

CALTECH NEWS

October 1986

Search begins for new Caltech president

The appointment of both a trustee selection committee to find a replacement for President Marvin L. Goldberger, and a faculty advisory committee to aid in that process, has been announced by Ruben F. Mettler, chairman of the Caltech board of trustees. On March 11, 1986, President Goldberger announced his plan to retire as president of Caltech by June 30, 1988.

Members of the trustee's committee, in addition to Mettler, are John Akers, Stephen Bechtel, Jr., Shirley Hufstедler, Gordon Moore, Simon Ramo, and Lew Wasserman.

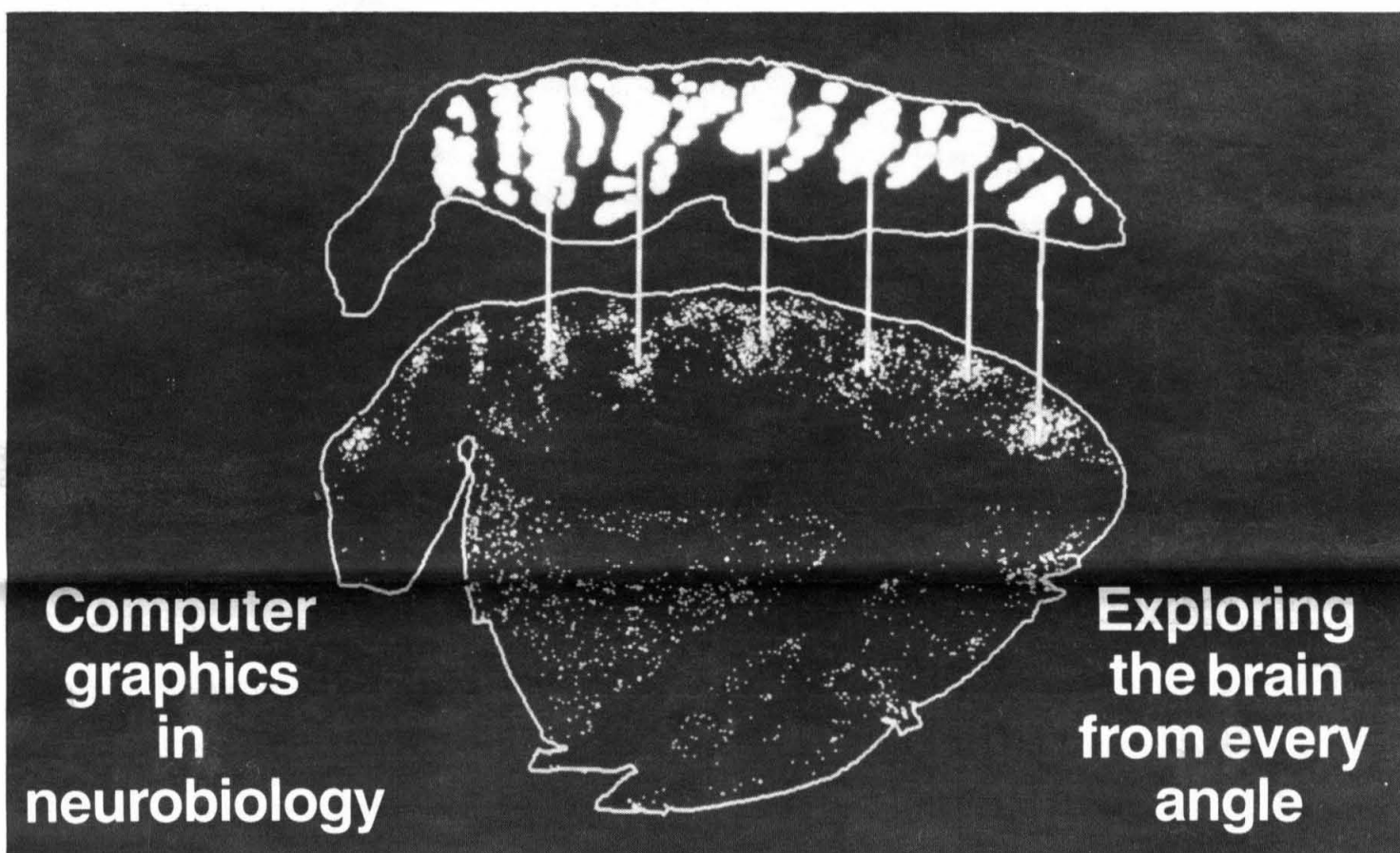
Donald Cohen is chairman of the faculty advisory committee, whose members include Bruce Cain, Peter Goldreich, Steven Koonin, Thomas McGill, David Van Essen, and Ahmed Zewail.

The faculty advisory committee will work closely with the trustee selection committee in all phases of the search for a new president. It will provide comments on general Caltech issues that are relevant to the choice of a president, and will seek suggestions for candidates from Institute faculty and staff, as well as from academic and intellectual leaders throughout the nation.

The advisory committee will also be involved in formulating a list of candidates for serious consideration, and will advise the trustee selection committee in making a final recommendation to the board of trustees.

The search for candidates will begin on October 25 when the two committees meet together. At that time they will review selection criteria, solicitation and screening plans, and time schedules.

Individuals with suggestions for a candidate are asked to address them to: Dr. Donald Cohen, chairman, faculty advisory committee, Caltech 112-31, Pasadena, California, 91125. All correspondence will be treated in confidence and will be restricted to the two committees.



Electronically reproduced images of brain segments as they are shown on the IRIS screen. The images appear in a three dimensional form; they may be rotated and examined from any angle. They are being analyzed by Professor David Van Essen and his colleagues. Both segments reveal different subregions in the brain that are related to a function of the visual process. Clusters of brain cells in the bottom segment have been marked with an antibody. The antibody indicates cells that may have had a common developmental history. The top segment shows the distribution of cells affected by another marker, an enzyme. Researchers can correlate the effects of the two markers and find out which subregions are linked to one another — and are thus likely to share the same function.

By Winifred Veronda

Computer graphics made its first mark on the consciousness of many Americans when they watched the heroes defeat the villains in the grand finale of the first motion picture in the *Star Wars* trilogy. That battle took full advantage of computer graphics of the mid 1970s to thrill viewers with a dramatic conflict between the forces of good and evil.

In the following decade, computer graphics has made giant strides in its sophistication and its capacity to make complex information much clearer and more understandable than was previously possible. And the technology that delighted viewers of motion pictures and television has found increasing use in research laboratories. Here it is an important tool for gaining insights into areas ranging from the structure and organization of the brain to the properties—at the

atomic level—of a new ceramic material.

At Caltech a boon to research in the Division of Biology is a new computer graphics device, the Integrated Raster Imaging System, or IRIS, which is shared by several researchers. This color graphics workstation is a major feature of a computerized neurobiology facility where it operates in two modes. In its primary role, it is part of a system that enables neurobiologists to reconstruct intricate three-dimensional brain structures on the computer screen. In its alternate mode, it serves as a visual stimulation system to determine the responses of cells in the visual cortex to complex but precisely controlled visual patterns, such as a rotating cube or sphere.

This technology greatly strengthens researchers' ability to learn more

about how information is processed within the brain. The \$78,000 facility was the initial purchase made possible by a \$1 million gift for equipment from the W. M. Keck Foundation in 1984.

David Van Essen, professor of biology, and James M. Bower, assistant professor of biology, have been the principal users of the system. John M. Allman, professor of biology, and Mark Konishi, the Bing Professor of Behavioral Biology, also plan to use it in their research.

Were an architect to use the system, she could, utilizing computer graphics, and with up to 16 million color tones at her disposal, create on the screen a three-dimensional prototype of a building complex and "fly through" it, like a science fiction character, examining the buildings

Continued on page 10

Boston's WGBH joins 50 stations; airs *Mechanical Universe*

The Mechanical Universe, Caltech's visually glamorous college-level introduction to the history, laws, and application of classical mechanics, is on the air this fall on more than 50 educational television stations across the country.

Station WGBH (channel 2) in Boston joined other stations carrying the show this fall, and is airing the telecourse on Saturday mornings from 10 to 11 a.m. After a preview on September 13, the programs began to air on September 20, and will continue for 13 weeks.

The second semester of the series, *The Mechanical Universe and Beyond*, will air on WGBH in the spring of 1987 at a time to be determined. This portion covers electricity and magnetism, relativity, thermodynamics, optics, and modern physics. Itek Optical Systems, a subsidiary of Litton Industries, is the corporate sponsor, and Bridgewater State College is offering *The Mechanical Universe* as a college credit course.

In the greater Los Angeles area, *The Mechanical Universe* will be shown on KCET (channel 28) on Tuesday and Thursday nights at 12:30 a.m.; on KOCE (channel 50) on Mondays and Wednesdays at 6 a.m.; and on KLCS (channel 58) on Tuesdays and Thursdays from 8:45 to 9:15 a.m.

Falcon (cable channel 50) in the San Gabriel Valley is showing the series on Monday and Wednesday both at 4 p.m. and at 7 p.m.. Group W channel 10, which airs only in the Arcadia/Sierra Madre area, is presenting the show on Mondays and Wednesdays at 10 p.m. and on Fridays at 3 p.m.

Alumni in other cities are urged to contact their local educational television stations for information on airing times, and to request that the series be shown if the station has not made plans to show it.

Its creators point out that, although *The Mechanical Universe* is designed as a rigorous college-level physics course with an accompanying textbook, it was also created to offer the interested layperson a high level of visual interest as well as information. To meet this challenge, the producers utilized many tricks of the modern filmmaker's trade, including

computer animation, outer-space sequences, on-site filming, and other special effects. David Goodstein, Caltech professor of physics and applied physics, is host, and has been the project director.

The series was co-produced by Caltech and the Southern California Consortium with funding by the Annenberg/CPB Project. It was developed for both teachers and students, and its creators hope that it will make a significant contribution to better scientific education in the country.

More information is available from *The Mechanical Universe* office at Caltech, (818) 356-4215.

Harry Gray named director of new Beckman Institute

Harry B. Gray (the Arnold O. Beckman Professor of Chemistry) has been appointed director of the newly



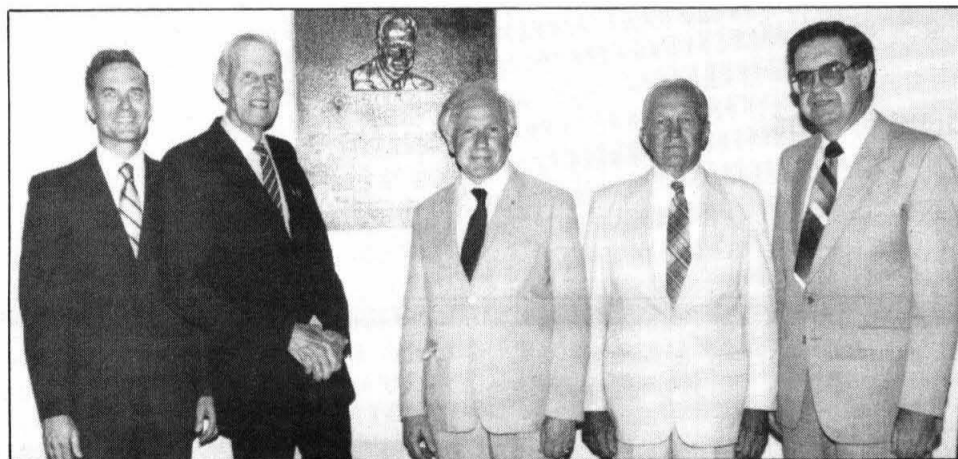
established Beckman Institute at Caltech.

The Beckman Institute was established in June with a gift of \$50 million from the Arnold and Mabel

"The Beckman Institute will allow us to undertake important problems that don't fit neatly in traditional academic research groups," says Gray.

Beckman Foundation. The major objective of the Institute will be to attack problems at the interface of biology and chemistry that require multidisciplinary approaches. It will eventually be located in its own building on campus.

Gray is noted for his research in inorganic and bioinorganic chemistry.



Honoring Chester Carlson, developer of xerography, at the unveiling of a plaque in Carlson's honor are: Robert Carlson; Roy Carlson, cousin of Chester Carlson and uncle of Robert Carlson; President Marvin L. Goldberger; Jack Sturgess, one of Carlson's former Caltech classmates; and Arnold Miller, president of the Electronics Division of the Xerox Corporation.

He is a member of the National Academy of Sciences and is the recipient of many honors and awards, including the 1986 National Medal of Science. From 1978 to 1984 he served as chairman of the Division of Chemistry and Chemical Engineering.

In announcing the appointment, President Marvin L. Goldberger said, "The Beckman Institute has found the ideal director in Harry Gray. His energy, vision, and outstanding leadership will help guide the Beckman Institute toward significant contributions in science and technology."

