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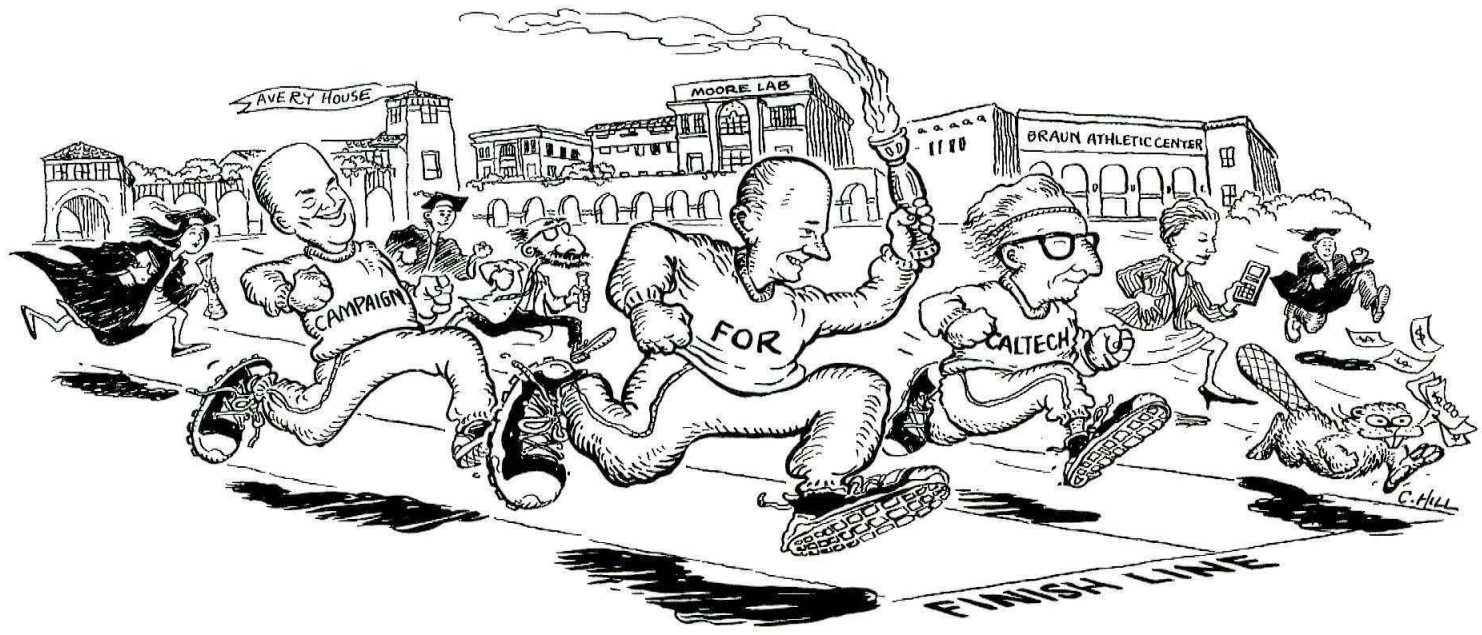

From left, Caltech President Tom Everhart, Chairman of the Caltech Board of Trustees Ruben Mettler, Board Vice Chairman and Chairman of the Campaign Executive Committee William Kieschnick, and a few other interested parties (all seen through the inventive eyes of cartoonist Cathy Hill) head for the finish line of the Campaign for Caltech. The three buildings in the background are among the major campaign gifts.

Campaign for Caltech passes $350 million mark: drive to fund key academic objectives continues

With several weeks still to go, the Campaign for Caltech: A Second Century of Discovery has reached its goal of raising at least $350 million in gifts and pledges by the end of 1993. A $2 million gift for scholarships put the figure over the top on October 20. The total now stands at $353 million.

The campaign, Caltech's fourth such fund-raising effort in its history, got under way in October 1989 with the inception of a 15-month "quiet phase," and entered its public phase in January 1991. The campaign officially ends on December 31.

"To have achieved our principal financial objective two months ahead of schedule is a considerable achievement, particularly given the nation's economy and the hurdles currently facing higher education," says William Kieschnick, vice chairman of Caltech's Board of trustees, and chairman of the Campaign Executive Committee that has overseen the campaign on behalf of Caltech's trustees. "Of course such an outcome doesn't happen by accident—it reflects the commitment and vision of the Institute's trustees, alumni, and many other supporters, and is a testimony to the talent and hard work of volunteers and staff. It is an accomplishment of which we can all be proud."

Adds Tom Anderson, Caltech's vice president for Institute Relations and the head of the Institute's overall fund-raising efforts, "To raise $353 million in only three public years is an enormous tribute to the dedication and generosity of Caltech's trustees, volunteers and friends."

Both Kieschnick and Anderson emphasize, however, that this campaign is not yet over—a statement that is true in more ways than one. "Despite our success in numerical terms, some very important campaign objectives remain to be met," says Kieschnick. "In particular, we are determined to reach our goal of raising $40 million for the vital area of graduate and postdoctoral fellowships and undergraduate scholarships. This has been a high priority of the campaign since its inception."

The Institute hopes to raise $15 million in funds for undergraduate scholarships, $10 million for graduate scholarships, and $15 million for postdoctoral fellowships. Thus far, about 60 percent of the total amount has been raised, a substantial portion of it in the last two years.

"We've worked hard to accelerate the rate of gifts and pledges for fellowships and scholarships," says Anderson. "During the first two years, $5 million was donated. In the third year alone, we raised $6 million, and this year to date, we've received almost $14 million. We will continue to emphasize this area after the campaign is over."

Says Kieschnick, "We are also committed to completing the goals for two areas that have a direct impact on the quality of the research that is carried out by Caltech's faculty—endowed funds for new research ventures and capital funds for constructing new laboratories and classrooms in already existing space."

The goals for endowed research-venture funds and new laboratories and classrooms are $10 million each.

The Campaign for Caltech has been led by the Institute's trustees in collaboration with Caltech's Development staff, under the direction of Anderson and Campaign Director Tanya Mink. Its overall aim has been to provide funds for a wide range of academic priorities that were first identified and outlined in a 1989 Institute-wide Aims and Needs Study. These priorities fall into three basic areas: endowment, capital funds, and programs and current operations.

"We already have 79 percent of the pledges in cash," says an obviously pleased Mink, "which is very good for this point in a campaign."

According to Mink, in endowment funds, the campaign has reached 101 percent of its goal—a particularly important and welcome achievement because it is these funds that guarantee Caltech a reliable source of future revenue. Endowment funds are invested in a variety of interest-bearing vehicles, and the income from the investments is used to support ongoing programs.

Thus far, Caltech has raised a total of $30 million in unrestricted endowment funds—money that can be put to whatever use the Institute deems most appropriate. Another $23 million has been raised for endowed chairs, including support for 15 new named professorships. Seven of the professorships have already been finalized, and faculty members appointed to the posts.

Also part of endowment are postdoctoral and graduate fellowships and undergraduate scholarships. Thus far, 6 postdoctoral fellowships, 17 graduate fellowships, and 44 undergraduate scholarships have been funded.

Other donations to the endowment include $20 million designated for such specific purposes as visiting scholars and faculty teaching awards. One million dollars will endow a venture fund for cutting-edge research projects.

With regard to capital funds, the campaign is at 98 percent of its goal. Support for major projects totals $106 million and includes a variety of facilities whose construction promises to transform the campus landscape and will in some cases have a significant impact on the larger scientific environment as well. Among these new buildings are the already constructed Braun Athletic Center which was completed last year through a gift of $4.7 million from the Carl F Braun Trust made possible by Caltech trustee Pamela Pesenti and her father, the late trustee John G Braun, and the Moore Laboratory of Electronic Materials and Structures, funded with $16.8 million from trustee Gordon Moore and his wife, Betty. Construction on the Moore Laboratory is scheduled to begin next year, as is work on a new student residence, Avery House, made possible by a $10 million gift by Trustee Chairman Emeritus R. Stanton Avery. Construction has already begun in Mauna Kea, Hawaii, on the Keck II Telescope, funded with $74.6 million from the W. M. Keck Foundation. Another $3 million is earmarked for renewal of laboratories and classrooms, and $3 million has been given for other capital improvements.

For programs and current operations, the campaign has received $139 million—103 percent of the goal. These funds include donations from the Annual Fund and the Associates, research grants from foundations and corporations, student aid funds, and

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CAMPUS UPDATE

Photo by John Roberts

Till Wolfgang Liepmann '79 (left) and his father, Caltech professor Hans Liepmann (right), shared a moment with Bill Clinton in the White House Rose Garden in September, when the president presented the senior Liepmann, Caltech's Theodore von Kármán Professor of Aeronautics, Emeritus, with the National Medal of Technology. Liepmann received the National Medal of Science in 1986, making him one of only 11 Americans to win both awards. (Another is Caltech Board of Trustees Chairman Emeritus Arnold Beckman, PhD '28.) The first National Medal of Science was presented in 1962 by Clinton's boyhood idol, John F. Kennedy to Liepmann's mentor and Caltech colleague Theodore von Kármán.

White House looking for a few good fellows

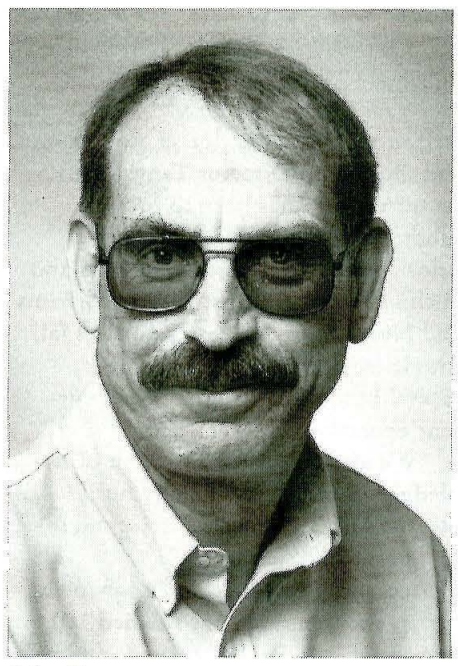
If you're in the "early or formative stage of your career," looking for an "opportunity to deal one-on-one with America's leaders [and to] help shape world events," or just interested in getting to know Janet Reno better, the President's Commission on White House Fellowships would like to hear from you. The commission is inviting Caltech alumni to apply for this unique program, which since 1964 has offered young men and women the opportunity to work for one year as full-time, paid Special Assistants to Cabinet Secretaries or to other top-level executive-branch officials.

Ten to 20 White House Fellows are selected each year—this year's group numbers 17 and includes lawyers, scientists, educators, doctors, and entrepreneurs, working for such offices as the departments of State, Justice, Education, and the Interior; the National Security Council; the Office of the Assistant to the President for Domestic Policy; and the offices of both the Vice President and the Chief of Staff. The fellowships are open to all U.S. citizens and have no special educational or professional requirements.

Three Caltech alumni have been White House Fellows: Walter Baer '59, Wayne Collins '73, MS '74, and Robert Chess '78. Chess worked in the Office of Economic and Domestic Policy; Baer and Collins for the Vice President's Office. For further details on the program, a brochure, and an application, please call the Office of the President's Commission on White House Fellowships at (202) 395-4522. The application deadline is December 15.

First Centennial Professor named

Caltech Professor of Chemistry John Bercaw has been named the first occupant of the Institute's newly endowed Centennial Professorship. The chair, which has been established with a gift of $1.5 million from an anonymous donor, is an Institute-wide appointment, meaning it may be occupied by an outstanding faculty member in any field.



John Bercaw

Caltech's new Centennial Professor of Chemistry has been a faculty member since 1972. He conducts research in organometallic chemistry, synthesizing compounds that contain organic groups bonded to transition metals, and investigating their reaction with common chemical feedstocks, including molecular nitrogen, carbon monoxide, and hydrocarbons.

Bercaw applies the results of these fundamental studies to the development of more effective and efficient catalysts in processes that range from polymer synthesis to petrochemical production. One focus of his research is developing efficient ways to convert methane gas to the fuel methanol.

Bercaw received his BS in 1967 from North Carolina State University and his PhD in 1971 from the University of Michigan. After a year of postdoctoral work at the University of Chicago, Bercaw joined Caltech's faculty as the Arthur Amos Noyes Research Fellow in Chemistry. He was named assistant professor of chemistry in 1974, associate professor in 1977, and full professor in 1979. From 1985 to 1990, he held the position of Shell Distinguished Professor and professor of chemistry.

In 1990 Bercaw was elected to the National Academy of Sciences, one of the American scientific community's highest honors. He was elected in 1991 to the American Academy of Arts and Sciences. His other awards include an Alfred P. Sloan Research Fellowship (1976), the Camille and Henry Dreyfus Teacher-Scholar Award (1977) and the American Chemical Society awards in Pure Chemistry (1980) and Organometallic Chemistry (1990). He was honored by Caltech's undergraduates with an ASCIT award for outstanding teaching in 1984.

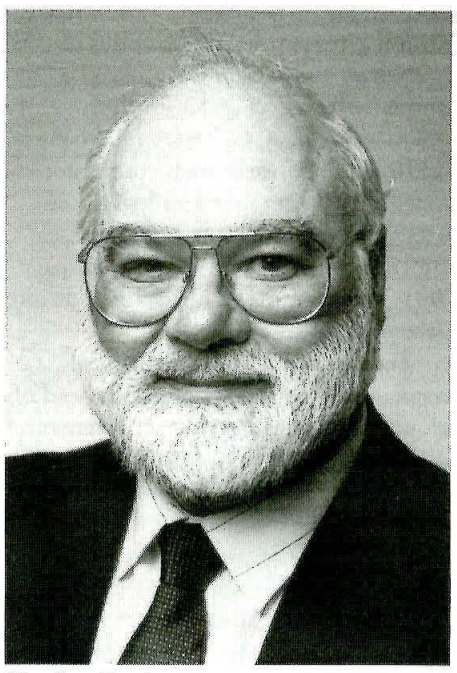
Alumnus Charles Peck is new chair of PMA Division

Professor of Physics Charles (Charlie) Peck is the new chairman of the Division of Physics, Mathematics and Astronomy, succeeding Gerry Neugebauer, who stepped down October 1 after five years in the position.

A Caltech alumnus, Peck received his PhD from the Institute in 1964, after earning his BS degree from New Mexico A&M, and he has been associated with Caltech ever since. He was named assistant professor in 1965, associate professor in 1969, and professor of physics in 1977. From 1983 to 1986, he served as executive officer for physics.

