

# CALTECH NEWS

June 1986



At dedication ceremonies for the Arnold and Mabel Beckman Laboratory of Chemical Synthesis, President Goldberger reads wording from a plaque for the building that expresses appreciation to the Beckmans for their gift.



Peter Dervan, chairman of the steering committee for the new building, and Fred Anson, chairman of the Division of Chemistry and Chemical Engineering, with Mabel and Arnold Beckman. Plaque for the new laboratory is in the foreground.

## Beckmans honored at laboratory dedication

A balmy, sparkling April day added special graciousness to dedication ceremonies for the Arnold and Mabel Beckman Laboratory of Chemical Synthesis. Beneath the connecting bridge between the east and west wings of the laboratory that is adorned by the Calder arches, friends of the Beckmans gathered for the dedication and ribbon cutting. The ceremonies were part of a full day of activities honoring the Beckmans and the 50th Anniversary of Beckman Instruments, the company that Dr. Beckman founded.

Fred Anson, chairman of the division of chemistry and chemical engineering, observed that when it is completed, the new facility "will meet our needs well into the 21st century." He told the guests that "Caltech had attracted a distinguished group of synthetic chemists to its faculty, but its laboratory facilities had deteriorated until they were not worthy of the inhabitants."

"Dr. Beckman recognized the consequences, and a proposal to the Beckman Foundation resulted in the grant that made this renovation possible. We owe him a deep debt of gratitude for recognizing how important these facilities will be to the

Continued on page 3

## The spiraling cost of laboratory equipment: How do we pay the bill?

By Winifred Veronda

*"Private support for equipment has made the difference between our being where we are—hanging on—or falling off the cliff."*

Paul C. Jennings,  
chairman of the Division of  
Engineering and Applied Science.

Across the nation, much equipment in university research laboratories is growing old and obsolete—and threatening to undermine a major source of our country's scientific and technological strength. President Marvin L. Goldberger has described the issue of up-to-date instrumentation for academic research laboratories as "one of the most acute problems facing universities today."

The average age of instruments and equipment in university laboratories is estimated to be twice that of comparable ones in industry, and one fourth of the equipment at top research universities in several areas (computing, physical sciences, and

engineering, for example) is considered obsolete, according to the National Science Foundation.

In 1984, NSF analyzed data from 25 major research institutions that perform about 38 percent of all federally funded research and development at colleges and universities and found that these institutions needed to invest \$1.3 billion per year in construction and refurbishing of science, engineering, and medical facilities over the next five years.

George Keyworth II, former White House science adviser, has warned, "These deficiencies directly affect the ability of university scientists to conduct front line research. They hamper the ability of students to learn the newest technologies, and they make it more difficult for universities to compete with industry for faculty."

Caltech is deeply involved in this struggle to keep research labs at the cutting edge. Meanwhile, the cost of equipment constantly rises, newly created equipment becomes essential to maximum research productivity, and federal funding enters an era of

grave uncertainty as the Gramm-Rudman federal budget balancing law is implemented.

As one example of the latter constraint, a researcher in biology received a 10 percent cut when his grant from the Allergy and Infectious Diseases Institute of the National Institutes of Health was re-funded in January.

Says one spokesperson, "Caltech has about one million dollars each year to invest in replacement equipment for research and education on the campus. It is never enough. Often even sponsored research [for which the federal government funding source typically allows 10 percent of the total for equipment needs] must be supplemented by Caltech funds."

The Institute is taking a hard look at its overall equipment needs for the next five years. Current projection of the costs: \$10 million.

Some of these funds would replace instruments so outdated that the parts to maintain and repair them are no longer available. Others would bring still-useful instruments up to

Continued on page 4

## Stephen Onderdonk named Caltech Trustee

Stephen R. Onderdonk, president and chief executive officer of Econolite Control Products, Inc., of Anaheim, has been named to the Caltech



Stephen Onderdonk is president and chief executive officer of Econolite Control Products, Inc., of Anaheim.

Board of Trustees, according to Chairman Ruben F. Mettler.

"We have long been proud that Stephen Onderdonk has included Caltech in the list of institutions that have benefited from his interest," said Mettler. "We are even more pleased that he has agreed to bring his management expertise to our board of trustees."

Onderdonk's corporate experience includes positions with United California Bank, Colwell Mortgage Trust, and Seeley Company. In 1978, he became president, CEO, and half owner of Econolite, the nation's largest manufacturer of traffic control products. In 1982 he became president, CEO, and half owner of California Chassis, Inc., a Cerritos, California, manufacturer of steel enclosures and carts for the electronic and aerospace industries.

His civic activities include service as a trustee for Polytechnic School in Pasadena and for the Los Angeles County Museum of Natural History. He also serves on the board of directors of the San Gabriel Valley Council of the Boy Scouts of America, and is a member of the Friends of the Huntington Library and Art Gallery, San Gabriel Valley Chapter of the Young President's Organization, and Valley Hunt Club. He is a member of The Associates.

## Beckman recipient of Tolman Medal

Arnold O. Beckman, founder of Beckman Instruments, Inc., is recipient of the 1986 Richard C. Tolman Medal. The award is made annually by the Southern California Section of the American Chemical Society. It was presented at a dinner in Dabney Lounge on April 24, honoring Beckman.

The Richard C. Tolman Medal, the highest honor given to a chemist by the ACS Southern California Section, recognizes broad accomplishments in



The Tolman Medal, awarded to Arnold Beckman, recognizes broad accomplishments in chemistry and contributions to the field.

chemistry and contributions to the field.

Beckman is internationally recognized as a scientist, educator, business and civic leader, and philanthropist.

He was the first alumnus named by Caltech to its Board of Trustees in 1953, served as chairman from 1964 to 1974, and then was elected chairman emeritus. In his honor, the Arnold O. Beckman Professorship of Chemistry was established in 1980. He was presented with the Institute's Distinguished Alumnus Award in 1984, and with Caltech's Robert A. Millikan Medal for distinguished service to the Institute in 1985.

## Goldberger honored by Carnegie-Mellon

President Marvin L. Goldberger was honored by his alma mater, Carnegie-Mellon University, in April at an entertainment program, "Carnegie Salutes Carnegie."

Goldberger was one of a few alumni chosen to be honored as an "exemplary, successful alumnus" at the program which combined the talents of professional entertainers who are Carnegie-Mellon alumni with those of student performers.

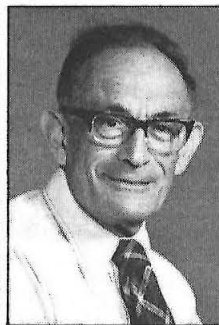
## Gray, Liepmann awarded National Medal of Science

Two Caltech faculty members have been awarded the nation's highest scientific honor—the National Medal of Science—at ceremonies in the White House.

They are Harry Gray, the Arnold O. Beckman Professor of Chemistry,



Harry Gray



Hans W. Liepmann

and Hans W. Liepmann, the Theodore von Kármán Professor of Aeronautics, Emeritus.

The National Medal of Science is awarded for "distinguished achievements and outstanding contributions to science and engineering development." Gray and Liepmann were among 20 U.S. scientists who received it this year.

Gray received the medal for his research in bio-inorganic chemistry and inorganic photochemistry—work that involves the conversion of sunlight into more useful forms of energy.

Liepmann received the medal for his theoretical and experimental contributions to fluid mechanics, including research that laid the groundwork for high-speed flight, space reentry vehicles, and more efficient combustion engines.

Among those who greeted Gray and Liepmann at the ceremonies in the White House were three Caltech alumni: William R. Graham, Jr. (BS '59), acting director of NASA; Ronald L. Kerber, (MS '66, PhD '70), deputy undersecretary for research and advanced technology with the Department of Defense; and Alvin W. Trivelpiece (MS '55, PhD '58), director in the office of Energy Research of the Department of Energy.

Gray and Liepmann are the 19th and 20th Caltech faculty members to receive the National Medal of Science and the first two to receive it in the same year. The first medal ever awarded was presented to Theodore von Kármán, founder of Caltech's Graduate Aeronautical Laboratories (GALCIT), in 1962.

## Phillips: director of submillimeter observatory

Thomas G. Phillips, professor of physics at Caltech, has been named director of the Caltech Submillimeter Observatory in Hawaii. The observatory consists of a 20.4 meter (34-foot) radio dish located on 13,800-foot Mauna Kea on Hawaii. It is scheduled to become operational this year.

Phillips, who received both his undergraduate and doctoral degrees from Oxford, came to Caltech in 1980 from Bell Laboratories. He has been associate director of Caltech's Owens Valley Radio Observatory,



Thomas G. Phillips

responsible for the millimeter-wave observatory there.

A relatively new field, submillimeter-wave astronomy covers one of the few unexplored regions of the electromagnetic spectrum and promises to be a major contributor to the understanding of our galaxy and other galaxies. Submillimeter waves are emitted by dust particles and by many compounds of hydrogen, nitrogen, carbon, and oxygen in space. By studying these particles and molecules, astronomers gain clues to conditions in interstellar space and in other galaxies.

Until the Caltech submillimeter-wave telescope, no large radio dish has had either the high surface accuracy needed to focus the waves, or the high-frequency radio detectors to measure them.

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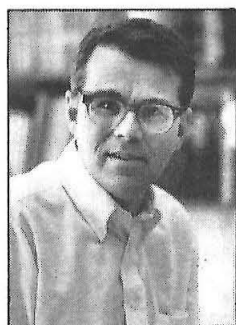
Editor: Winifred Veronda  
Copy editor: Diane Davis  
Personals/Obituaries: Kathy Danaher  
Production artist: Barbara Wirick  
Photographer: Robert Paz



## Neugebauer named California Scientist of the Year

For his pioneering use of infrared astronomy to advance our understanding of the solar system, the stars, and galaxies, Gerry Neugebauer (PhD '60) has been named California Scientist of the Year by the California Museum of Science and Industry.

The award, the highest civilian honor in the state, was presented by



Gerry Neugebauer

Governor Dukmejian at a testimonial banquet on April 30. Neugebauer is the Howard Hughes Professor and professor of physics. He has been director of Palomar Observatory since 1981.