Said Gray, "I'm honored by my selection. The Beckman Institute will provide a unique source of support for research at the frontiers of biology and chemistry. Caltech is well known for its flexibility in addressing challenging scientific problems. The Beckman Institute will allow us to undertake important projects that don't fit neatly in traditional academic research groups."

Arnold Beckman (PhD '28) is founder and chairman of Beckman Instruments. He was a member of Caltech's faculty until 1940 when he left to devote full time to his company. He served as chairman of the Caltech Board of Trustees from 1964 to 1974, when he was elected chairman emeritus.

He has received many honors for his technical, business, and civic contributions, including the Distinguished Alumni Award and the Robert A. Millikan Medal for distinguished service to the Institute.

NAE chooses Lathrop

Kaye Don Lathrop (MS '59, PhD '62) was elected to the National Academy of Engineering earlier this year. His name was omitted from a list of new faculty and alumni members. We regret the omission.

Xerox Corporation honors founder with bronze plaque

When the late Chester Carlson (BS '30) graduated from Caltech in the depths of the depression, he wrote more than 80 letters applying for work and he received two replies. Both turned him down. Undeterred, he went on to New York where he got a job as a patent clerk, saw the need for a better way to make paper copies, and developed xerography.

He would continue to need the tenacity that was a marked personality trait, because seven years would pass before he got his first patent, and 18 years before his first successful demonstration. Today, points out former classmate Jack Sturgess (BS '30), about two million Xerox copiers throughout the world produce some 10 billion copies daily.

In July, friends of Carlson, Xerox executives, members of the class of 1930, and other members of the Caltech community gathered in the lobby of the Noyes Laboratory of Chemical Physics for the unveiling of a bronze plaque honoring Carlson, a gift of the Xerox Corporation.

President Marvin L. Goldberger, John Roberts (the Institute Professor of Chemistry), and former classmate Sturgess paid tribute to the man whose philosophy was "work, work hard, work longer, and never give up." The speakers also praised Carlson as a philanthropist who gave away more than \$100 million to foundations and universities, including millions to Caltech. The event concluded with "high tea" in the Noyes courtyard.

Among the guests were Arnold Miller, the president of the Electronics Division of the Xerox Corporation, and other Xerox executives; Roy Carlson, who was a cousin and close friend of Chester Carlson; Roy Carlson's nephew, Robert Carlson; and Roland Hawes (BS '30).

Roberts awarded nation's highest chemistry honor

John D. Roberts, Institute Professor of Chemistry, has been named recipient of the 1987 Priestley Medal, the nation's highest honor in chemistry.

Roberts is internationally recognized for his pioneering work in both chemical reactivity and Nuclear Magnetic Resonance (NMR) spectroscopy. NMR is a technique of studying the structure of molecules by subjecting them to high magnetic fields and pulses of radio waves.

His NMR studies in organic chemistry, beginning in the 1950s, have resulted in new discoveries about numerous chemical substances, including many that are important in making plastics, medicines, detergents, pesticides, and other products.

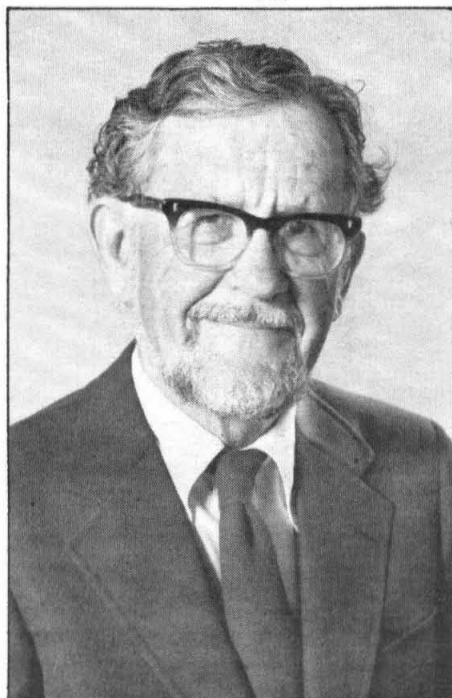
A colleague of Roberts describes him as a chemist who combines a keen scientific intuition about promising areas of research with a genius for exploiting new experimental techniques and spectroscopic tools. Says the colleague, "Few individuals have had a greater impact on a discipline than has Professor Roberts on chemistry."

In recent years, Roberts and collaborators at Caltech and the Huntington Medical Research Institute at Pasadena have pioneered in efforts to establish NMR as a powerful diagnostic and imaging tool in medicine.

Unlike X-rays, the magnetic fields and radio impulses used in NMR have no potential for damage to living tissue. Using NMR, it is possible to compute three-dimensional images of internal organs and tissues, whereas X-rays image the body's soft tissues poorly. A concerted effort is now under way to develop NMR procedures to monitor human-body chemistry. Success in these ventures could greatly advance the understanding and treatment of cancer, heart and brain diseases, and other disorders.

Roberts served as chairman of the Institute's Division of Chemistry and Chemical Engineering from 1963 to 1968 and was Caltech's provost and vice president and dean of the faculty from 1980 to 1983.

The Priestley Medal is the latest of many tributes he has received. His



"Few individuals have had a greater impact on a discipline than has Professor Roberts on chemistry," says a colleague.

medals for achievements in chemistry include the Richard Chace Tolman Medal, the Roger Adams Medal, the Willard Gibbs Medal, the William H. Nichols Medal, and the Theodore William Richards Medal. His honors also include the American Chemical Society Award in Pure Chemistry, the Michelson-Morley Award, and honorary doctorates from Temple University and the University of Munich.

Named for Joseph Priestley, who discovered oxygen in the 18th century, the Priestley Medal is awarded annually by the American Chemical Society for distinguished service in chemistry.

Barnes honored for astrophysics research

Charles A. Barnes, professor of physics, has been awarded the Medal of Astrophysics by the Paris Institute of Astrophysics, in recognition of his "major contributions to the field of nuclear astrophysics."

In a separate honor, Barnes has received a Senior U.S. Scientist Award from the Alexander Von Humboldt Foundation in Bonn, West Germany, for a year of endowed study and research at the University of Muenster and at the Max Planck Institute for Nuclear Physics in Heidelberg.

Barnes's research, carried out for the past 30 years in Kellogg Radiation Laboratory, has helped to demonstrate that all the chemical elements in the universe heavier than helium have been generated by thermonuclear fusion reactions inside aging stars.

Franzgrote named to executive post

Ernest Franzgrote (MS '57), former technical staff member at JPL, has joined Caltech as senior executive assistant to the provost. In this capacity he will be involved in the analyses, planning, and administration of policies and projects within the scope of the provost's office.

After receiving his MS, Franzgrote joined the technical staff at JPL, where he was involved in several projects, including the Surveyor lunar lander and the Voyager mission to the outer planets. On Surveyor, he was co-investigator on the Alpha Scattering Experiment, which made the first analysis of the lunar surface. On Voyager, he served as science representative for the Caltech cosmic ray subsystem and three other experiments.

Attardi named Guggenheim Fellow

Giuseppe Attardi, Grace C. Steele Professor of Molecular Biology, has been awarded a 1986 Guggenheim Fellowship by the John Simon Guggenheim Memorial Foundation of New York City for "unusually distinguished achievement in the past and exceptional promise for future accomplishment." He was one of 272 Fellows selected from among 3,700 applicants.

Attardi and his colleagues are developing techniques to introduce new genes into mitochondria, the tiny structures that are the powerhouses of living cells. His research is aimed at understanding how alterations in the genetic material of mitochondria can cause malfunctions and may cause some inherited disorders.

Lowenstam awarded medal for research

Heinz Lowenstam, professor of paleoecology, emeritus, has been awarded the 1986 Medal of The Paleontological Society. The honor will be presented to him this fall at the annual meeting of the Geological Society of America in San Antonio, Texas.

Lowenstam's research has focused on the ecology and evolution of living and fossil marine organisms, including the ecology of the ancient seas and the environmental and biological factors that have shaped the evolution of invertebrate marine life.

Benzer recognized for genetics research

Seymour Benzer, James G. Boswell Professor of Neuroscience, was awarded the Thomas Hunt Morgan Medal of the Genetics Society of America, "in recognition of a lifetime's contribution to genetics," at the GSA's annual meeting in Urbana, Illinois.

Benzer is best known for his studies of the genetic and physiological bases of behavior in the fruit fly *Drosophila*. His work with mutant *Drosophila* has traced physical and sensory disorders to specific biochemical defects in the insect's nervous system and helped to illuminate the causes of some nervous system malfunctions in higher animals.

Fairchild Scholars Program renewed

The Sherman Fairchild Foundation has announced that it will fund the Sherman Fairchild Distinguished Scholars Program at Caltech for at least another six years. The foundation will provide \$5.55 million for the program, which enables Caltech to bring outstanding scholars to campus for periods of three months to a year.

The Sherman Fairchild Foundation established the program at Caltech in 1972 with gifts of \$750,000 per year for ten years. In 1980, the foundation extended the program, and the annual award was increased to \$875,000. The latest renewal provides annual awards of \$925,000.

President Marvin L. Goldberger said the program has "enormously enriched the quality of intellectual life at Caltech." He added that it has enabled the Institute to bring some of the most creative and talented scholars in the world to Caltech as visitors, and that they have "worked with our own faculty on an enormous range of topics. The result has always been significant advances in knowledge."

Over the years, the program has brought more than 225 internationally recognized scholars to the Institute. Alumni of the program have included Nobel Prize-winning physicists Hans Bethe and Kenneth G. Wilson; geologist, astronaut, and U.S. Senator Harrison Schmitt; and theoretical physicist Stephen Hawking, major contributor to the theory of black holes.

The Sherman Fairchild Foundation was named in honor of the founder of the Fairchild Camera and Instrument Corporation and of Fairchild Industries.

Caltech welcomes 198 new freshmen; 24 women enroll

A student who has invented a new type of calculator . . . one who conducted research on the effects of acid rain on Australian plants . . . and several who built lasers according to instructions in the *Scientific American*—these are a few of the new freshmen who enrolled at Caltech this fall.

A total of 198 students, including 24 women, make up the freshman class—down from last year's class of 236, one of the largest in the Institute's history. The ideal class size is considered to be 215. The class of 1986 compares in size with 187 freshmen in 1983 and 194 in 1984.

The number of women in the entering class compares with 32 in 1985, 26 in 1984, 34 in 1983, 41 in 1982, and 36 in 1981.

The Institute offered admission to fewer students this year than last, with the intention of avoiding another class that substantially exceeded the target size. This year, however, a smaller percentage of those who were admitted accepted the invitation to enroll. The acceptance rate this year was 49 percent, compared with 53 percent in 1985 and 45 percent in 1984.

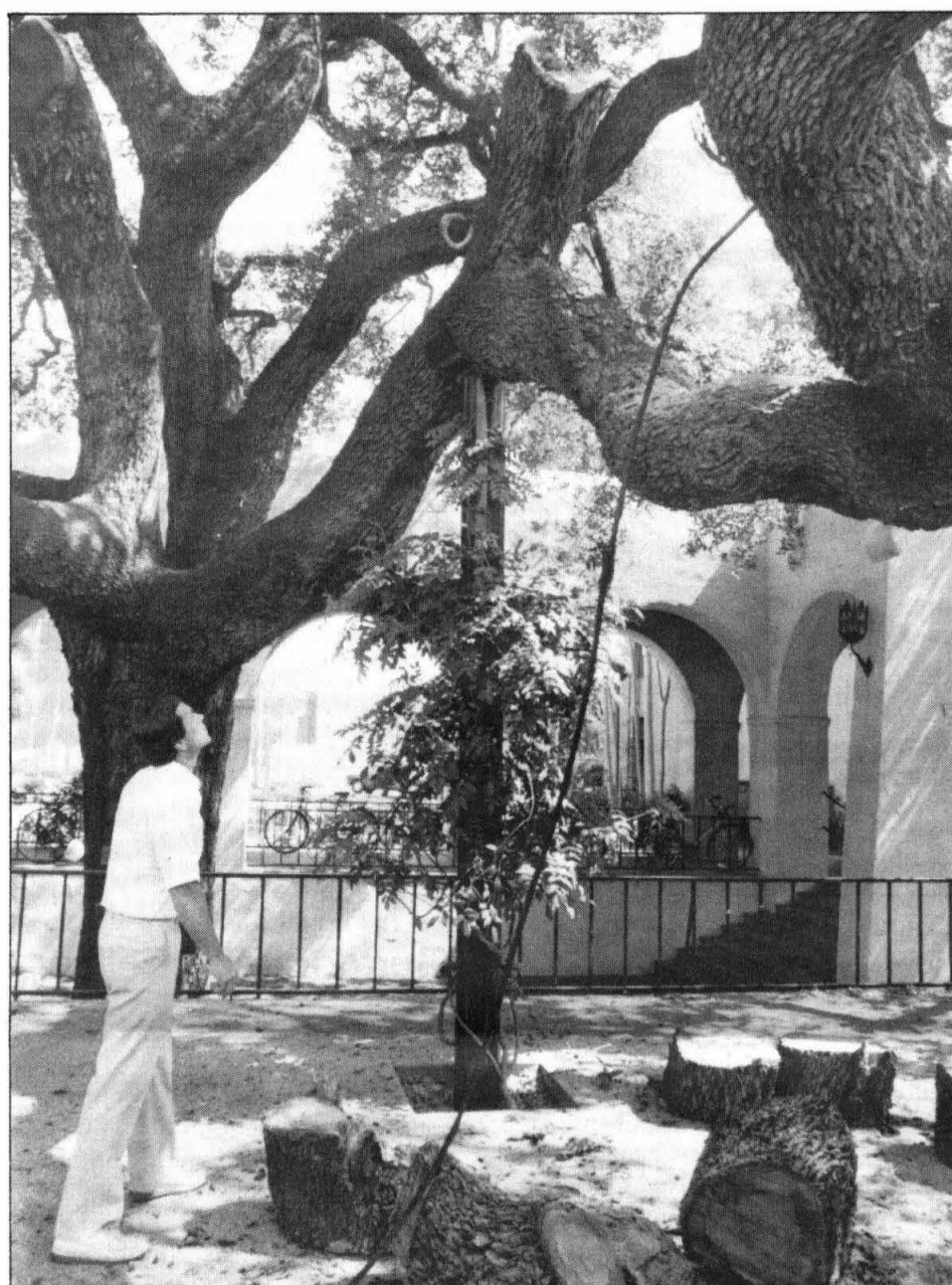
The Institute received applications this year from 1,341 students—a 13 percent increase over the previous year, when 1,188 applied.