Peck's research is in the area of experimental particle physics—designing and conducting experiments to study the basic constituents of matter—and he has been involved in work at the forefront of this field throughout his career. As a graduate student, he used the electron synchrotron then at Caltech to investigate a class of exotic short-lived particles known as "strange." He has since participated in a wide range of accelerator-based studies aimed at probing the structure and properties of quarks—the fundamental building block of matter—and at clarifying the nature of the strong and weak nuclear interactions, two of the four fundamental forces of nature. When the "charmed quark," a previously unknown type of matter, was discovered in the 1970s, Peck collaborated in the design of the "Crystal Ball," an instrument that he and other physicists have used extensively at Stanford's Linear Accelerator Center (SLAC) and elsewhere to study both this quark and the subsequently discovered "bottom" quark.

With his Caltech colleague Barry Barish (the Ronald and Maxine Linde Professor of Physics), Peck is currently involved in an international collaboration to search for magnetic monopoles at the Monopole, Astrophysics, and Cosmic Ray Observatory (MACRO), a laboratory situated 3,200 feet under the Gran Sasso Mountain in Italy's Apennine mountain range. The discovery of monopoles—magnetic particles theorized to have only a single pole—could provide a key confirmation of physics' so-called Grand Unifed Theory, which seeks to unify three of nature's four forces. The new PMA chairman expects to continue active participation in this experiment.



Charles Peck

Geophysicist Hiroo Kanamori honored as California Scientist of the Year

Of the 36 California Scientists of the Year, a designation awarded annually by the California Museum of Science and Industry, 13—the largest number from any single institution—have been

Hiroo Kanamori

members of the Caltech faculty. This year it was the turn of Hiroo Kanamori, the John E. and Hazel S. Smits Professor of Geophysics and director of Caltech's Seismological Laboratory, to receive the state's highest civilian honor. The Japanese-born seismologist, internationally known for his work on the causes of earthquakes and the relationship between seismic activity and tsunamis, was honored for research that, in the words of the Museum foundation, "provides us with a deepening understanding of the nature of earthquakes, the waves they produce, and the earth's plate-tectonic engine." The award includes a $5,000 prize.

Kanamori's recent work has focused on earthquakes caused by sources other than faults—sonic booms from space shuttles, the eruption of Mount Pinatubo, and seafloor landslides. He has also studied the relationship between earthquakes and tsunamis and has discovered that large earthquakes that cause tsunamis are not always strongly felt because they release most of their energy in long-period seismic waves. This finding has particular significance for tsunami early-warning systems in coastal regions, since such systems currently do not use long-period waves as warnings of impending tsunamis.

Kanamori, who received his PhD in geophysics from the University of Tokyo in 1964, spent a year at Caltech as a research fellow in 1965, and returned in 1972 to join the faculty as professor of geophysics. He was named the Smits Professor in 1989 and the director of the Seismo Lab in 1990.

Other California Scientists of the Year currently on the Caltech faculty include John Hopfield (1991), Harry Gray ('89), Gerry Neugebauer ('86), Peter Goldreich ('81), Norman Davidson ('80), Roger Sperry ('71), Maarten Schmidt ('65), and Willy Fowler ('58).

From left, Speaker of the California Assembly Willie Brown, Caltech President Tom Everhart, and California Governor Pete Wilson were among 120 representatives of government, academia, business, and industry who came to campus in October to officially inaugurate Project California, a venture dedicated to securing and revitalizing the state's economic future through the creation of advanced technologies, industries, and jobs. Brown and Wilson were on hand to sign a declaration of commitment to the Project's goals; Everhart is the senior president among the five universities (Caltech, Stanford, USC, University of California, and California State University) that make up the California Council on Science and Technology, the organization that created and will oversee Project California.

Campaign

Continued from page 1

gifts of equipment.

Just as the funds raised will go to support a broad spectrum of needs, the scope and nature of the contributions reflect the commitment and interests of a wide range of donors. "A particularly noteworthy aspect of this campaign," says Anderson, "is that so many segments of the Caltech community have contributed to the effort." Although some donors belong to more than one group, the breakdown is essentially as follows: $80 million has been given by trustees, $22 million has been donated by non-trustee alumni, $3 million has been donated by the faculty, and $22 million comes from other friends of the Institute. Foundations have given $136 million; corporations have given $59 million, and $11 million has come from the Annual Fund and the Associates. Bequests total $19 million.

Assessing the campaign's progress to date, Anderson gives particularly high marks to the level of trustee involvement, calling the board's participation crucial to the campaign's overall success. "The trustees have made all the difference in the success of the campaign," he notes, "because of the significant amount of time and energy each board member has contributed. Their advice on campaign strategy and campaign details has been invaluable."

Among those spearheading the trustees' efforts have been Kieschnick, Caltech President Tom Everhart, and Board Chairman Ruben Mettler. A key role was played by Caltech alumnus and trustee James Glanville, who was serving as campaign chairman at the time of his death last year following an automobile accident.

"Jim Glanville's dynamic leadership was a tremendous asset to the campaign," says Mettler. "He was deeply dedicated to the Institute and its future. No one would have been more pleased than he to learn that the campaign had reached its financial goal ahead of schedule, or more committed to seeing that our outstanding academic goals—particularly the fund-raising efforts for fellowships and scholarships—meet with equal success. And no one would have been more pleased than Jim to know that Bill Kieschnick would step in as anchorman to finish the campaign."

Anderson had warm words as well for other Institute supporters, including the Caltech Associates, "who have shown us once again," he notes, "how seriously they take their role as an Institute support group and whose generosity reminds us how fortunate Caltech is in its friends," and Institute alumni, many of whom contributed through Caltech's Annual Fund Office. Participants in the Annual Fund, mostly alumni, says Anderson, "have been a bedrock for our fund-raising efforts."

Left to right, Board of Trustees Vice Chairman William Kieschnick, Trustee Chairman Ruben Mettler, Nancy Glanville, wife of the late James Glanville, Trustees Pamela Pesenti and Gordon Moore, and President Tom Everhart celebrate the news that the Campaign for Caltech has passed the $350 million mark.

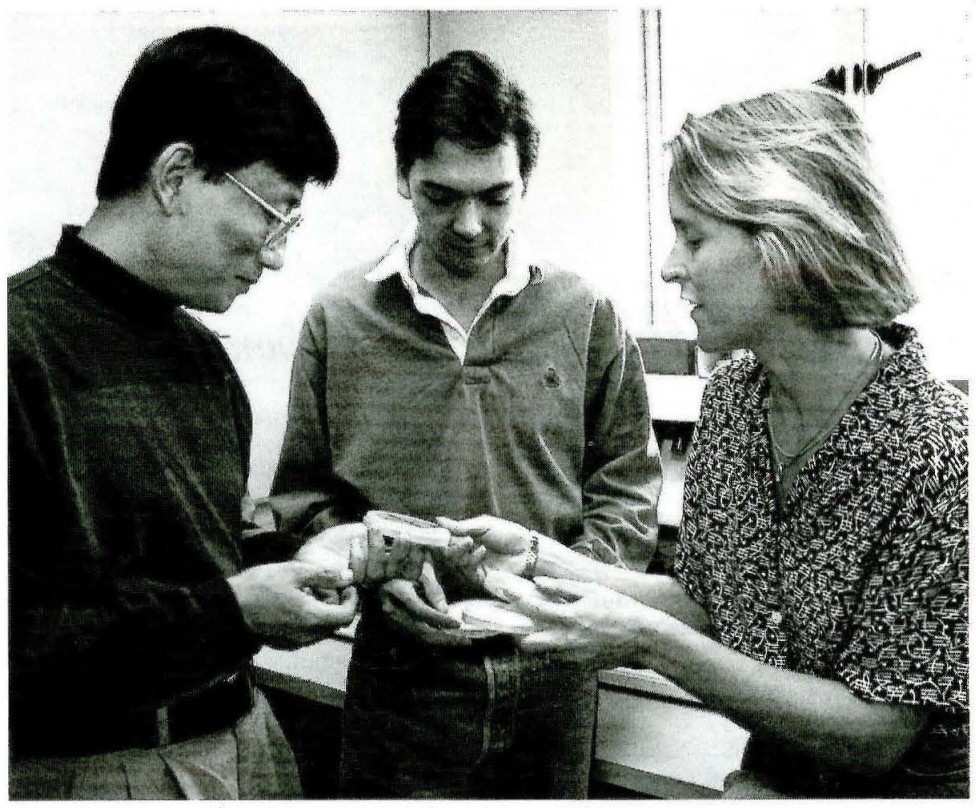
The last three years, adds Anderson, have also brought many new friends to Caltech. "There is no doubt that during the campaign we have successfully engaged people who had not previously been familiar with the Institute. We will try to keep them involved."

Already, says Anderson, the Institute is looking ahead, knowing that in any successful campaign, the conclusion of one phase is but the stepping stone to the next. "Post-campaign, we will be studying specific campaign objectives that weren't fully funded to determine which ones need more work," he says. "The campaign has helped people think about Caltech's scientific priorities, and I consider that to be one of our significant accomplishments. We hope that Caltech alumni and friends who have learned more about the Institute's teaching and research will continue to give their support."

"While we can be proud of the money raised," says Anderson, "the real story is that important Institute priorities have been funded for now and for the future. University campaigns are only successful if academic priorities are identified, communicated, and supported. The actual dollars raised are only a means to the end of securing and advancing the future of Caltech. Ultimately, that is the goal toward which we are all striving."

Young faculty at the frontiers

by Heidi Aspaturian



From left, research fellow in molecular biology Li You, graduate student in chemical engineering Jeffrey Moore, and Associate Professor of Chemical Engineering Frances Arnold check out recent samples of a mutated enzyme.

This is the first installment of a two-part story on the Institute's Packard Fellows—young professors whose research at the forefront of their disciplines reflects the range and originality of the work being pursued by Caltech's younger faculty. The Institute currently has seven Packard Fellows, each of whom is supported by a $500,000, five-year research grant awarded by the David and Lucile Packard Foundation.

The Packard Foundation Fellowships in Science and Engineering were established in 1988 with the aim of supporting outstanding university researchers at the early stages of their careers and to encourage them to remain in academia where students could benefit from their talents and expertise. Twenty fellowships are awarded nationwide each year. The program is designed to help alleviate a situation with which plenty of young scientists are familiar—that the outset of their careers, the very time when they are most likely to be filled with energy and ideas, is also often the very time when they are most likely to have difficulty obtaining substantial research support.

This philosophy—and the amount of money and lack of strings that go with it—has guaranteed the Packards a high place in academic circles, where they are among the most coveted research awards. One of the most attractive aspects of the program, in the eyes of many scientists, is the extent to which it encourages interdisciplinary approaches to important questions—and doesn't insist on knowing in advance what the answer is likely to be.

According to Caltech Vice Provost and Professor of Physics and Applied Physics David Goodstein, that attitude begins with the proposals the Packard nominees are asked to submit, in which they have all of two pages to outline their research projects. Goodstein serves on the eleven-member scientific advisory committee representing eleven of the nation's leading universities that evaluates the proposals and selects the Packard Fellows. He notes that unlike many funding agencies, the Packard Foundation doesn't need to be told from the outset where an idea will lead—and he points out that in a two-page writeup, the candidate has no real opportunity to tell them. "The selection committee is interested in the quality of the ideas themselves," Goodstein says. "That is the way science ought to be."

Goodstein's sentiments are echoed by Assistant Professor of Electrical Engineering Yu-Chong Tai, a Packard Fellow since 1991. "The Packard is the backbone of my research," says Tai, one of a handful of scientists who are leading the way in the new field of micromechanics—the design and construction of microscale mechanical devices. "The great thing about it is that it's so flexible—so when we have some crazy idea, we can go ahead and do it. And some of these crazy ideas have great possibilities."

Caltech's Packard Fellows, and the years in which they received the Fellowships, are Frances Arnold, associate professor of chemical engineering (1989), Geoffrey Blake, PhD '86, associate professor of cosmochemistry (1988), Shrinivas Kulkarni, professor of astronomy (1990), Stephen Mayo, PhD '87, assistant professor of biology (1993), Andrew Myers, associate professor of chemistry (1989), Yu-Chong Tai, assistant professor of electrical engineering (1991), and Nai-Chang Yeh, assistant professor of physics (1992).

This issue focuses on work being carried out in chemical engineering, chemistry, and physics by Arnold, Myers, and Yeh. The second installment, featuring Blake, Kulkarni, Mayo, and Tai, will appear in an upcoming issue of Caltech News.

Unnatural acts

If you're a chemist or an engineer and you want to make a better product, why not take a cue from a manufacturer who's been in the business for three billion years? That's the approach Associate Professor of Chemical Engineering Frances Arnold is following. Arnold heads up a research group that has for the first time taken an enzyme—a catalyst invented by nature to carry out a specific chemical reaction in living things—and made it work in a setting for which nature never intended it.

Working with Arnold is a large and diverse group of research fellows and graduate students, from fields that range from chemical engineering to molecular biology. Arnold's own background and interests are similarly interdisciplinary—she received her PhD in chemical engineering from UC Berkeley in 1985 and did postdoctoral work at Caltech in both physical chemistry and biochemistry before joining the Institute's chemical engineering faculty in 1987. She's been thinking about how to engineer enzymes for quite some time.

"Our goal as engineers," she says, "is to make biological catalysts that can be used in the chemical and pharmaceutical industries. As scientists, we are hoping to learn more about enzymes from the ways they adapt to new environments."

Enzymes are nature's movers and shakers—proteins whose basic function is to break something up or put something together. (Pepsin, which breaks down food proteins as they enter the stomach, is a classic example.) Evolution has designed enzymes to work with extraordinary specificity, and they're equally exacting about their surroundings—most function best in watery solutions, at the mild temperatures and neutral pH levels that living things generally find congenial. They perform poorly, if at all, in the absence of water, at high temperatures or pressures, or in the other types of harsh or toxic environments that characterize many chemical and industrial processes, from pharmaceuticals manufacturing to environmental cleanup. But compared to the exquisite precision with which enzymes go about their work, the nonbiological catalysts currently used in such operations are mostly rank amateurs. They turn out small quantities of the desired product, they leave considerable detritus in their wake, and they're oblivious to certain kinds of impurities. For instance, most nonbiological catalysts can't tell the difference between a left- and a right-handed isomer—that is to say, between the active molecular agent in a particular compound and its inert mirror image—and blindly turn out both. (This may not sound like much, except that sometimes the right-handed isomer is really an evil twin: it was the seemingly innocuous right-handed isomer of thalidomide that led to medical disaster in the 1960s.)

