support group on "Science Policy in the Future of the Research University."



From left are Associates President George Smith '44, PhD '52, NSF Director Neal Lane, Jean Smith, Doris Everhart, Joni Lane, and President Tom Everhart.



President Tom Everhart and Dr. Lane with Caltech geology professors (and wife and husband) Joann Stock and Brian Wernicke, whose research has been supported by NSF Young Investigator Awards.



Dinner guests included (from left) Associates Board Member Bud Smoot '50, Board President-Elect Warren Schlinger '44, PhD '49, and Ruthie Smoot.

ALUMNI

Chapter News

Myopia mended

The Hubble Space Telescope, which received a new set of "eyeglasses" from a visiting optometric corps of Space Shuttle astronauts last year, has been busy establishing its reputation as a premier scientific instrument—it recently carried out experiments suggesting that the universe may be substantially younger than previously thought. Members of the Colorado chapter learned about one of the telescope's instruments, the Wide-Field and Planetary Camera 2 (WFPC2), on September 8, from JPL's John Trauger, principal investigator on WFPC2.

Trauger traveled on to the New Mexico chapter meeting on September 16, where 39 alums and their guests heard about the steps taken to correct Hubble's aberration and the installation of WFPC2. Trauger also showed highlights from early Hubble science programs and included pictures taken by the Hubble of Comet Shoemaker-Levy 9's death spiral into Jupiter.

Slip slidin' away

Plate tectonics was the subject of a talk, "Giant Earthquakes in the Pacific Northwest," given by Thomas Heaton, PhD '79, to the Seattle-Puget Sound chapter on September 13. Because Puget Sound is near the border of several tectonic plates, the 49 alums and their guests listened with great interest, according to chapter president Ernest Janzen (BS '61). Heaton, a research geophysicist with the USGS office in Pasadena, described the earthquake hazards in the Pacific Northwest, earthquake source physics, and tidal triggering of earthquakes.

Caltech after the war

Members of the Chicago chapter learned about some of the outstanding Caltech faculty who came to the Institute in the 1950s when Institute Archivist and Faculty Associate Judith Goodstein spoke at a dinner meeting on September 20. In her talk entitled "DuBridge's School," Goodstein used historical photographs to illustrate her anecdotes about Lee DuBridge, the head of MIT's wartime radar project, who became Caltech's president in 1946.

Goodstein also visited with members of the Phoenix/Tucson chapter during two events on October 20 and 21. The alums heard why DuBridge and fellow faculty members—physicists Robert Bacher, Richard Feynman, and Robert Christy, biologist George Beadle, and astrophysicist Jesse Greenstein—decided to head to Southern California after World War II, and how they got along there.

A big bang and buffet

The recent collision of Comet Shoemaker-Levy 9 with Jupiter was the subject of a joint event held by the San Diego chapter and MIT alumni. JPL researcher Trina Ray discussed the nature of comets, the special significance of Shoemaker-Levy 9, and the technical details of Galileo's observation of the collision. Seventy-one Caltechers joined 33 MIT grads for the dinner and lecture on September 22.

Beyond Star Wars

More MIT alumni were on hand October 17, when the Houston chapter held its first joint meeting with its MIT counterpart. About 35 graduates of both schools attended the meeting to hear JPL's chief technologist Terry Cole, PhD '58, speak about space movies—that is, movies created from data collected by NASA spacecraft. Cole described how huge databases of remote-sensing information can be made into motion pictures through the use of extremely powerful parallel supercomputers.

REUNION CALENDAR

May 11, *Class of 1940, 55th Reunion Dinner*, the Athenaeum.

May 11, *Class of 1945, 50th Reunion Dinner*, the Athenaeum.

May 12, *Half Century Club Reception and Luncheon*, the Athenaeum.

May 12, *Class of 1950, 45th Reunion Dinner*, the Athenaeum.

May 12, *Class of 1955, 40th Reunion Dinner*, the Athenaeum.

May 12, *Class of 1970, 25th Reunion Dinner*, the Athenaeum.

May 13, *58th Annual Alumni Seminar Day and Dinner*, the Caltech campus.

May 13, *Class of 1960, 35th Reunion Dinner*, the Athenaeum.

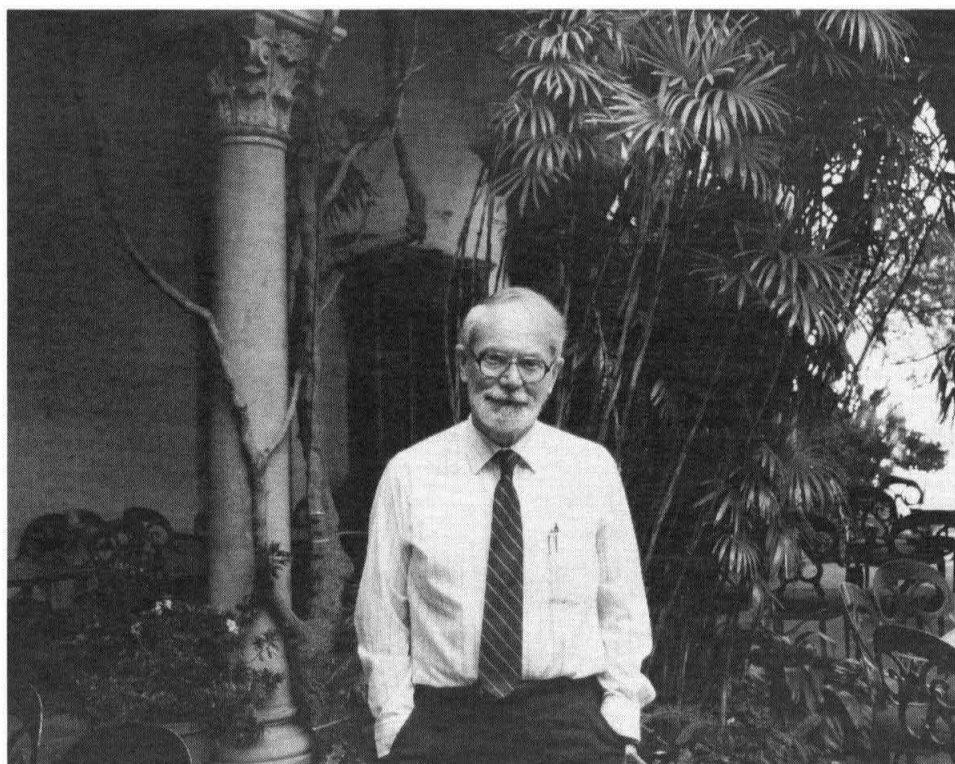
May 13, *Class of 1965, 30th Reunion Dinner*, the Athenaeum.

May 13, *Class of 1985, 10th Reunion Dinner*, the Athenaeum.

For information concerning these reunion events, please contact Patsy Gougeon at (818) 395-8366.