The 1986 freshman class is academically as impressive as ever, with SAT scores in the top two percent of the nation. In choosing its students, the Institute continues to look for a commitment to science and technology, and for an enthusiasm for those fields that transcends good academic performance.

In geographic diversity, the class entering in 1986 is similar to that entering in 1985, with a slightly larger proportion from California. This year, 37 percent are Californians, compared with 33 percent in 1985. Of the other entering freshmen, 16 percent are from other Western states, 14 are from the Midwest, 14 percent are from the South, 11 percent are from the Northeast, and 8 percent are from overseas schools.

Foreign countries represented in the class are Spain, Greece, Pakistan, Taiwan, Indonesia, Australia, Canada, Hong Kong, India, and Singapore.

In addition to the freshmen, the new student roster includes eight regular transfers and 15 students from



The campus's 400-year-old Englemann oak lost a limb in the July 8 Palm Springs earthquake which measured 5.8 on the Richter scale. Ron Kibbe of Caltech physical plant assesses the damage, above.

the 3-2 program. This program enables students at certain liberal arts colleges to follow a prescribed course for three years and then to transfer into the third year of an engineering option at the Institute.

Efforts to attract as many strong applicants as possible will continue. According to Stirling L. Huntley, director of admissions, next year more alumni will visit schools to talk to teachers and students, and, for the second year, more members of the admissions office staff will visit a larger number of schools to talk to students, counselors, and teachers, to help them become more familiar with Caltech and its programs. This fall these visits will increase by 50 percent.

The staff visits high schools that, over the years, have sent substantial numbers of good students to the Institute, and other schools that Caltech would like to have send more students because of the academic quality of these graduates.

400-year-old oak fights quakes, wind, aging process

Caltech's 400-year-old Englemann oak lost a limb as a result of the July 8 tremor near Palm Springs, which registered 5.8 on the Richter scale. The campus's oldest living inhabitant, the oak stands near the arches connecting Dabney Hall and Parsons-Gates Hall of Administration.

The branch, 24 inches in diameter, broke off and shattered on the ground when the quake loosened a hook holding cables that supported the limb.

This was the tree's second loss of a limb this year. Another large branch was a casualty of a January wind storm. But loss of limb doesn't signal loss of life. A tree surgeon has devised a plan for cutting back the broken stumps that will encourage new growth.

The hook-and-cable support for the limbs was installed in 1974. Then leaning badly, the tree was diagnosed

by experts as having oak root fungus. Part of the treatment was to clean and excavate around the then-buried trunk, and to construct brickwork to keep the earth from caving in again. At that time, the cable supports were added.

Another of the oak's afflictions is heart rot disease, for which there is no known cure. Fortunately, this is not life threatening. "The tree," says George Mecado (head of Caltech's grounds service for physical plant) "could live for another 500 years."

Because of its age and beauty, last year the oak was chosen as the subject for a bookplate for the Friends of Caltech Libraries (FOCAL). A sketch by Pasadena artist Virginia Hall Ackerman appears in reproduction on the inside front cover of all books donated to the library through FOCAL.

On the cover

On the cover, SURF students Eric Gaidos (left) and Jason Beresford (right) with Bruce Murray (professor of planetary science) study maps of the Martian surface. Along with three other SURF students — Brian Hayes, Erik Krumrey, and Leo Merken — Gaidos and Beresford were members of a research team planning a hypothetical flight over the Martian surface by a balloon carrying research instruments. Such unmanned exploration of Mars by balloon is planned by the Russians for 1990 and is an essential step before exploration by humans. Says Murray, "This SURF team now represents the state of the art — within the United States — in knowledge about balloon flight on Mars."

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Campbell Lab: its demise stirs memories of Caltech as a world center for plant biology

The Campbell Plant Research Laboratory disappeared from the Caltech landscape during July, to be replaced by a grassy, landscaped area. With the little laboratory went the last tangible reminder of an era more than 30 years in duration when Caltech was a world center of innovation in plant biology.

During this time, plant hormones were developed on the campus, and most of the senior plant biologists who are at work around the world today came at one time or another to conduct research.

In terms of physical facilities, this era began in 1929 when a greenhouse was constructed north of San Pasqual near Michigan. In 1939, two controlled temperature greenhouses were added.

These operated throughout World War II as centers of plant physiology studies. But by 1947, space limited the number of different conditions that could be reproduced in the greenhouses, and expansion was essential.

This opportunity came through a grant from the Earhart Foundation, and Caltech's Earhart Plant Research Laboratory was constructed in a location adjacent to the greenhouses. This was the first laboratory in the world where plants could be grown with the control of every possible climatic condition.

Frits Went, one of the world's leading plant physiologists, designed and supervised the building of the lab. In the facility, light, temperature, humidity, wind, rain, fog, or the gas content of the atmosphere could be simultaneously and independently controlled. The active ingredients of smog were determined here through their effect on plants. Biologists from many countries came to Pasadena to study how to match plants to climate and how to predict ripening, flowering, and other phases of the plant growth cycle.

James F. Bonner, professor of biology, emeritus, takes credit for coining a name for the new structure: the phytotron, from word roots meaning "plant" and "machine"—a word chosen because the building was to biologists what the synchrotron and cyclotron were to physicists. The word became adopted as

the name for similar facilities at other institutions, and eventually there were phytotrons around the world. Today, the largest phytotron is in Australia, says Bonner.

One of the most fundamental discoveries at Caltech's phytotron was the knowledge that a plant is not only the product of environmental conditions that are acted on in the present; it is also the product of conditions that acted on it in the past. It could almost be said that plants have memories.

But the facility was extremely expensive to operate, and as funding priorities and research interests shifted, it became a financial drain on the Institute. Finally, early in the 1970s, Caltech's phytotron was torn down to make way for the Beckman Laboratories of Behavioral Biology.

Meanwhile, the Campbell Laboratory had been constructed in 1959 as an addition to the phytotron to provide 3,000 square feet of de-smogged, air conditioned plant-growing space for a total of 19 temperature-controlled plant growing rooms for studies of plant viruses and plant developmental problems. Constructed primarily with funds from the Campbell Soup Company and the U. S. Public Health Service, the little laboratory was frequently referred to as "the soup kitchen."

It continued to be used for a time for plant research after the phytotron was torn down, but then was turned into an aviary for birds used in biological studies on campus. In the end, the birds were moved elsewhere and the building sat empty.

Now the newly landscaped plot replaces the last visible reminder of this chapter in Caltech's history.



The Campbell Plant Research Laboratory as it appeared shortly after its construction. The building was demolished during the summer.

Graduates in EE, E&AS get most job offers

Caltech students graduating in June with degrees in electrical engineering or in engineering and applied science received the most job offers this year—despite a continuing slowness in electrical engineering offers.

In fact, there were no fields in which job offers increased this year, according to Sally J. Asmundson, director of the Career Development Center. The commercial computer and electronics areas continued to be soft, and both the Space Shuttle accident and Gramm-Rudman have

Salary offers to BS degree recipients ranged from \$22,000 to \$39,000, with an average offer of \$31,000. These figures represent a five percent increase over 1985.

created a downturn in hiring among southern California aerospace firms. However, the number of firms that came to campus to interview remained stable at 201.

Salary offers to BS degree recipients ranged from \$22,000 to \$39,000, with an average offer of \$31,000. These figures represent a five percent increase over 1985. The highest job offer went to a graduate in physics who accepted an engineering position in the aerospace industry.

Among the 201 bachelor's degree recipients in the June graduating class, there are five who will attend

medical school, one who will enroll in veterinary school, one who will begin a combined law and business program, one who will attend a theological seminary, and 58 who will begin master's or PhD programs in science and engineering.

Students taking jobs have also made some interesting choices. One student with an engineering degree turned down several technical job offers to accept a position as a financial analyst with an investment banking firm. Another used an international computer network and through it, obtained a systems programming position in Amsterdam. Another, who plans to go to medical school eventually, has obtained a fellowship to do service work in Israel.

Of the 162 students graduating with MS degrees, 71 plan to go on for a PhD—63 of these at Caltech. By June, 62 of the others had accepted jobs and 9 were still seeking graduate school opportunities. Six had other plans. The goals of the remainder were unknown.

The average salary offer to MS degree recipients was \$34,000—up 6 percent over 1985. The highest offer, \$40,200, was to a graduate who took a job as a member of the technical staff with a scientific research firm.

This year Caltech awarded three engineer and 132 PhD degrees. By June, 45 had accepted postdoctoral appointments, 14 were in academic positions with tenure track, and 51 had accepted jobs in industry. One was entering an MD program and the remainder were still seeking employment. Of the three who earned PhDs

Continued on page 7

This article contains excerpts from the State of the Institute report by President Marvin L. Goldberger to the Caltech faculty. Portions omitted feature topics that have already been reported in Caltech News.

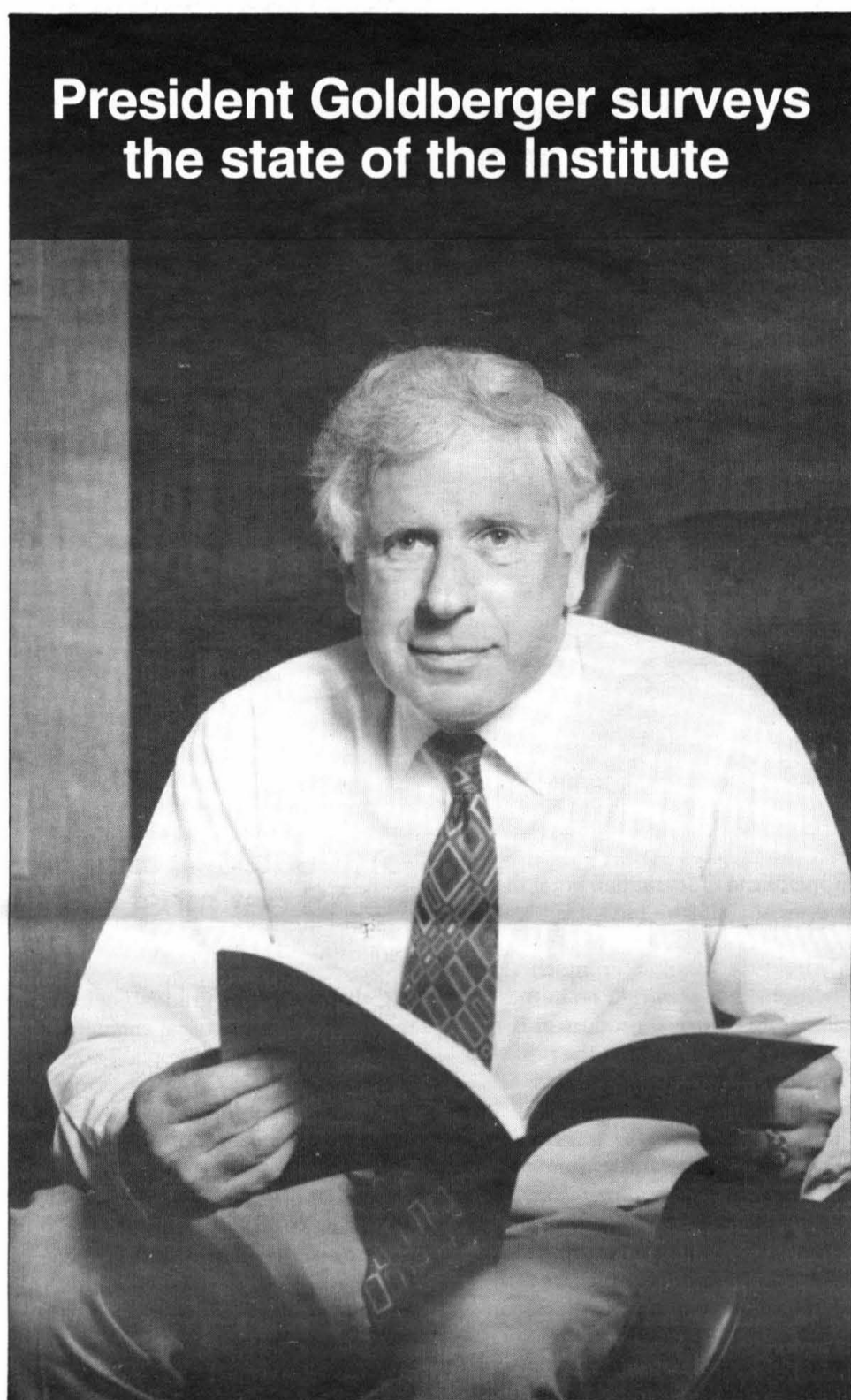
Research

It is virtually impossible to give a brief report on all of the year's important research accomplishments. One of these is the new option recently approved by the faculty board and called computation and neural systems. Attempts to pattern computation and computers on neural networks have been given a gigantic boost from the contributions of Professor John Hopfield. His work on associative content-addressable memories has made him what *Business Week* calls the guru of neural networks.