Many of these problems, says Arnold, might be overcome if enzymes could be persuaded to act as catalysts in industrial and manufacturing settings. "Nature built extremely sophisticated catalytic machinery into enzymes, but never adapted it to industrial manufacturing," she says. "We are tuning enzymes to work in nonnatural situations—to overcome the fact that nature's objectives are different from modern industry's."

In their first attempt to get an enzyme to do what comes unnaturally, Arnold's team worked with subtilisin, an enzyme that takes its name from its host bacterium, Bacillus subtilis. Like all enzymes it's happiest in water, where it goes to work like a cleaver, chopping proteins into their constituent amino acids by cutting the peptide bonds that hold the acids together. But Arnold and postdoctoral researchers Keqin Chen and Li You have succeeded in producing forms of subtilisin that function with equal dexterity in a nonaqueous solution, one containing an organic solvent known as DMF. And they've modified the subtilisin so that once it's in this alien habitat, it no longer breaks the bonds between amino acids; instead, it joins them back together. It's a talent, Arnold points out, that could prove extremely useful in materials and chemical synthesis.

"One reason we chose to work with subtilisin is that we knew that in the presence of DMF, the 'wild type' or natural form already has a feeble ability to put amino acids back together," says Arnold. "But it doesn't form bonds in DMF with anywhere near the efficiency that it cleaves them in water. So, the wild type has this latent potential but it's poorly expressed. What we did was drive the enzyme's evolution in a direction that optimizes that particular potential."

To lead the enzyme down their chosen path, the Caltech researchers employed directed evolution, which is another way of saying that they mutated the enzyme in the laboratory with a definite aim in mind. Like all proteins, an enzyme's structure and functions are determined by its amino acid sequence, which in turn is governed by its DNA. Arnold's team used a common genetic-engineering technique called polymerase chain reaction (PCR) to turn out multiple copies of subtilisin DNA, and deliberately introduced errors into the copying process. All the mutations were made at random, the

same method evolution has employed for the last three billion years. As the mutated variants accumulated, they were screened for enhanced activity in DMF. Those that seemed especially proficient were put through further rounds of random mutation until the researchers isolated a form of subtilisin that thrived in high DMF concentrations.

Only ten amino-acid changes, says Arnold, account for the striking differences between the wild-type subtilisin and the new variety that deftly assembles bonds in DMF. "If you put natural subtilisin into a solution that's, say, 60 percent DMF, it hardly functions at all. But our new subtilisin variant works in DMF nearly as well as the wild type does in water."

Now that she's shown what can be done with one enzyme, Arnold has a shopping list of features she'd like to modify in others. For instance, she'd like to develop a class of enzymes that can catalyze reactions at temperatures considerably higher than their normal comfort zone of between 25° and 50° C. Other enzymes might be altered to function in highly acidic or alkaline environments, or to work on slightly different substrates. "Now that we know this procedure works in principle," says Arnold, "there's a whole range of properties we can begin to think about changing."

It took Arnold the chemical engineer only six weeks to get from water-friendly to DMF-friendly subtilisin, a finding that Arnold the biochemist thinks should make students of evolution sit up and take note. "When we started screening the new variants for enhanced activity in DMF, we had no idea how long the process might take," she says. "The question was, 'Are there few, or many, solutions to this problem?' Well, it turns out that the solutions are not rare—we had to sift through only 4,000 varieties to find the result we wanted. But at the beginning we didn't know whether it would take 3,000 tries or 3 billion. That's like the difference between six weeks and 6,000 years. So, the larger question we've been dealing with is, how adaptable are the molecules of life? It looks like they may be very adaptable. And that has some fascinating implications, not only for directed evolution, but for evolutionary biology."

Compound complex

Associate Professor of Chemistry Andy Myers has spent the last few years investigating a class of "very interesting compounds" that are both beautiful and deadly. He's intrigued by how the one characteristic relates to the other. Psychologists and philosophers ask this question a lot too, but Myers' concerns are different. The chemical compounds he works with are among the most potent antitumor agents ever isolated. They're manufactured by microbes, and as long as they remain in that particular bacterial milieu they appear to be harmless. But insert them into a mammalian cell and they destroy it—an undesirable outcome if the cell is healthy, but a highly desirable one if the cell happens to be part of a malignant tumor. They mount these attacks with remarkable efficiency.

"These compounds are extremely potent cell-destroying agents," said Myers. "They appear to be effective at far lower concentrations than many of the chemotherapeutics that are currently in use."

To those attuned to molecular aesthetics, they're also quite beautiful, with some of the most intricate architecture yet seen in organic molecules. How these complex molecular arrangements generate such potent antitumor properties is one of the key questions that Myers and his research team of more than a dozen graduate students and research fellows have been trying to answer. They've taken a hands-on route to the solution, building these molecules in the lab. After more than three years of work, they've almost completed the synthesis of one target compound, neocarzinostatin, and have made considerable headway with another, dynemicin. In the process, says Myers, they've learned some exciting new chemistry that has helped them to understand the molecular basis for these substances' antitumor activity.

Associate Professor of Chemistry Andy Myers (right) and graduate student in chemistry Marlys Hammond scrutinize a molecular model of an intermediate step in the synthesis of neocarzinostatin.

A key player in neocarzinostatin's metamorphosis to a cellular toxin turns out to be a molecule called glutathione. Although it's not found in bacteria, glutathione is present in all mammalian cells, where one of its chief functions is to identify and eliminate alien substances that might harm the cell. In the presence of neocarzinostatin, however, this defense mechanism boomerangs. "Instead of destroying neocarzinostatin," says Myers, "glutathione literally reshuffles its molecular structure in such a way that it becomes lethal to the cell. The evidence so far suggests that the reconfigured neocarzinostatin does this by cleaving the cell's DNA and thus destroying it. One of our goals is to understand the precise molecular mechanisms that underlie this behavior. Another is to synthesize molecules that function just like neocarzinostatin but whose structure is less complicated."

While Myers and his colleagues have made impressive progress on both these fronts, their task hasn't been an easy one. Think of putting together an intricate kinetic sculpture—a Calder mobile on the nanoscale—and then trying to fashion a replica that carries out precisely the same functions with fewer parts and a less elaborate configuration. One of the chief challenges facing Myers and his team has been that the dynamics of neocarzinostatin have turned out to be as complicated as its design. The chemical bonds that hold the compound together are, in Myers' words, "highly strained," and the experimenters have had to work out how to build this strain into their synthetic version. It's not only a matter of securely positioning each spring-loaded bond; Myers and company have also had to develop ways to contain the bonds' explosive potential in a molecule that has "a tendency to react with just about everything."

Nature throws compounds like neocarzinostatin together with apparent ease. Chemists have to assemble them through multistep synthesis—"a brutal process," says Myers, who discovered just how demanding it could be as a graduate student of E. J.Corey's, the Harvard chemist who won the Nobel Prize for his work in synthetic organic chemistry. In the case of a reactive substance like neocarzinostatin, it takes approximately 50 steps and considerable patience and ingenuity to put the molecule together. The chemists need to figure out which reaction will successfully convert compound A to compound B, and which will make B into C, and so on. There are numerous false starts and failed leads along the way.

"To make these compounds we typically have to develop highly specific reaction conditions for every step in the process," Myers says. "We design experimental conditions that we believe will do the trick, and then we see if the desired reaction occurs. Frequently, it doesn't, and then we have to try something else. In a complicated molecule, this process can take years, and the failure rate is high. Making the technique succeed requires an intimate knowledge of chemical reactivity and a very sound grasp of the reaction mechanisms."

Although they remain about a dozen steps away from completing neocarzinostatin, Myers and his team have succeeded in synthesizing a number of molecules that exhibit its properties in the test tube. How effectively these substances would work in living organisms remains an open question. And if they do function as well as their natural counterparts, there's the problem of toxicity to consider. Like many forms of chemotherapy, neocarzinostatin doesn't confine its deadly effects to cancerous cells, it devastates the healthy ones too. "Ideally," says Myers, "you'd like to be able to customize these compounds so that they would preferentially attack tumor cells."

That limitation hasn't stopped a number of pharmaceutical companies from looking closely at the potential biomedical applications of this type of work. One strong possibility, says Myers, is that a uniquely powerful compound like neocarzinostatin or its synthetic analogs could be used in conjugation with monoclonal antibody therapy, which targets specific tumors for destruction while sparing the healthy cells.

Physics in flux

"In the kind of physics I study," says Assistant Professor of Physics Nai-Chang Yeh, "the basic language is quantum mechanics, and that's not a language most people—even some scientists—are especially familiar with." How true. So Yeh, the only woman on Caltech's teaching faculty in physics, has worked up a few listener-friendly sentences to help demystify her work. She explains that she's studying how superconductors—devices in which an electric current can, like a frictionless bearing, run forever—respond in the presence of strong direct-current (DC) magnetic fields.

The kind of field-strength Yeh is talking about is in the 100,000 gauss range. (Earth's magnetic field, by way of comparison, is about 0.5 gauss.) Her research, says Yeh, has applications on both the large and small scale: the former includes MRI (magnetic resonance imaging), plasma fusion, energy storage, and—always a popular example—the design and construction of levitated trains; the latter encompasses microwave device components such as oscillators, filters, and antennas for data communications, as well as superconducting quantum interference devices (SQUIDs) for ultra sensitive voltmeters and magnetometers. Yeh is interested in these possibilities, but her real focus is on fundamental questions. She's trying to understand why nature has chosen this arena to exhibit some bizarre and—to a physicist—beautiful behavior.

In terms of their response to mag-

Continued on page 7

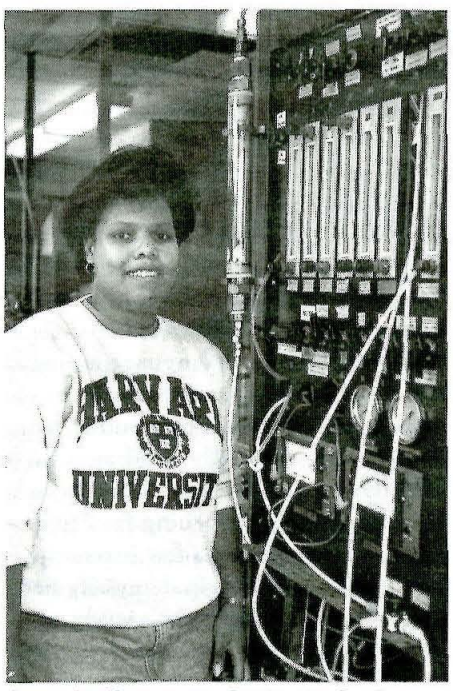
FRIENDS

Irvine Fellowships open vistas for Caltech students

On a typically hot, smoggy day in Pasadena, it's not unusual to find Jean Andino indoors, in a hot, smoggy laboratory. Andino, a fourth-year graduate student in chemical engineering, spends most of her time in Caltech's first indoor smog chamber, which she designed and built during her first year and a half on campus.

Officially called an indoor photochemical reactor, the chamber resembles a tanning booth standing on end. The earth's atmosphere is simulated in a Teflon bag that hangs from the top of the chamber, surrounded by an array of ultraviolet lights.

Andino pumps a variety of chemical compounds into the bag, such as isooctane, a gasoline component. She turns on the lights that initiate the chemistry, and then monitors the reactions. She then develops computer models of the reactions that can be used by government agencies to predict, for example, how regulating certain emissions can affect the air we breathe.



Jean Andino, a graduate student supported by an Irvine Foundation Fellowship, stands in front of the controls to the photochemical reactor that she designed and built to simulate smog. Andino, who grew up in New York City, became interested in the chemical nature of smog while she was an undergraduate at Harvard.

"I've always been interested in chemistry," Andino says, "but this seemed practical to me and something that would make a difference."

Andino is one of eight graduate students on campus who are supported by the James Irvine Foundation Minority Fellowship Program. The program, which has also funded the work of three postdoctoral fellows and is currently funding three more, started at Caltech in 1990 with a $1 million grant.

The purpose of the fellowship program is to help increase the numbers of African Americans, Native Americans, Hispanics, Native Alaskans, and Native Pacific Islanders in the sciences and engineering. Due to limited opportunities and incentives, few underrepresented minorities have gone into these fields. Another goal of the program is for the Irvine fellows to become role models and draw other young people of minority groups to careers in science and technology.

Underrepresented minorities account for only about 2 percent of all graduate students at Caltech, compared to 8 percent of undergraduates. But Caltech recently hired Connie Calderón, assistant dean of graduate studies, to help recruit minority graduate students and, with the help of the Irvine Foundation, the Institute hopes that the Caltech student, teaching, and research community will better reflect the makeup of the U.S. population.

"One of the highest priorities at Caltech is to increase the presence of exceptional minority students on campus," says President Tom Everhart. "The Irvine Minority Fellowship Program has enabled us to attract such students to Caltech, where they are doing well."

Since the Los Angeles riots of April 1992, many Southern California foundations and corporations have been reevaluating their grantmaking strategies, focusing more on social and education programs that benefit underserved communities. The Irvine Foundation has been concentrating on innercity programs for more than 10 years. Last year alone, it donated $2.8 million to community organizations working in riot-affected areas of Los Angeles.

The Irvine Foundation is the largest private foundation dedicated exclusively to the people of California. It has been a leader in encouraging women and underrepresented minorities to pursue higher education, and Caltech is a major recipient of its funds.

"Helping Caltech attract and support top graduate students from minority communities fits in perfectly with the Irvine Foundation's mission to help make higher education accessible to all Californians," said its president, Dennis Collins.

Attracting minority students to Caltech's graduate programs is also one of Andino's goals. "One of the things Caltech needs to do is to introduce more people to the Caltech environment," says Andino, who has done some recruiting for the Institute. "If Caltech doesn't take a stand when recruiting more people of different cultures and races, then it looks like Caltech is trying to exclude people."

The Irvine Fellowship Program is one way Caltech is taking a stand. One of the benefits of having the five-year Irvine Fellowship is that Andino can be assured of financial support through her graduate years and can concentrate on her studies.

"If I didn't have the Irvine Fellowship, I'd need to be concerned about support from year to year," says Andino, a founding member of the campus chapters of the Society of Hispanic Professional Engineers and the National Society of Black Engineers. "It provides me with some peace of mind."

Reunion gift results announced

Presentation of class gifts to Caltech's Annual Fund is very much a part of the reunion festivities that take place each year in conjunction with Seminar Day. Since those gifts were presented, additional funds have come in, contributing to the overall totals. Here are the final amounts, announced by the Annual Fund:

The Class of 1943, chaired by Ernest Wade, raised $51,047, with contributions from 45.4 percent of the class. Gift committee members were: Earle Bunker, Jr., Robert Davis, Mitchell Dazey, Raymond Harless, W. Lawson Jones, Richard McWethy, Walter Rhoades, and Lawrence Rockwood.