Association president outlines distinct roles, mutual goals, of Alumni Association and Alumni Fund

by Pete Mason '51, PhD '62



Pete Mason, senior member of the technical staff with JPL, is this year's Alumni Association president.

In this article, I will discuss the relationship between the Alumni Association and the Alumni Fund. It is the issue that causes the most confusion to our membership (and many others). It is also a matter of continuing concern to the board.

The formal position is that the Alumni Association is an independent membership organization. Its goals are to be of service to Caltech and alumni, and to involve alumni with Caltech in social and intellectual ways. One result of these goals will certainly be an atmosphere that encourages alumni to donate to Caltech and to serve as volunteer solicitors for the Alumni Fund.

Unlike the Association, the Alumni

Fund is part of the Development Office of the Institute, and is fully staffed and directed by the Institute. The goal of the Development Office is to raise money for the Institute from many sources. The alumni contributions are an important part of this overall effort.

In the past a particular point of confusion has had to do with the difference between Association dues and contributions to the Fund. Dues are not a contribution to the Fund, and conversely, contributions to the Fund do not make one a member of the Association.

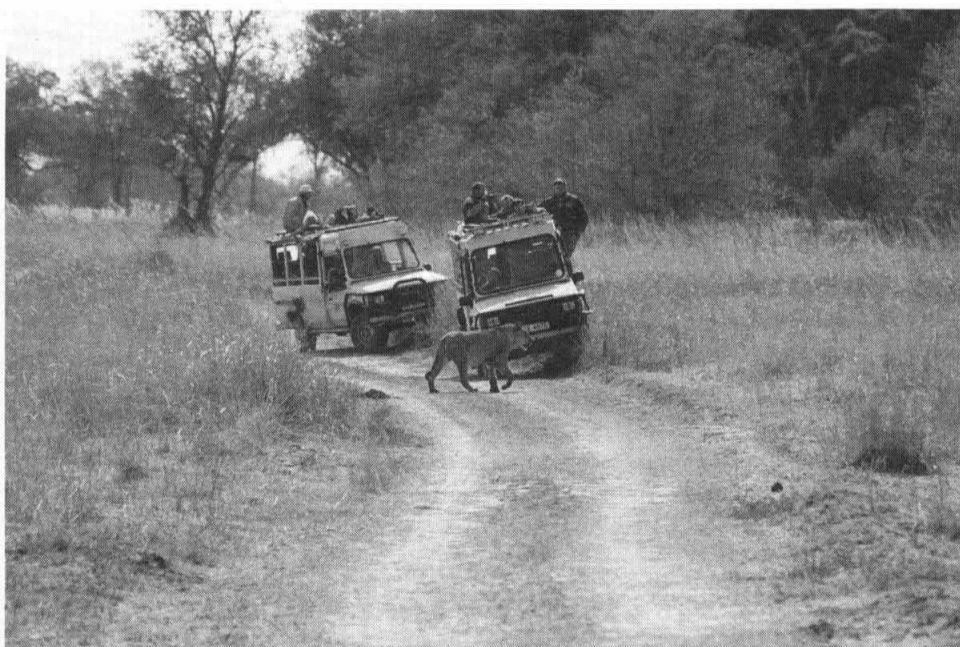
There are many important details to add. The Association started the Fund in 1948 and administered it until 1966. During Caltech's 1966 capital

campaign, the Association agreed to hand over responsibility for the Fund to the Institute, under the auspices of Development, where it has remained ever since. More recently, the name was changed to the Annual Fund to reduce the confusion between the two organizations. (This didn't seem to help much, and the name has now been changed back to the Alumni Fund to emphasize to the Institute and to the Board of Trustees that it is indeed the alumni who contribute.) Most of the volunteers who actually contact donors are members of the Association, who recruit additional volunteers as needed.

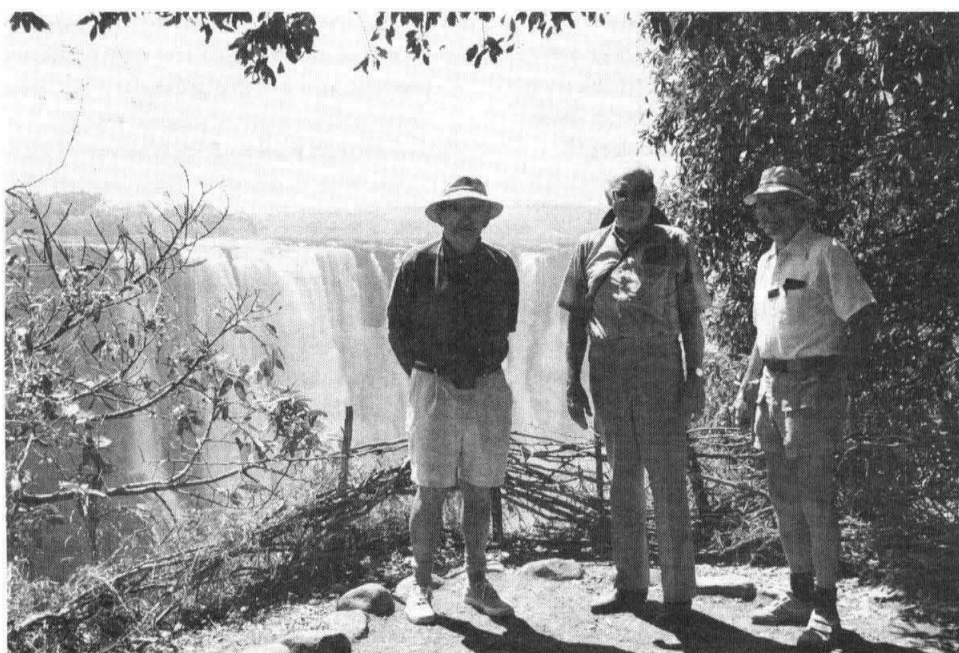
Much of the money that alumni donate to the Institute is unrestricted. This is particularly valuable because it can be applied flexibly to meet such needs as faculty salaries and scholarships. In 1993-94 the alumni donated \$2,762,000, up from \$2,391,000 in 1992-93. Participation was 30.7 percent of eligible alumni, down from 35.5 percent. The money figure is encouraging, but the percentage is important too. Large donors often consider the number of alumni contributors to be a significant measure of the opinion of those best qualified to judge the benefits of a school's educational program. President Everhart has issued a challenge to the Alumni Fund to increase participation to 50 percent within three years. The Association will work with the Fund to achieve this goal.

Both the Alumni Fund Office, under

Director Diane Binney, and the Association are considering ways to increase cooperation and to improve the performance of the Fund. As an example, the Association has recognized that the class-based reunion structure does not reach those alumni who were here exclusively as graduate students. We will plan additional reunions based on division structures to involve these alumni. The Association and the Fund are working closely to make these reunions a success and to promote goodwill and knowledge of Caltech among alumni who received their graduate degrees from Caltech. We are also focusing on recruiting younger alumni into the Association, and have cooperated over the past several years with the Fund to organize the Senior Barbecue. I will have more to say on these efforts and related activities in the future.