The new option will combine aspects of neurobiology, computation, information theory, VLSI technology, materials, and the general concepts of the richness of complex systems. Students and faculty will be drawn from biology, engineering and applied science, and physics, mathematics and astronomy. Provost Robbie Vogt played an important role in bringing this option into being and, because of its strongly interdivisional character, the option will be under his supervision. This is one of the most exciting intellectual developments at Caltech since I've been here, and I don't think it could have happened anywhere else.

The Keck Observatory Project is well under way. It is a major technological challenge because the 10-meter segmented mirror design has never been tried before, but the group working on it is confident of success. The foundation and dome are under construction, and the glass for the 36 mirror segments (each six feet in diameter) is being poured in Germany.

The Caltech concurrent computation program is really getting into high gear. The emphasis has been on the development of algorithms and the use of hypercubes to solve significant scientific problems. For the benefit of some who may not follow these things closely, let me say that hypercubes are computers designed on principles of concurrent processing, and that all the ones we work on flow from the pioneering developments of Caltech's computer science group.



President Goldberger surveys the state of the Institute

Approximately 20 Caltech professors are now involved in the program, and there are about 50 completed applications for the hypercube.

Developmental biology is one of the central interests in our Division of Biology. It encompasses the phenomena of embryological development, growth and morphogenesis, and the functional differentiation of specialized cell systems such as those of the immune and nervous systems. We look forward to a major and continuing involvement in this area. A first step in creating a true center for developmental biology at Caltech was taken with the award of \$12.5 million over five years by the Markey Foundation.

There is another unusual activity involving Caltech faculty that I think is very exciting and important. Biology professor Jim Bower called

up Phil Jordan, the superintendent of the Pasadena Unified School District, and told him that science education in the schools stank. This was based on Bower's investigation of his daughter's experience.

Jordan said, "OK, what are you going to do about it?" Bower's response was to engage colleague Jerry Pine, and the two of them, in collaboration with Kenneth Montoya from the school system, have submitted a \$2.5 million proposal to the National Science Foundation for a three-year program to develop a series of curriculum modules for K through 5 that emphasize a science methods approach. Working with teacher specialists in the schools will be 30 Caltech and JPL people who have volunteered to serve as expert consultants. This extremely important project is a prime opportunity

for Caltech, as an institution, to do something significant for Pasadena and by example, for the country.

I want to conclude with the observation that Caltech is in much better (financial) condition this year than we were last. We obviously need much more—I think our endowment should be doubled—and although our needs are many, for the first time we can see a little flexibility. I'm cautiously optimistic.

Financial Affairs

Caltech's operating budget for the 1986-87 fiscal year is forecast at \$153 million. Revenues and expenditures will be in balance. Tuition is established at \$10,440, an increase of 5½ percent. Tuition provides about 12 percent of Caltech's total operating revenues. Campus federal research support is estimated to be \$67 million—or 44 percent of the total. The remaining revenue is divided between gifts, endowments, JPL fee, and sponsored research support from corporations and foundations. Caltech's

"The Keck Observatory project is well under way. It is a major technological challenge because the 10-meter segmented mirror design has never been tried before, but the group working on it is confident of success."

endowment stands at \$340 million and will generate about \$20 million in income.

Last year we hired a fund-raising consultant to make a pre-campaign study. The object was to assess Caltech's readiness for a campaign, to determine a campaign dollar goal, to identify volunteer leadership, and to identify prospective donors.

From this study we learned that Caltech has an image of excellence and uniqueness. We also learned that the potential for future fund raising is substantial but that we must first better develop and coordinate our alumni, Associate, and trustee leadership so that we can maximize our efforts.

Also affecting the decision were my plans to step down as president by July 1988. Sometime after a new president steps in, the issue of a campaign will be reassessed. In the meantime, I plan to work as aggressively as possible to insure that our fund-raising programs are as successful as can be.

To help prepare for a major capital campaign we have made a commitment to improve our public relations

program. By becoming more aggressive and creative, we believe we will be able to develop a national image more conducive to our fund raising goals.

The State of JPL

JPL has experienced rapid growth over the past two years, both in total sponsor funding and on-site workforce. We expect that fiscal year 1986-incurred-cost (a good measure of business activity) will amount to approximately \$830 million. This compares to \$650 million in fiscal year 1985.

The number of regular employees has climbed to an all-time high of approximately 5,100. Perhaps more significant is that the total number of on-site contractor employees has grown by approximately 400 during the past year, and now totals some 2,000 persons.

As a consequence, the laboratory is experiencing severe crowding at its Oak Grove site. Average work space per employee is considerably lower than desirable, and parking facilities are seriously overstrained.

A major new facility, the central engineering building, was scheduled to be fully occupied by late summer. Caltech has provided \$17 million of capital funding for the building construction, and NASA is repaying Caltech over 12 years, starting at the time of building occupancy.

Availability of the facility will enable the return of approximately 600 JPL personnel from off-site leased buildings, and the elimination of some 42 on-site personnel trailers, and of some obsolete buildings. Unfortunately, it will provide relatively little new additional space.

A major event for JPL occurred in January 1986 with the encounter of the Voyager spacecraft with the planet Uranus. On the negative side, the Space Shuttle Challenger accident has had a major impact on JPL space mission prospects:

- The Galileo mission to Jupiter, which was to have been launched in May, will probably be delayed until January 1989, and the necessity to utilize a lower energy interplanetary trajectory means that the spacecraft will not arrive at Jupiter until 1994.
- The Ulysses mission, also planned for launch in May, will be delayed at least until August 1988. This is a European Space Agency mission for which JPL is providing tracking and mission support, as well as science instruments.
- The Magellan project, previously scheduled to be launched toward

Venus in the spring of 1988, will be delayed until the fall of 1989.

- The Hubble Space Telescope, for which Caltech is providing the key instrument—the Wide Field Planetary Camera—will be delayed approximately two years.

In addition, numerous small-scale scientific investigations that have been programmed for various flights and reflights on the space shuttle, or for satellites that were to be launched by the shuttle, will be delayed approximately two years.

In non-NASA work, project management for the Department of Energy's solar energy program has been brought to a successful conclusion. Technology development activities will continue in photovoltaics, energy conversion, and conservation.

Concurrent with reduction in the energy program, there has been substantial growth in undertakings for various elements of the Department of Defense, concentrated in information system and space system development.

Caltech embarks on major campus planning program

Caltech has embarked on a major campus planning program that will establish targets for ultimate Institute growth and development. The new project will enable the Institute to coordinate long-range plans with standards recently set by the city of Pasadena for development activities.

In this endeavor, Caltech has hired the architectural firm of Kurt Meyer Partners. Firm members will conduct studies seeking to balance Caltech's future needs in terms of ultimate campus population, student housing, parking requirements, and circulation patterns.

The planning program will also deal with land zoning uses, and with setting priorities for various phases of growth.

Caltech's current master plan was completed in 1979. At that time, no formal framework had been established by Pasadena's city government to give long-range approval to master development plans.

In July 1985, the city of Pasadena overhauled its zoning ordinances and adopted new codes that directly affect Caltech's plans for growth and expansion. The new legislation—as well as new levels of awareness among Caltech's geographic neighbors—has made it essential that the Institute re-evaluate and redesign the master plan and submit it for approval to the City Planning Commission.

Tennis courts: everything's new but the players

Everything on the courts is new but the players. The Athenaeum tennis courts, at Hill and San Pasqual, have been given new surfaces, perimeter and center fences, nets, and lighting. Each court now has its own light controls—a change from the old system, when a central switch doused lights on all courts simultaneously. New lights have also been installed on courts adjacent to the athletic field.

Liepmann awarded Guggenheim Medal

Hans W. Liepmann (the Theodore von Karman Professor of Aeronautics, Emeritus) has been awarded the 1986 Daniel Guggenheim Medal by the United Engineering Trustees of the United Engineering Center of New York. Earlier this year, he was named a winner of the 1986 National of Science.

In receiving the award, Liepmann was cited for his "outstanding leadership in fluid mechanics research and education and significant contributions to the development of a generation of outstanding leaders in the field."

The United Engineering Trustees is an international society sponsored by the American Association of Mechanical Engineers, the Society of Automotive Engineers, and the American Institute of Aeronautics and Astronautics.

Attardi awarded Guggenheim Fellowship

Giuseppe Attardi (the Grace C. Steele Professor of Molecular Biology) has been awarded a 1986 Guggenheim Fellowship by the John Simon Guggenheim Memorial Foundation of New York City. The fellowships are awarded annually to scientists, scholars, and artists whose work has shown "unusually distinguished achievement in the past and exceptional promise for future accomplishment."

Attardi and his colleagues are developing techniques to introduce new genes into mitochondria, the tiny structures that are the powerhouses of living cells. His research is aimed at understanding how alterations in the genetic material of mitochondria can cause malfunctions and may be the cause of some inherited disorders.

Attardi was one of 272 Fellows selected from among 3,717 applicants.

James Lee named Wang Fellow in Chinese Studies

James Lee, assistant professor of history, has been named a 1986-89 Wang Fellow in Chinese Studies by the Wang Institute of Graduate Studies in Tyngsboro, Massachusetts, and, in a separate honor, has received a grant from the National Program for Advanced Study and Research in China. He will use the grants to conduct research in the U.S., China, and Japan on "Agrarian Population and Economy in China: Price History and Family History of Liaoning, 1772-1982."

"Top Prof" article features three on Caltech faculty

Three members of the Caltech faculty were among ten California professors selected for an August *California* magazine photo essay entitled "Preferred Profs." Those preferred were William B. Bridges (Carl F. Braun Professor of Engineering), Richard P. Feynman (Richard Chace Tolman Professor of Theoretical Physics), and Jean-Paul Revel (Albert Billings Ruddock Professor of Biology). Three was the largest number of professors selected from a single institution.

According to the article, faculty and students were surveyed to identify the "best teachers in each of the ten majors most popular with today's undergraduates."

Tenure track academic salaries improve dramatically

Continued from page 5

in the social sciences, two accepted academic offers and one went to work in industry. Salaries ranged up to \$58,000 (for an assignment as a member of the technical staff with a firm doing basic scientific research) with the average salary at about \$38,000.

While postdoctoral salaries remain low (\$26,000 to \$27,000), tenure track academic position offers have improved dramatically over the past few years, according to Asmundson, and salaries in many disciplines compare favorably with those in industry.

PhD offers in chemical engineering increased slightly this year, with most offers from private consulting and research organizations.

Association President Paul Winter: "My path has not been typical"

By Winifred Veronda

When they were the parents of two young boys—Paul, 4, and Eric, 2—Paul Winter and his wife, Betty, decided it would be exciting to spend two years in Kabul, Afghanistan.

Winter, a structural engineer who designs buildings, had been offered the post of technical education specialist with UNESCO and the assignment as director of the Afghanistan Institute of Technology. The job would offer many opportunities for travel in that part of the world.

The Winters said "yes" to the opportunity, took the boys, had a marvelous time, and embarked on the pattern of living that Winter alludes to when he speaks of his career and says, "My path has not been typical, and it has made me appreciate that a Caltech degree makes possible many career options."