The Class of 1948, chaired by Richard Alexander, raised $140,090 from 35.8 percent of the class—the largest amount ever raised by this class. The Gift Committee was made up of Vincent Honnold and Robert Stokely.

The Class of 1953, chaired by Rolf Hastrup, raised $18,780, with contributions from 44.4 percent of the class. The Gift Committee members were: William Gardner, John Gee, Ronald Helin, Richard Jaffe, Earl Jacobs, Sheldon Rubin, and John Winslow.

The Class of 1958, chaired by Robert Schenter, raised the largest contribution in the history of the class—$42,030, with contributions from 45.2 percent of the class. The Gift Committee members were: Gene Beisman, Terry Cole, Antanas Dundzila, Alan Forsythe, Gordon Glattenberg, Lance Hays, Riley Holly, Bruce McKeever, Harold Morris, Lawrence Nelson, Philip Reynolds, Richard Van Kirk, and Robert Worlock.

The Class of 1963, chaired by Susan Wu, also achieved the best contribution record in its history—$15,510 from 41 percent of the class. The members of the Gift Committee were: Irwin Alber, John Alleman, Philip Banks, Thomas Cole, Herbert Curtis, Vladimir Dvornychenko, James Geddis, Harris Gold, Jackson Ito, Michael Krieger, John Letcher, Jr., John Lewis, John May, Alfred Pinchak, John Porter, Ivar Tombach, and Charles Wang.

The Class of 1968, chaired by Michael Casteel, broke two records—one for the largest amount raised by the class, and the other for the largest 25th reunion gift. The contributions, from 37.5 percent of the class, totaled $41,990. The Gift Committee members were: Randall Cook, Ronald Drucker, Leonard Erickson, John Frazzini, S. Rock Levinson, Barry Lieberman, Kau-Un Lu, Adelbert Owyoung, and Craig Zumbrunnen.

The Class of 1983, chaired by Gary Tanigawa, also raised the largest amount ever donated for this class, with $13,538 in contributions coming from 26.3 percent of the class. The Gift Committee members were: Philip Albert, Cynthia Atherton, Christopher Barrett, Walter Chen, Arthur Fortini, Maurice Hernandez, Wendy Hofius, Joseph Humphrey III, John Nugent, Jr., Russell Quong, Gregory Schenter, and Eric Sinn.

What could be more PC (President's Circle, that is) than paying a visit to Washington? And that's what members of the Associates' President's Circle did this past August when they embarked on a land and sea tour of the state of Washington's Olympic Peninsula and San Juan Islands, led by Emeritus Professor of Geology and Geophysics Clarence Allen. For good measure, they even brought a president along with them. Above: Doris and Tom Everhart (back seat), George Smith '44, PhD '52, and Robert Henigson '48, MS '49, cruise the waters off the San Juan Islands. Below: On the same excursion, Associates Stan and Mary Johnson soak up a few rays and a little zinc oxide.

The CAMPAIGN *for* CALTECH
A SECOND CENTURY OF DISCOVERY
OCTOBER 1993

Campaign Report

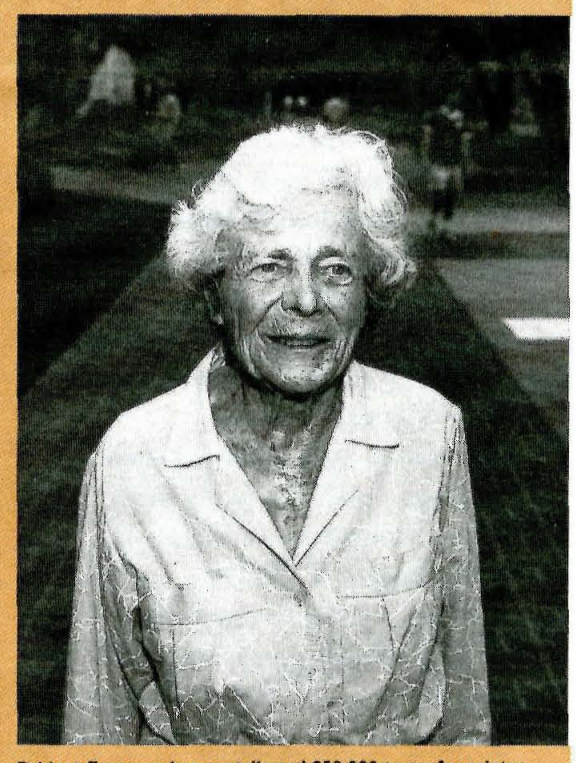
ASSOCIATES MOBILIZE TO ENDOW UNDERGRADUATE SCHOLARSHIPS

Sometimes raising money for scholarships at Caltech requires some inventiveness. Earlier this year, convinced that funds for undergraduate scholarships were a vital priority of the Campaign for Caltech, a group from the Associates of Caltech got together and devised an unprecedented plan that has generated highly successful results.

The plan basically called for individual members of the Associates to pool their resources, and as a result, they have established two undergraduate scholarships. Since June, when the plan for a group scholarship was unveiled, $675,000 has been raised for the Associates Endowed Undergraduate Scholarships.

"I'm quite pleased with the way things have gotten started," said George F. Smith, president of the Associates, an Institute support group that provides funds for research and educational programs. "In just a few months, 26 people responded and I'm sure there will be more."

Most of the Associates who participated in the program contributed $25,000 each, while one, Bridget Emerson, pledged $50,000. The others who participated are Laurel and Dr. Hubert Dubb, Miriam and Clayton Englar, Myrtle and William Harris, Beverly and Wayne Herzig, Margaret and George D. Jagels, Mary and J. Stanley Johnson, Bobbie and Ralph Jones, Helen Keeley, Shirley and Carl Larson, Doreen and Meyer Luskin, Ilene and Dr. J. Howard Marshall III, Elise Mudd Marvin, Nancy and Dr. Fred Morris, Joanna and Downie Muir III, Doris and Charles Pankow, Richard Parker, Deedee and Dr. Eberhardt Rechtin, Margaret and J. Randolph Richards, Pat and Dr. William Russell, Elizabeth Loucks Samson, Dorothy and Joseph Schirtzinger, Jean and Dr. George Smith, Elizabeth and Frank Whiting, Patricia and Dr. William Wright, and Robert Zurbach. Smith hopes that at least 13 more Associates will participate, so that they can create four endowed scholarships at $250,000 each.



Bridget Emerson has contributed $50,000 to an Associates drive to raise money for undergraduate scholarships. An artist, Emerson says, "Caltech generates a lot of enthusiasm for science – and that's contagious."

Members of the Associates have been among the strongest supporters of undergraduate education at Caltech, establishing 23 endowed scholarships over the years. They have also demonstrated their support through a program established in 1990 called Dollars for Scholars, which provides full and partial scholarships. That program provided $150,000 in scholarships during the last calendar year, as part of the $6.8 million that the Associates contributed to Caltech last year.

So far, the Campaign for Caltech has raised 44 endowed undergraduate scholarships out of the 60 needed. As the cost of a Caltech education has increased and federal assistance has dried up, scholarships have become increasingly important to attract the top high school students interested in science and engineering.

In the 1980 academic year, federal aid accounted for 46 percent of all undergraduate financial aid at Caltech, while the Institute contributed 41 percent from several sources, including gift income and endowment. Last year, the federal government provided only 21 percent of total aid, while Caltech's share was 74 percent.

The increase in funds from scholarships has not been enough to offset the dwindling share of federal aid, so Caltech has had to use money from its general fund to meet students' financial aid needs. Last year, 58 percent of Caltech undergraduates received need-based scholarships or grants at an average amount of $11,823.

"Coming up with the money to provide grant funds for undergraduates is getting increasingly difficult for Caltech to do," says Gary Lorden, vice president for student affairs. "The shortfall between endowment funds for scholarships and the money Caltech has had to come up with to supply undergraduate aid growth is over $4 million a year. That has been increasing at a faster rate than any other part of the Institute budget."

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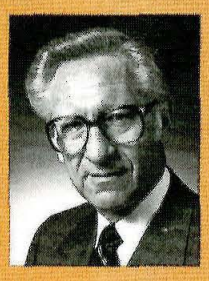
INSIDE

A MESSAGE FROM THE CAMPAIGN EXECUTIVE COMMITTEE



Total attainment to date for The Campaign for Caltech has topped our $350 million nominal goal. This is good news. The Campaign Executive Committee extends its heartfelt congratulations to the many Caltech alumni and friends whose personal generosity and volunteer efforts have helped make this possible. This is truly an achievement of which we can all be proud.

The bad news is that we are far from meeting the dollar goals for five areas of high academic priority. Because not all gifts to the Campaign were for projects included among the targeted academic objectives, we must still raise $32 million to meet the dollar goals for the following areas of need: endowment gifts for scholarships, graduate fellowships, postdoctoral research fellowships, research venture funds, and gifts for renewal of campus facilities.

These priorities are sufficiently important to Caltech's long-term success that we cannot declare victory for the Campaign unless these objectives are also met.

In the last year, through special efforts to raise endowment funds, Caltech's friends have proved that they can respond to the Institute's priorities, and that their response can have real impact. During that time, Caltech alumni and supporters contributed over $12 million for endowed scholarships, graduate fellowships, and postdoctoral fellowships, and almost $1 million in additional funds for current scholarship aid.

The Glanville Postdoctoral Fellowship, established in memory of my good friend and fellow trustee, Campaign Chairman James W. Glanville, was one result of those efforts. The Bechtel Graduate Fellowships, the Packard Foundation and Vincenti gifts for endowed student aid, and the Associates Endowed Undergraduate Scholarships are others.

To everyone who participated in these efforts, I extend heartfelt thanks. The final two months of the Campaign give every individual in Caltech's extended family an opportunity to step forward and be counted – either by making a first gift to the Campaign, or by adding to a previous Campaign commitment.

Caltech is blessed with a very loyal group of alumni and friends. Let us join together to make The Campaign for Caltech a success in every sense of the word.

For the Campaign Executive Committee
William F. Kieschnick
Vice Chairman
Caltech Board of Trustees

GLANVILLE POSTDOCTORAL FELLOWSHIP COMMEMORATES LATE CAMPAIGN CHAIRMAN

Caltech has received over $1 million in gifts and pledges to establish the James W. Glanville Postdoctoral Fellowship. Named after the Caltech alumnus and longtime trustee, who died last year, the fellowship will be assigned as needed among various disciplines at the discretion of Institute Provost Paul Jennings.

Glanville, a general partner in the Wall Street firm of Lazard Frères & Co., was serving as chairman of the Campaign for Caltech when he died of complications from injuries suffered in an automobile accident. Among his many positions at Caltech, Glanville was chairman of the Investment Committee, vice chairman of the Board of Trustees, and served on the Executive, Nominating, and JPL committees.

"Jim Glanville served Caltech with great distinction," said William F. Kieschnick, vice chairman of the Board of Trustees and chairman of the Campaign Executive Committee. "His tireless efforts are a major reason why the Campaign has met with such success."

Among the many projects Glanville supported were the Beckman Institute (for which he funded the Beckman Exhibit Room and the Glanville Courtyard), the McLean Brothers Scholarship Fund, the Harold Brown Professorship, and an Athenaeum renovation project. He also made numerous unrestricted gifts.

The idea to pay tribute to Glanville with a postdoctoral fellowship was conceived by a group of his friends and relatives, along with members of the Board of Trustees. Contributions to Caltech in Glanville's name were sent to the Institute even before the idea of a fellowship was established.

A Texas native, Glanville received his BS from Rice University in 1944, his MS from Caltech in 1946 and a Caltech Professional degree in 1948, all in chemical engineering. After working as a research and reservoir engineer for the Humble Oil Company for 10 years, he joined Lehman Brothers in 1959 as an associate in their petroleum, chemical, and natural resource industries department and became a general partner at Lehman Brothers in 1963. He moved to Lazard Frères in 1978.

Glanville's eldest son John, a Caltech construction manager, said his father would have been honored to have a fellowship named after him.

"My dad was a man of few words," Glanville said. "You just knew through his actions, the amount of time he dedicated to Caltech, and the amount of time he spent on the capital campaign that Caltech was right up there in his list of priorities."

James Glanville

CALTECH FELLOWSHIP AND SCHOLARSHIP DRIVE PICKS UP SPEED AS PACKARD FOUNDATION MAKES GIFT OF $1 MILLION

The David and Lucile Packard Foundation has donated $1 million to support the establishment of a graduate fellowship and undergraduate scholarship program at the Institute. The program will be named in honor of David and Lucile Packard. Mr. Packard is a co-founder of the electronics company Hewlett-Packard. He and his wife Lucile, who died in 1987, have long been generous supporters of education. The foundation awarded the support in response to a Campaign appeal for endowed scholarships and fellowships.

"David Packard and the Packard Foundation have shown their generosity to Caltech for many years," said Caltech's president Tom Everhart. "With the establishment of the David and Lucile Packard Foundation Endowed Fellowship and Scholarship Program, Caltech will be able to recruit some of the best undergraduate and graduate students. Combined with the Foundation's Fellowships in Science and Engineering program for young faculty, which includes seven Packard Fellows from the Caltech faculty, this grant will be helping to support our nation's next generation of young scientists and will facilitate some very exciting research at Caltech."

David Packard, a life member of the Caltech Associates, retired in September as chairman of the board of Hewlett-Packard Company. Caltech has benefited from millions of dollars in donations of electronics equipment from Hewlett-Packard over the years.

The David and Lucile Packard Foundation was created in 1964 to support and encourage organizations dependent on private funding and volunteer leadership. It makes grants for programs in the arts, community, marine biology, environment, population, education, and children's health.

GENE VINCENTI: HELPING TO NURTURE THE FUTURE

Longtime Pasadena resident Marion Gene Vincenti has donated nearly $1.6 million to Caltech to establish an endowed fund to support student aid. The gift will contribute to undergraduate scholarships, graduate fellowships, and postdoctoral research fellowships.

"My thought is to make college possible for kids who have the qualifications but don't quite have the money," said Vincenti, a member of the Associates of Caltech since 1971. "I found out there was such a need, so the fund meets the need."

Vincenti said that rather than restrict the fund to a particular division or discipline, she just wanted to support higher education.

"Gene Vincenti has been a friend to Caltech for many years, and we are deeply grateful for her latest gift," said President Tom Everhart. "The nature of the gift is particularly important, since without unrestricted scholarship and fellowship funds, many needy students would not be able to attend Caltech."

Vincenti and her late husband, Louis, the former president of Mutual Savings & Loan Association in Pasadena, joined the Associates in 1971 and were active for many years. Before then, however, Mrs. Vincenti would often visit Caltech while she was growing up in Altadena. As a teenager, she attended dances on campus. And her sister, who was secretary to the Institute's comptroller, occasionally invited her to lunch at the Athenaeum.