Above: The first lioness sighted by Caltech alumni in Moremi Wildlife Reserve in Botswana, Africa, strolled nonchalantly across the road, but created great excitement for those in the vans. She was followed by an entire pride, including two cubs. Twenty-three alumni, family members, and friends participated last fall in this two-week travel/study program to Botswana and Zimbabwe, led by Caltech Professor of Anthropology and African specialist Thayer Scudder. Right: In Zimbabwe, Dick Montgomery, PhD '48, Heinz Pfeiffer, PhD '49, and Stan Burket, PhD '50, were among those enjoying this view of Victoria Falls. The falls, covering a width of 1.7 km, are twice the size of Niagara Falls and pour 555,000 cubic meters of water each minute into the Zambezi Gorge, some 98 meters below.



ALUMNI ACTIVITIES

December 4, *Los Angeles Public Library Caltech/MIT Family Event.* Afternoon storytelling featuring tales of Christmas, Hanukkah, and winter, followed by a library tour.

December 5, *Seattle Chapter Dinner/Meeting*, with guest speaker Gregory Bearman, member of the technical staff, JPL.

January 2, 1995, *Tournament of Roses Parade Event.*

For information on the above, please contact Arlana Bostrom at 818/395-8363.

Biology

Continued from page 2

freshman laboratory course, which is taken by many majors. And our introductory molecular biology class is taken by many students who don't end up majoring in biology."

Established in 1953, the Howard Hughes Medical Institute is the nation's largest private philanthropic organization. The Institute's mission is to change the face of science education at college campuses and K-12 schools nationwide. An earlier HHMI grant to Caltech was used to develop new teaching methods in chemistry and biology and to fund outreach programs for minorities and elementary schools.

Engineering

Continued from page 2

that in some respects designing this new relationship may prove to be as much of a challenge as building the "machines of the future."

"We are not only aiming to develop the infrastructure for neuromorphic systems," he says. "We want to design a robust industrial liaison structure for effective technology transfer as well."

Technology transfer

Continued from page 3

incidentally, bring royalties back to Caltech," says Vice Provost David Goodstein, whose office will oversee the new position. "He has an extensive background in university technology transfer, and we are delighted that he is transferring his experience and expertise to Caltech."

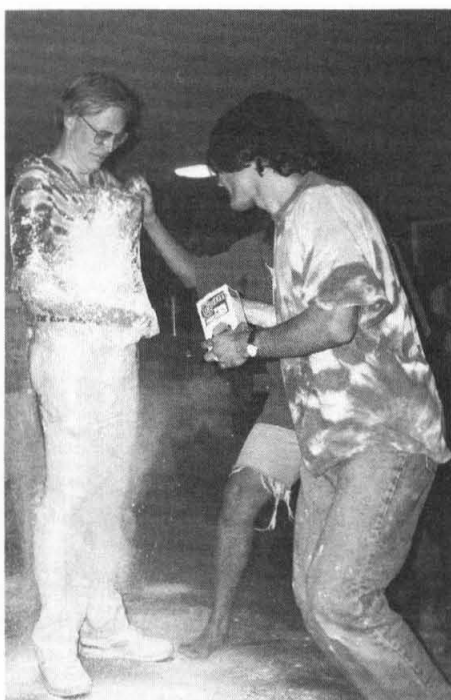
A graduate of Brandeis who holds a law degree from the Suffolk Law School, as well as a master's degree in international management, Gilbert served as MIT's patent attorney from 1966 to 1969, and was MIT's director of patent licensing from 1970 to 1975. He spent more than a decade as a patent consultant to a number of universities, including Tufts, Vanderbilt, and the Universities of Maine and Massachusetts, before joining Boston University in 1987.

Freshman Camp

Continued from page 5

gonged and then thrown in the ocean. Unruffled by this dramatic display, which was undoubtedly staged, freshman musicians and performers face the crowds. The audience turns out to be much more appreciative of the new students. In fact, "awestruck" might best describe people's reaction to the rich voice of freshman Myfanwy Callahan during her rendition of "One Tin Soldier." One might use other words to describe the reaction to the less-serious acts, but Sharyn Slavin, assistant vice president for student affairs, behaves with admirable restraint as the keeper of the gong.

When the freshmen are finished with their antics, the upperclass students (who, in theory, are at camp to serve as role models) give their younger peers a lesson in Caltech humor. They form groups representing their various student houses and proceed to spoof campus administrators and camp



The dean gets dumped on during a Dabney House skit by senior Steve Skovran and fellow conspirators.

sessions alike.

Kiewiet gets the brunt of their jokes, first when he is called to the stage as a "volunteer" by students from Dabney House. The students begin their prank by enveloping Kiewiet several times in plastic wrap. Apparently it's also a camp tradition for the Dabney House skit to involve cornstarch, so that's what the house members then pour all over the dean and themselves, while announcing: "Dabney House, because we can."

In a more accessible skit and a crowd favorite, Ruddock House students spoof the movie *Forrest Gump*. In this version, Gump (played by junior Chris Marsh) wants to attend Caltech. So his mother seduces a top administrator—dressed suspiciously like Kiewiet—in order to secure Gump's admission. To the sur-

prise of anyone familiar with Caltech, Gump receives a football scholarship, but he finds that he's the only one on the team. He doesn't do so well in school, but rationalizes his performance by misquoting a comment first heard the previous day. Well, Gump reasons, "the dean said that half of us would be ranked in the bottom one-third of our class."

While at Caltech, Gump meets "a girl named Jenny" (played by sophomore Melissa Hampton), but laments that, "so does everyone else." Here the audience gets a demonstration of "glomming"—when several guys hover around one woman—a term that came up in a session with campus counselors earlier that day. Following a series of escapades, Gump gets transferred out of Caltech to the city college across the street. He waits for the bus to take him there.

The following day finds the new students waiting for the launch to take them to their own bus stop. Before you know it, the voyagers find themselves back in Pasadena—not at the city college but at the California Institute of Technology. After locating their luggage (or not), they walk off in a sleepy haze toward the houses to get some nourishment, to get reoriented, and to rest up for the real Caltech experience that awaits.



Renowned British playwright Tom Stoppard knows how to engage an audience. Shown here during a workshop with members of Caltech's theater arts program, the author of *Rosencrantz and Guildenstern Are Dead* and many other plays came to campus in October to present the Institute's Distinguished Michelin Lecture. Stoppard, whose works have often juxtaposed humanistic and scientific themes, entitled his Michelin talk "Playing With Science."



MAKE YOUR GIFT A LEGEND

Caltech legend, of course!