And indeed it has, for that path has taken the Winters on a several years' cruise on a sailboat through the South Pacific with stops to work in Japan (for two years), in Honolulu, and in New Zealand; on an assignment for an architectural firm in Tehran (the Shah was falling from power and the Winters' hotel lobby was sacked by a mob of Shiite Muslim revolutionaries three months after they arrived. The Winters decided it was time to come home); and to a far Eastern post that gave Winter regular assignments in Bangkok, Seoul, Tokyo, Manila, Jakarta, Singapore, Hong Kong, and Kuala Lumpur.

"We decided early that we wanted to travel," says Winter. "My wife was more ready to go than I. Once you are open to the possibility of living abroad, then the opportunities come along. This may not be the way to rise to the top of one's profession, but we've had many rewarding experiences and have gained some understanding of peoples in other parts of the world."

During the years when the boys were young and students in Polytechnic School in Pasadena, Winter worked as a partner with the architectural-engineering firm of Neptune and Thomas. (Paul A. Winter, BS '70, earned his degree from Caltech in engineering; Eric Winter graduated in engineering and law from USC).

While their sons were in college, the Winters embarked on their South Pacific sailing adventure, teaming

with another couple as co-owners of a 55-foot cutter. Sailing had become a way of life for the couple while their sons were young, and the boys and Mrs. Winter had lived on the family's 30-foot sailboat during the summers. Winter would come down to the marina on weekends for sailing trips up and down the coast.

"Most people probably wouldn't actually enjoy a long cruise," says Winter of the South Pacific expedition, "because the weather is occasionally bad and the life can be absolutely miserable. But there are so many other times when life is glorious. You get hooked on the contrasts."

"We went through our share of bad weather, but the greatest challenge on the cruise was in the area of personal relationships. When you live and work so closely with another couple there are a lot of tests. Fortunately, we ended up as good friends. Just recently we spent six weeks cruising with them, assisting another couple in making the passage from Majorca in the Mediterranean to Puerto Rico in their 50-foot trawler."

It was a little over a year after Winter took the far-Eastern job with travel to major cities of the Orient that he says, "I realized I didn't want to have to travel all the time back and forth across the Pacific and up and down Asia." That year, 1980, the

"Once you are open to the possibility of living abroad the opportunities come along. This may not be the way to rise to the top of one's profession, but we've had many rewarding experiences."

Winters returned to Pasadena, bought a home there, and Winter opened an office just over the city line in Los Angeles.

The Winters' life is more conventional now, with season tickets to two symphonies, attendance at a number of other musical and dramatic productions, and an active role in Immanuel Presbyterian Church where he teaches an adult Bible class and she is a deacon.

Assignments for clients still occasionally take Winter to far parts of the world (a current project is under construction in Japan), and the couple finds vacation time to drive through Europe, or to explore the San Juan Islands. But settled city life is claiming more of their attention.

"I like big cities very much," says Winter. "Tokyo, for example, is wonderful. It has so much to offer. There

are five full-time symphony orchestras . . . But metropolitan Los Angeles has become one of the great areas of the world to live in. We're very happy to be here."

The move back to Pasadena on a permanent basis brought Winter into renewed contact with Caltech. A Throop Club member, he had lived off campus with his parents in South



Pasadena as a student, and as a senior he was part of the Navy V-12 program.

"During the time that I lived in Ricketts, we double-timed in formation to the athletic field for early morning classes—and then marched to classes in uniform," he says. "Our class graduated a little early, in February '44 rather than in June. After graduation I was commissioned as a Naval officer, and served in the south Pacific until the end of the war."

"The Caltech degree has meant a lot as a credential, and the educational experience has been even more valuable. Caltech develops a disciplined, analytical approach to problem solving and provides its students with the ability to succeed in a wide variety of careers. Many of us didn't fully appreciate the Caltech experience until we were older. But I realize now that Caltech gave me the professional tools to explore a variety of activities in which I was interested."

Betty was a part of his life during those Caltech years; he had met her during high school at Lake Avenue Congregational Church, and the romance continued during college while she was at UC Berkeley.

It was partly through Betty Winter's interests that Paul re-established his ties with the Institute. "She's always enjoyed Seminar Day," he says, "and we started attending it after coming back to Pasadena. I worked on the Seminar Day committee,

eventually becoming chairman. Then I served in various offices of the Alumni Association board before being elected president."

Meanwhile, he had become a member of The Caltech Associates, having been recruited by friends who are alumni of Stanford and Harvard.

As Alumni Association president, Winter wants to expand alumni participation on committees—positions traditionally filled by board members. He mentions the Seminar Day committee ("one of the most successful") which is composed of non-board members, and he would like to see more of this pattern on other committees.

Another goal of Winter's is to involve more alumni across the country in Association activities. One way is to establish more chapters and to achieve closer coordination between these chapters and the Institute, including use of traveling professors who might be able to speak at chapter meetings.

"We have an exceptionally good board this year, and we have strong support from the Institute for our programs," says Winter. "Last year's programs were well received, and we're looking forward to an even more exciting year ahead. Past presidents have set a high standard of leadership, and I hope to continue in this tradition."

Alumni Fund workers needed

During the coming year, Alumni Fund workers face a difficult task as they seek to continue maintaining and building on the gains achieved during the Irvine Challenge Campaign. The goal for the year is \$2,000,000 in unrestricted funds for the Institute.

During September and October, many alumni are being asked to do more than renew their financial commitment; they are also being asked to become workers. To make their assignment as easy as possible, only a few prospective donors are assigned to each volunteer.

Alumni need not wait to be called. Many potential volunteers are overlooked each year because there isn't enough time to ask everyone to help. If you can spare a few hours, please contact: Bedford McIntosh, director of annual giving, at Caltech 1-97, Pasadena 91125, or at (818) 356-6285.

Grinthal emphasizes increasing Fund contributions

E. Ted Grinthal (PhD '69) will head Caltech's Alumni Fund in 1986-87 as regional campaign coordinator.

"The emphasis this year will be on increasing contributions," says Grinthal, a resident of Berkeley Heights, New Jersey. "We raised over \$1,800,000 last year, and this year we're trying for at least \$2,000,000."

"Considering that the Irvine Challenge ended the year before, we did very well last year. We were down a little from the previous year but what we achieved has to be great, because we're way up from where we were before the three-year challenge campaign (that year the Fund raised \$1,167,000). Not every institution that took part in the Irvine Challenge has had this degree of success."

To increase contributions in the year ahead, Grinthal says the Fund plans more student phonathons, with current students calling alumni throughout the country. "These have been very successful," he notes. "And we're planning to advance the target date by three weeks for contacts in the regional campaign."

Grinthal expresses his satisfaction that 50 percent of all Caltech alumni gave to the Fund last year—a percentage equaled by only a few other schools—and that 1,200 workers made contacts for the Fund. "We'll try to maintain both these levels of participation this year," he says.

"Workers are the key to the success of the Fund," Grinthal emphasizes. "I can't call everyone. But with hundreds of alumni and students making contacts, we can personally contact almost every Caltech graduate." He hopes that eventually, the percentage of alumni giving to the Fund will reach 80 percent.

"Caltech's a great place, this is a worthy cause, and alumni should feel honored that they have a chance to give," is Grinthal's conviction.

He points out that money not designated for a specific use, such as that raised by the Alumni Fund, is becoming increasingly important to the Institute because more and more corporations, foundations, and individuals are restricting their gifts to specific areas. "The Institute must rely on money like that from the Alumni Fund to pay all the expenses necessary to keep operating," he stresses.

He notes that the Alumni Fund and Alumni Association have recently implemented a new computer system, and Grinthal wants to improve its usefulness and its effectiveness as a tool for data access and reports.



"We're making progress, and I think we'll have really great reports by the end of next year," he says.

Grinthal, who did his undergraduate work at New York Univer-

sity and graduate work at the University of Pennsylvania, came to Caltech for his PhD, seeking a spot on the West Coast. A married student (he had met his wife, Sue, while doing graduate work in Pennsylvania), he lived on Wilson Avenue and walked to campus. "I developed a real attachment to the Institute," he says, "more than to any other school I'd attended."

After finishing his degree, he and Mrs. Grinthal moved to Poughkeepsie, New York, where he worked in IBM's semiconductor division as a staff engineer on integrated circuit reliability. He went, after a few years, to AT&T Bell Labs in Murray Hill, New Jersey, where he is involved in computer-aided design for integrated circuits.

Grinthal had been out of touch with Caltech for awhile when Josiah Smith called him, asking him to be an area coordinator for the Alumni Fund. He said "yes" and was given

central New Jersey as his territory.

"You get ten other volunteers to go out and ask for money," he explains his role.

After handling this assignment for several years he was asked to become the regional coordinator for region 11—Mid-Atlantic—and this year he accepted responsibility for coordinating the work of all 13 Fund regions in the United States and abroad.

When not working at his job or for the Alumni Fund, Grinthal spends time with his wife, Sue, and their daughter, Alison, and their son, Michael. He likes to swim, read, play tennis, and visit the country's national parks. This year the Grand Canyon and Yosemite were on the family's vacation schedule.

As regional campaign coordinator, Grinthal will make four trips to California during the year—and for a man who still loves the West Coast, he says, "that won't be an excessive burden."

Alumni Fund honors top performers

The Alumni Fund honored a few outstanding volunteer achievers for being "the best of the best" at its annual Leadership Conference in August. Some 70 area coordinators from throughout the country came to the campus for the conference. Here they attended workshops and presentations designed to help them in communicating Caltech's needs to other alumni.

Donald Stewart, Jr. (BS '47) was honored as the regional chairman within California who achieved the highest level of participation. Stewart's participation rate in Region 2, South Coast Cities, was 53.1 percent — the highest participation rate for any region.

Honored for achieving highest participation in a region outside of California was Ted Grinthal (PhD '69) of Region 11, Mid-Atlantic. Grinthal attained a 51.6 percent participation rate with the most volunteers in any region — 84.

Pierre St. Amand (MS '51, PhD '53), who manages Area 200, Bakersfield, received the award for attaining the greatest increase in participation over last year in California. St. Amand raised participation from 59.3 percent to 69.9 percent.

Tak Lo, of Area 352, North Sound — Alaska, was honored for achieving a 71.8 percent participation rate compared to 40.7 percent last year outside California. This was the highest participation rate for any area.

Peter Gottlieb (BS '56) received the

award for recruiting the most volunteers. The number of workers in Area 130, TRW, was 19.

Three regional chairmen who are retiring were honored for exceptional achievement over the years. They were Don Stewart, Jr. (BS '47), Region 2, South Coast Cities; Robert Brydolf (BS '44), Region 1, Caltech and vicinity; and Chris Dalton (BS '65), Region 10, Midwest.

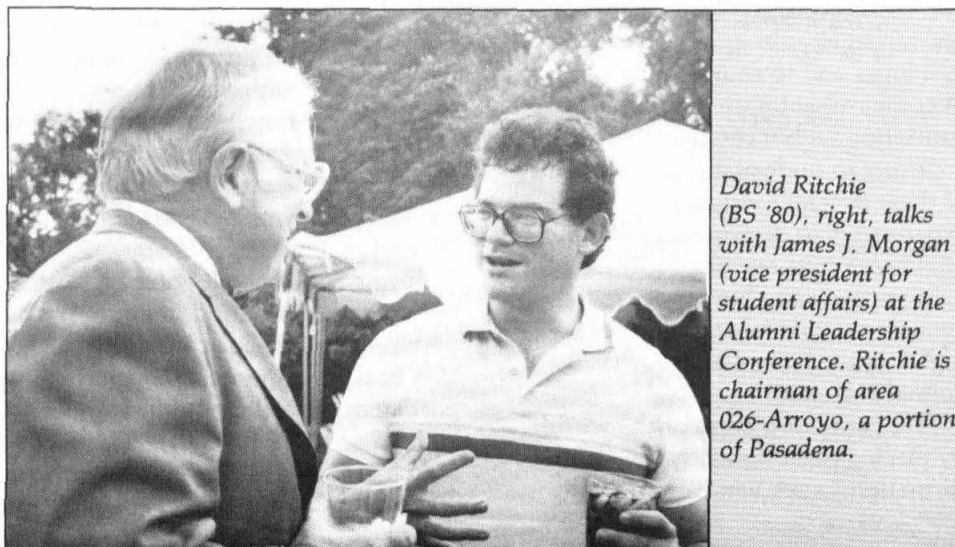
Alumni who made presentations at the conference were Ted Grinthal, who, as regional campaign coordinator, moderated the beginning meeting; Ben Burke (BS '61, MS '62), who talked about recruiting and training; and Carl Constanten (BS '72, MS '73), who discussed making solicitations.