On one such occasion, as they were walking to the Athenaeum, she remembers seeing a man with wild white hair leaving the building. She recognized him at once as Albert Einstein.

As they were approaching Einstein, her sister told her that if he was in a good mood, he might say hello. Her sister stopped him and they talked for a while. Vincenti has never forgotten the meeting.

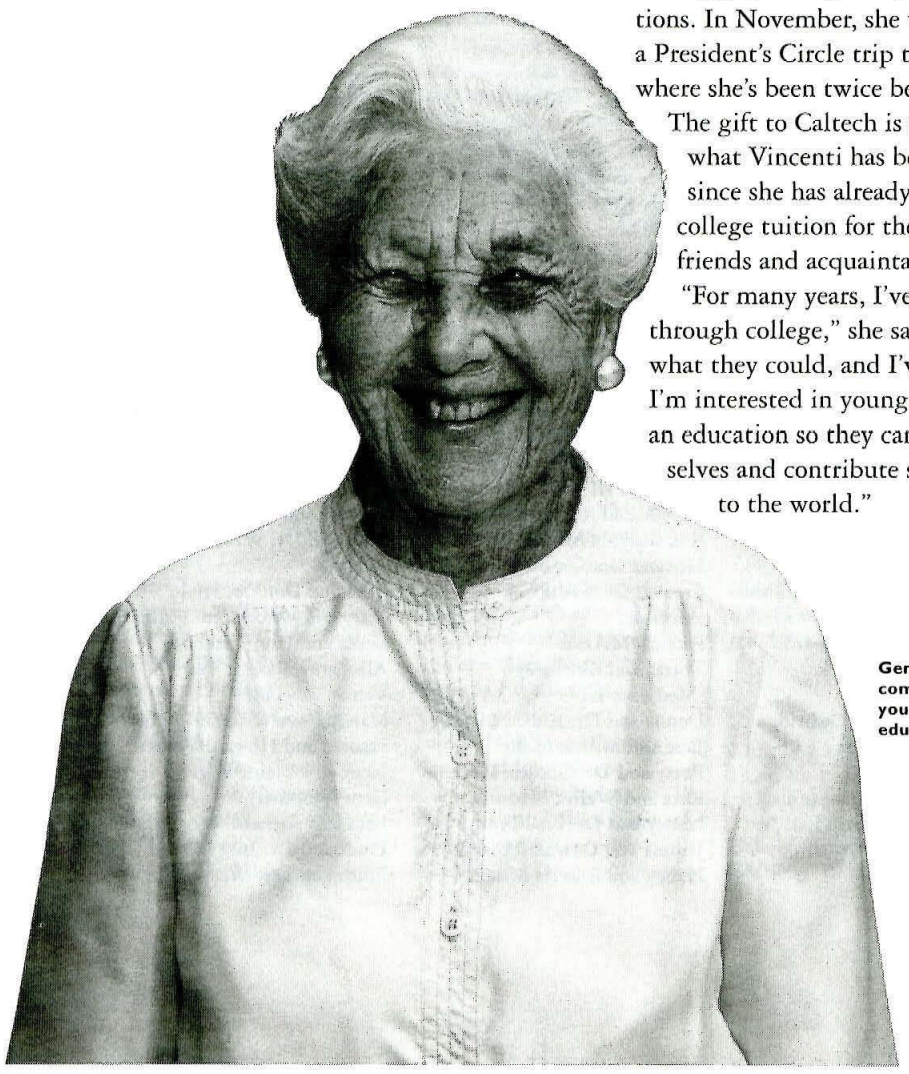
An avid gardener, with two greenhouses filled with orchids, Vincenti swims, reads three newspapers, and spends at least two hours on her investments every day. A contributing life member of the Associates and a member of the President's Circle, Vincenti is also an active traveler, having made trips to Vietnam, the North Pole, and Egypt, among many other destinations. In November, she went on a President's Circle trip to New Zealand, where she's been twice before.

The gift to Caltech is a continuation of what Vincenti has been doing for years, since she has already helped pay the college tuition for the children of several friends and acquaintances.

"For many years, I've put youngsters through college," she says. "They've paid what they could, and I've done the rest. I'm interested in young people getting an education so they can support themselves and contribute something to the world."

"For many years, I've put youngsters through college. They've paid what they could, and I've done the rest. I'm interested in young people getting an education so they can support themselves and contribute something to the world."

– Gene Vincenti



Gene Vincenti is committed to helping young people get an education.

BECHTELS MAKE GIFT OF TWO GRADUATE FELLOWSHIPS

Mr. and Mrs. S. D. Bechtel, Jr., have established two endowed graduate fellowships in engineering at Caltech. Named after the international engineering and construction firm, of which Bechtel is chairman emeritus, the Bechtel Graduate Fellowships in Engineering are intended to support high-potential engineering graduate students, with a preference for women and African Americans.

As the Campaign for Caltech has neared its conclusion, the areas most in need of funding are undergraduate scholarships and graduate and postdoctoral fellowships. The gift from Mr. and Mrs. Bechtel was a direct response to an appeal to Caltech's trustees by William Kieschnick, chairman of the Campaign Executive Committee, urging them to support scholarships and fellowships.

"Endowed funds for student aid continue to be one of Caltech's greatest needs, and we are gratified that the Bechtels have responded to this particular appeal," said President Tom Everhart. "We are honored to have the Bechtel name associated with fellowships in engineering at Caltech, as well as other areas of the Institute."

Stephen D. Bechtel, Jr., has served Caltech for many years. Named to the Board of Trustees in 1967, he is also a member of the Campaign Executive Committee and the Buildings and Grounds Committee. He and Mrs. Bechtel are life members of the Associates of Caltech and members of the President's Circle.

John Seinfeld, chairman of the Division of Engineering and Applied Science, said that having the Bechtel Fellowships will help the division attract the nation's top graduate students in engineering. He said that the division is currently considering candidates for the Bechtel Fellowships.

"Endowed funds for student aid continue to be one of Caltech's greatest needs, and we are gratified that the Bechtels have responded to this particular appeal," said President Tom Everhart.

NEW TAX LAW "FRIENDLY" TO POTENTIAL CAMPAIGN CONTRIBUTORS

Individuals who have been contemplating a gift to Caltech may have several additional reasons to give this year due to provisions of the new 1993 tax law.

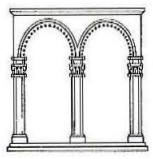
"With the new tax law, a gift to The Campaign for Caltech could bring significant tax benefits to the donor," says Tom Smith, Caltech's director of gift and estate planning. "A number of people we have talked to have cited higher tax rates and the elimination of the alternative minimum tax for gifts of appreciated property as additional reasons for making a gift before December 31."

As a rule of thumb, the larger the gift, the more significant the tax benefits are likely to be. A brochure available from the Caltech Office of Gift and Estate Planning explains these potential benefits in more detail. While Smith cautions that everyone's situation is different and suggests that individuals consult with their own tax advisors before making a significant gift, he says, "We're here to help, and we're always happy to talk to people who are thinking about supporting the Institute."

For further information about making a gift to Caltech, or to request the brochure mentioned above, contact the Office of Gift and Estate Planning at 818/395-2927.

1992-1993 HONOR ROLL

Caltech takes this opportunity to thank all of the many individuals who have supported its programs this past year. In particular, we wish to recognize the following groups of individual donors who have made contributions during the period July 1, 1992, through June 30, 1993.



THE ASSOCIATES

Members of the Associates who have made contributions of $6,000 or more in a given year are recognized as members of the President's Circle.

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Ivo Tammaru
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Glenn E. Thomas
A. E. Thompson
Thomas A. Tisch
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Alvin W. Trivelpiece
Arthur P. Turner
Sze-Hoi H. Tye
Harris E. Ulery
Mabry Van Reed
Vito A. Vanoni
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Hugh F. Warner
John C. Warren
John Watson
Ralph M. Watson
Frank E. Weagant
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Martin E. Weiner
LeRoy A. Weller
Joseph F. Westheimer
William M. Whitney
Robert H. Widmer
Richard R. Williams
Lawrence A. Wise

Edgar Y. Wong
Shu K. Wong
Homer J. Wood
Eric J. Woodbury
Dale A. Woodford
Kenneth T. Yano
Huan-Wun Yen
Clyde S. Zaidins
Keirn Zebb

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G. L. Hatch
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Hisayuki Kurihara
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Warren Y. Lai
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Lou-Chuang Lee
Yuan C. Lee
J. A. Leermakers
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Jack E. Leonard
Murray L. Lesser
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Roy N. Levitch
John E. Lewis
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Gerald Lippey
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David M. MacKenzie
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Harry H. Miller
Maurice E. Miller
Wendell B. Miller
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Charles P. Moeller
Douglas M. Moody
James M. Moore
John D. Moore
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Merle L. Morgan
William R. Muehlberger
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Glenn D. Prestwich
Werner H. Pyka
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Mark S. Radomski
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Eli Reshotko
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Mark A. Satterthwaite
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Robert E. Schenter
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Louis V. Schmidt
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Edward A. Schroeder
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Conway W. Snyder
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Terry W. Spencer
John D. Spikes
Sankaran Srinivas
James M. Stana
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Lawrence D. Starr
Alan R. Stearns
Jean B. Stevens
John A. Stevenson
Stanford G. Stiles
Gary P. Stockinger
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Leo Stoolman
Roger P. Stout
Catherine D. Strader
William C. Straka
Paul B. Streckewald
William N. Sullivan
Richard F. Sunseri
Stephen B. Sunshine
Jean H. Swank
Donald H. Sweet
Francesco Tamanini
Sanford Tandowsky
Fan-Chia Tao
Timothy J. Tardiff
Dean D. Taylor
James J. Taylor
Robert W. Taylor
Jonathan M. Teich
Jack Tielrooy
Paul O. Tilker
Alvin V. Tollestrup
Ivar H. Tombach
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Richard R. Tracy
Payson S. Tseu
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David P. Turner
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S. R. Varanasi
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Janis Vasilevskis
Eric P. Verheiden
Alwar Vijayaraghavan
Thomas Vrebalovich
Edwin P. Wald
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Richard A. Wallace
Don L. Walter
Chiun Wang
Duen-Pao Wang
Run-Han Wang
Jerry D. Ward
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Willes H. Weber
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G. B. Welch
Robert L. Wells
Jerard B. Werner
John W. Wesner
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Andrew B. White
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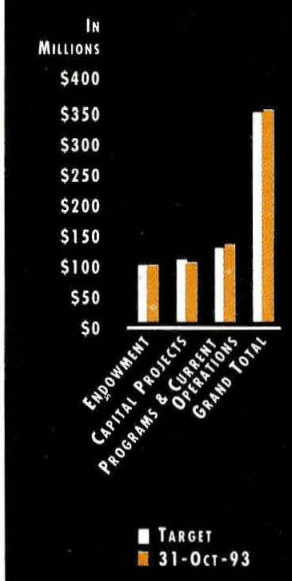
Albert C. Yen
Ajit P. Yoganathan

** *Indicates an Honorary Member of the Alumni Association*

CAMPAIGN ATTAINMENT AT $353 MILLION

With three months to go before its conclusion on December 31, The Campaign for Caltech has reached an overall attainment of $353 million in cash and pledges. The distribution of campaign commitments by purpose among endowment, capital funds, and programs and current operations is shown below.



ASSOCIATES SCHOLARSHIPS

(Continued from Cover)

Since admission to Caltech is based on students' academic ability rather than their financial background, requiring students and their families to contribute more toward tuition and expenses would change the quality of the student body. The Associates have been quick to realize the importance of undergraduate scholarships in maintaining the high caliber of Caltech's undergraduates.

"I've been impressed with how responsive the Associates have been when they see how difficult it is for undergraduates," Lorden says. Through the endowed scholarship fund, "the Associates really have found something to keep Caltech affordable for the best students in the world."

Joanna Muir, a past president of the Associates, conceived of the idea for a pooled Associates' scholarship earlier this year as a complement to efforts to raise funds for postdoctoral fellowships, graduate fellowships, and undergraduate scholarships from individual Associates as part of the Campaign for Caltech. "I just thought it was a practical idea," says Muir. "It seemed that if we could divide a scholarship into five or ten increments, there might be a number of persons who would be willing to contribute at a time when dollars are rather precious."

Muir discussed her idea with a small group of Associates, including Smith and past Associates' president Robert Henigson, who figured that there were many Associates who would want to contribute to a joint effort to fund a fellowship or scholarship.

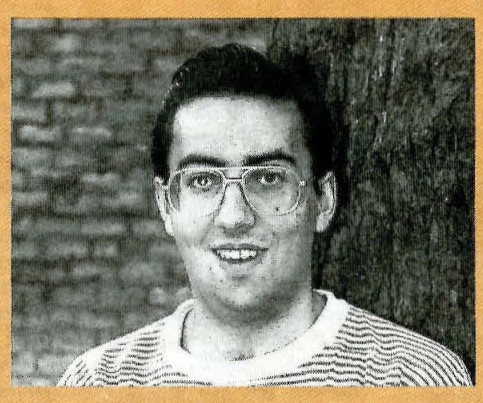
"We thought that maybe if we got together as a group, we could help the scholarship and fellowship part of the Campaign," Smith said. He figured that if at least ten people could be found willing to provide $25,000 each, at least one Caltech endowed scholarship could be established. When 21 responded within the first month, Smith and the group that planned the scholarship set their sights on 40. They hope that at least ten will come from the San Francisco Bay area, so that a separate endowment funded by Associates from Northern California can be created.

Smith has a personal interest in undergraduate scholarships, since, as a Caltech undergraduate in the 1940s (he also has an MS and a PhD from the Institute), he received a scholarship.

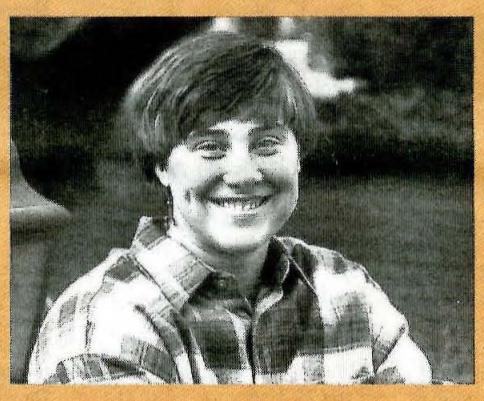
"I strongly endorse the idea that a student should not be denied the benefits of a Caltech education if qualified but unable to meet the financial requirements," Smith said. With a total Campaign goal of $15 million in endowed scholarships, "even if we get $1 million, we're not going to make up all the difference, but at least it will help."