With the holiday season nearly here, what better gift than to share Caltech with family and friends. The Alumni Association still has available its limited-edition, 2-volume, boxed set of *Legends of Caltech*, and *More Legends of Caltech*. The soft-bound volumes are encased in a handsome leather-like gray box with the Centennial seal embossed in gold. To order your set, please complete the form below and return it with your check to:

Caltech Alumni Association
Mail Code 1-97
Pasadena, CA 91125

Please send _____ limited edition boxed set(s). Enclosed is \$30.00 plus \$4.10 for postage and handling for each set ordered. (Allow 2 weeks for delivery.)

_____ Check enclosed in amount of _____

_____ Please bill my _____ MasterCard _____ Visa # _____

Expiration date _____ Signature _____

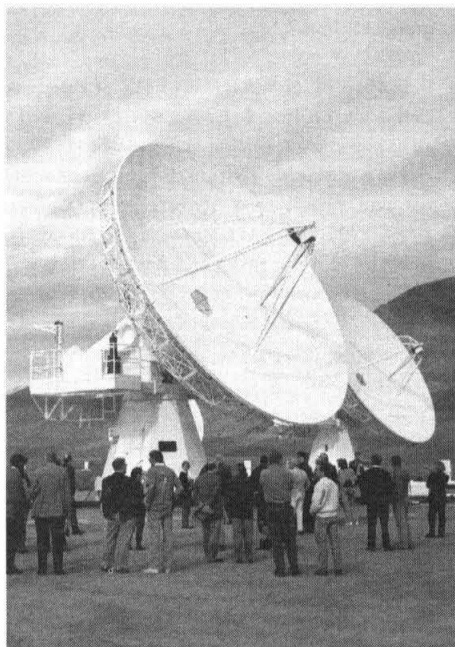
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PERSONALS



Caltech dedicated a new telescope in October, as the Norris Planetary Origins Telescope became the newest member of the millimeter-wave array at the Owens Valley Radio Observatory. A gift of the Kenneth T. and Eileen L. Norris Foundation, the new instrument will be used in concert with five other radio dishes to search for nearby planetary systems. Institute administrators and astronomers and Norris Foundation officials took part in the ceremony, which included a demonstration of the astronomical sextet in motion along their 200-meter T-shaped track, a display that one onlooker said reminded him of "the dancing mushrooms in *Fantasia*."



Caltech's first-ever jazz CD has hit the shelves! Music enthusiasts from near and far can now savor the ragtime, blues, and Latin tunes of the Institute's two jazz bands. The \$10 CD and a \$6 cassette are available from the Caltech Bookstore, which handles mail orders through their toll-free number: 1-800-514-BOOK. On the recording, one finds old favorites like "Stormy Weather" and "Taking a Chance on Love," sung by guest vocalist Angie Whitney. Then there's an award-winning composition by Les Deutsch, PhD '80, and plenty of selections that give band director Bill Bing the chance to feature additional alumni, as well as student, JPL, and community musicians. And by the way, the logo on the CD cover above was designed by Mike Rigler '86.

1948

YUAN-CHENG FUNG, PhD, professor emeritus at UC San Diego, was awarded the Melville Medal of the American Society of Mechanical Engineers (ASME) during its International Mechanical Engineering Congress and Exposition, November 6–11, in Chicago. The medal, established in 1914 in honor of George Wallace Melville, the 18th president of ASME, is given for the best original paper on a mechanical engineering subject presented for publication during the preceding calendar year. Fung and his coauthor, Shu Qian Liu, also of UC San Diego, are receiving the award for their paper "Elementary Mechanics of the Endothelium of Blood Vessels." Fung's doctorate is in aeronautics, and early in his career he was best known for his work on the flutter of high-speed aircraft and on the control and alleviation of shock loading and loads due to gusts and clear-air turbulence. He published three books. Since 1960 he has worked in biomechanics, bringing physics to biology and mathematics to medicine and presenting his approach to physiology in a three-volume set of books and 202 technical papers; his equations and theories are now used in orthopedics, cardiovascular and pulmonary physiology, and prosthesis design. He retired from teaching in 1990 and is now working exclusively on the growth and remodeling of living tissue under stress, a new field called tissue engineering. A Fellow of ASME, Fung is also a Fellow of the American Academy of Mechanics, of which he was president in 1983, and of the American Institute of Aeronautics and Astronautics. He is a member of the National Academy of Engineering, the National Academy of Sciences, and the Institute of Medicine, as well as a number of other medical and biomedical organizations. He is also an honorary member of the Chinese Academy of Science's Institute of Mechanics and is an honorary professor at several Chinese universities. He has received many awards, including the Institute's 1994 Distinguished Alumni Award.

1959

ANTHONY J. IORILLO, MS '60, has been elected chairman of American Mobile Satellite Corporation's board of directors. Recently retired as senior vice president of Hughes Aircraft Company, he was during his 34 years with Hughes involved in all phases of space systems development and management and won several awards for his invention of the Hughes Gyrostat satellite technique used in most of Hughes' communications satellites. Prior to his retirement, he was a member of the Office of the Chairman and was president of Hughes' Telecommunications Sector.

1960

THOMAS H. TEBBEN offers an update about his life. "After graduating from Caltech," he writes, "I earned an MBA from the University of Chicago in 1962. I spent the next two years with the Autonetics Division of North American Aviation in Anaheim, California. During this interval I married the former Linda Peterson, who had graduated from Westridge and Stanford University. In 1964, we moved to Northern California and I joined SRI International. In 1967, I joined the consulting division of Arthur Andersen & Co. In 1980, we transferred to Salt Lake City, Utah, where I became the division head for Management Information Consulting. In 1985, we transferred to Copenhagen, Denmark, where I was managing partner for Management Information Consulting. In 1989, we returned to Northern California and I became the managing partner for Business Systems Consulting for the Western Region of Arthur Andersen. On August 31, 1994, I retired from Arthur Andersen after more than 27 years, including 20 as a partner. Linda and I will continue to reside in Menlo Park,

California. Our daughter, Christine, is a budget analyst for Multnomah County, Oregon. Our son, Steve, is a correctional officer in Salt Lake City, Utah."

1966

BILL COLGLAZIER, PhD '71, has been named executive officer of the National Academy of Sciences (NAS) and the National Research Council (NRC), after serving since July both as acting executive officer for the NAS and NRC and as executive director of the NRC's Office of International Affairs. He joined the staff of the NRC as international affairs executive director in March 1991. From 1983 to 1991 he was a professor of physics and directed three science and technology policy centers at the University of Tennessee, Knoxville. Prior to that he was a research fellow with the Center for Science and International Affairs, Kennedy School of Government, Harvard University. While in that position he served with the Aspen Institute for Humanistic Studies as associate director of the program in science, technology, and humanism. He was a congressional science fellow in 1976–77 with Congressman George Brown, and he has performed research in theoretical physics, holding positions at the Stanford Linear Accelerator Center, the Princeton Institute for Advanced Study, and the Rutherford Laboratory in England. He has authored numerous publications dealing with issues such as hazardous and radioactive waste management, energy and security, global warming, strategic defense and arms control, and engineering risk assessment. He has received a commendation from the State Planning Council on Radioactive Waste Management—a presidential commission—and an award for lifetime contribution from the Section on Environmental and National Resources Administration of the American Society for Public Administration. He serves on the boards of the Fermilab High-Energy Physics Accelerator and the Oak Ridge Associated Universities.