James J. Morgan, vice president for student affairs, spoke after dinner on

student life at Caltech. During a morning session, Susie Pearce, director of development, welcomed the group and talked on development at Caltech. David W. Morrisroe, vice president for business and finance, and treasurer, talked on finance at Caltech, and Lew Allen, vice president and director of JPL, described "What's New at JPL."

Grinthal was the moderator for sessions for Alumni Fund leaders in two other cities: At the San Francisco Airport Hilton in the San Francisco Bay Area on September 6, and at the Crystal City Hyatt in Washington, D.C. on September 13.

Martin Poggi (BS '37) and Ronald Findlay (BS '64) made presentations in the Bay Area while Alan Beagle (BS '70) and Arch Corriher (MS '50) led the sessions in Washington.



David Ritchie (BS '80), right, talks with James J. Morgan (vice president for student affairs) at the Alumni Leadership Conference. Ritchie is chairman of area 026-Arroyo, a portion of Pasadena.

Computer graphics: vital new tool for exploring the brain's structure

Continued from page 1

from every angle by manipulating their position.

In the same way, a biologist can create a three-dimensional image of a portion of the brain and examine it on the screen from every desired perspective. The scientist can understand its structure and the relationships of its parts and their connections with far greater accuracy, speed, and precision than would have been possible without this technological tool.

"Computer technology has opened up new horizons in terms of our capacity to analyze intricate structures and pathways in the brain. This kind of detailed analysis is essential if we are to understand the function of the brain—which itself is an incredibly sophisticated computing device," says Van Essen.

"To capitalize on the research opportunities that are opened up by advances in the computer field, we must have access to state-of-the-art equipment. Unfortunately, this kind of equipment is very expensive, and it is difficult to obtain through the support provided by funding agencies.

"Instruments like the IRIS computer graphics system let us ask questions about the brain that were simply inaccessible ten years ago—questions that represent a quantitative jump in complexity and sophistication. These include structural studies—how the brain's circuitry is organized, for example—and physiological studies of how messages are transmitted through these circuits."

Van Essen's group is using macaque monkeys to study how the brain processes visual information. It is known from earlier anatomical studies that there are more than a dozen distinct visual areas within the monkey's cerebral cortex, each of which is presumed to carry out a different type of analysis of the visual world.

Use of the IRIS system has helped Van Essen's research team to identify several previously unrecognized visual areas and to characterize a type of compartmental, or "modular" organization within certain other areas.

Efforts to understand the functions of these different visual areas involve experiments to determine how individual nerve cells respond to different light patterns and how those responses provide information to higher brain centers about what the animal is seeing.

"We gain our picture of the world by piecing together many bits of information," says Van Essen. "In the

early stages of the visual system, our visual images are broken into millions of tiny pieces, and we analyze the characteristics of those fragments. This goes on in the eye and in the primary visual cortex. At these early stages, we know that many cells respond well to simple edges, or bars of light, but only to edges of a particular orientation. Then all of these fragments have to be reintegrated through processing in the higher visual areas, where our research effort is concentrated.

"We're trying to see how the visual image is put back together," says Van Essen, "how the visual centers decide

lineage during development on the establishment of network connections in the cerebellar cortex.

The cerebellar cortex is a highly folded layer of cells around the core of the cerebellum whose principal cells, Purkinje cells, are organized in a continuous one-dimensional sheet. Herrup's previous research has revealed that these cells trace their heritage to one of eight to eleven "ancestor" or progenitor cells that are present in the very early stages of an organism's development.

In the mouse, each progenitor cell has produced genetic "families" of 16,000 to 20,000, resulting in a total

Actually, what distinguishes the strains is an abundance of the enzyme glucuronidase, found in one strain of neurons. The enzyme makes cells from that original embryo turn red after special histological processing, while cells from the other embryo are green.

The ability to identify cells histologically as belonging to one embryo or another (red or green, in this case) gives the researchers a way of seeing lineage patterns within the cerebellar cortex that would otherwise be invisible.

Thus they can attempt to understand if cell lineage carries part of the information that tells incoming nerve fibers whether or not to connect with a specific neuron in the cerebellar cortex. In this particular part of the brain, adjacent Purkinje cells are sometimes influenced by nerve fibers carrying information from very different body parts (e.g., upper lip and tail).

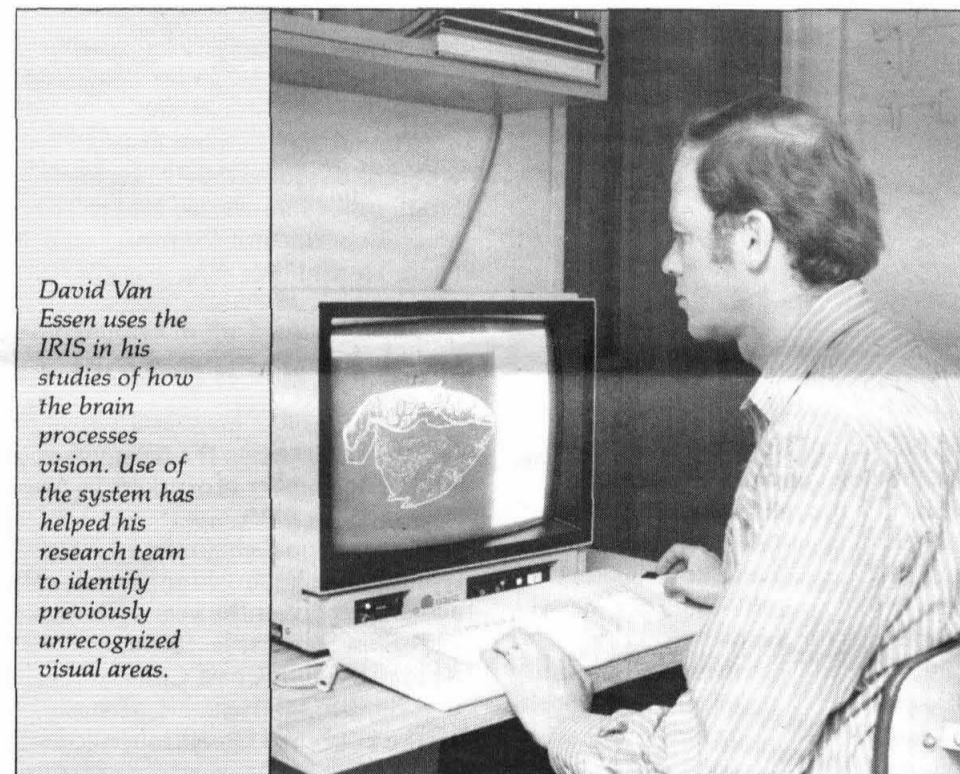
If cell lineage is important in setting up these physiological boundaries, then Bower and his colleagues would expect to find, for example, red Purkinje cells on one side of the boundary and green Purkinje cells on the other.

Given the tremendous functional importance of establishing the correct neuron-to-neuron connections in the nervous system, it is fundamentally important to know if cell lineage plays a role. But unfortunately, the vast numbers of neurons and the geometric complexity of their distribution makes generating lineage maps by hand very difficult.

However, with computer graphics—and guided by the redness or greenness of the cells that reveal their lineage—spatial information about the location of many individual neurons can rapidly be converted into large three-dimensional lineage maps on the screen.

Once it has been computerized, the biologist can rotate the lineage-map image, examining it from any perspective to see overall patterns of organization, clusters of cells genetically related to "ancestor" cells in the early embryo, and relationships between these clusters and physiological maps of where the upper lip- and tail-responding neurons are located.

Without the neuroanatomy facility and the three-dimensional perspective on the nervous system that it provides, this information would be overwhelming and these important comparisons very difficult, if not impossible, to make.



what we see and what we will ignore, and how we identify objects and patterns of interest. This entails the use of more complex patterns than the simple spots and edges that are adequate for studying lower visual centers. In this mode the IRIS system will generate images of richly textured, three-dimensional objects for presentation to the monkey, while the experimenter monitors the activity of single nerve cells in the visual cortex.

"By analyzing the responses of nerve cells to patterns differing in shape and texture, much can be learned about the strategy used by the visual system to decipher and interpret its view of the world around us."

Bower and his colleagues are studying the organization of neurons within the cerebellar cortex in relation to their response to touch. In particular, in collaboration with Karl Herrup of Yale University, this research group is using the IRIS workstation to study the effects of cell

of 160,000 to 200,000 Purkinje cells in the cerebellum.

To study the effects of these lineage relationships on circuitry, the scientists use chimeric mice (their name

"Computer technology has opened up new horizons in terms of our capacity to analyze intricate structures and pathways in the brain. This kind of analysis is essential if we are to understand the brain's function," explains Van Essen.

derives from Greek mythology)—mice created by surgically sticking together two embryos that, despite representing two sets of parents, go on to produce a single organism.

By mixing up two embryos from biochemically different strains of mice, neurons originating from cells generated from one or the other embryo can be distinguished in the adult chimera.

Critics have often taken the Wright brothers for a couple of tinkering bicycle mechanics who lucked their way into history.

Not so, says Fred Culick (professor of applied physics and jet propulsion). In fact, the Wright brothers' success, which launched the aviation age, was the culmination of a carefully planned and systematically executed program of development.

"This is why they succeeded and others failed," Culick observes.

And Culick is one who should know. Later this year, if all goes well, a full-sized replica of the Wright Flyer will be subjected to wind tunnel testing, and two years later, with Culick as test pilot, a second aircraft will be flown.

"We'll probably test it locally first," says Culick. "Later, we'd like to take it back to Kitty Hawk and test it there."

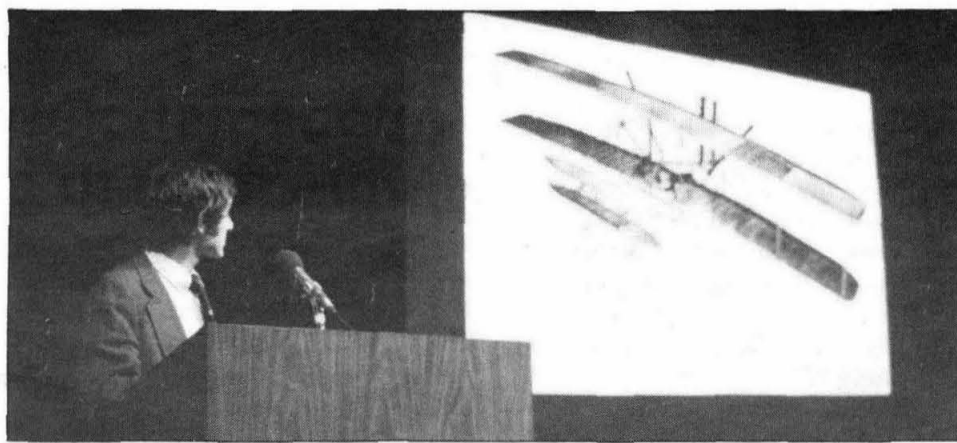
In addition to his role as test pilot, Culick is project engineer for the team from the Los Angeles chapter of the American Institute of Aeronautics and Astronautics that is involved in a project to replace a 1953 replica of the Wright brothers' 1903 "Flyer" with one that will actually fly. Jack Cherne, retired from TRW Inc., is project manager, and Howard Marx, who works at Northrop, is his deputy.

The first replica, built for the 50th anniversary of the historic Kitty Hawk flight, was destroyed in a 1978 fire at the San Diego Aerospace Museum. (The original 1903 plane, after flying a total of 98 seconds in its career, now resides at the Smithsonian Institution.)

With insurance from the fire, the local AIAA section decided to make a flying replica. Through this effort they would gain a thorough understanding of the aerodynamic principles and engineering innovations of the Wrights.

"We wanted to clarify what they did," says Culick. "Our primary purpose has been to do a complete documentary of the airplane."

Among the team members are several Caltech alumni who have played major roles in the project, Culick notes. Henry Jex (MS '53) has been involved in applying modern theories in an analysis of the craft's performance, stability, and control. Duane McRuer (BS '45, MS '48) and Irving Ashkenas (BS '37, MS '38, MS '39), founders of Systems Technology Inc., have made facilities at their firm available in this analysis.



Fred Culick displays a drawing of the Wright Flyer during an Alumni Seminar Day program.

Improving on the Wright Brothers

Carl Friend (BS '38) has completed a stress analysis of the plane, required before it can be tested in a NASA full-scale wind tunnel. Friend has also made detailed design changes to strengthen the structure of the replica, and supervised the process of rigging the aircraft.

Roger Schaefe (MS '52) of McDonnell Douglas is chairman of the advisory board for the project, and Robert S. Clark (Ex '44) of Northrop is a member. "People at both of these companies have given us a lot of advice and help," says Culick. He also credits Douglas Aircraft, noting that considerable work has been done on the aerodynamics of the plane, using modern computational methods. Computer programs at Douglas have been utilized in this endeavor.