SCHOLARSHIPS HELPED LAUNCH THESE CALTECH STUDENTS

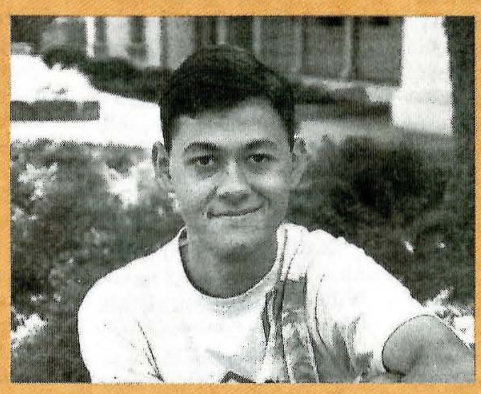
For many Caltech students, scholarship aid is the difference between being able and not being able to attend the Institute. More than half of all Caltech undergraduates, including the four shown here, currently receive some form of scholarship support.



Robert Fisher, the Naozo and Tsuki Kashiwabara Scholar, is a senior physics major from Northlake, Illinois. Fisher says he plans to continue his education in graduate school, studying theoretical physics. "The power of ideas and insight into nature," Fisher says, is what attracts him to the discipline. Fisher recently published his first paper, in which he reported on the properties of fragmentation and evaporation of metal clusters. The research, which he conducted through computer simulations, could have applications to the study of interstellar dust grains, Fisher says.



Jasmine Anderson has wanted to be a chemist ever since she got a chemistry set while growing up in North Hollywood. The Gordon and Betty Moore Scholar, Anderson is a junior chemistry major who recently assisted Associate Professor of Chemistry Andy Myers on the synthesis of an anti-tumor drug. "I worked on a small part of a large molecule," says Anderson, whose role was to prevent unwanted reactions from occurring during the synthesis process. Anderson, who plans to do graduate work in chemistry in preparation for a teaching career, says, "I wouldn't be at Caltech if it wasn't for the scholarship I have."



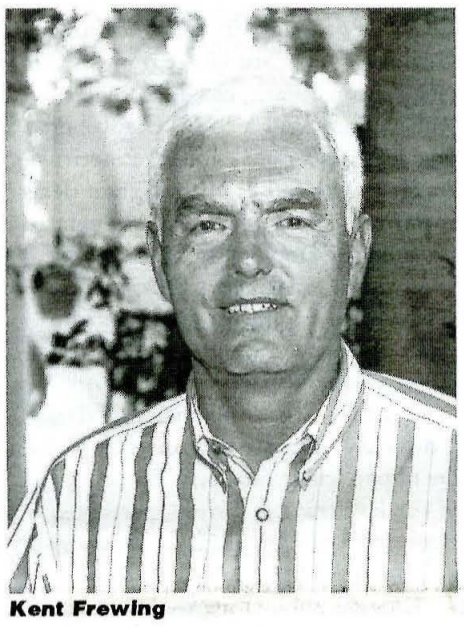
A junior majoring in physics, Anthony Gonzalez hopes to pursue a career in astronomy or physics. The Richard E. Springer Scholar, Gonzalez recently completed a Summer Undergraduate Research Fellowship at the Jet Propulsion Laboratory. A native of Key Largo, Florida, Gonzalez spent the summer using computer techniques to process hundreds of infrared images taken of a cluster of galaxies from the Kitt Peak Observatory. "It was interesting and fun," Gonzalez says of his research work.

When Jennifer Cato was growing up in Jacksonville, Florida, her father, who works for General Motors, would bring her brochures with pictures of the latest automobile models and photographs of prototypes. Now a junior majoring in engineering and applied science, Cato is studying aerodynamics and fluid mechanics so she can become an automotive designer. "I'd love to get out there, get a job, and get hands-on experience," says Cato, the Max Beeler Alcorn and Ruth Brown Alcorn Scholar. "It would be ideal to design automobiles."

Writer:
Michael Rogers

Kent Frewing new Annual Fund chair

Caltech's Annual Fund has a new chairman—Kent Frewing '61. A senior member of JPL's technical staff and a Fund volunteer since the early 1970s, Frewing succeeds Stan Holditch



Kent Frewing

'48, who's been chairman since 1985.

As Annual Fund chairman, Holditch presided over fund-raising efforts that succeeded in raising close to $12.5 million in contributions during the last six years. Frewing says he looks forward to building on that strong record, adding that, "Fund-raising, friend-raising, and volunteer-raising will be our motto." Among his goals for the coming year: maintaining the strength of the volunteer program; developing new programs that will be equally effective in helping the fund continue to grow; and increasing the level of alumni involvement

Frewing's own association with the Annual Fund dates back to one memorable evening in the early 1970s when he agreed to help man an Institute fund-raising phone bank set up in Sears, Alhambra. He had such a good time talking to and working with alumni all around the country that he decided to keep on doing it, soliciting contributions for JPL under the direction of Kirk Dawson '61, MS '62, and Ray Heacock '52, MS '53, and then serving as reunion chair for the class of 1961 in 1991. In 1992–93 he was reunion chair for all class gifts.

Frewing, who received his BS from Caltech in engineering, holds an MS in electrical engineering from Stanford, and a law degree from Santa Clara University. At JPL, where he's been a staff member since 1967, he has worked as a system engineer for the Mariner, Voyager, Magellan, and Mars Observer missions, as well as playing an active role in the lab's total quality management and professional development programs. In his spare time he teaches as an adjunct associate professor in the USC Master of Science in Systems Management Program.

Physics

Continued from page 5

netic fields, superconductors come in two varieties, known for bookkeeping purposes as type 1 and type 2. Throw a magnetic field around a type-1 superconductor, and the result is a zero-sum game. If the field is weak, the superconducting material expels it and continues to superconduct. If the field is strong, it overwhelms the material and destroys its superconductivity. The changeover from one state to the other—physicists call it the "phase transition"—is extremely abrupt.

From an applications standpoint, type-1 superconductors aren't of much use, since even a fairly modest magnetic field can put them permanently out of business. Yeh studies type-2 superconductors, whose behavior in a magnetic field is altogether more exotic and, from a physicist's or engineer's standpoint, considerably more interesting. Type-2 superconductors also expel a weak magnetic field. But once a field's strength increases beyond the point where it can be expelled, type-2 materials undergo a more gradual phase transition than the type 1s—an interval in which they don't immediately lose all their superconductivity. Instead, as it's penetrated by the discrete flux lines of the encroaching magnetic field, a type-2 superconductor generates a kind of protective net. This takes the form of whirlpools of current, or "vortices," that trap the magnetic flux lines at localized points and shield the rest of the superconductor, so that, for a while at least, it can continue to function. Known in the trade as a vortex-solid state, this phenomenon persists as long as the vortices and their captive flux lines remain immobilized, either because the very low temperatures in which they're obliged to operate freeze them into position, or because "pinning centers," engendered by defects in the superconducting material, hold them in place. How does the superconductor "know" the precise type of arrangement that's needed to contain the magnetic field lines, and what determines its ability to withstand that field? These are among the questions Yeh is trying to answer.

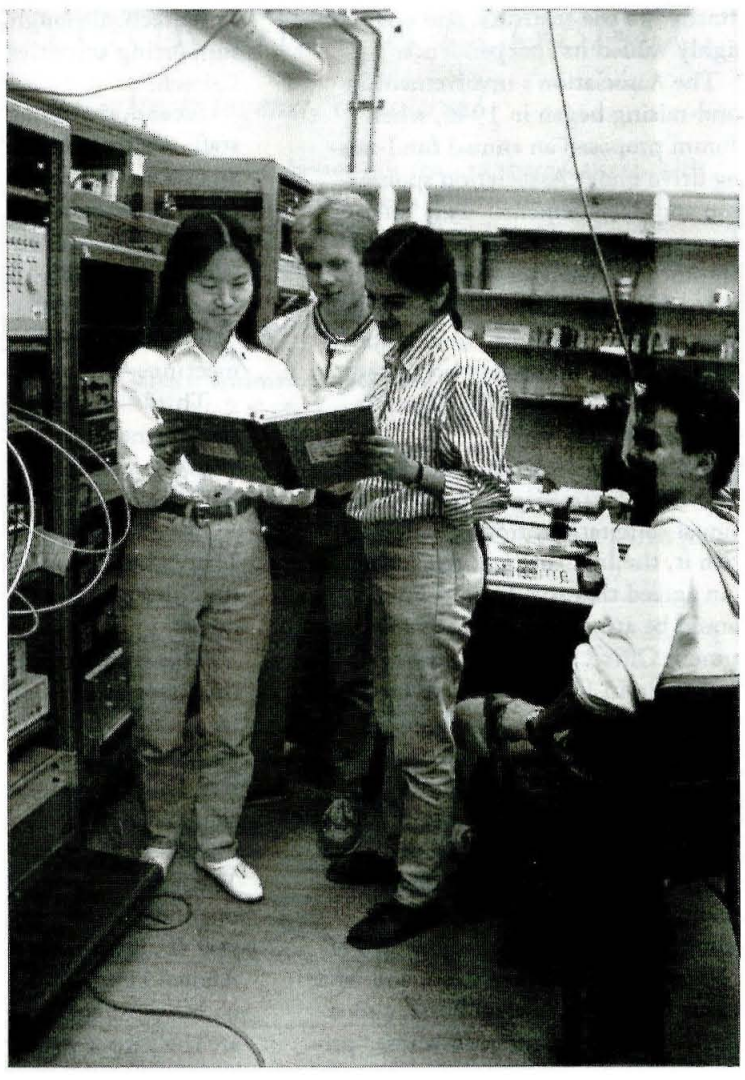
"Ultimately," she says, "I'd like to use that information to prolong the superconducting vortex-solid phase so that the superconductor can withstand an increasingly strong magnetic field and continue to work."

Yeh's research into vortex dynamics has taken on a new dimension with the discovery (in 1987) of high-temperature superconductors. For reasons still unknown, these materials can operate at much higher temperatures (in some cases, up to about 120 kelvins,) than their conventional counterparts and they respond in an equally intriguing way to magnetic fields. Like low-temperature superconductors, the high-temperature materials generate vortices to trap magnetic flux lines, but their ability to function at higher temperatures means that the previously frozen vortices have a chance to thaw out. The vortices begin to behave like spaghetti noodles set on simmer—they lose their rigidity and, in Yeh's words, "start to meander." Given enough heat and enough meandering vortices, the superconductor undergoes a "melting transition" from a vortex solid into a vortex liquid, a state in which, in a sense, it both is and is not superconducting. "One of the most interesting things we've found," says Yeh, "is that the vortex-liquid retains some degree of superconductivity, although technically, it's no longer a superconductor."

Yeh is investigating how this phenomenon works and how it might be exploited in engineering and research settings. "There are a number of other questions that interest me here," she says. "Does the changeover from vortex-solid to vortex-liquid occur as a phase transition? If so, is the change essentially instantaneous as in the type-1 superconductors, or more gradual, as in the type 2? If we can understand what controls the dynamics of the change, maybe we can learn to manipulate it so that we can prolong the superconductivity."

Dealing with unusual phenomena, Yeh isn't shy about raising unusual issues. Barely out of graduate school, she became the first in her research field to suggest that the best way to approach the mystery of vortex dynamics (specifically how trapped magnetic field lines in superconductors affect the dynamics of electron transport and magnetic properties) was to study the problem over a broad frequency range. At the time, the theories and tools needed to carry out this type of systematic investigation did not exist, so Yeh, then a postdoc at the IBM J. Thomas Watson Center in New York, proceeded to invent a number of them. At Caltech, the innovative approach she and her research team have taken has opened new avenues of investigation and inspired similar research efforts elsewhere. "At Caltech, we were the first to develop probes that can operate over a very broad frequency range, from DC to microwave frequencies. And that, of course, opens a much larger window onto the dynamics and properties of the materials we're studying."

A native of Taiwan, Yeh became interested in her line of research while she was a graduate student at MIT. "What especially appeals to me about this field," she says, "is that, while the problems are very complicated, they don't require a huge facility or a large team of researchers, as is the case with many areas of experimental physics. I can also do both theoretical and experimental work, which really intrigues me." At Caltech, the Packard award has supplied some of the funding Yeh has needed both to support her research group and to set up a state-of-the-art research facility. As with most research in experimental physics, the start-up phase has been pretty costly. "I have a lot of material expenses," says Yeh, who also admits, a bit ruefully, to working "terribly hard." But she has no doubt that the reward is worth the heavy investment. "I look forward to the day when engineers and scientists can use our research to address design and conceptual problems," Yeh says. "But first to solve these problems, we need to understand the fundamental principles."



Assistant Professor of Physics Nai-Chang Yeh and members of her research team study the results of the latest series of experiments run on the instrument at left, a high-frequency oscilloscope for measuring the quality of superconductors at microwave frequencies. Left to right, Yeh, physics graduate students Dan Reed and Ushma Kriplani, and (seated) senior Tony Fong.

ALUMNI

Alumni Association has a unique past, plays an important role

By Bill Whitney '51

Readers of this column may remember that, in the previous issue of *Caltech News* (August 1993), I set out in some detail the relationship between Caltech, the Alumni Association, and the Annual Fund, and promised to say more on this subject as the year went on. The relationship has some unusual features that set us apart from many other alumni groups, and I would like to discuss them here.

Caltech's alumni association can trace its origins to an organization founded by graduates of Throop University in 1897. While the initial motivation was social, there was a strong component of service that rapidly grew in emphasis and diversity, especially after Throop became Caltech, and the alumni saw that their reinvented and ambitious alma mater could benefit from their involvement.

Over the years, the efforts of the Association and its members to serve the interests of the Institute, its students, and its graduates have been innovative and broad in scope. These efforts have had an impact on student recruiting, scholarships, job placement, and the social and cultural environment. Alumni were kept in close touch with the Institute through the introduction of Alumni Seminar Day, the *Alumni Review* (later to become *Engineering & Science*), and an alumni directory. All the above activities (and others not mentioned) were introduced and accomplished through volunteer labor, by an organization not formally attached to the Institute, and one that highly valued its independence.

The Association's involvement in fund-raising began in 1946, when alumni proposed an annual fund-raising drive under Association sponsorship and management. This concept was put into practice in 1948 as the Alumni Fund, and an Alumni Fund Council was later established to provide management oversight. One of the Fund's significant early achievements was the completion of the Alumni Swimming Pool.