1967

WILLIAM B. MILLER writes, "I have a successful management consulting practice, W. Miller & Co., and have recently had the good fortune of authoring a popular book on world-class manufacturing techniques." The book, *All I Need to Know about Manufacturing I Learned in Joe's Garage: World Class Manufacturing Made Simple*, is into its fourth printing.

1970

THALES M. PAPAZOGLU, MS, is chairman of the Universities Power Engineering Conference '96 (UPEC '96), to be held in Iraklio, Crete. The conference has been held annually in September since 1966 and brings together researchers from universities and industry—currently about 300 people from 30 countries. A three-day event, it covers in parallel sessions all topics having to do with electric power systems, with particular emphasis given to the work of young researchers. "I would very much welcome the participation of Caltech people," he writes, "and anyone interested can contact me, so that they can receive all subsequent information." His address is SYNEDRIO UPEC '96, P.O. Box 1365, 711 10 Iraklio, Crete, Greece, or he can be reached by telephone at 3081 315055, or by fax at 3081 259253.

1974

CAROL NOTTENBURG received her juris doctor degree at the University of Puget Sound School of Law on May 15. She had graduated from Stanford University in 1981 with a doctorate in genetics. She will be practicing patent law with Seed and Berry in Seattle.

1982

JACK KAYE, PhD, and Dawn Bressler-Kaye report the birth of their third daughter, Allison

Shira Kaye, born March 28 and joining sisters Rebecca and Hannah. While still serving as manager of the atmospheric chemistry modeling and analysis program in NASA's Office of Mission to Planet Earth, Kaye has also been serving as program scientist for the Atmospheric Laboratory for Applications and Science (ATLAS) series of Space Shuttle flights, the third of which was scheduled for October. Among his activities in recent years is the editing of the book *Isotope Effects in Gas Phase Chemistry* for the American Chemical Society's Books Division. Contributors with known Caltech connections include chemistry PhDs DONALD TRUHLAR '70, ALBERT WAGNER '72, JOEL BOWMAN '75, GEORGE SCHATZ '76, LARRY HARDING '79, PETER ARMENTROUT '80, and JAMES GARVEY '85, plus Professor of Planetary Science Yuk Yung and graduate student (to be PhD '95) RICHARD DISSLY.

1985

TED WOODWARD, MS, PhD '88, and SHERYL WOODWARD (née SMITH), MS '85, PhD '88, "are pleased to announce the birth of their second child, a daughter, Miriam Joyce, on March 22, 1994. Both Ted and Sheryl have been employed since graduation as Members of Technical Staff at AT&T Bell Laboratories in Holmdel, New Jersey. Ted is in the Advanced Photonics Research Dept. and Sheryl in the Lightwave Communications Research Dept. They live in Lincroft, New Jersey."

1986

SANDRA LYNN LEE and Dennis Lyon "have a son, Brandon Lyon, born November 7, 1993. Lynn is a Massage Therapist practicing Soma Neuromuscular Integration in Olympia, Washington. Dennis is an artist, designer, and restaurant owner."

1988

JOE BECKENBACH writes, "I'm currently working with Lotus cc:Mail as a software engineer, specializing in software construction and distribution. My current projects include companywide and worldwide process improvement, expansion of my team of two engineers chartered with software release and manufacturing, and integrating software development efforts across the country. Our software efforts across several projects have benefited by reduced cycle time on the order of 5% with minimal intervention, and we've set the stage for more fundamental changes within the development process. Mountain View has been my home for the past year, and the Bay Area for the past three-and-a-half. Since I arrived, I've founded a Renaissance choral group, which has toured locally within the area, assisted with personal effectiveness seminars in San Jose, and worked on the DirecTV project for Hughes. Part of my relaxation while at General Magic included a skydive at Yolo County airport—let me tell you, the world looks so different after a skydive! (My body still remembers the first few seconds of free flight once out the door. Makes for beautiful dreams. . . .) I look forward to further adventures over the summer, and to more information on Alumni Association activities. May your work continue happily and smoothly."

1991

MARK LYTTLE recently had a research paper, "Modelling of Continuous Recrystallization in Aluminum Alloys," published in the British *Journal of Materials Science*. Another of his papers, on the same topic, appeared in the book *Advances in Hot Deformation Textures and Microstructures*, a collection of recent work, published in the United States by ASM International. He has also been reelected captain of the University of Virginia's Ultimate Frisbee team.

OBITUARIES

1926
EDWARD C. WARD, of Beaumont, Texas, on March 30; he was 89. He had retired in 1968, after working for the Sun Company for 29 years, serving as head of the production gas lab and as engineering supervisor in the Beaumont area. He is survived by his wife, Beula; a son, Donald; and a granddaughter, Brenda.

1929
REYMOND J. KIRCHER, of Bethesda, Maryland, on July 12; he was 86. After graduating from Caltech, he earned his MS at the Stevens Institute of Technology in New Jersey while employed at Bell Laboratories. He received 26 patents for electronic communications equipment, most during his 26 years at Bell, where he pioneered in radar, transistors, and fiber-optic technology. He also contributed to the Southern California aerospace industry from 1955 to 1968, designing long-range communications and guidance systems for satellites and space probes, ballistic missiles, and civilian and military aircraft. He was an adjunct associate professor in the USC Graduate School of Engineering as well. He was a life member of the Caltech Alumni Association, and a senior member of the IEEE. His wife, Muriel, died in 1987. He is survived by a daughter, Kate Talev; a sister, Rita Keating; two granddaughters; and many nephews and nieces.

1932
PAUL G. PARSONS, of San Marino, California, in May. He is survived by his wife.

WORRELL F. PRUDEN, MS '33, on March 18. He is survived by a son, John.

1933
EDWARD A. HAYES, of Tucson, Arizona, on April 26. He is survived by his wife. He was a Caltech Associate and a life member of the Caltech Amateur Radio Club.

1934
OLIN C. WILSON, PhD, of West Lafayette, Indiana, on July 13; he was 85. A noted astronomer, his career with the Hale Observatories spanned more than 40 years. He was a member of the National Academy of Sciences and received the Catherine Wolfe Bruco Medal in 1984 for his pioneering contributions to stellar spectroscopy. He is survived by his wife, Katherine; a daughter, Nicole McMillin; a son, Randall; and four grandchildren.