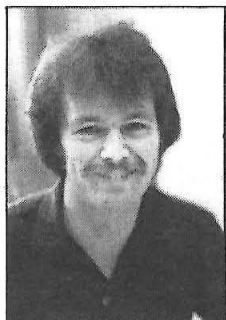
Neugebauer has played a major role in infrared studies of the planets, helping to develop instruments for the Mariner missions to Venus and Mercury, the Pioneer missions to Jupiter and Saturn, and the Viking missions to Mars. During the 1960s and 1970s, his ground-based surveys of the infrared sky, carried out in collaboration with colleagues at Palomar and Mt. Wilson observatories, produced major discoveries about the birth and death of stars and the nature of galaxies.

Neugebauer was instrumental in planning and implementing the 1983 IRAS (Infrared Astronomical Satellite) mission, which detected 250,000 new sources of infrared radiation that are now being analyzed on campus at IPAC.

He is the tenth member of the Caltech faculty to be named Scientist of the Year. His predecessors were William Fowler (1958), Frank Press (1961), Jesse Greenstein and Maarten Schmidt (1965), Robert Sinsheimer (1968), Roger Sperry (1971), Peter Goldreich (1981), and Lee Hood (1985).

## Leal named Chevron Professor

L. Gary Leal has been named the Chevron Professor of Chemical Engineering. Leal, whose research is in fluid mechanics and polymer physics, succeeds Henry Weinberg,



L. Gary Leal

who was appointed to the chair in 1981.

The Chevron Professorship was established in 1980 by a gift to Caltech from the Chevron Corporation. The professorship is held for five years by an expert in an energy-related field of chemical engineering.

Leal came to Caltech in 1970 and became a full professor in 1978. His research aims at an understanding of the fundamental fluid mechanics behind such phenomena as the movement of oil drops in porous media, important in the technology of enhanced oil recovery.

He is also trying to understand the relationship between the behavior of individual particles or macromolecules in suspension or polymer liquids, and the bulk flow properties of these materials. Such studies are important in the engineering of advanced polymers in the petrochemical industry, and in the efficient use of polymer drag reduction to reduce energy consumption in pipeline transport of crude oil.

Leal's honors include the 1978 Allan Colburn Award of the American Institute of Chemical Engineers and the 1987 Technical Achievement Award of the Southern California Section of the AIChE. He was named a John Simon Guggenheim Fellow in 1976.

## Hoffman receives humanities honor

Phillip Hoffman, associate professor of history and social science, has received an Arnold L. and Lois S. Graves Award in the Humanities from Pomona College and the American Council of Learned Societies.

Hoffman will use the \$5,000 award to return to France, where he has been studying economic and political life in selected peasant villages, during the period from the late 15th century to the French Revolution.

## Two named Presidential Young Investigators

Two young Caltech faculty members are among 100 gifted young researchers nationwide named by the National Science Foundation as recipients of 1986 Presidential Young Investigator Awards. They are Erik Antonsson, assistant professor of mechanical engineering, and P. P. Vaidyanathan, assistant professor of electrical engineering. Each receives a base grant of \$25,000 annually to support his research over the next five years.

Antonsson, 31, is developing computer-aided design tools that will help engineers early in the development of products, when designs are still preliminary. He is also developing a laser measurement technique that could allow manufactured parts to be inspected more precisely.

Vaidyanathan, 31, is developing digital filter circuits to enable computers to transmit data with minimal distortion and interference. This research is expected to have major applications in such fields as satellite and spacecraft communications and in the design of computers that respond to human speech.

The awards "provide cooperative research support for the nation's most outstanding and promising young science and engineering faculty," according to NSF.

## On the cover

In the new Arnold and Mabel Beckman Laboratory of Chemical Synthesis, graduate student Leigh Clawson determines the structure of an organic molecule, using a new nuclear magnetic resonance spectrometer (in the background). Acquired in 1984, the spectrometer is used by all members of the chemical synthesis group at Caltech, and was the first instrument to be purchased with money from a \$460,000 five-year fund established by Arnold and Mabel Beckman to equip research groups in synthetic chemistry with the most modern research instruments possible. This gift and others from the private sector help the Institute to meet an acute need for funds for research and teaching equipment.

## Beckmans honored as new laboratory is dedicated

*Continued from page 1*

future of chemical synthesis at Caltech," Anson said.

Peter Dervan, chairman of the steering committee for the Beckman Laboratory, observed that "in 2036, the 1980s will be seen as the time of an emergence of a new era in chemical synthesis—a time when we moved from the era of discovery to the era of innovation."

Synthetic chemists are creating new catalysts that don't exist in nature, and substances made of materials that don't have a biological source, Dervan said. Chemical synthesis has entered an era of molecular engineering, he told the group.

This development pattern parallels that of Arnold Beckman's career—that of a research scientist who, mid-course in his career, became an inventor, Dervan noted.

President Marvin L. Goldberger asked the Beckmans to join him at the podium as he unveiled a plaque for the building that commemorates their gift. A ribbon cutting followed, and then Dr. Beckman thanked Caltech for "providing the opportunity for the Beckman Foundation to put its funds to use in an optimum way to help mankind."

Noting that he has had a connection with Caltech since he came here in 1923 as a graduate student, he stressed his and Mrs. Beckman's pride in "what Caltech is," and their appreciation for it.

Earlier in the day, guests heard a presentation of the second annual Arnold O. Beckman Lecture in Chemistry, given by Jerrold Meinwald (the Goldwin Smith Professor of Chemistry at Cornell University), who revealed the sophistication of insects' chemical signals, and the use of these signals in defense, courtship, and mate selection.

A dinner in the Athenaeum celebrating the 50th anniversary of the founding of Beckman Instruments concluded the day. Beckman Instruments executives, members of the Caltech Board of Trustees, faculty members of the Division of Chemistry and Chemical Engineering, and special guests attended the event.

The ceremonial day commemorated the completion of the first phase of renovation of Crellin Laboratory of Chemistry and Church Laboratory of Chemical Biology to create a new facility. The project was made possible by a \$6.5 million gift from the Arnold and Mabel Beckman Foundation.



## Meeting the challenge of equipment costs:

### Private funds make a critical difference

Continued from page 1

date—in some instances by hooking computers to non-automated instruments or by adding more capacity to computers that are saturated.

Other funds would outfit labs for new faculty members or pay for expensive new pieces of equipment needed to advance research in a specific area.

As the Institute surveys its situation with respect to equipment, it is keenly aware that funds from private sources—corporations, foundations, and individuals—will make the critical difference.

A quick look at the recent history of government funding for academic research shows how the crisis has developed, nationwide. In the post-Sputnik era, the federal government poured hefty sums into basic research. This investment helped to cement the role of the United States as a world leader in university science. New research equipment was a major component in the funding package.

But in the late 1960s, government funding diminished and, during the 1970s, colleges and universities, faced with rising costs and declining enrollments, found it hard to invest money in equipment. Awareness of the mounting problem motivated the federal government in the early 1980s to increase its financial outlays for equipment and for basic research and personnel. But demand has continued to far outstrip supply, and today, as budgets are cut under Gramm-Rudman requirements, the future of federal funding is one of grim uncertainty.

For a top-line research institution such as Caltech, the need for the most modern equipment is particularly critical. "Our faculty members are at the forefront in their areas," explains Rochus E. Vogt, vice president and provost, and the R. Stanton Avery Distinguished Service Professor. "With the right tools, they can make breakthroughs that otherwise are not possible."

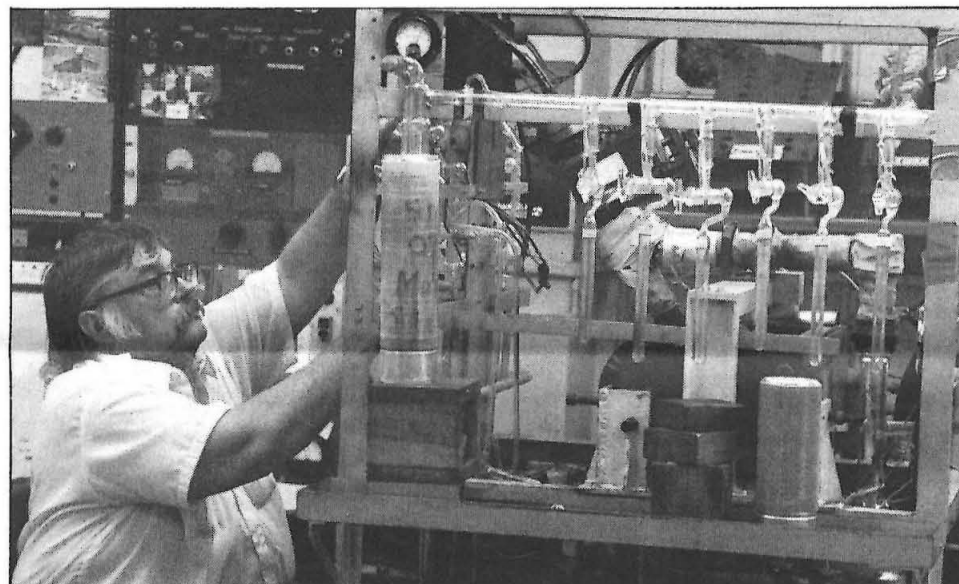
He notes that "our students traditionally go on to become leaders in academia and industry. Outmoded equipment produces outdated students. We must have the most modern equipment and laboratories to provide them with a state-of-the-art education."

This need is gradually being met, faculty members agree, because the

administration has made excellent facilities for students a major priority.

The need for funds for equipment is intensified because of the speed with which new instrumentation is being developed.

"Equipment is available today that didn't exist five years ago," says Edward C. Stone, chairman of the Division of Physics, Mathematics and Astronomy. "This equipment may be essential to a researcher if he is to work to capacity, and the instrumentation may cost tens—even hundreds—of thousands of dollars."



Hugh Taylor (Robert P. Sharp Professor of Geology) measures oxygen and carbon isotopic composition of rocks, using a vintage mass spectrometer that came to the campus in 1953. By April 21, the instrument had performed 83,800 analyses—probably producing more of this kind of work than any other mass spectrometer currently in use in the world. A replacement would cost \$140 thousand.

One example within the physics division is a \$35 thousand spectrum analyzer, needed for monitoring the operation of electronics at the new submillimeter observatory on Mauna Kea. So far, money to purchase it has not been available.