Culick's own interest in the Wrights' achievements was sparked when he examined the San Diego Flyer replica before it burned. He went on to obtain a copy of the Wrights' collected papers covering their work from 1899 gliders to the production aircraft of 1909.

"I was amazed when I read that first paper and realized how technically astute they were," says Culick. "They only had high school educations, but it was clear that they were very thoughtful and systematic in their approach."

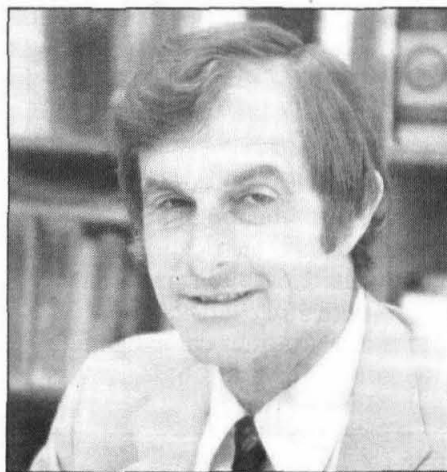
"They started from zero, read all the literature, and took off from there. In this respect, they proceeded just as people involved in a complex technological project would work today."

Culick's first endeavor was to create a 1/6 scale model of the Flyer, which he tested in the GALT 10-foot wind tunnel on the campus in December 1979. He built the model himself with some help from Caltech's machine shop and a small grant from NASA. The model was similar to the original plane. It was constructed of spruce and plywood

and covered with doped fabric, with external structural members of aluminum and steel. The propellers were driven by a 1/15 horsepower electric motor.

Meanwhile, Culick had become involved in the AIAA project to build the full-sized flying replica and was continuing his research on the Wright brothers' achievement.

That research showed that the Wright brothers were well acquainted with prevailing theories of their time,



"It was a dangerous plane, and nobody has successfully flown a replica, although several have tried," says Culick.

and progressed far beyond what others had accomplished. In addition, their own research on the measurement of lift and drag with their gliders and in their own wind tunnel enabled them to develop several important innovations.

One of these was in-flight wing twisting—aviation's first aileron. Before he built his first glider, Wilbur Wright's observations had shown him that birds regained their balance in flight by a torsion of their wing tips. This insight led the Wrights to develop wing warping, which they used on all their gliders and on the 1903 Flyer. Wing warping not only

enabled the Wrights to stabilize the plane in a straight path, but also to turn it.

Previous designers had considered the tail the means of steering a plane, like the rudder of a boat. But a plane turns by rotating around its longitudinal axis, and the Wrights accomplished this by wing warping. The Flyer's double vertical tail moved only when the wings were flexed, and its true function was its contribution to control of yawing motions about the aircraft's vertical axis. The combination of roll and yaw control was the basis for the basic patent for the airplane, granted to the Wrights in 1906.

The Wrights built their own 15-horsepower engine. They also designed and built their propellers and, in the process, developed the basis of modern propeller theory. This innovation is credited to others since they never published their work. Their propellers were rotating airfoils that were almost 50 percent more efficient than the crude air paddles of their competition.

In recreating a flying model of the Wright brothers' plane, the AIAA team is taking advantage of modern technology to analyze the aerodynamics and power of the machine. The project, says Culick, is continuing what the Wright brothers would have done if today's technology had been available.

He notes that the improvements in the Flyer's design would only be noticed by an expert.

Some of these modifications from the original are in the name of safety. "It was a dangerous plane," says Culick, "and nobody has successfully flown a replica, although several people have tried."

One reason for this is that the plane needed to be flown in a strong headwind, according to Culick. The Wrights were fortunate in having that advantage. The Wright Flyer was opposing a 24-27-mph headwind that December day near Kitty Hawk.

"Without the wind," says Culick, "I don't think they could have accelerated to flying speed. But with it, all they had to do was accelerate to about six mph relative to the ground, to reach flying speed."

In their work on the Flyer, the AIAA group is using an area donated to them in Torrance. Culick acknowledges that in seven years, dozens of people working as a committee have failed to complete a project that the Wright brothers, working alone, did in four years. But there are reasons.

"Most of the people have full-time jobs," he notes, "and sometimes an important member of the team goes away for months. This makes things go slowly. And although we have

Continued on page 12

June graduate Marc Schuyler runs in tough race for California state assembly

When Marc Philip Schuyler (BS '86), from Tarzana, California, entered the primary campaign for California state assemblyman for the 43rd district while he was a Caltech senior, he never thought that he would actually have a chance to win the election.

Already interested in politics, he had heard that the California Senate minority leader was looking for someone to run in the primary against the lone Republican contender—a Lyndon LaRouche candidate—and Schuyler decided it would be an interesting experience, and helpful to his future law career, to conduct a campaign. The Democratic incumbent, Grey Davis, would be unbeatable in the general election, everyone agreed.

"I knew he could beat me into the ground," says Schuyler candidly.

But on filing day, Davis, to everyone's surprise and totally without warning, filed instead for state comptroller. This meant that Schuyler actually had a chance of being elected to the office for which he was running.

Fortunately he was only carrying 22 units during his last term as a Caltech undergraduate, and thus he had time to undertake a 60-hour-a-week campaign with two speaking engagements a day, seven days a week. Working on a low budget and concentrating on door-to-door contacts, he won the primary by an approximate 60-40 margin.

Afterward he had a week before finals in which to concentrate on his Caltech assignments. "I didn't listen to the radio on election night," he says. "I was too busy, working 24 hours straight on my electrical engineering project."

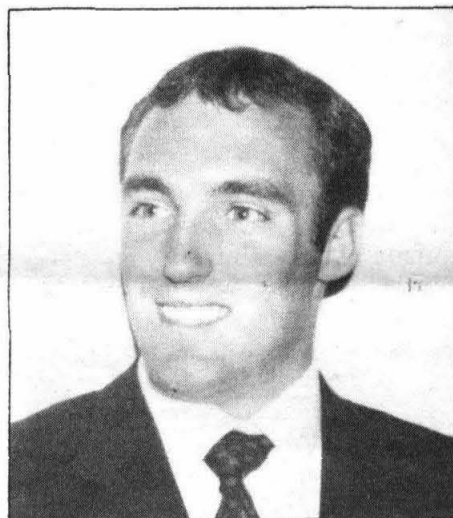
By winning the primary, Schuyler acquired four seats in the Republican Central Committee—and deprived

the LaRouche candidate of the goal of winning them in order to gain influence.

He also acquired a formidable challenge—working hard enough and successfully enough to win in a complex district where 51.5 percent of the voters are registered Democrats and 38 percent are registered Republicans. The district includes Los Angeles' "West Side"—Pacific Palisades, Bel Air, Beverly Hills, part of Santa Monica, West Hollywood, Westwood, and other portions of the city, and San Fernando Valley communities like Tarzana, Toluca Lake, Sherman Oaks, Encino, and Van Nuys.

Meanwhile, Schuyler was admitted to law school at UCLA this fall—studies he will have to defer if he is elected.

"There's a tough battle ahead," said Schuyler in July. "I know I have a



chance to win if I can work hard enough and meet enough people. The Democrats in the district are more likely to defect; Republicans are more likely to vote a party ticket."

In his door-to-door campaigning Schuyler says his Caltech degree has

When he entered the primary, he never thought that he would actually have a chance to win the election.

been helpful. "It commands a lot of respect," he notes.

On the campus he was a member of Fleming House (he lived off campus after his freshman year), and he launched an unsuccessful attempt to start a fraternity. He played football for three years and in his senior year was all-conference tackle. He also played baseball, and he was a member of the Pasadena Rugby Club. A sports enthusiast, he likes to ski, scuba dive, and play golf and basketball.

The young alumnus, who graduated with a double major in social science and in engineering and applied science, brings to his campaign experience in working for the state

Senate as a Beckman intern, a yearly honor given to a Caltech student.

In this role in Sacramento two years ago he was a staff assistant for the 19th state Senate district. "This is what got me interested in politics," he says.

Schuyler was already a member of the Young Americans for Freedom when he came to the Institute, and he started a Caltech chapter of this non-partisan conservative youth group. He later left the Caltech chapter to become chairman of the chapter in Los Angeles County, and a member of the organization's state board.

Meanwhile, "as a hobby" he started attending political conventions, finding this a good way to learn how to conduct oneself in political crowds, and how to meet and mix with political figures.

In his campaign, Schuyler has been concentrating on precinct walking, and his goal has been "not to spend a lot of money and to lure my opponent into not spending a lot." In July his campaign chest contained \$5,000, and with the help of a new financial manager and treasurer, he had set a goal of \$30,000 for the November election.

"Steve Lalli (BS '86) was my original treasurer," says Schuyler. "But he was bought off by a good job offer and now he's with an investment and banking firm."

Among the campaign issues that Schuyler focuses on are overdevelopment in the area and how to deal most effectively with the traffic problems it creates, stopping the Metrorail proposed for Los Angeles at a cost of an estimated \$10 billion, and finding other and less expensive ways of relieving traffic pressures; overhauling the tort system in California ("It's in terrible shape; victims should only be

compensated by guilty parties"); eliminating probation and determinate sentencing; and implementing the death penalty.

If Schuyler is elected in November he will postpone plans to go on to law school—but only for awhile. "I'm determined to get a law degree," he says, "and I think political experience would be a big help to me in my practice."

Meanwhile he's out ringing doorbells as he works hard for the assembly seat he thought he had no chance to win.

Athletes enjoy new Fox Stanton Track and Field

Caltech athletes and campus joggers are enjoying the new six-lane all-weather Fox Stanton Track and Field that was installed during the summer.

The new track, and other improvements in track and field facilities, were made possible by a \$450,000 grant to the Institute from the Lon V. Smith Foundation with the support of Smith Foundation board member W. Layton Stanton (BS '17, PhD '31). Stanton, a member of The Caltech Associates, is the son of William Layton "Fox" Stanton, director of athletics at Caltech from 1921 to 1942.

The new track has a rubberized surface and features two additional sprinting lanes on the south side. The irrigation and drainage system for the track area has been improved, and new runways have been created for the long jump, pole vault, steeple chase, and discus throw events—all of which have been relocated to accommodate new countours of the track.

The Wright Brothers

Continued from page 11

electrically powered tools to work with, we have to proceed in construction just about the same way that the Wright brothers did. The process can be tedious."

Why is it worthwhile to spend so much time recreating the Wright brothers' plane? Says Culick, "For one thing, this is an interesting opportunity to participate in the complicated design and construction of an airplane. And historically it's interesting because the Wrights kept a lot of diaries and records."

"Moreover, the Wright brothers' achievement is an important monument in the history of technology in the United States, and the lessons of their achievement are still valid. Today people often think that technological achievements should happen very easily. They often forget that these accomplishments don't happen so easily, and that they never have."

"Many people believe that progress must have come easily when the Wright brothers were at work, because technology was less complicated then. The truth is that designing and building their plane was a prolonged, systematic, complicated process for them, and it is significant for us to recognize this."

There is one other reason why the project is worthwhile to do, says Culick. That's because it's a lot of fun.

President's Circle follows Lewis and Clark trail



Robert Sharp describes geological terrain near the Great Falls of the Missouri River to members of the President's Circle. On a summer trip, a total of 35 President's Circle members followed the trail of Lewis and Clark through the northwestern United States, with Sharp as guide. Photo by Hugh Colvin (BS '36).

Cleveland alums hear Ruben Mettler

Cleveland-area alumni were given the opportunity on June 18 to meet each other and to learn about life at Caltech from Ruben F. Mettler (BS '44, MS '47, PhD '49), chairman of the board of trustees. At a reception and dinner in the Union Club, Mettler described new facilities and other developments at the Institute—among these, the Beckman Laboratory of Chemical Synthesis, Keck Observatory, the DNA sequencer, and student enrollment.

Mettler emphasized the importance of alumni in strengthening Caltech's

image across the country and thanked them for their support. He stressed his hopes for the success of Alumni Association efforts to reach alumni in the eastern U.S. and to learn more about their needs and concerns.

Craig Marks (BS '50, MS '51, PhD '55), who organized the evening, is vice president of science and technology at TRW Inc. in Cleveland. He told the group that he hopes the alumni who attended realize how important they are to each other and to the Institute.

Alumni may join trek to Russia

Alumni and other friends of Caltech are invited to become participants in a trip to Russia and Copenhagen in late March with George Cheron, second-year Russian teacher at the Institute.

Cost is \$1,450 (including hotels, air fare, three meals a day, city tours with English-speaking guides, and transfers between cities) plus \$25 for a Soviet visa.

Included on the itinerary will be four days in Moscow, with an excursion to the Monastery of Zargorsk,

and visits to the Bolshoi Theater, the Tretyakov Art Gallery, Moscow University, the GUM department store, and other sites; three days in Leningrad, with visits to the Hermitage, St. Isaac Cathedral and the house of Peter the Great, and other attractions; and a day in Copenhagen.