1938
JAMES R. BALSLEY, JR., of Sebec, Maine, on August 23; he was 77. He was a retired geophysicist with the U.S. Geological Survey. He received his MA in geology in 1941 and his PhD in geophysics in 1960, both from Harvard. His career with the USGS began in 1939 when, as a junior geologist, he did field mapping on the Olympic Peninsula in Washington State. He began conducting ground and airborne USGS magnetic surveys in 1941. During World War II he worked on cooperative investigations in geophysics with the Manhattan Project, the U.S. Army Air Forces, and the U.S. Navy. That and subsequent work at the USGS and with the Office of Naval Research and Bell Labs led to his pioneering work in airborne geophysics. In the late 1940s he conducted some of the first aeromagnetic surveys of Antarctica, and his instruments and techniques have been applied around the world to the mapping of geologic structures and the detection of hidden ore bodies. He served as chief of the USGS's Geophysics Branch (1953-59), and, as assistant chief geologist for geologic processes (1959-62), he established a number of projects, including the Rock Magnetism Project; this latter project led to some of the key discoveries behind the theory of plate tectonics. From 1962

to 1970 he served as department chairman and professor of geology at Wesleyan University. In 1970 he returned to the USGS as assistant director for research, and in 1971 he coauthored with other senior USGS scientists a new procedure for evaluating environmental impacts on land and water resources, leading to what the USGS has called "a new environmental role for USGS and the earth science community." He introduced what USGS director GORDON P. EATON, MS '53, PhD '57, has termed "a breath of fresh air. . . . He was willing to work behind the scenes and throw out challenging ideas that led us in new directions. . . . And he still had the enthusiasm to lead the singing at the annual Pick and Hammer Show and poke fun at stuffy scientists." Balsley retired in 1980. During his career he authored nearly 100 publications and served on dozens of scientific boards, committees, and working groups. He was a fellow of the Geological Society of America and a member of the American Geophysical Union, the Cosmos Club, Sigma Xi, the Society of Exploration Geophysicists, and Tau Beta Pi. His many awards include the highest award of the Department of the Interior (the 1962 Distinguished Service Award) and an honorary degree from Wesleyan University (1963). He is survived by two sons, Chris and Dave, and by five grandchildren. Jane, his wife of 51 years, died in July at their home in Sebec.

1939
GEORGE O. CROZIER, of Burbank, California, on August 14; he was 78. He was a hydraulics engineer at Lockheed for 38 years, retiring in 1979 as a senior design specialist. He helped design aileron and landing-gear systems for numerous aircraft. He played baseball for Caltech and enjoyed a lifelong interest in sports as a player, coach, and fan. He is survived by his wife, Grace; his sons, Thomas and Donald; and four grandchildren.

J. NORTON WILSON, PhD, of Richmond, British Columbia, on December 8, 1993. He is survived by a sister, Kathleen Kottmeier.

1941
STANLEY E. SOHLER, on February 22; he was 75. He wrote under the name of and was frequently known as Jayson Loam. He is survived by his children, Gary, Mel, Randy, and Melanie.

1942
PAUL S. BERGH, of Rockville, Maryland, on January 13. He is survived by his wife, Phyllis; two daughters, Lisa Nylund and Nancy Candela; and five grandchildren.

CHARLES E. RUTHERFORD, of Rolling Hills, California, on July 4; he was 76. He was a life member of the IEEE and of the Caltech Associates. A longtime boating enthusiast, he was a member of the West Coast Yacht Club. He is survived by his wife of 50 years, Marilyn; four children, Diane, Janice, Joan, and Lee; and five grandchildren. A fellowship fund has been established at Caltech. Those wishing to contribute should write to the Charles E. Rutherford Fellowship Fund, 1201 East California Boulevard, 105-40, Pasadena CA 91125.

CHARLES M. SEIBEL, MS '43, of Arlington, Texas, on July 9; he was 74. After graduating from Caltech, he began his career working at Bell Helicopter's Buffalo, New York, facility. Then he started Seibel Helicopter Co. in Wichita, Kansas, and from 1945 to 1951 the company gained recognition for its production of the Seibel S-3 and S-4 models, which, with their high-quality control systems and performance, were hailed as innovative helicopters. Cessna Aircraft Co., also of Wichita, acquired the company in 1952 and made Seibel director of its new helicopter division. In 1956 he was

named president of the American Helicopter Society. In 1963 he was appointed chief experimental project engineer by Bell Helicopter and led teams through the development of the Bell Jet Ranger, Huey Cobra, Model 212, and others. After he retired from Bell as director of experimental engineering, he and his wife created Flight Bonus Inc. and, using sophisticated drag-reduction techniques, improved the performance of the Cessna 182 Skylane. He is survived by his wife, Julie; a son, David; a daughter, Diane Robie; a stepson, Bill Childs; and seven grandchildren.

1945
HENRY E. LESTMANN, Ex, of Perryville, Missouri, on April 30. He is survived by his wife.

1946
JERRY F. DANIELS, JR., MS, Eng '47, in December 1992. A retired U.S. Navy captain, he had spent more than 30 years in naval aviation and, after his retirement, had worked for McDonnell Douglas. "One of his fondest memories was of the time he spent at Caltech." He is survived by a son, Jerry F. Daniels III.

PAUL C. DURUP, MS, Eng '47, of Granada Hills, California, on May 17. He had retired from the U.S. Navy in 1962 and from Lockheed in 1990, and until his death was a consultant for the Galaxy Scientific Corporation, in New Jersey. He is survived by his wife; a son, Rich; and a daughter, Liz Mitchell.

1947
GEORGE G. KELLEY, of Kingston, Tennessee, on August 27, 1993; he was 73. A leader in the fusion program at the Oak Ridge National Laboratory, he began his career there in 1947 and retired as a senior physicist in 1979; his work resulted in several patents. He was a fellow of the American Physical Society. After retiring, he cofounded Scientific Endeavors, a graphics software company. A lover of classical music and an accomplished craftsman, he built harpsichords and guitars and developed and built a unique electronic organ to duplicate the sound of a pipe organ. He was also an avid runner and enjoyed sailing and flying—although he hadn't earned his pilot's license, he had taken flying lessons. He is survived by his wife of 46 years, Ruth; two sons, David and Steve; four daughters, Becky Brown, Laura Ousley, Janet Kelley, and Jean West; and five grandchildren.

1948
HARVEY O. NAY, MS, Eng '52, of Marysville, Washington, on April 21; he was 68. During his career he worked for Douglas Aircraft, General Electric Gas Turbines, Hughes Helicopters, Lear Jet, and Cessna. When he retired in 1991, he was vice president for engineering at Piper Aircraft in Florida. A member of the National Academy of Sciences Aeronautic and Space Engineering Board, he also served on advisory panels to NASA and to congressional groups and conducted seminars on airworthiness certification procedures in China at the invitation of the Chinese government. He is survived by his wife, Lois; a daughter, Barbara; a son, Andrew; four grandchildren; and a brother and sister.