The challenge becomes increasingly formidable as the cost of equipment—for both teaching and research—increases. "We never have enough funds for all the equipment we would like," says Fred C. Anson, chairman of the Division of Chemistry and Chemical Engineering. "We're faced with a constant need to modernize the undergraduate teaching labs, for example. They require state-of-the-art equipment, and the equipment changes rapidly—not quite at a geometric rate, but sometimes at a rate that seems close to that."

Meanwhile, says Anson, instrumentation needs are harder and harder to meet. "Instrument money from government agencies is increasingly tight; funding from these

sources is generally concentrated on people and is given for fellowships, for example."

Nevertheless, says Paul C. Jennings, chairman of the Division of Engineering and Applied Science, "We are in a better position than most universities. Because of our small size, the integration of divisions here, and combined programs in research and teaching, many opportunities exist to share equipment. But there is a constant struggle to keep up with needs."

In engineering, rising enrollment over the last several years has placed

if we are to stay competitive.

"With Gramm-Rudman, the picture is more uncertain than ever. We may be facing cuts in our grants of 10 to 30 percent, and this makes it hard to plan."

At the Owens Valley Radio Observatory (OVRO), two large grants from NSF provide major support for the millimeter interferometer—one for studies of star formation regions, and the other for very long baseline interferometry (VLBI) studies of the nuclei of radio galaxies and quasars.

"To make significant advances," says Anthony C. S. Readhead, director of OVRO, "we must have outstanding scientists and engineers, and to keep them, we must offer competitive salaries. But last year our grants only increased by one percent. The only place to find salary money was to tap the equipment portion of the grants. As a result, we were only able to spend \$10 thousand on equipment to increase the capacity of the observatory; we should be spending over \$50 thousand per year to keep abreast in this area."

One much-needed piece of equipment is a new generation spectrum analyzer, which cost \$35 thousand and which the observatory cannot afford. "Every time I go up, the engineers plead with me for one," says Readhead, "but we cannot possibly purchase one out of our present support, and as a result, our efficiency is reduced."

**The Institute is taking a hard look at its overall equipment needs for the next five years. Current projection of costs: \$10 million.**

The high cost of keeping faculty labs supplied with needed equipment is illustrated by these examples:

- In chemistry, each faculty member on the average requires about \$30 thousand annually to purchase new laboratory equipment.
- Each new faculty member in biology needs new instrumentation worth about \$20 to \$50 thousand every four years.
- Every five years physics needs more than \$1 million in capital funds to equip a new facility.
- Periodically, the Division of Geological and Planetary Sciences must substantially renovate a laboratory or purchase or fabricate a large new instrument. For example, a

major strains on the capacity of instructional equipment. For example, David B. Rutledge, associate professor of electrical engineering, teaches a class on the fabrication of integrated circuits that enrolls 120 freshmen. The course is divided into 14 sections with eight or nine students each ("meeting at almost every conceivable hour of the day and week") so that each student may have access to one of two semiconductor parameter analyzers that belong to the division. Caltech would like to own more of them to reduce the number of sessions and the pressure on the equipment, but cannot afford to buy them. The instruments cost \$30 thousand each with component parts.

James H. Strauss, acting chairman for the Division of Biology while Lee Hood is on sabbatical, notes that "to get the money for the equipment we need has been very difficult. NIH, NSF, and other federal agencies have tightened their funding, and we must have the most up-to-date equipment



scanning electron microprobe will cost more than \$800 thousand. Generally, \$500 thousand is needed every three to five years for major instrument development.

Not only must current equipment and facilities be upgraded, but new faculty members' laboratories must be equipped—often at an investment of from three to eight times the salary of the professor, according to Anson, and "with no alternative if you're going to hire and keep the best people."

Another expense—not always visible on the surface—is defined by Stone, who points out that "much of our equipment today is so sophisticated that it requires money for maintenance, and trained personnel to service and operate it." Electron microscopes and large computer centers are examples. In some instances, the Institute has turned down equipment donations because of the high maintenance costs.

In its efforts to cope with increasing budgetary constraints, the Institute is looking increasingly to the private sector for help with equipment needs. In 1985, non-governmental gifts from corporations and foundations accounted for approximately 5.8 percent of the total spent for equipment by the Institute—a small but vital increment.

One of the initial gifts to provide some support for equipment came in 1984, when four corporations—Aerojet General, GM, GTE, and TRW—pledged \$4 million for equipment, fellowships, and research through a five-year project called the Program in Advanced Technologies. This program has been enormously important in providing the engineering division with funds for special equipment needs, says Jennings. The division's own discretionary fund for equipment must all be allocated for instruments for the instructional program.

Highly valuable to Caltech's work in chemical synthesis is a five-year fund of \$460 thousand—a gift from Arnold and Mabel Beckman to equip research groups in the Beckman Laboratory of Chemical Synthesis with the most modern research instrumentation possible. Faculty members, through their grants, are expected to match this sum each year with an equal amount.

The geology division received a major boost in 1984 when the Atlantic Richfield Foundation awarded Caltech \$500 thousand for two instruments—an automated electron microprobe and a Fourier transform infrared analyzer. Both instruments

are used by geologists to analyze terrestrial and lunar rock samples, as well as meteorites, for clues to the origin of geological features on earth, and to the origin and evolution of the solar system.

Grants from industry were critical in a multi-million-dollar educational computing program launched at the Institute during 1984. Companies including Compaq, Data General, Digital Equipment Corporation, Evans & Sutherland, Hewlett-Packard, IBM, Lotus, Microsoft, and Tektronix donated more than \$9 million in hardware and software, as well as giving extensive discounts on their products.

A \$1 million gift for equipment was received from the W. M. Keck Foundation in 1984—the first of its kind. Two thirds of the grant was used for current acquisitions of equipment (awarded competitively among divisions), and the remaining third has been retained as an endowment to support future equipment needs.

As one example of an initial purchase, the Institute spent \$78 thousand for interactive computer graphics equipment that will be shared by many researchers in the Division of Biology. The color graphics workstation is the heart of a

In 1985, the Institute received a substantial boost through a \$1 million gift from the Irvine Foundation—for current equipment needs to be awarded among divisions on a competitive basis—and a \$500 thousand grant from the Chevron Corporation to establish the Chevron Research Fund. This fund is used to purchase equipment and to renovate faculty labs in the divisions of Chemistry and Chemical Engineering, and Geological and Planetary Sciences.

A \$1 million gift in 1986 from IBM to support innovative research and education will be used in part to

### **The Institute hopes, over the next five years, to build an equipment endowment of \$15 million.**

purchase equipment for research initiatives by faculty members, and a \$250 thousand gift from Boeing to establish the Faculty Development Fund also helps to buy equipment for new faculty. An annual unrestricted gift to the engineering division from the Garrett Company of approximately \$100 thousand is usually used to purchase equipment. (The corporate gifts are pledged over a five-year period except for IBM, which is

example, a computer scientist may receive a new piece of equipment before it has been marketed because the company wants it tested intensively. "People don't like to buy something that hasn't flown," one faculty member notes. "If the manufacturer can say, 'It's been used at Caltech,' its chances in the marketplace are a lot better.

"But there is a lot of equipment that no one is motivated to give us, and we must have the money to buy these pieces. There is also a lot of software that needs to be developed, and this costs money."

To meet its long-range equipment needs, Caltech has formulated a major goal. "We have many immediate, pressing equipment needs," says Vogt. "But buying every piece of equipment on the list will not solve the problem. What we really need is a reliable source of funding that will allow us to keep our instruments in a state-of-the-art condition—to maintain them, to replace them periodically, and to acquire or develop new instruments."

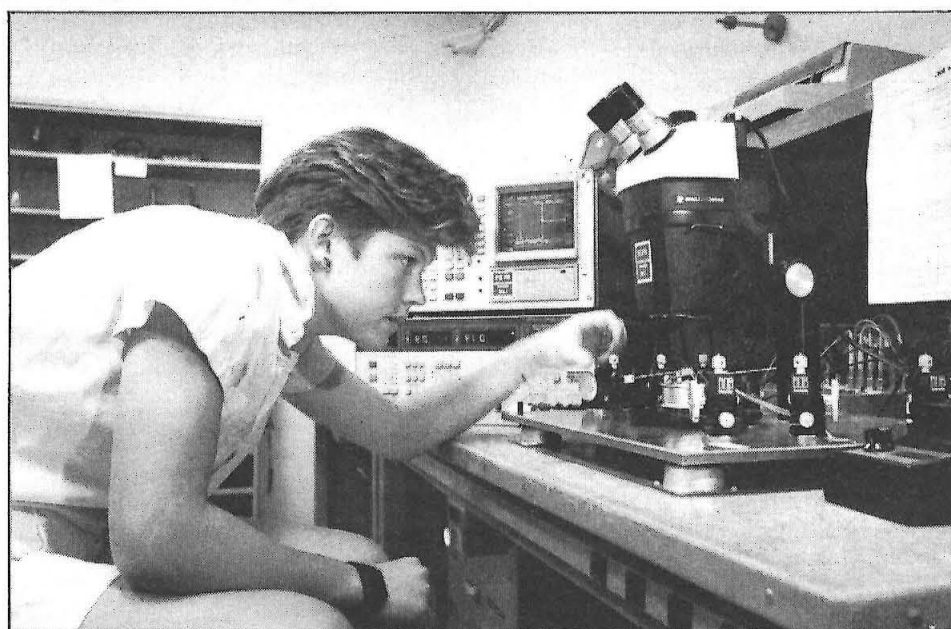
To achieve this goal, the Institute hopes, over the next five years, to build an equipment endowment of \$15 million. The endowment would provide Caltech with about \$1 million a year to acquire, develop, and maintain equipment. The Keck Foundation endowment would serve as the foundation.

There is no question that the Institute will continue to depend heavily on private support to maintain its scientific leadership and its ability to respond quickly to needs and opportunities.

"Many institutions wait for NSF to decide that a new field is important before they move into it," says Stone. "But the availability of private money has allowed Caltech to move into desirable new fields and to develop programs before these fields have gained acceptance by Washington agencies. This is why Caltech became what it was within three or four years after Robert Millikan arrived here—and why it has been what it has been ever since."

Jennings stresses, "Without the support of private funds, there is no way we could have met the need for more laboratory equipment that has been created over the last 12 years by expanded enrollment. Corporate support has made the difference between being where we are now—hanging on—or falling off a cliff."