In 1958, Caltech announced a major fund-raising campaign. To keep the annual solicitations from interfering with it, the Institute and the Association agreed that the Alumni Fund should be attached to Caltech's Development Office. The same strategy was used again in 1966, when the Institute embarked on another campaign. That year the Association and the Institute formed a group to propose long-range guidelines for their relationship. The result was the first of two predecessors to the 1983 Trilateral Agreement (discussed in the August *Caltech News*), defining the roles and relationships of the Institute, the Association, and what is now called the Annual Fund, a separate volunteer organization whose "primary purpose is to raise money for the Institute by means of annual solicitation of alumni."

Here are what strike many of us as the most interesting and unusual features of this relationship:

First, our Alumni Association is not the adjunct of a development office, as is the case at so many other universities. It is an independent corporation of the state of California, responsible for its own governance, and with its own income (namely, dues from life and annual members). Consequently, alumni who join the Association and pay their dues are not, by that act alone, making financial contributions

Bill Whitney

to Caltech, although they are certainly supporting activities that benefit Caltech.

Second, the Association has no paid staff. Caltech, from its funds, pays for an executive director and staff to support Association initiatives, and covers other expenses, such as the costs of editing and publishing *E&S* and *Caltech News*. Caltech also provides a building (Alumni House) for Association offices, meetings, and other activities.

Third—and here is perhaps the most significant departure from the practices of many other alumni groups—the Association has no explicit responsibility for soliciting alumni contributions. That is the role of the Annual Fund, the third party in the Trilateral Agreement.

This third feature has a downside for the Association. Some people unfamiliar with our history, upon learning that we have no fund-raising responsibilities, falsely conclude that the Association and Association members have no interest or involvement in fund-raising. The fact is that hundreds of Association members volunteer their services each year to support the activities of the Annual Fund. While the Association no longer manages the fund drive, we are the primary source of volunteers to do the actual solicitation, under the direction of the professional staff of the Fund and the oversight of the Annual Fund Council.

The role of the Association in fund-raising is analogous to our role in recruiting applicants for admission. We provide a volunteer work force of more than 300 Alumni Admissions Representatives. Under the direction of Carole Snow, Caltech's director of undergraduate admissions, they establish relationships with high schools throughout the country and directly recruit applicants. The two roles differ in that we do not have organizational responsibility for recruiting volunteers for the Fund, although the elaborate network of Association member alumni contacts and 14 Association chapters is at the disposal of the Fund.

In revisiting the Trilateral Agreement, up for renewal this fiscal year, one of our goals will be to ensure that the Association's role in fund-raising is clarified, and its strong support for such activities is reaffirmed. We aim to accomplish this objective without in any way jeopardizing the Association's independence, which we value highly, and without deemphasizing the many other activities, not directly connected with fund-raising, that occupy such a large portion of time on the part of our staff and our board of directors, and that draw such enthusiastic and imaginative support from our members.

In putting together the above story, I have drawn heavily from "Caltech Alumni and Their Association," a personal history being written by Ted Combs '27, which will eventually be made available to interested alumni through the publications committee of the Association. I am also indebted to Arlana Bostrom and Judy Amis for additional help with chronology and events. I welcome comments from alumni (or others) who have ideas to add or corrections to make to the above material.

Act now to reserve spot on travel/study tour of Glacier National Park

Yes, it's the announcement for which many of you have been waiting! Be a part of the Alumni Association's Geology Travel/Study Program in Glacier National Park, to be led by Dr. Robert Sharp '34 MS '35, the Robert P. Sharp Professor of Geology, Emeritus. As Sharp explains, "The program deals specifically with geological and related phenomena graphically displayed in Glacier National Park. Special consideration will be given to the stratigraphy of formations within the Belt Super Group, especially the environment and mode of deposition of these sediments. The stromatolitic deposits are of particular interest. Evolution of the landscape features—particularly the role played by glaciers—is given much attention."

The trip, which begins and ends in Missoula, Montana, is scheduled for June 25–30, 1994. The cost is $950 per person, double occupancy, and $1,150 per person, single occupancy, which includes all accommodations, transportation, and meals while with the group. The cost of airfare to and from Montana is not included.

If this special opportunity sounds enticing, don't delay: complete and return the form below, with your deposit check, as there will be room for only 40 lucky participants on this visit to some of the most magnificently scenic vistas in America. If more than 40 responses are received, a lottery drawing will be held on December 15 to determine participation. A detailed description of the program will then be sent to all those taking the trip. Don't miss this unique educational opportunity! If you have any questions, please call Helen Shafran, assistant director for programs, at (818) 395-8364.

CALTECH ALUMNI ASSOCIATION
Glacier National Park Travel/ Study Program, June 25–30, 1994

REGISTRATION FORM

I/we wish to participate in the Alumni Association's travel /study program in Glacier National Park. Enclosed is my deposit check for $ _____ , representing _____ persons at $200.00 per person.

Name: _____

Address: _____

Phone (home): _____ (business) _____

Please make check payable to Caltech Alumni Association, and return with this form to Caltech Alumni Association, Mail Code 1-97, Pasadena, CA 91125

REUNION CALENDAR

May 19, *Class of 1944, 50th Reunion Dinner*, the Athenaeum.

May 19, *CAVU Class of 1944, 50th Reunion Dinner*, the Athenaeum.

May 20, *Half Century Club Reception and Luncheon*, the Athenaeum.

May 20, *Class of 1949, 45th Reunion Dinner*, the Athenaeum.

May 20, *Class of 1954, 40th Reunion Dinner*, the Athenaeum.

May 20, *Class of 1969, 25th Reunion Dinner*, the Athenaeum.

May 20, *Class of 1974, 20th Reunion Dinner*, the Athenaeum.

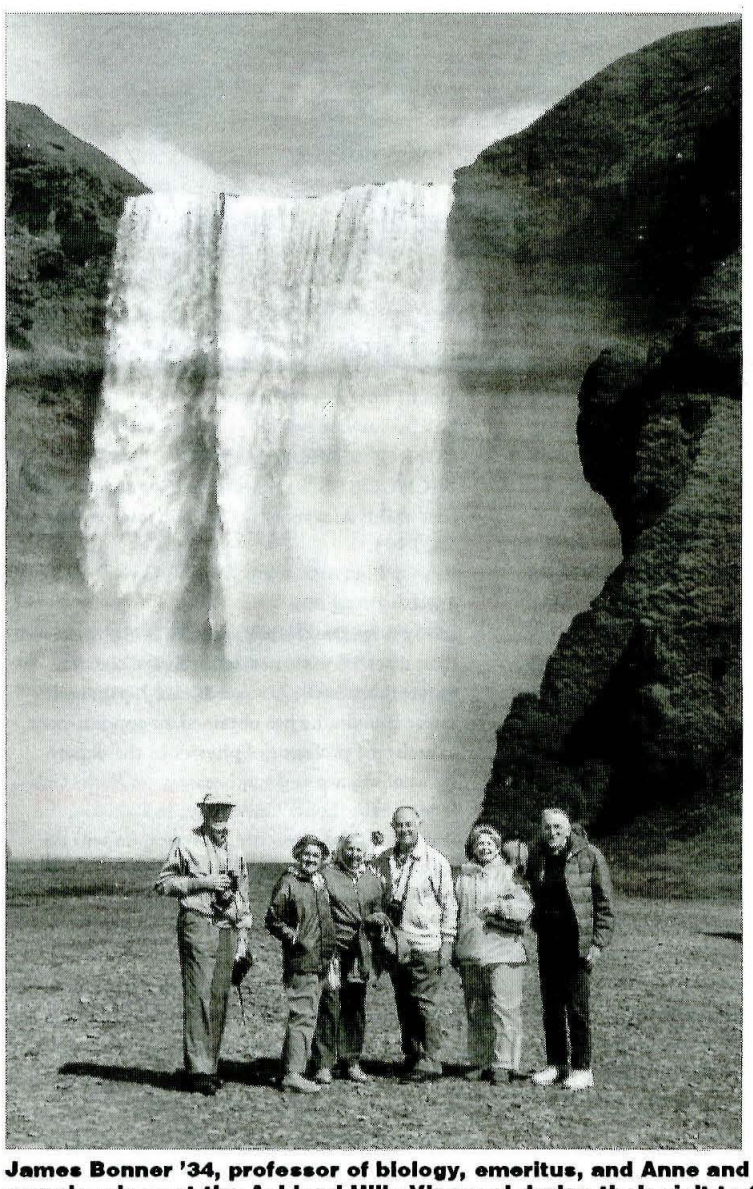
May 21, *57th Annual Alumni Seminar Day and Dinner*, on the Caltech campus.

May 21, *Class of 1959, 35th Reunion Dinner*, the Athenaeum.

May 21, *Class of 1964, 30th Reunion Dinner*, the Athenaeum.

May 21, *Class of 1984, 10th Reunion Dinner*, the Athenaeum.

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



Water, water, everywhere, but much too cold to drink! From left Raymond and Carolyn Emrich, Ruth Siechert, Paul Siechert '38, Peggy Wright, and Ham Wright, PhD '48, got a good look at one of Iceland's raging waters when they visited the Skógafoss Waterfall in July. They were part of a group of 42 who took part in the Association's second travel/study excursion through the geologic, volcanic, and geothermal vistas of Iceland.

James Bonner '34, professor of biology, emeritus, and Anne and Milt Andres '49 sample wines at the Ashland Hills Vineyard during their visit to Oregon as part of the Association's second Ashland Shakespeare Festival travel/study program.

ALUMNI ACTIVITIES

November 11, *Santa Cruz Area Monthly Luncheon*, Peachwood's at Pasatiempo Inn, noon. For reservations, call Bob Shacklett at (408) 722-6021. The next lunch will be held December 9.

November 13, *Santa Barbara/Ventura Counties Alumni Day Trip*, with Bob Sharp, Sharp Professor of Geology, Emeritus.

November 16, *San Francisco Chapter Dinner/Meeting*, with Yu-Chong Tai, assistant professor of electrical engineering.

November 18, *San Francisco Peninsula Monthly Luncheon*, Ming's Restaurant, Palo Alto, noon. For reservations call Hugh Dubb at (415) 362-3800 or (408) 773- 9100. The next lunch will be held December 16.

November 18, *Colorado Chapter Meeting*, with Garret Moddel, associate professor of electrical engineering, University of Colorado, Boulder.

November 18, *Washington, D. C., Chapter Dinner/Meeting*, with Judith Goodstein, Institute archivist and faculty associate in history.

November 22, *Boston Chapter Meeting*, with Professor Farouk el-Baz, Center for Remote Sensing, Boston University.

November 30 and December 1, *Phoenix/Tucson Chapter Dinner/Meetings*, with Robert Staehle, senior research scientist, JPL.

December 14, *Seattle Chapter Dinner/ Meeting*, with Lee Hood, professor and chairman, Department of Molecular Biotechnology, University of Washington School of Medicine.

January 1, 1994, *Tournament of Roses Parade Event*.

February 10, *Tri-State Chapter Dinner/ Meeting*, with Elliot Meyerowitz, professor of biology.

February 13–27, *Guatemala Travel/ Study Program*, led by Bill Schaefer, senior research associate in chemistry.

February 17, 1994, *San Francisco Chapter Dinner/ Meeting*. Rey Gomez, president and CEO of Terrapin, will speak on "Discovering and Developing Human Pharmaceuticals."

April 22, *Tri-State Chapter Dinner/ Meeting*, with Harry Gray, Arnold O. Beckman Professor of Chemistry and director of the Beckman Institute.

June 25–30, *Glacier National Park Travel/Study Program*, led by Bob Sharp, Sharp Professor of Geology, Emeritus.

For information, contact Arlana Bostrom for chapter events, (818) 395-8363; Patsy Gougeon for Seminar Day/ Reunions, (818) 395-8366; and Helen Shafran for travel/study and local programs (818) 395-8364.

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 _____

Name _____
(please print)

Address _____

City _____ State _____ Zip _____

Daytime phone _____

PERSONALS

1925
MARKHAM E. SALSBURY writes, "This October marks a milestone for me—my ninetieth birthday. I don't know how many more anniversaries I'll have, but I am thankful for each one. Soon after graduation I went to work for the Los Angeles County Engineer. In 1927 I shifted to the Los Angeles County Flood Control District, worked up through the ranks and retired as Chief Engineer in 1965. The work was varied and interesting. We dealt with river improvements, reservoirs, storm-drain systems and provisions for conservation of flood waters. In 1930–31 I was president of the Alumni Association. It was small then and didn't have near the clout that it has today. I am a member of the Gnome Club and still attend its Founders' Day meetings in March. My wife and I moved from Pasadena to Fallbrook seventeen years ago. We have a small avocado grove, a few citrus trees and a 'kitchen garden' that keep us busy and supplied with fresh produce. We are healthy and active and still love to travel. We have pretty well covered the world but now we confine ourselves to visiting family and friends in the western half of the U.S."

1943
FREDERICK W. BOLLINGER, MS, of Westfield, New Jersey, reports that he lectured at the University of Kaiserslautern, Kaiserslautern, Germany, on May 28, on the subject of diazotransfer reagents.

1945
MERLE G. WAUGH and his wife, Dorothy, write with the sad news that their son, Thomas, was shot and killed in a Boston subway station, March 15, 1992. They are "interested in gun control and ideas for curbing violence rampant in the U.S."

1946
ALI B. ÇAMBEL, MS, professor emeritus of engineering and applied science at the George Washington University, in Washington, D.C., has had his book *Applied Chaos Theory—A Paradigm for Complexity* published by Academic Press, Inc. "It is an intermediate level and interdisciplinary text," he writes. "The emphasis is on applications and the interpretation of equations rather than on their derivations. It deals with physical, life, and social sciences."

1961
ROBERT M. RUBY, of Atlanta, Georgia, writes, "After 29 years with IBM in a variety of marketing positions, I've taken early retirement. I am making a mid-life career change and have become an agent for Northwestern Mutual Life."

1963
JEN-SHIH LEE, MS, PhD '66, of Charlottesville, Virginia, and chairman of the department of biomedical engineering at the University of Virginia, has been named a Fellow of the American Society of Mechanical Engineers.

1965
JERRY NELSON, project scientist for the W. M. Keck Observatory, has been named the winner of one of the annual DISCOVER Awards for Technological Innovation, which are given by *Discover* magazine. He was cited for his innovations and leadership in developing and completing the Hawaii-based Keck Telescope, which comprises 36 individual mirror segments computer controlled to function as a single 10-meter mirror.