JERRY F. WOZNIAC, of Los Altos, California, on September 7; he was 68. He began his studies at Caltech prior to World War II, joined the U.S. Navy during the war as an ensign and served in the South Pacific, then returned to Caltech. After graduating, he went to work for Westinghouse, and he was called back to active duty during the Korean War. He worked for Lear Jet and Electronic Control Systems before joining Lockheed in 1958, where he worked as

an electrical engineer until his death. The father of Apple Computer cofounder Steve Wozniak, he is survived by his wife, Margaret; a brother; a sister; a daughter; two sons; and four grandchildren.

F. HAMILTON WRIGHT, PhD, of Pasadena, California, on June 1; he was 81. He worked as an engineering specialist at JPL 1946-1959, and as a physicist, division director, staff scientist, and consultant at Aerojet-General Corp. 1959-1994. He was a fellow of the American Institute of Aeronautics and Astronautics, as well as a member of the American Physical Society, IEEE, and Sigma Xi. He is survived by his wife, Peggy; four children; and eight grandchildren.

1950
DANIEL MARKOFF, of San Luis Obispo, California, on March 29. He is survived by a sister, Bonnie Markoff.

J. HOWARD PINCKARD, PhD, of Long Beach, California, on April 14. He is survived by his wife.

1954
WILLIAM F. ANDERSON, MS, of Sun City West, Arizona, on March 12. He is survived by his wife, Olive; a son, William J.; a daughter, Martha; and four grandchildren.

1955
RICHARD B. READ, PhD '62, of Altadena, California, on June 4; he was 60. He was a member of the professional staff in solar astronomy at Caltech. As a graduate student he did the survey work for the north arm of the two-antenna, variable-spacing interferometer at the Owens Valley Radio Observatory (OVRO) and, once that arm started functioning, used it to determine accurate declinations for a number of celestial sources, reducing the error boxes for the location of many of those objects and allowing the important identification program of the time to accelerate. That work formed part of his thesis. He joined the Caltech faculty as a senior research fellow at OVRO, becoming a member of the professional staff in 1975 and joining the solar astronomy staff in 1980. He is survived by his wife, Dorothy. A memorial fund is being established at Caltech. Those wishing to contribute should write to the Richard Read Memorial Fund, 1201 East California Boulevard, 105-40, Pasadena CA 91125.

1960
HARRY H. BINGHAM, JR., PhD, of Berkeley, California, on August 24; he was 63. A physicist and teacher who had joined the UC Berkeley faculty in 1964, he had recently retired as professor of physics. Following his graduation from Caltech, he spent two years on bubble-chamber development at the École Polytechnique in Paris, and two years as a Ford Foundation Scholar at the European Center for Nuclear Research (CERN). He worked in the field of experimental elementary particle physics, for many years leading a Berkeley research group in a series of fundamental experiments that studied the interactions with matter of high-energy neutrinos, photons, and hadrons, and conducting experiments at leading research centers around the world, including the Stanford Linear Accelerator Center, CERN, and the Fermi National Accelerator Laboratory, with results to be found in over 100 papers published in physics journals. He also spent sabbatical years at CERN, at the Rutherford Laboratory in England, and at the Texas Accelerator Center. He received national attention in the summer of 1989 when, as acting chair of the physics department, he offered a Berkeley position to the prominent Chinese astrophysicist and suspended

university administrator Fang Lizhi, following the protests in Tiananmen Square. Always interested in university affairs, he chaired, over his career, two major committees of the Berkeley Academic Senate. He was a Fellow of the American Physical Society, and during his career received a Ford Foundation Fellowship and a National Science Foundation Visiting Scientist and Travel Fellowship. He was known as an enthusiastic and well-loved teacher, offering both undergraduate and graduate courses—14 graduate students who received doctorates under his supervision now hold appointments in universities, research centers, and industry. He enjoyed sailing, skiing, running, and soccer, and was an avid poker player. He is survived by his wife of 34 years, Judith; two sons, Harry and Sanford; a daughter, Alison Mankin; two grandsons; a sister, Leslie Williams; a half-brother, John Pannes; and his mother, Ernestine Pannes.

1962

DONALD C. SHREFFLER, PhD, of St. Louis, on August 8; he was 61. A professor of genetics at Washington University School of Medicine, he had joined the medical school's faculty as professor in 1975 and served from 1977 to 1984 as the James S. McDonnell Professor and as head of genetics. Prior to coming to Washington University, he was a professor at the University of Michigan and performed research at the University of Illinois at Urbana-Champaign. He was a member of many professional groups and editorial boards. He is survived by his wife, Dorothy; two sons, Douglas and David; and three sisters, Dorothy Ball, Phyllis Herscher, and Joyce Ayers.

1964

DAVID J. HELFMAN, of Ojai, California, on March 15, 1993. The owner of Databridge, Inc., a data-processing company, his real love was a Los Angeles-based chorus called Song of Earth, which he conducted and which "performed ethnic music from around the world long before the World Beat craze began." He is survived by his wife, Linda.

1965

CHANG CHIH CHAO, PhD, of Lexington, Massachusetts, on May 11; he was 61. Born in China, he came to the United States to pursue graduate studies. After graduating from Caltech, he performed research at Cornell University before becoming professor of materials science at Northeastern University in 1970. Prior to his retirement last January, he had been a senior scientist with the Mobil Solar Energy Corporation, in Billerica, Massachusetts. In 1988 he received a U.S. patent for his work in crystal growth. A lover of music and the outdoors, and an avid reader of Chinese literature and poetry, he was also skilled in the art of Chinese calligraphy. His work is on display in public areas in Greater Boston. He is survived by his wife, Yenshew; a son, Philippe; and two daughters, Yvonne and Viviane.

1972

JOHN R. CAMERON, of Oakland, California, on May 12. He received both his PhD in biochemistry and his MD from Stanford, and practiced as an internist. He is survived by his wife, Michelle.