"Caltech's vitality has always been based on our ability to respond effectively and quickly to urgent needs and outstanding opportunities," says Vogt. "We intend to find the ways to keep on doing so."



*Heidi Langeberg, teaching assistant in a class on fabrication of integrated circuits, uses one of two semiconductor parameter analyzers that belong to the division. Class enrollment of 120 freshmen places heavy pressure on the two parameters, which cost \$30 thousand each.*

computerized neuroanatomy facility that will operate in two modes.

It will serve as a visual stimulation system for determining the responses of cells in the visual cortex to complex visual patterns—a face, for example, or a tree.

It will also be linked to a flexible microscopy system to serve as a computerized anatomy system. Using this system, biologists will construct three-dimensional neuron structures to obtain precise data on how sound location information is processed within the brain.

pledged over three.)

The chemistry division was the beneficiary of an endowment of more than \$1 million by a member of its own professional staff. Joseph Koepfli, senior research associate, emeritus, who was with the division as senior research associate from 1944 to 1972, established the endowment to be used to support visiting faculty members or for equipment needs.

Because of its reputation, Caltech has been more successful than many institutions in obtaining donations of specific pieces of equipment. For



## Caltech initiates Associates into family traditions



Members of the Caltech Stock Company entertain The Associates with vintage lyrics from musicals about Caltech that were performed during the 50s, 60s, and 70s. From left: Professors Ward Whaling, James Knowles, David Wood, and Robert Oliver.

Caltech is a family with family traditions, J. Kent Clark (professor of literature) told members of The Associates at a dinner in April—and one family tradition is to know some of the words to “The Richter Scale.”

“The Richter Scale” is one of the most popular of the many songs written over the past 30 years for the Caltech Stock Company by Clark and his partner, Elliott Davis, an attorney, now retired.

The Caltech Stock Company—described by Clark as “a sturdy band of extroverted eggheads who lead double lives as professors, secretaries and faculty wives”—performed in a succession of musicals over the years; the productions commemorated anniversaries, retirements, and the awarding of Nobel Prizes to Caltech luminaries.

Now it seemed time for The Associates to join in this musical madness, as Clark and his colleagues presented an after-dinner show called “The Caltech Family—or That Happy Faculty.”

“The Richter Scale” was the first number on the program, as Clark reminisced that once Richter heard the words, “He loved it. He realized that if you’re going to be famous you can’t be just a word before a scale; you have to be a real person.” Some stanzas from “The Richter Scale”:

*Charley Richter made a scale for calibrating earthquakes*

*Gives a true and lucid reading every time the earth shakes.*

*Increments are exponential, numbers 0 to nine*

*When the first shock hit the seismo everything worked fine*

*It measured One two on the Richter scale, a shabby little shiver*

*One two on the Richter scale, a queazy little quiver*  
*Waves brushed the seismograph as if a fly had flicked her*

*One two on the Richter scale, it hardly woke up Richter.*

*Some day pretty soon we fear our many faults will fail us*

*Slide and slip and rip and dip and all at once assail us*

*Seismic jolts like lightning bolts will flatten us that day*

*When the concrete settles down geologists will say, “it measured*

*Eight nine on the Richter scale, it rocked ‘em in Samoa*

*Eight nine on the Richter scale, it cracked like Krakatoa*

*Waves crunched the seismograph, just like a boa constrictor*

*One two on the Richter scale, three four on the Richter scale*

*Eight nine on the Richter scale (CRASH)*

*It really racked up Richter.”*

Another Stock Company favorite to which The Associates were introduced moved Clark to observe that “We at Caltech are the first people to consider the moral aspects of rocks.” After calling on pianist and mathematics professor Gary Lorden for some rock music (Lorden complied with a stanza of “Rock of Ages,”) the Stock Company performers sang “It’s Not Gneiss.”

*Gneiss is a laminated metamorphic rock,*

*The only stone a man can trust*  
*All others are crude, if not faintly lewd,*

*They fill a good man with disgust.*  
*Salt is salacious and chalk is cretaceous*

*They’re not gneiss*  
*Limestone and coral can never be marl*

*They’re not gneiss*  
*You won’t find a dope as seductive as topaz*

*It’s not gneiss*  
*Think of the peril connected with beryl*

*It’s not gneiss*  
*A hangover starts from fooling with quartz*

*Basic basalt is primeval*  
*Coal and bitumen are black and inhuman*

*Gold is the root of all evil*  
*Granite’s a doomstone, a head for a tombstone*

*It’s not gneiss*  
*We say once again, we’re innocent men*

*Nothing will lead us to vice*  
*You can’t trap us with your lapis*  
*It’s not gneiss.*

At the program conclusion, The Associates joined in a rendition of “Let’s Grow Old Disgracefully (I’ll Chase You, You Chase Me).” Meanwhile, rumors abounded that The Associates would collaborate with the Caltech Stock Company next year in a musical production—cementing Caltech family ties and helping to carry on a tradition that began in 1954-55 with the first Stock Company show, “The Road to Stockholm,” that celebrated the awarding to Linus Pauling of his first Nobel Prize.

## Wasserburg receives distinguished honor

Gerald J. Wasserberg (John D. MacArthur Professor of Geology and Geophysics at Caltech) has been awarded one of the scientific community’s most prestigious honors, the 1986 Crafoord Prize of the Royal Swedish Academy of Sciences. He will receive the award and the Crafoord gold medal from King Carl Gustaf of Sweden in Stockholm on September 24.

Wasserberg shares the prize of approximately \$138,000 with Claude Allegre of the University of Paris.

In honoring Wasserberg, the Academy cited his “major impact on our knowledge of the universe, focusing on the origins and history of the solar system and its component bodies.

“His work has established a time scale for development of the early solar system and the formation of the planets, the moons, and the meteorites,” the citation continues.

## Space Center visit



Joanna and Downie Muir at the Johnson Space Center in Houston. The Muirs were among 62 members of the President’s Circle who visited the Space Center in March.

## Politzer, theoretical physicist, honored

David Politzer, professor of theoretical physics, has been named co-recipient of the 1986 J. J. Sakurai Prize, “for analyses of non-Abelian gauge theories at short distances, and the implications for understanding the strong interaction between quarks.” He received the award at the April 28 meeting of the American Physical Society in Washington, D.C.

The award recognizes Politzer for his role in explaining how quarks, believed to be the basic constituents of matter, can behave like free particles when relatively close together, while remaining permanently trapped inside protons and neutrons.



## Harvey Mudd concludes cannon caper: returns antique weapon

The 115-year-old cannon that accentuates the entrance to Fleming House is back, after several weeks on the Harvey Mudd campus.

Several Harvey Mudd students stole the old firing piece during spring break in late March. They convinced security guards that they were workmen taking it away for repairs.

Caltech students considered several means of stealing the cannon back, including using a helicopter to lift it out, or bringing the Marines in to aid in a rescue party, but claimed the Harvey Mudd administration blocked all such efforts to reclaim the weapon.

Finally, as sensibilities between students of the two schools became increasingly bruised, President Goldberger asked Harvey Mudd President D. Kenneth Baker to have the cannon returned.

Harvey Mudd students decorated the cannon with streamers and balloons and with signs announcing, "To Murph with love, from Harvey Mudd," and loaded it onto a truck. On its return trip, carloads of Caltech students chased the truck, attempting to remove the streamers and signs, until, after a fender bender and shouting match, the truck reversed its direction and the cannon headed back to Harvey Mudd. Caltech officials later returned to escort the unadorned cannon home to the Olive Walk. There it was greeted by strains of Wagner's "Ride of the Valkyrie" through house windows, as students sipped champagne.

The cannon originally came to the Olive Walk in 1972, on long term lease from Southwestern Academy, a private school in San Marino. It was returned to Southwestern several years later on request of the Caltech administration after the concussion from a blast to summon students to an ASCIT meeting blew some windows out of an adjacent building. The cannon came back to campus in 1981, through the efforts of a new generation of Fleming House students.

## Work hard but have more fun, ASCIT leader advises peers

By Winifred Veronda

Clea Bures, a red-haired junior from Victoria, British Columbia, emerged first in a field of four candidates and was elected president of ASCIT for the coming year. A physics major, she is the second member of her family to attend Caltech. A brother, who after two years at the Institute decided to major in creative

convey to the administration ideas from the student body for the renovation of the adjoining basements of the four south houses.

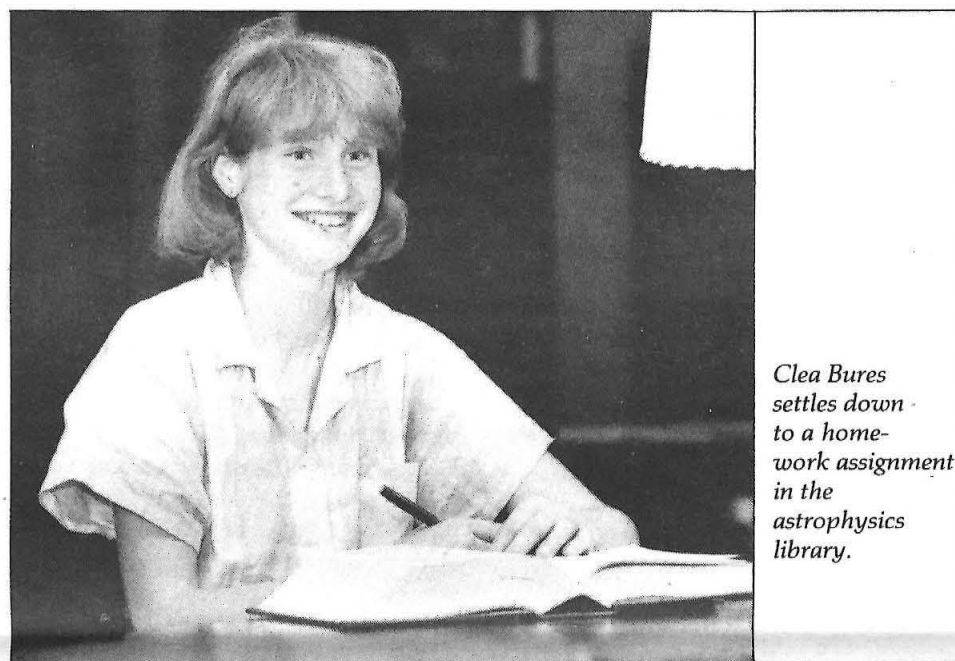
The connecting basements will be ready for use around the beginning of winter term. The coffee house will move to the new location, which will also become headquarters for ASCIT

students here who find the time to have fun and to enjoy being here, but not enough of them."