Josiah Smith ('39, MS '40, Eng '48), retired aerospace engineer and athlete extraordinaire, made his way through Caltech in leaps and bounds and recently did the same in the National Senior Olympics. Smith raced to a fourth-place finish in the 800-meter run at the 1993 national competition, which was held in Baton Rouge, Louisiana. Competing in the 75–79 age group, Smith's time was 3 minutes and 38.6 seconds. In his second event of the Olympics, Smith's long jump of almost 10 feet was captured on film by his son-in-law, Greg Asbury, of Altadena. In past years, Smith set a regional long-jumping record of 10 feet, 4 3/4 inches, as well as a handful of running records, in the Northern Virginia Senior Olympics. It's hard to believe he's only been in training for the last four years. For a full 50 years before that, his exercise consisted of yard work, including climbing trees. But at Caltech, he played football and was a three-year varsity letterman in track.

Photo by Greg Asbury

1966
PAUL G. RICHARDS, MS, PhD '70, Mellon Professor at Columbia University, current president of the seismology section of the American Geophysical Union, and a former MacArthur Fellow, joined the U.S. Arms Control and Disarmament Agency in September as a William C. Foster Fellow, to work on verification methods for a comprehensive test-ban treaty.

HERB SCHILLER, MS, of Wheatley Heights, New York, recently joined Vicon Industries as director of materials management. Vicon manufactures and distributes closed-circuit television systems for applications in security, surveillance, communications, safety, and control. He and his wife, Bunny, have just celebrated their 25th anniversary. They have two daughters. The oldest, Susan, teaches mathematics and is pursuing her master's degree at Dowling College, in Oakdale, New York. The youngest, Lori, is in her second year at the State University of New York College at Oneonta.

JERRY YUDELSON received his MBA in June 1992 from the University of Oregon. He was class valedictorian. He is starting a new business in Portland to export U.S. environmental technology to Asia.

1967
ARVEL B. WITTE, PhD, of Rolling Hills, California, has joined DULY Research Inc. as director of program development. DULY Research, located in Rancho Palos Verdes, is a high-technology research and development firm whose products and services include innovative radio-frequency and microwave concepts, components, and subsystems. In addition, it offers broad fundamental analysis and design skills in the fields of physics and aeronautical, electrical, and mechanical engineering. Witte began his 30-year career in the aerospace industry as a research engineer at JPL, developing rockets during the Sputnik era. He worked in space science and technology for 26 years at TRW, in Redondo Beach, California, rising to director of technology in the space and electronics group.

1971
WILLIAM T. ALMASSY, MS '72, of La Cañada Flintridge, California, and Marlene C. Schmidt, of Los Angeles, announce their engagement. After graduating from Caltech, Almassy served in Florida with the U.S. Air Force for two years. He is currently employed in the aerospace industry as a mechanical engineer and is active in tennis and softball leagues and church.

1972
JOHN H. WILSON, PhD, professor of biochemistry and molecular genetics at Baylor College of Medicine, in Houston, is one of eight Baylor faculty members honored as outstanding teachers by the 1993 medical graduating class. The eight were singled out for their outstanding contributions and commitment to education and to student guidance.

1977
CLAUDIA SPIRO, MS '77, and her husband, Robert Silverman, announce that their son Michael Isaac was born on July 20, joining his brother, Joel, age four, and his sister, Sarah, who is two and a half. "As of October 15," Spiro writes, "our new address will be 24 Standish Way, Canton, MA 02021. Now that I have my family started, I plan on becoming more active professionally. For the past year and some, I have been a reviewer for *Math Reviews* in my spare time—something I can continue to do, regardless of where I live. I would love to hear from any of you."

1979
FRANCE CÓRDOVA, PhD, professor and head of the department of astronomy and astrophysics at Pennsylvania State University, has been named chief scientist of NASA, where she will be the principal liaison between NASA's top administrator and the national and international science community. Prior to joining the Penn State faculty in 1989, she was deputy group leader of the space astronomy and astrophysics group at Los Alamos National Laboratory, where she served as staff scientist for the earth and space science division from 1979 to 1989. She was elected vice president of the American Astronomical Society in 1993, and chair of its High-Energy Astrophysics Division in 1990. Her husband, Christian J. Foster, is director of Penn State's New American Scientist Initiative in the Eberly College of Science, and is a doctoral candidate in the College of Education. They have two children, Anne-Catherine Córdova Foster and Stephen Córdova Foster. The family plans to return to Penn State following Córdova's three-year appointment with NASA.

CONNIE SENIOR, MS, PhD '84, and CHUCK NICHOLS, BS '81, announce the birth of their first child, Alexander Stuart Nichols, on August 24, 1993.

1981
IAN H. REDMOUNT, MS, PhD '84, writes that, after 10 years as a research associate at universities in the United States, Japan, and Great Britain, he has obtained an appointment as assistant professor of physics in the department of science and mathematics at Parks College of Saint Louis University, in Cahokia, Illinois. Besides teaching physics, he will be continuing his research in gravitation theory and cosmology.

1982
BILL ANKER, MS, and his wife, Susan, now have two children, Lauren (three and a half years old) and Brian (one and a half). He writes that they are enjoying their new home at 52 Chase Road, Londonderry, New Hampshire 03053, "where visitors are always welcome." He is "doing software" at Racal-Redac, and his favorite recreation remains Ultimate Frisbee, which he enjoys with his friends at AT&T.

GEOFFREY D. RUBIN writes, "Eleven years after graduating from Caltech, I have finally finished my postgraduate medical training. On August 1, I will begin a three-year appointment as Assistant Professor of Radiology in Thoracic Imaging at Stanford University Medical School. My research activities over the past several years have centered upon the development and clinical application of three-dimensional spiral computed tomographic angiography in the abdomen and pelvis and the evaluation of various strategies for breath-held magnetic resonance angiography of the pulmonary arteries. Although Rhesa and I are currently looking for a larger house, we remain proud citizens of East Palo Alto."

OBITUARIES

1984
STUART E. GOODNICK "was recognized as having attained to the Degree of Reason of the Sacred Ternoonald at Tayu Center—a Fourth Way Spiritual School—on September 18, 1993, and was ordained a minister of Tayu Order. He currently supports his Work as the manager of the Power Products Group at Parker Compumotor in Rohnert Park, California."

1985
MICHAEL J. BARELA has been transferred from New Delhi, India, to become officer in charge of the Engineering Services Office in the U.S. embassy in Sofia, Bulgaria—this via Bulgarian language training at the Foreign Service Institute in Rosslyn, Virginia. His wife, Traci, and daughter, Kate, who is now three years old, "are looking forward to seeing snow again."

JAMES F. GARVEY, PhD, associate professor of chemistry at the State University of New York at Buffalo, has been named a Fulbright Fellow for 1994 at the University of Sussex, England. He is also taking his sabbatical this year as a visiting associate professor at Rice University, and will be associated with Rick Smalley's group.

1987
PAMELA (FELDMAN) COSMAN, of Palo Alto, California, writes, "In a busier-than-usual week, our second son, Rafael Sivan Cosman, was born on June 7, and I got my PhD in electrical engineering from Stanford University on June 13. Now I'm starting a postdoc at Stanford and looking forward to sleeping in September or October."

1988
DAVID GOLDREICH, of Pittsburgh, Pennsylvania, writes, "My wife, Deborah, gave birth to our second daughter, Rebecca Helen, on April 18. I'm working on my doctorate in financial economics at Carnegie-Mellon University."

Lowenstam Fund established

Caltech's Division of Geological and Planetary Sciences has established a special fund to honor the memory of Heinz Lowenstam, Caltech professor of paleoecology, emeritus, who died in June. The eventual aim of the fund will be to establish a student scholarship in the division, where Lowenstam taught for more than 30 years. Please send contributions (payable to Caltech) to: The Heinz A. Lowenstam Memorial Fund, Caltech 105-40, Pasadena, CA 91125.

1922
RALSTON E. BEAR, of Escondido, California, on May 12. He spent 41 years with General Electric, starting in Schenectady, New York; he was a manager in the company's Los Angeles office at the time of his retirement. He is survived by Dorris, his wife of 70 years; his daughter, Marcia Fowler; and one grandson.

1925
GLENN M. SCHLEGEL, of Santa Cruz, California, on February 14.

1930
FRANCIS D. BODE, MS '31, PhD '34, of Sequim, Washington, on May 22; he was 88. He served on Caltech's faculty before becoming a petroleum geologist and working in Canada, Central and South America, Europe, and Africa. He managed foreign exploration for Texaco and retired as director of geological research. He was a member of Sigma Xi, a fellow of the Geological Society of America, a registered petroleum engineer, and a member of numerous professional societies. After moving to Sequim in 1967, he served as president of the Dungeness Community Club and as chairman of the Clallam County Shoreline Advisory Committee its first four years. He is survived by his wife, Margaret; a daughter, Lucy; one brother; and four sisters.

THEODORE F. STIPP, on June 17.

1933
ROBERT C. (PAT) HOGAN, of Rolling Hills Estates, California, on June 5. He is survived by his wife, Dorothy.

L. JACKSON LASLETT, of Berkeley, California, on May 8. He is survived by his wife, Barbara.

EARL M. OLDS, of Houston, Texas, on May 20; he was 82. He worked for Technicolor Motion Picture Corporation as a film technician and research scientist, starting in 1934 and retiring in 1972. He spent two years as the supervisor of the NASA film laboratory, working on Apollo missions. He is survived by his wife, Delma; two daughters, Louise and Susan; five grandchildren; a brother, Robert; a sister, Helen; and three nieces.

1935
ALLEN A. RAY, of Laguna Hills, California, on May 31. He was founder and chairman of Ray Products Co., Inc., of El Monte, California; a former president of the Alhambra Chamber of Commerce; and active in the Caltech Alumni Association and the Associates. He is survived by his wife, Peggy; sons Chuck, Bruce, and Darryl Ray; seven grandchildren; sisters Alice Dalhman and Betty Stocking; sister-in-law Bernice Garoutte; and numerous nieces and nephews. A memorial fund has been established at Caltech. Those wishing to contribute should write to the Allen Ray Memorial Fund, Caltech, 1201 East California Boulevard, 105-40, Pasadena CA 91125.

1940
ROBERT E. SPEAR, on June 14. He is survived by a sister, Elizabeth Armstrong.

JACK TIELROOY, of Fullerton, California, on September 7; he was 74. He had pursued an interest in amateur radio since the age of 12, and he was an avid skier. "Jack was very proud to be a graduate of Caltech." He is survived by his wife, Terry; two sons, Charles and John; and a daughter, Diane Weber.

1941
PAUL LIEBER, MS, PhD '51, of Orinda, California, on December 12, 1992; he was 74. During World War II he did aeronautical engineering work at Douglas Aircraft. After the war, he was appointed assistant professor at Brooklyn Polytechnic, where he taught graduate and undergraduate courses and rose to the rank of full professor. It was near the end of his tenure at Brooklyn that he earned his PhD from Caltech. From Brooklyn he moved to Rensselaer Polytechnic Institute (RPI) as professor of aeronautical engineering. After a few years he returned to his first interest, the earth sciences, when he joined RPI's geophysics department. While at both Brooklyn and RPI he presented papers at numerous meetings around the world; he also worked as a consultant for the U.S. Navy and the Sandia Corporation. He was a Fulbright scholar in 1956, and he spent a year consulting on the curriculum at the Technion in Haifa, Israel (he had spent several years in the 1930s attending school in what was then Palestine). After his year in Israel, he joined the faculty of UC Berkeley. Over the course of his career he taught many distinguished students and became acquainted with many of the world's great scientists; he worked with Beno Gutenberg at Caltech, and he knew Einstein, Schrödinger, von Kármán, Sir Jeffrey Taylor, and Anthony Biot, among others. "He loved nature, God and music—he was especially devoted to Beethoven." He is survived by his wife of 48 years, Bettina; three sons, Leo, Joseph, and Jonathan; a daughter, Victoria; a son by a first marriage, Michael; and four grandchildren.

1943
EARLE R. (DICK) ATKINS, JR., of Whittier, California, on July 19. He worked for Unocal for 38 years and retired in 1982. He is survived by Myrtle, his wife of 48 years; a son, Larry; two daughters, Charlene and Janet; and four grandchildren.

1944
JOHN R. UKROPINA, of La Quinta, California, on September 16; he was 69. He served as engineering officer on a destroyer during World War II. After the war, he was in the concrete-pipe business for five years, then became a prominent builder of Southern California freeways. In 1971 he received his master's degree in education from Cal State Los Angeles and began teaching at his alma mater, South Pasadena High School, where he remained for the next 18 years; he was a popular math teacher and golf coach, and was affectionately known as Mr. U by the students. He is survived by his wife, Maryann; his daughters, Marsha Aguirre and Jan Mary Devens; his sons, Robert and Bill; his mother, Persida; his brother, James; his sister, Jo-An Barnett; and 11 grandchildren.

1945
WILLIAM H. EBERHARDT, PhD, of Atlanta, Georgia, on June 5; he was 73. He had been a Regents Professor at the Georgia Institute of Technology until his retirement in 1984. A physical chemist and a spectroscopist, he was the recipient of several awards for teaching excellence. He was a member of Phi Beta Kappa and Sigma Xi and was active in the National Science Foundation, the National Academy of Sciences, the American Chemical Society, and the Advisory Council on College Chemistry. He is survived by his wife, Dorothy; daughters Christine Eberhardt, Barbara Hodges, and Carol Chiasson; and five grandchildren.

Robert Langmuir remembered

Dear Editor:

I knew nothing about Professor Langmuir's many and varied scientific achievements in the years before 1952 until I read with deep regret his obituary in the June issue of *Caltech News*. In recent years our paths had sometimes crossed on campus and we would then reminisce about "those days."

Caltech took me into its fold in 1951, and I took senior electronics in Langmuir's class. These were scary years for me as an ex-GI with only junior college training and a growing family. It felt like tightrope-walking amongst my brainy classmates and lofty faculty members. Professor Langmuir was a tough teacher and forceful, yet somehow one liked to come to his class.

I was ecstatic when he asked me to help evaluate a scale model of the new synchrotron cavity that was destined to accelerate the circular electron's beam to much higher energy than was thought possible before. Under his guidance I became familiar with the tools of the trade in the old synchrotron lab that had not too long before witnessed the grinding and final polishing of the 200-inch mirror for the Palomar Observatory. What I liked most about Langmuir's method was that he allowed me to discover things for myself with only minimal guidance on his part. Yet somehow I knew he was there when the need arose. He must have liked my work, for he recommended me to a former colleague's firm for a job during the summer of 1953.

I shall always remember him as a teacher and role model.

Rolf D. Weglein '53
Los Angeles

For the record

The obituary for Edward Posner that appeared in the August *Caltech News* misstated a detail regarding the Edward C. Posner SURF Fellowship. The fellowship will be open to all outstanding students working in a field related to Posner's own research interests.

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