Linus Pauling

1901–1994

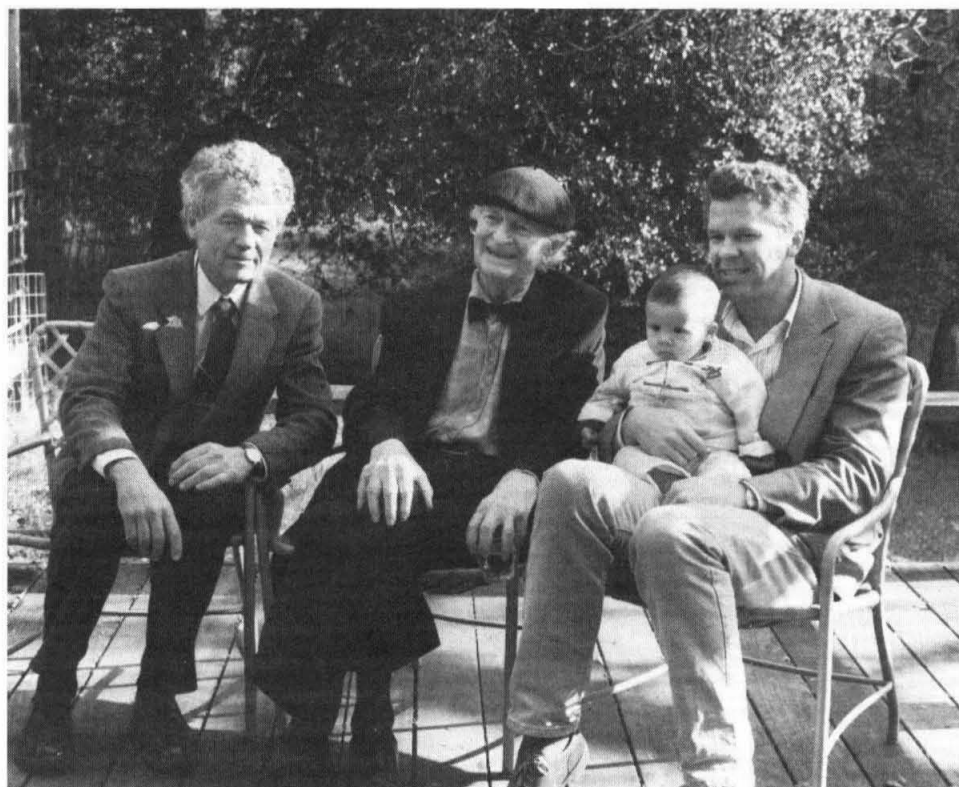
Linus Pauling, the only winner of two unshared Nobel Prizes and widely considered one of the greatest scientists of the 20th century, died August 19 in Big Sur, California. He was 93.

Less than a decade but a world of diverse concerns separated Pauling's two Nobel Prizes. The first, awarded for chemistry in 1954, recognized his pioneering insights into the nature of the chemical bond—work that revolutionized the study of chemistry and led to numerous advances in chemical engineering, biochemistry, and molecular biology. In 1962, Pauling was awarded the Nobel Peace Prize for his years of impassioned opposition to atmospheric nuclear testing. His personal crusade against atomic weapons has been credited with helping to inspire the 1963 Nuclear Test Ban Treaty between the United States and Soviet Union. He was also among the first scientists to raise public awareness of the harmful biological effects of exposure to radioactivity.

Born in Portland, Oregon, in 1901, Pauling left high school without a diploma, finding many of the required courses useless. In 1918, he enrolled in Oregon Agricultural College (now Oregon State University), where he earned a BS in chemical engineering and his extraordinary scientific talents were almost immediately recognized. In her book *Millikan's School*, Caltech Archivist Judith Goodstein recounts that "There were two chemistry seminars during his senior year—one on the chemistry of fish, given by a staff member, and one on the electronic nature of the chemical bond, by Pauling."

In 1922 Pauling brought his interest in the chemical bond with him to Caltech, receiving his PhD in 1925. He spent the next two years in Europe, where he was among the first Americans (another was J. Robert Oppenheimer) to be exposed to and to appreciate the tremendous importance of the burgeoning field of quantum mechanics. Returning to Caltech, where he was appointed professor of chemistry in 1931, he set about applying quantum mechanical principles to his studies in structural chemistry, work that saw him elected in 1933, at the age of 32, to the National Academy of Sciences. Throughout the 1930s, Pauling continued this research, using X-ray and electron diffraction techniques to determine the structure of molecules. In 1939, he published *The Nature of the Chemical Bond*, considered one of the most influential scientific books of the 20th century.

In the mid 1930s, Pauling's attention turned to biological molecules. His research in this area included work



Pauling's Caltech connections spanned generations, professionally and personally. Last February, the scientist celebrated his 93rd birthday with family members, including, from left, son-in-law Barclay Kamb '52, PhD '56, Caltech's Rawn Professor of Geology and Geophysics and the Institute provost from 1987 to 1989; grandson Alexander (Sasha) Kamb, PhD '88; and great-grandson, Alexander Kamb.

to develop a structural theory of denatured protein molecules, and studies of oxygen-carrying hemoglobin molecules—an interest that culminated in his discovery, with Harvey Itano, of the molecular basis for the hereditary disease sickle-cell anemia. Pauling's research projects were interrupted by World War II, during which he worked on explosives and developed an oxygen detector. After the war, he continued to explore biological molecules through his work on antibodies and on an artificial blood serum. In the late 1940s, he discovered the alpha helix as the basic structure of proteins.

For his work on the structure of biological molecules, Pauling has been hailed by Nobel Laureate Francis Crick as "the father of molecular biology." Said Crick, whose discovery with J. D. Watson of the structure of the DNA molecule was greatly influenced by Pauling's work on the alpha helix, "It was his example in building models of molecules and dealing with those molecules creatively that helped us in the discovery of the double helix."

Pauling was appointed chairman of Caltech's Division of Chemistry and Chemical Engineering in 1936, a position he held until 1958, as well as serving as director of the Gates and Crellin Laboratories of Chemistry. He left the Institute in 1964 and went on to positions at the Center for the Study of Democratic Institutions in Santa Barbara, at UC San Diego, and at Stanford. In 1973 he established the Linus Pauling Institute of Science and Medicine in Palo Alto to concentrate on the chemistry of life and on challenges in medicine. In the late 1960s, he began the work for which he is perhaps best known to the general public—his studies of Vitamin C and his advocacy of its therapeutic benefits, a stance that continues to generate considerable interest,

debate, and controversy.

Pauling was named professor emeritus at Caltech in 1971. In 1986 and 1991, the Institute held two symposia, honoring his 85th and 90th birthdays. In 1990 Caltech established the Linus Pauling Professorship in the chemistry and chemical engineering division and named chemical physicist Ahmed Zewail its first occupant.

In addition to his two Nobel Prizes, Pauling won numerous other awards, including the Presidential Medal for Merit in 1948 and honorary doctorates from some 45 universities.

During his professional career of more than six decades, Pauling published approximately a thousand papers, including nearly 700 scientific papers and about 200 articles on social and political questions, especially about peace. His many books include *The Structure of Line Spectra* (with Samuel Goudsmit) and *Introduction to Quantum Mechanics, with Applications to Chemistry* (with E. Bright Wilson, Jr.).

In 1923, Pauling married Ava Helen Miller, whom he had met when she took the home economics class he taught (along with the chemical bond course) at Oregon Agricultural College. Ava Helen Pauling died in 1981. The couple is survived by their children, Linus Pauling, Jr.; Peter J. Pauling; Crellin Pauling; and Linda Pauling Kamb, whose husband is Caltech's Barbara and Stanley R. Rawn, Jr., Professor of Geology and Geophysics Barclay Kamb. Pauling is also survived by 15 grandchildren and 19 great-grandchildren, and his sister Pauline Emmett.

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