A member of the Caltech Y Executive Committee, Bures also served as an alternate student representative on the Freshman Admissions Committee, a student member of the Upper-class Admissions Committee, and as her house athletic manager. After graduation she plans to go on to graduate school, and she eventually wants to work in industry. She is the fourth woman president of ASCIT in the past six years.

As ASCIT president she sees her goal as "communicating to the faculty and the administration what the students want—and improving the quality of life at Caltech by supporting groups that want to do something to make it better."

With a goal like that, Bures can look forward to a busy year.



Clea Bures settles down to a home-work assignment in the astrophysics library.

writing at another university, gave her insight both into Caltech's strong and weak points.

The strengths, she believes, are the chance to get an excellent education, the opportunities to do research, and the lack of competition within the student body.

"Really," she says, "the competition here is mostly with yourself, and with your own feelings about what you should accomplish."

The negatives: "Students in general are overworked and there's a lot of tension. Not enough people here find the time to have fun."

Although Caltech may not have been right for her brother, Bures is very happy with the choice she made. "I wouldn't encourage everyone to come here, but for certain people Caltech's a great place, and the educational quality is unsurpassed," she says.

Those who will be happiest at the Institute, Bures believes, "are those who care deeply about science and are willing to work very hard, and who will find time for other activities despite their work load."

To help create opportunities for more students to enjoy their Tech years is one of Bures's goals as ASCIT president. She wants to work for an eventual campus center building ("The outlook for one in 10 or 15 years is pretty good," she believes), and in the meantime, she will help

and for some of the student publications. Meeting rooms, practice rooms, and club rooms will be a part of the new facility.

The new ASCIT president hopes that such a common gathering place will encourage students to develop more friendships with people from other houses. Bures, who is a social member of Ricketts, Ruddock and Page Houses, would like to see undergraduates thinking of themselves first as Caltech students—and second in terms of their house membership.

Holding office during the year following the fourth faculty student conference brings a special responsibility, which Bures defines as "giving the planning committees kicks so they'll keep working."

"The faculty was very pleased because the students came to the conference so well organized and with specific goals," she says. "Now the committees have to keep meeting, because it will take a lot of work to make the goals a reality."

One of these goals—in which Bures is particularly interested—will not be an easy one to achieve, she acknowledges. This would be to make the regular course load per term four, rather than five, classes. Then, she believes, "students would spend more time on the courses they're taking, and would get more out of them. People feel overworked and there's a lot of tension. There are

## Memorial benches in Dabney Garden honor Marrie Casey

In the fall of 1984, the young alumnus, then a graduate student on the east coast, telephoned for Marrie Casey at the Registrar's Office to obtain some information about his transcript. There he learned that Casey had died of a heart attack a few weeks earlier.

"I knew she was going to retire soon," he said, "but —! She didn't have to die!" Then he began to sob.

His reaction was an expression of the love that many students came to feel for the woman who was in charge of undergraduate records at Caltech for 24 years, and who met and helped thousands of undergraduates. She was the person to whom countless students brought their drop cards and preregistration cards, and who handed them back if they contained an error. At one point, students organized contests between houses to see which house had the fewest drop cards returned.

It was this feeling for Casey within the Caltech community that motivated friends and family of the long-time staff member to present two benches, each with an inscribed plaque, to the Institute in her memory.

The benches are in Dabney Garden. Landscaping in the area where the benches are placed is also part of the gift.



## Women's Club offers campus architectural tours

Architectural tours of the Caltech campus are a new feature organized by a docent group of the Caltech Women's Club. The docent program, called the Caltech Architectural Tour Service, offers tours at 11 a.m. on the fourth Thursday of each month; special tours may be arranged on request.

Docent members are Paula Samazan (chairperson), Romy Wyllie (president of the Women's Club), Missy Jennings, Roxanna Anson, Jane Caughey, Bunny Gould, Linda Kamb, Theo Page, Robin Shectman, and Micheline Vogt.

The tours cover the areas of architect Bertram Grosvenor Goodhue's masterplan for the campus, beginning at the Athenaeum and leading to the "grand entrance" that he conceived—the two blue-domed porticos at the corners of North Mudd and Kerckhoff. After stops at Bridge, Dabney, Robinson, Arms, and Parsons-Gates, the tours return to the Athenaeum by way of the newer campus areas.

Reservations for the tours should be made with Bonnie Baker in the public relations office, 356-6326, 1-71, Pasadena CA 91125.

## Solution sought to "mystery bench" origins

The Caltech Women's Club is seeking help from alumni who may know the origins of a "mystery bench" that has recently found a new home in the Athenaeum.

The oak bench was discovered in the gallery of Dabney Lounge by the Caltech Architectural Tour Service of the Women's Club (CATS) and, at CATS request, it was moved to the Athenaeum where more people could see it.

The bench features an elaborately carved back with a central panel depicting Architect Bertram Goodhue's vision of the early campus. The design shows the domed memorial building and the west court with three pools of water that were part of the original plan. Rows of cypress trees stand along the biology and geology buildings that flank the north and south sides of the court.

Anyone who has information about when the bench was designed, who created it, and where it was originally located is asked to contact Romy Wyllie, 818-794-7773, or to write the public relations office, Caltech 1-71, Pasadena, CA 91125.

## Survey brings Caltech freshmen into focus

Each fall when the new freshmen class arrives at the Institute, its members are asked to take part in a national survey of freshmen. Sponsored by UCLA and the American Council on Education, the survey queries the newcomers about their backgrounds, attitudes, and aspirations. Responses from Caltech freshmen are compared with those from freshmen at other highly selective private universities (HSPU).

This fall, 194 Caltech freshmen participated in the survey, and results have been passed along to the Caltech admissions office. According to the results, 15 percent of Caltech freshmen are 17 or younger, compared to about 6 percent for other HSPU. Of the Caltech students, 69 percent come from more than 500 miles away, while in other highly selective universities, only about 46 percent typically come from that distance. Precisely 27.3 percent of the freshmen who responded consider themselves Asian-American/Oriental; the figure for other HSPU is 9.2 percent.

Exactly 32.5 percent of Caltech freshmen come from families with incomes of \$25,000 a year or less, while only about 13.5 percent of other HSPU freshmen come from families in this income group.

At the other end of the financial spectrum, one-half of one percent of Caltech students come from families with incomes above \$150,000, while more than 10 percent at other HSPU come from families of this income level.

About 70 percent of the Caltech freshmen reported that they plan to go on for a doctorate, while only 25

percent at other HSPU indicate they are planning to do so, and only 18 percent had that goal at all private colleges and universities.

Of those responding to the survey, 44.4 percent at Caltech indicated no religious preference, compared to 17.8 at other HSPU with no preference to state. The largest single group to indicate a religious preference at the Institute was the 27 percent who identified themselves as Protestants. This figure compares with 15.3 percent indicating Roman Catholic preference and 2.6 percent indicating Jewish.

These figures compare with 24.9 Protestants, 38.2 percent Catholics, and 12.7 percent Jewish at other HSPU.

Of the Caltech freshmen, 38.1 percent chose the physical sciences as a probable major. Within this category was a large subgroup—29.8 percent who chose physics. Exactly 48.1 percent of the newcomers chose engineering (26.7 percent selected electrical engineering). Computer science was selected by only 2.1 percent of the entering Caltech freshmen.

At other HSPU, 7.6 percent planned to major in the physical sciences (3.0 percent in physics), 48.2 percent in engineering (26.7 percent in electrical engineering), and 1.8 percent in computer science.

The students were also asked to comment on goals that they consider essential or very important. When asked about their interest in influencing political structures or social values, promoting racial understanding or participating in community action, the Caltech freshmen showed

markedly less interest than their colleagues at other universities.

When asked questions about government policy, women's roles, taxes, drugs, and social attitudes, the students tended to be somewhat more conservative than students elsewhere.

Most important to the Caltech freshmen was to become an authority in their field: 74.9 percent, compared with 75.1 at other HSPU.

Other important goals were: gaining respect from colleagues (59.2 percent at Caltech, compared with 58.5 percent at other schools), achieving financial success (57.6 percent at Caltech, compared with 60.9 at other HSPU), developing a philosophy of life (55.5 percent at Caltech, compared with 59.7 at other HSPU), making theoretical contributions to science (54.7 percent at Caltech, compared to 23.9 percent at other schools), and raising a family (50.8 percent at Caltech, compared with 69 percent at other HSPU).

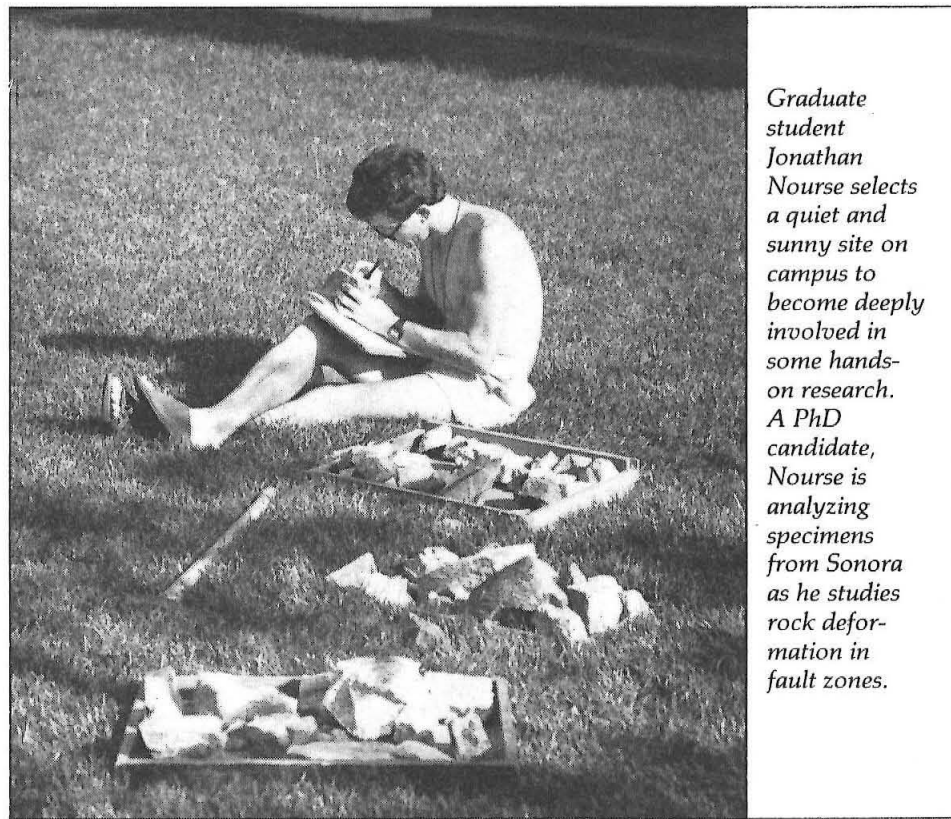
## Techers win title as top student programmer team

A team of five Caltech students has become the top student programmer team in the country, after winning the 1986 International Scholastic Programming Contest of the Association for Computing Machinery. The contest pitted the students against teams from 24 colleges in the United States, Canada, Great Britain, and Switzerland, all of whom had won regional championships. Altogether, 200 schools competed in the contest.

Members of the Caltech team were: Steve Burns, Dave Gillespie, Rajiv Gupta, Tim Kay, and Steve Rabin. Gillespie is a senior in computer science. The others are graduate students in that field.

In winning the championship, the Caltech team was the only one to solve all eight programming problems given contestants during the allotted six-hour period. They used Pascal programming language and IBM PC/XT computers. The eight problems consisted of such tasks as figuring the optimum route for a railroad through a series of cities, and planning the hubs of an airline given the location of its principal cities.

For winning, team members received a trophy, certificates, and a plaque from Epsilon Pi Epsilon, the computer science honor society. Caltech received two computers, an assortment of software, and a \$1,000 scholarship award.



*Graduate student Jonathan Nourse selects a quiet and sunny site on campus to become deeply involved in some hands-on research. A PhD candidate, Nourse is analyzing specimens from Sonora as he studies rock deformation in fault zones.*



# Strong effort marks spring sports season

## Baseball

The 1986 Caltech baseball team finished the season with an overall record of 6-27. As the record indicates, the season was rough from start to finish. Injuries and eligibility problems made it difficult to establish a consistent lineup, and the team's overall lack of experience proved costly when facing a tough slate of opponents.

To the players' credit, however, they maintained a positive attitude and consistently won respect for fine effort in the face of sometimes overwhelming odds.

Top individual honors went to Jim Hamrick, a senior. Hamrick set a total of 14 single-season and career records in these offensive categories: Hits (39-120), doubles (10-17), triples (7-13), home runs (7-17), RBI's (39-107), runs (26-95), career games (126), and career at bats (374).

In addition, Hamrick led the team with a .963 fielding average from his catching position. For these accomplishments, he was voted to the All-SCIAC Conference first team and was presented the 1986 Alumni Trophy as Tech's outstanding player.

The Peterson Trophy for the outstanding freshman player went to Brian Colder, a pitcher/infielder. Colder batted .239 and was the pitcher of record in four of the team's six victories.

Other lettermen include seniors Brandon Mymudes, Min Su Yun, Alan Marumoto, Brian Lund, and Mike Rigler; junior Brett Bush; sophomores Kenny Lin, Doug Roberts, and David Bruning; and freshmen Jim Burleigh, Jim Coykendall, and Brian Lemoff.

Claremont and La Verne tied for the conference championship with 15-3 records, followed by Redlands (12-6), Whittier (8-10), Occidental (7-11), Pomona (6-12), and Caltech (0-18).

The team demonstrated much courage and dignity while battling through a tough season. The seniors in particular deserve praise for the leadership they provided. The underclassmen gained valuable experience that will be of great benefit in years to come. "All things considered," says coach Dan Bridges, "this was a good season and one of which all the team members should be proud."

## Fencing

The fencing league in which Caltech competes—the Intercollegiate Fencing Conference of Southern California—was composed of nine teams this season, but three schools failed to field teams in two events and thus were dropped from the league. Those dropped were Occidental, San Diego State, and UC Santa Barbara.

Caltech fielded a strong sabre team, even though Chien-Wei Han, last year's captain, had graduated. Scott Lewicki, Matt Himmelstein, and newcomer Nathan Good performed above expectations. Lewicki and Himmelstein placed third and fourth among individuals, and Good ranked 11th among 28 competitors. As a team, men's sabre finished in third place.

Based on results, the other teams—men's foil, men's epee, and women's foil—fared poorly, although there were some notable individual results. Among these: Dana Pillsbury, in her first full season, won sixth place in a field of 31 competitors. Dee Morrison and Ann Lewis, with no prior fencing experience, placed 23rd and 24th. In men's foil, Scott Grossman closed out his college career in tenth place—his best ever. Craig Keller ranked 12th among 30 foilists.

## Golf

The good news for the 1985-86 golf team was the arrival of freshmen Tim Archer and Chris Habecker of Estes Park, Colorado. During the first part of the season, they played in almost every match and, along with John Mann, a junior from Liverpool, New York, they kept the program alive.

The bad news was that Caltech was able to field a full five-man team in only four of the nine scheduled matches in the conference this season.

During the season second half, Archer, Habecker, and Mann were joined by Dan Bikle, a junior, and seniors Rob Fatland and Robin Whitt. Thus they were able to score in the final four matches and to field a team at the conference tournament. It was at the tournament that Habecker surprised everyone with a first-round score of 80 and a second-round score of 98 to lead the Caltech team. Habecker's performance not only won him Caltech's J. Ben Earl Trophy, but makes his prospects for the future very bright.

Caltech didn't win any matches this year, but with four of the six golfers returning, and with help from

the new freshman class, the team should be in much better shape next year.

In the SCIAC Conference, Redlands repeated as champions, followed by Pomona-Pitzer, Claremont-Mudd, Occidental, La Verne, and Whittier.

## Men's Tennis

Led by seniors Sung Kim, Brian Porter, Ted George, and Ashok Krishnamoorthy, the men's tennis team completed its finest season in many years. With victories over La Verne, Whittier, Christ College, and the Caltech faculty, the team assured itself of a season it could look back on with pride.

For the first time in more than 15 years, Tech played close, competitive matches with Occidental and Pomona, including a near (4-5) upset over Pomona.

The team was filled out by experienced juniors Tom Nolan, Steve Koshowski, and Khanh Nguyen, and by two excellent freshmen, Raleigh Chiu and David Garza.

Though the Redlands and Claremont teams dropped in quality this year, they are still in the top 15 Division III teams in the country, making the SCIAC Conference one of the strongest in the nation.

This year, Caltech also played a junior varsity schedule with practice matches against Pomona, Claremont, Redlands, and Occidental. Members of the Caltech team included Mark Berman, Greg Martin, Tung Yin, Michael Tran, Hungse Cha, Chad Martin, Tim Ma, Javier Castellero, Frances Ho, Anh Tuan Le, and Brian Patterson. Michael Tran and Anh Tuan Le are particularly promising freshmen who may help to fill in next year for graduating seniors.

## Women's Tennis

Led by first-year coach Giny Marum and returning seniors Margaret Carter, Tammy Choy, Lisa Cummings, and Joy Watanabe, the Caltech women's tennis team has concluded its best season. After a shaky first half with losses to SCIAC leaders Occidental, Pomona, and Claremont-Mudd-Scripps, the team went on to defeat La Verne in an exciting match, 5-4.

Coming off spring break, the team posted two wins over Citrus Junior College (5-1) and Cal Lutheran (7-2). Two close matches against conference foe Whittier College resulted in losses of 7-2 and 6-3.

Although the team finished with an overall record of 3-9, there were several outstanding performances. Tammy Choy had a strong season with six wins at the number one position. A returning All-SCIAC member, Choy teamed with her sister, Carol, for a record eight wins at the first doubles spot—good enough for third place in SCIAC. Pam Feldman had five singles wins at the number six spot and was a steady influence at third doubles. The women's tennis team made a strong finish at the SCIAC tournament in Claremont. For the first year, a Caltech team was back to compete on Saturday—the second day of the tournament. Tammy and Carol Choy lost in the semi-finals of the doubles to the championship team from Occidental. In an upset, Pomona captured the league tournament, but Occidental is this year's conference champion, and will represent the conference at the nationals. The team loses four seniors, but talented freshmen and returning junior Pam Feldman give Tech a good shot at a strong showing next year.

## Letters: Celebrating Linus Pauling's birthday

Dear Editor:

February 18, 1986, an academic holiday at Caltech, was one of the great days of my life. It was, first of all, a review of 20th century chemistry (a synonym for Linus Pauling). The excitement of the discovery of the alpha helix was relived, and Linus once again demonstrated his "stochastic method" of determining structures. In essence, he thinks about the molecule, puts together a reasonable structure using the most likely bond length and angles and packing, calculates the intensities of the X-ray lines, and—presto! Agreement.

When straightforward, computerized methods of determining crystal structure became available, most of the fun was gone. But in the last few years, new structures have been determined at 140,000 atmospheres, and insufficient data are available for routine determination—which gave Linus "a new lease on life." The stochastic method and his pocket calculator are again supplying reasonable structures for what otherwise requires a "new state of matter" for explanation of the x-ray lines. (See,

*Continued on page 10*



## Letters

Continued from page 9

e.g., *Nature*, Vol. 317, 10 October 1985, pp. 512-514.)

But Linus was not the only star of the day. Sir Francis Crick's modest introductory remarks were worth the trip to Pasadena. Norman Davidson's review of two decades of Linus's life at Caltech were perceptive, interesting, and entertaining. His opinion that Linus deserved a third Nobel Prize in pure chemistry for his fundamental ideas on the nature of the chemical bond—and also his explanation of the coordination patterns of transition group metals—was provocative, as was his statement that Linus is certainly the greatest chemist, and one of the three greatest scientists, of the 20th century.

At the reception, my wife obtained the signatures of five Nobel laureates (representing six prizes) in five minutes. The splendid dinner supplied by the Athenaeum was only a preliminary to more witty but heartfelt remarks. Provost Vogt opined that Caltech, following in Linus Pauling's footsteps, still had, if not the best, certainly one of the best chemistry departments in the world.

He then indiscreetly (for a provost) remarked that it was probably the best department at the Institute, which brought the anticipated rejoinder from department members that this comment be recognized with the next paycheck.

Edward Hutchings presented a brilliant pictorial talk on the life of Linus Pauling from infancy to maturity, highlighting all the major (and many of the minor) events in his life, both personal and scientific.

Finally, Linus was crowned King of Kings by Ahmed Zewail, with the presentation of a photographic montage of Linus Pauling as King Tutankhamen, complete with Egyptian headdress and gold beard. A more serious presentation, made by Fred Anson, was a bronze plaque naming Gates 22 as the Linus Pauling Lecture Theater.

Linus's acceptance of these honors, and his expression of his eternal love affair with Caltech, and the trials, tribulations and triumphs experienced during his many decades as student, professor, and department chairman concluded a celebration that those of us fortunate enough to attend will remember all the days of our lives.

Sincerely,  
Ralph Spitzer (PhD '41)

Ed. note: *Caltech News* expresses thanks to Dr. Spitzer for his interesting account of the celebration honoring Linus Pauling on his 85th birthday.

## Don't forget your Alumni Fund gift

The 1985-86 Alumni Fund will officially close on June 30, and Harry Moore (BS '48), Alumni Fund chairman, reminds all alumni who have not yet contributed to send in their gifts before the end of the month.

"The Fund has been attempting this year to maintain the gains made during the three years of the Irvine Challenge," says Moore, "and we've been able to stay about even, although it's been a struggle. Nevertheless we're way ahead of where we would have been without the Irvine Challenge and the gains that it brought us."

By May 12, the Fund had raised \$1,562,411 from 6,736 donors toward goals of \$2,100,000 from 7,623 alumni.

Through the Irvine Challenge Campaign which concluded last June, the Irvine Foundation matched, up to agreed limits, increases in total contributions from alumni over the previous year for three successive years.

## ALUMNI ACTIVITIES

June 13

Commencement on the Caltech campus.

June 19

Annual meeting and dinner honoring new honorary alumni and officers, at the Athenaeum.

October 5-10

Zion-Cedar Breaks trip for Alumni Association members and families or guests. Beautiful scenery amid fall colors in southern Utah. Call Janet Davis, Alumni Association office, 818-356-6594 for more information and to make reservations.

## Washington alumni hear President Goldberger

Caltech alumni in the Washington, D. C. area gathered on April 7 at the National Academy of Sciences for a reception featuring President Marvin L. Goldberger. Approximately 100 alumni and friends of Caltech attended. Goldberger, who was introduced by Bruce Abell (BS '62), presented an overview of research at Caltech and of future plans for the campus.

## Personals

1944

STANLEY E. DAY, an earth science instructor at Los Altos High School in Hacienda Heights, was named outstanding earth science teacher for 1985 by the Far West Section of the National Association of Geology Teachers. He has been teaching at the high school since 1970; he also teaches geology at Cal State Dominguez Hills. He and his wife, Evelyn, live in Rowland Heights.

J. FRANK VALLE-RIESTRA, MS '49, retired in January from the Western Division of Dow Chemical U.S.A., after 37 years of service. Until his retirement, he was a research scientist and manager of research engineering with the company. He will continue as lecturer in the chemical engineering department at UC Berkeley.

1948

JAMES C. FLETCHER, PhD, has been confirmed by the U.S. Senate as new administrator of NASA. Fletcher, a former president of the University of Utah, served as administrator of the space agency for six years during the 1970s, a time when NASA launched the space shuttle development program and carried out the last manned flights to the moon as well as the Apollo-Soyuz mission with the Soviets.

1952

JOHN A. BOPPART, MS '53, has been appointed senior vice president of Garrett Turbine Engine Co., in Phoenix, Arizona. He joined Garrett in 1953.

ELIAS A. JARVINEVA, MS, retired last year as an aeronautical consultant with Valmet Defense Equipment Group, Finland. He also has a new home in Tampere, Finland.

1953

BRUCE N. AMES, PhD, received the Kenneth A. Spencer Award in February for his many contributions toward the study of genetic toxicology and molecular biology, including the Ames test, which uses bacterial strains to detect chemicals that mutate DNA—a likely cause of cancer. He is professor and chairman of the department of biochemistry at UC Berkeley. A member of the American Chemical Society, the American Society of Biological Chemists, the American Association for Cancer Research and the Federation of American Scientists, he has received many prestigious awards, including the Tyler prize for environmental achievement, in 1985.

ARTUR MAGER, PhD, has been named a Jimmy Doolittle Fellow by the Aerospace Education Foundation. Former group vice president of the Engineering Group at the Aerospace Corporation, he retired in 1983. He lives in Los Angeles.

1956

JOSEPH P. GIBBS writes from his new home in Marina del Rey, California, that in March, 1985, he accepted the position of president of Eaton Electronic Instrumentation, a manufacturer of microwave test and measurement equipment in Los Angeles. He also writes that his daughter, Adrea Gibbs Muldoon, is currently performing in "Cats" at the Shubert Theatre in Century City.

ROBERT KAUSEN of San Rafael is executive director of the Life Education Institute. He writes that he and his partner have developed a technique that allows them to teach common-sense understanding which enables people to interact more easily and function effectively without stress. Kausen left engineering management in 1976 to spend full time in human relations work.

WILLIAM L. MARCY, MS, writes, "After 33 years in government and industry, I have retired from Martin Marietta to begin a second career as a general aviation consultant specializing in light aircraft modifications."

SAMUEL R. PHILLIPS, MS '57, of Portola Valley, California, has been operating a consulting engineering office since July, 1985. He specializes in product engineering (the preparation of new products for manufacturing). Phillips is the director and secretary of the Silicon Valley Chapter of the Professional and Technical Consultants Association. His wife, Mitzi, is a research assistant and lecturer at the Gorilla Foundation, which investigates the intelligence of primates.

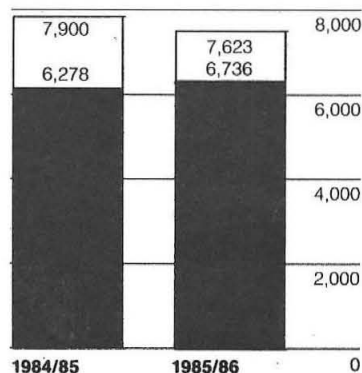
1957

C. ALLEN WORTLEY, MS, has been named associate dean for industrial relations in the University of Wisconsin-Madison's College of Engineering. He will continue his Great Lakes ice engineering research, his advisory services work with the university's Sea Grant Institute, and continuing education programming.

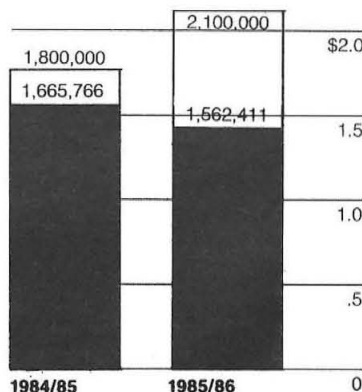
### The Alumni Fund 1985-86/Goals and Achievements

□ Goals ■ Achievements as of May 12, 1986

Donors



Dollars





1958

HAROLD K. FORSEN, MS '59, has been elected vice president of Bechtel, Inc., and has been appointed deputy general manager of the company's research and development division. Before joining Bechtel in 1981, he was vice president and director of Exxon Nuclear Company.

1959

DR. AKIRA KOBAYASHI, professor of engineering at the University of Tokyo, has been designated National Delegate of Japan to the International Committee on Aeronautical Fatigue.

1960

ROBERT WALSH lives in Albuquerque, New Mexico, where he is a principal in SYStems CALCulations, Inc, a new venture that is developing a database that interfaces the various computer tools used in circuit board development. He has also been training and consulting in reliability engineering in the United States, Canada, and Israel. Walsh has been playing in an outdoor soccer league for four years. He writes that in his spare time, he manages Walsh Administrative Services and lectures in engineering and business at local colleges.

1961

DAVID W. KENDLE of Santa Monica married Regan Ewing in May 1985. He recently celebrated the first anniversary of his business, D.W. Kendle & Associates, which provides custom software development and consulting services.

1961

HOWARD C. MERCHANT, PhD, president and principal engineer, MerEnCo., Inc., in Bellevue, Washington, has been named a Fellow of the American Society of Mechanical Engineers (ASME). He has been active in the fields of vibrations, dynamics, acoustics, and earthquake engineering. The grade of Fellow is conferred on ASME members with at least 10 years active engineering practice who have made significant contributions.

1962

DAVID GRIMES, classical guitarist in Glendale, California, gave the first concert in The Associates of Brand Library's 1985-86 concert series. A foremost teacher of classical guitar, he is considered by critics to be a powerful performer, noted for the strength and beauty of his tone and the originality of his repertoire.

1963

RAYMOND D. AYERS, MS '64, PhD '71, gave a program on acoustics of early woodwinds at UC Irvine in January. The lecture also included a computer-animated film and samples of sounds of woodwinds from Ayers' collection of renaissance and modern woodwinds. He is a professor of physics-astronomy at Cal State Long Beach, where he also teaches musical acoustics.

1964

ROBERT F. POE, MS, writes that "after many years in academia, I moved into the commercial realm three years ago and like it a lot better. I am an analytic scientist in advanced systems development, Eikonix Corporation (a Kodak company), specializing in digital imaging systems for graphic arts and other applications."

1966

JONATHAN F. CALLENDAR tells us that on January 11 he opened the New Mexico Museum of Natural History in Albuquerque, of which he is director. "In the first three months, we've had 120,000 visitors. Exhibits in geology, paleontology, zoology, and botany are 'hands-on', interactive."

1967

PETER N. CROSS writes that he has been a financial advisor to the Honduran Ministry of Public Health for the past three years. He adds that he finds his co-workers competent and feels that the country is making progress toward improving the quality of life of the Honduran people, both medically and politically.

BENJAMIN N. EARLY, MS, PhD '70, was married to Delilah Faye Mock on November 30, in Washington, D.C. They live in North Hollywood where he is a program manager for Aerospace Corporation.

1971

WILLIAM K. DELANEY was ordained as a Catholic priest in June 1985. Currently a visiting associate in mathematics at Caltech, he will be an assistant professor of mathematics at Loyola Marymount University in the fall.

J. GEORGE MAST, MS, has joined Kitchens of Sara Lee in Deerfield, Illinois, as director of food service research and development. He will direct all developmental activity for new and existing food service products. Before joining Kitchens of Sara Lee, he was vice president of Oregon Freeze Dry Foods.

JOHN G. VICTOR is living in Evanston, Illinois, where he has finished his master's thesis in chemical engineering and expects to receive a PhD in two years.

1972

NELSON E. BRESTOFF, MS, has been an attorney in the Los Angeles area since 1975. He has written two books: *How to Borrow Money Below Prime* and *How to Write Off Your Downpayment*. Another book, *Turning Neighborhoods*, will be finished in August.

YORKMAN LOWE, Ex'72, is working out of the South San Francisco office of United Parcel Service. He writes that in his spare time he is studying ballroom dancing, photography, and word processing.

1975

GORDON P. TREWEEK, PhD, writes that he is now employed as director of environmental services for Tetratex in Pasadena.

1978

POCHI YEH, MS, PhD '78, has been named Engineer of the Year by Rockwell International Corporation. He received the award—the company's highest honor for technical achievement—for distinguished contributions in advancing the fundamental understanding of optical wave interactions with matter and the creative use of this phenomenon in optical device applications. He has been associated with Rockwell since 1977; he currently lives in Thousand Oaks.

1979

DAVID R. TYLER, PhD, is recipient of an Alfred P. Sloan Fellowship, for special creative ability and exceptional promise of contributing to the advancement of knowledge. A member of the University of Oregon faculty since 1985, he was previously professor of chemistry at Columbia University. The inorganic chemist conducts research on the chemistry of transition metal complexes.

PATRICIA FRANCES SCOTT, PhD, and DAVID MARTIN COLE, PhD, were married in September. She has been a geophysicist with Citco Exploration in Dallas; he, a scientist with TRW in Redondo Beach, California.

1981

JAMES J. ANGEL writes, "I graduated from Harvard Business School with an MBA and I am now working on a PhD in finance at UC Berkeley. It feels great to be back in California!"

KENNETH L. CAMPOS has begun residency training at the Mayo Graduate School of Medicine, in Rochester, Minnesota. He received his MD degree from UC San Diego School of Medicine.

STEPHEN WILKOWSKI, MS, received the professional degree of electrical engineer from Columbia University. He is working at AT&T Bell Laboratories and is continuing his graduate studies at Drew University in Madison, New Jersey.

1982

MORGAN GOPNIK, MS, and her husband, Tom Bondy, "are thrilled to announce" the birth of their first child, Adrian G. Bondy, on November 13. The family is now living in Sacramento but plans to resettle in Washington, D.C., in the fall of 1986. The couple were resident associates of Fleming House in 1983-85.

1983

BJORN ECKART MATTHIAS married Susanne Spiess on February 14, in Los Alamos, New Mexico.

1984

DOUGLAS S. CLARK, PhD, assistant professor of chemical engineering at Cornell University, has been named a Presidential Young Investigator. The National Science Foundation award makes him eligible for \$100,000 a year in federal and private matching research funds. The awards are aimed at helping universities retain outstanding PhDs who might otherwise pursue non-teaching careers. Clark is a specialist in biochemical engineering.

## Obituaries

1924

ROBERT B. BRODE, PhD, professor of physics, emeritus, at UC Berkeley, on February 19. A pioneer in cosmic ray research, Brode was a member of the UC faculty for 40 years, with a brief hiatus during the Second World War when he worked at Los Alamos on the Manhattan Project. After his retirement in 1967, he continued as an academic administrator. He is survived by his wife, Bernice, and a son, John.

1925

ROBERT T. DILLON, MS '27, PhD '29, of Albuquerque, NM, on March 8. A distinguished chemist and member of the American Chemical Society and the American Society of Biological Chemists, he contributed to the development of Dramamine and to Enovid, the first birth control pill. Contributions to the Robert T. Dillon Memorial Fund may be sent to the Caltech Office of Memorial Funds, 1-36, Pasadena 91125. Dillon is survived by two daughters, nine grandchildren and one great-grandchild.

LELAND B. PRENTICE of Pasadena, on January 9. A retired administrator for Technicolor Corporation, he is survived by his wife, Elise.

1928

FRANK NOEL of Carpinteria, on January 28. Noel, who was retired, was an avid traveler and amateur radio operator. He is survived by his wife, Lorene.

1929

WILLIARD C. BRUCE, Ex'29, of Palo Alto, on February 6. He had retired from Pacific Telephone and Telegraph Co.

1932

DONALD E. MARSHALL, MS, of Green Valley, Arizona, in June 1985. He had been a development engineer for Westinghouse Electric Corporation until his retirement.

GRANT D. VENERABLE II of Oakland, on March 27 after a long illness. Venerable was president of George R. Healey Manufacturing Co. of Los Angeles. He is survived by three children.

1934

DAN R. MATHEWSON, of Palo Alto, in February. A retired partner of the insurance company Miller & Mathewson, he is survived by his wife, Lois, and two sons.

1937

WESLEY THEODORE BUTTERWORTH, MS, in May 1985. He was the owner of Butterworth's Dining in Auburn.

1938

NORMAN ELLIOTT, PhD, of Blue Point, New York, in 1985. He was a collaborator at Brookhaven National Laboratory in Upton, New York. He is survived by his wife.

1942

H. WILLIAM MENARD, MS '47, of San Diego, in February. He was professor of geology at the Scripps Institution of Oceanography (UC San Diego), a member of the National Academy of Sciences, and former director of the U.S. Geological Survey from 1978 to 1981. Menard was among the first to formulate the theory of plate tectonics, the movement of continental and oceanic plates across the earth's surface. In January, he received the highest honor of the American Geophysical Union. He is survived by his wife, Gifford, three children, and three grandchildren. He received the Distinguished Alumni Award.

1947

CLYDE C. ZEIGLER, MS, of Vienna, Virginia, on December 12, due to complications resulting from gastrointestinal surgery. A graduate of West Point military academy, he was awarded the Bronze Star and the Croix de Guerre for his service in the European Theatre during World War II.

1962

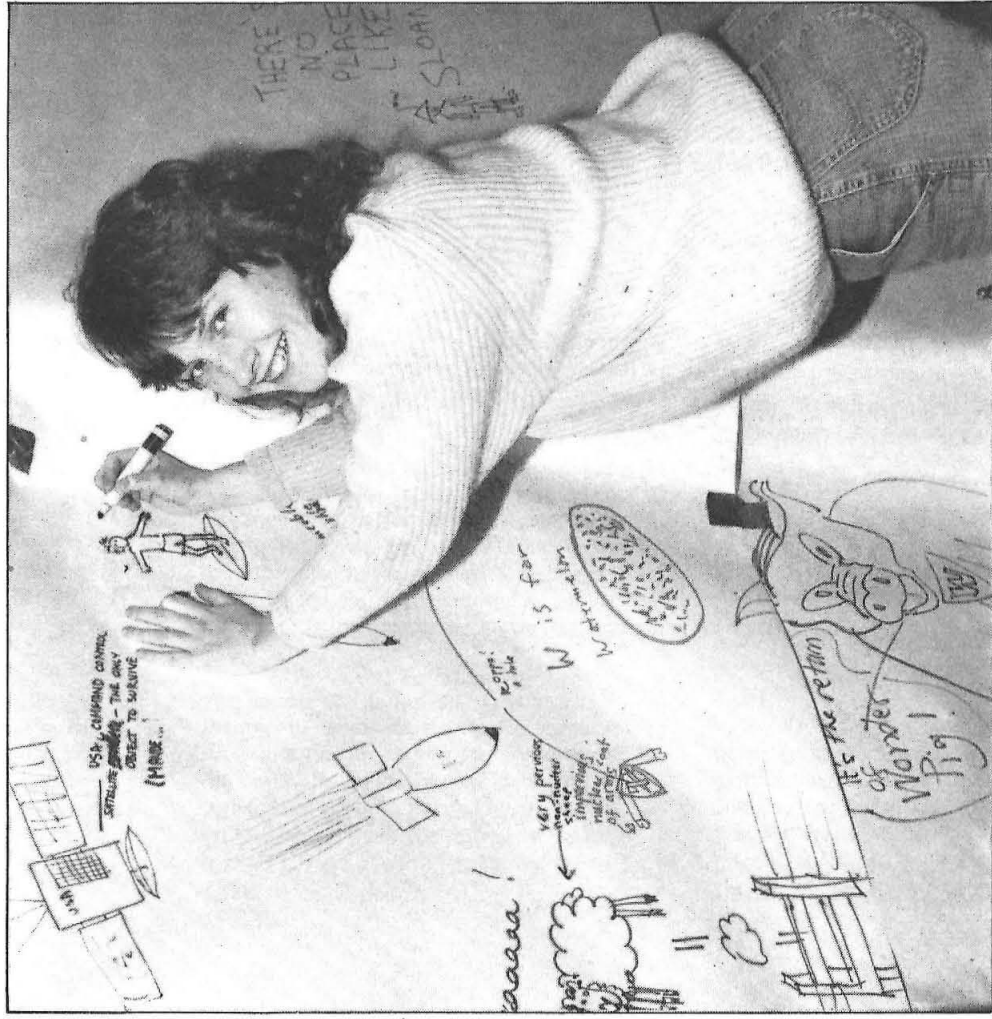
JOHN F. MCCARTHY, Jr., PhD, in February. He was corporate vice president and general manager of Northrop Corporation in Anaheim, California. McCarthy is survived by his wife, Camille.

1966

ROBERT WILLIAM GREENWOOD, Jr., of North Hollywood, on March 6.



# CALTECH NEWS



Elizabeth Scott makes her contribution to the graffiti wall during decompression. Sponsored by the Caltech Y, decompression offers students a variety of ways to release tensions during finals week.



In the new Arnold and Mabel Beckman Laboratory of Chemical Synthesis, graduate student Leigh Clawson uses a new nuclear magnetic resonance spectrometer to determine the structure of an organic molecule. See page 3.

June 1986

# CALTECH NEWS

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