More information is available from George Cheron, Division of the Humanities and Social Sciences, 101-40, Caltech, Pasadena, CA 91125. Deadline for payment is December 1.

Library to continue filming theses

A gift of \$2,000 from Friends of Caltech Libraries (FOCAL) will permit the library to continue its project of filming early Caltech theses. A year ago, the library received a gift of \$1,000 from FOCAL, enabling it to place on microfiche 120 theses covering the years 1911-1924. The additional funds will carry filming into the 1930s.

One copy of the microfiche reproductions of the early theses has been placed in the archives and the other

at the general reference desk in Millikan Library. Ultimate cost of the project will be at least \$20,000 but is considered well worth the expense. Housing and preserving the dissertations has become an acute problem.

Since 1963, when Caltech entered into an agreement with University Microfilms International, all Caltech theses have been sent to Ann Arbor, Michigan, for filming. But Millikan Library contains the only copies of most of the earlier dissertations.

Sharp to lead Alaska trip

Intrigued by glaciers? Fascinated with soaring bald eagles? Curious about life near the Arctic Circle? Read on about an opportunity to explore the last U.S. wilderness!

The Alumni Association has arranged a nine-day field trip in 1987 that takes a bite out of south central Alaska, with an itinerary designed to give a sense of many of the aspects of this vast and varied country. Robert P. Sharp, the Sharp Professor of Geology, Emeritus, will be the guide. Sharp has conducted extensive research on glaciers and is writing a layman's book on glaciers and glaciation.

The "bite" of south central Alaska will start with a sampling of coastal fiords and glaciers in the Turnagain Arm and Prince William Sound areas and later will bring alumni to the Portage Glacier with its iceberg-filled lake, and to the dramatically calving and receding Columbia Glacier. On a voyage from Whittier to Valdez, explorers will see many species of wildlife on land and sea.

From Valdez, alumni will travel northeast via the historical Richardson Highway, paralleled by the Alaskan oil pipeline. This route crosses the rugged, heavily glaciated Chugach Range. Here the group will explore the Worthington Glacier and inspect elevated sections of the oil pipeline that were specially designed to avoid problems with frost heaving, perennially frozen ground, and ground ice.

Crossing the Copper River Basin, the group will view the 16,000-foot peaks and active volcanoes of the Wrangell Range and the foothills of the Alaska Range. Here the travelers will take a short diversion westward along the Denali Highway into tundra country, with views of the snow-clad Alaska Range peaks, uplifted along the gigantic Denali fault. They will cross this range through the ice-scoured Delta River gap to the Tanana Lowland, which leads northwest to Fairbanks.

At Fairbanks, a voyage on a paddlewheel steamer on the Chena and Tanana Rivers will be followed

by inspection of a tunnel dug for study of permafrost and ground ice. Adventurers will tour an old placer mining gold dredge, and mining around Fairbanks will be discussed.

After a morning devoted to study of the geological hazards and history of the Fairbanks area, the group will trek southwestward into the Alaska Range and to Denali National Park. The next day will be devoted to a shuttle-bus tour of the park to the Eielson view point of the highest peak in North America, Mount McKinley. Along the way, chances of seeing caribou, moose, and grizzly bear—and even a bald eagle—are good.

From Denali Park, the alumni will travel south out of the Alaska Range past rock glaciers, through glacier-widened and lowered Broad Pass, to the open spaces of the Susitna and Matanuska valleys. Active volcanic peaks of the Aleutian Range west of Cook Inlet will be viewed, weather permitting, and the group will follow the Turnagain Arm of Cook Inlet east to Girdwood.

Girdwood will be a base for a one-day exploration into the scenic, ice-scoured terrain of the Kenai Peninsula. Alumni will travel south to the rail terminus and port city of Seward, which was devastated by tsunami waves generated by the Good Friday, 1964, magnitude 8.4 earthquake.

The group will assemble in Anchorage on Friday, June 19, 1987, and disperse on Sunday morning, June 28, in Anchorage. Those who wish may arrange for other Alaskan travels before or after the group trip. Cost is \$1,800 per person, double occupancy, and \$2,100 per person, single occupancy. Those who want to reserve a space should return the coupon below with a \$200 per person deposit to the Alumni Association, 1-97, Pasadena, CA 91125.

The price includes all transportation, meals, lodging, and reading materials. For additional information, call Kathy Harris (818) 356-6593, at the Alumni Office.

CALTECH ALUMNI ASSOCIATION

ALASKA TRIP, JUNE 19-28, 1987

Please make _____ reservations for the alumni trip to Alaska.

Name(s) _____ Class Year _____

Address _____

Phone _____

I enclose a check for \$ _____ (\$200 per person) as a deposit.
Make check payable to the Caltech Alumni Association and mail to 1-97,
Pasadena, CA 91125.

Alumni Activities

The Alumni Association is putting together its programs for 1986-87. Some of the major events are listed below, and more information will appear in future *Caltech News* issues. For additional facts about any event listed, call Janet Davis, executive director of the Alumni Association, at (818) 356-6594.

OCTOBER 17—NOVEMBER 26, 1986. *Chicago Space Photography exhibit*. See article on this page for details.

JANUARY 1, 1987. *Rose Parade program* featuring excellent parade seats and brunch at the Athenaeum. Alumni who live outside California and would like specific information should contact the Alumni Office.

MARCH 13 and 20, 1987. *Twenty-third annual winetasting program in the Athenaeum*. An opportunity to taste fine wines and to learn about their origin and characteristics.

MAY 1, 1987. *Reunion for the class of 1977* in the Athenaeum.

MAY 2, 1987. *Reunions for the classes of 1942 and 1952* at the Athenaeum.

MAY 3, 1987. *Sports Day* on the campus. A chance for alumni, faculty, and students to compete in a variety of sports activities for fun and fitness.

MAY 15, 1987. *Reunion for the class of 1962* in the Athenaeum.

MAY 16, 1987. *Fiftieth annual Alumni Seminar Day* on the campus. This promises to be an especially good Seminar Day. Please join us in celebrating 50 years of learning and achievement.

JUNE 5-6, 1987. *Reunion for the class of 1937*.

JUNE 6, 1987. *Half-Century Club luncheon* in the Athenaeum.

JUNE 18, 1987. *Alumni Association annual meeting and dinner* in the Athenaeum.

JUNE 19-28, 1987. *Alumni trip to Alaska*, guided by Robert P. Sharp, the Sharp Professor of Geology, Emeritus. Details are on page 13 of this issue.

OCTOBER 5-6, 1987. *Alumni trip through New Hampshire and Vermont*, guided by Robert P. Sharp and Jo Laird (PhD '77), professor of geology at the University of New Hampshire, and Wallace Bothner, also professor of geology at the University of New Hampshire. Details and sign-up information will be mailed early in 1987 to alumni in the east.

Space exhibit up for viewing by Chicago alums

Chicago-area alumni will have the opportunity to see the exhibit "25 Years of Space Photography" at the Museum of Contemporary Photography (600 South Michigan Avenue) from October 17 to November 26. Local alumni will receive an announcement about a special event on October 17 in connection with the exhibit.

The show, which was originally shown at Caltech's Baxter Art Gallery, features 140 images chronicling the unmanned space exploration of JPL—from the Ranger and Surveyor missions in the early 1950s through the Mariners, Vikings, and recent Voyager missions to Jupiter and Saturn.

The exhibit also includes images of Earth as seen by the radar of Seasat, SIR-A, and SIR-B. The Infrared Astronomical Satellite (IRAS) contributes glimpses outside the solar system into our own galaxy and beyond.

The exhibit was organized by Jay Belloli, former director of Baxter Art Gallery, and by Jurrie van der Woude of JPL. The photographs were made by JPL for NASA, and the exhibition was funded by the IBM Corporation. The show was at New York's IBM Gallery of Science and Art for three months and, after leaving Chicago, will move to San Francisco's Exploratorium in February 1987.

Obituaries

1919

PAUL A. SCHERER Ex, of Yachats, Oregon, on July 17. His father, James, was the first president of Throop Polytechnic Institute, and his father-in-law was astronomer George Ellery Hale, developer of the Hale and Palomar observatories. After serving as a naval officer in World War I, he was a fruit grower in Oregon and held several patents in cold storage refrigeration. In addition to serving on the National Defense Research Committee and heading engineering and transition, he was a former director of research for AiResearch Manufacturing Co. of Los Angeles, associate director of the National Science Foundation, executive officer of the Carnegie Institution of Washington, and a former president of the Cosmos Club in Washington, D.C. He is survived by 6 daughters, 15 grandchildren, and 18 great-grandchildren. His wife Margaret passed away in May, and a jointly named memorial fund has been established by the family. Contributions may be sent to the Scherer-Hale Memorial, Caltech, Pasadena, 91125.

1923

RICHMOND H. SKINNER of Dallas, Texas. Retired from the Army as a lieutenant colonel, he had been active in officiating at tennis, track and field, and swimming and diving events, and participated in golf and bridge.

1924

BORIS A. GRAY (formerly GOLIKOFF), of Los Angeles, on August 27, 1985.

W. LAWRENCE HALL, in Pasadena, after a short illness, on July 1. He had retired in 1966 from a 40-year career with the city of Los Angeles. He is survived by his wife, Margaret, four sons and a daughter.

1925

LYLE H. CHENEY, Ex, a sales representative for New York Life Insurance Co. in Pasadena, on April 8. He is survived by his wife, Arline.

1927

RAYMOND E. ST. CLAIR, of Manchester, California, in March, of pneumonia following a stroke.

1928

RICHARD H. DUVAL, of Laguna Hills.

1930

WILLIS CLARK, Ex, of Arcadia on February 10.

1932

ALFRED B. FOCKE, PhD, on June 8, of a heart attack while traveling to his brother's funeral in Pittsburgh. He had been a resident of Claremont since 1959, when he became the first chairman of the physics department at Harvey Mudd College. He retired in 1971, but continued to run the Edwards Geophysics Laboratory at the school. He was a physicist with the Navy before and after World War II and was chosen scientific director of Operation Wigwam, a project responsible for the only underwater nuclear bomb detonation by the U.S. From 1968 to 1971, he took a leave of absence from Harvey Mudd to act as scientific director of the US Navy Office of Naval Research in London. He is survived by his wife, Katherine, five sons, and a daughter.

1933

FRANK L. WATTENDORE, PhD, on June 11, at his home in Washington, D.C. A noted aeronautical engineer, his contributions to the field include work on the jet engine, and co-design of the 40,000-HP, 20-foot, wind tunnel. He helped plan and establish the Arnold Engineering Development Center, was a founding member of the von Karman Institute for Fluid Dynamics in Brussels, and was a co-founder of AGARD-NATO, an advisory group to NATO. His awards include the Medal of Freedom and Medaille Aeronautique. He is survived by his wife, Glenn, a son, and three grandchildren.

1937

JEAN WYLIE, of Palo Alto, on April 26. He had been a scientist with Lockheed Missiles and Space Corporation in Sunnyvale. He is survived by his wife, Jeanie.

1938

ROBERT C. McMASTER, MS, PhD '44, in Delaware, Ohio, on July 6, of cardiac shock. He was Regents Professor Emeritus of welding engineering and electrical engineering at Ohio State University. He joined the faculty there in 1955 and taught classes

in nondestructive testing (NDT) and welding processes until his retirement in 1977. Dubbed the "dean of TV weather," he also did weather forecasts—always educating viewers about the reasons for his forecasts on what was one of the country's first weather programs—on WBNS-TV, in Columbus from 1950-1964. He was a member of many technical societies, including Sigma Xi and The American Society for Nondestructive Testing (ASNT). He edited the first edition of ASNT's *Nondestructive Testing Handbook* in 1959; it is still widely used today. The holder of 19 patents in the area of materials evaluation, he also published more than 300 technical papers. He was inducted into the NAE in 1975. He is survived by his wife, Laura, two sons, a daughter, and seven grandchildren.

1941

VIRGIL E. SANDIFER, MS, of Salinas, California, a systems engineer for the Space and Missiles Division of Lockheed. He is survived by his wife, Mary.

1942

STANLEY CORRSIN, MS, Eng '42, PhD '47, of cancer on June 2 at his home in Riderwood, Maryland. An expert on the turbulent flow of fluids, he had been a member of the faculty at Johns Hopkins University since 1947. In 1981 he was named the first Theophilus Halley Smoot Professor of Engineering and held a concurrent post as professor of biomedical engineering at the Johns Hopkins School of Medicine. Corrsin's many contributions to the study of turbulence earned him numerous awards and honors. A fellow of the AAAS and the NAE, he was awarded the 1983 Fluid Mechanics Prize of the American Physical Society, was inducted into the University of Pennsylvania's Gallery of Distinguished Engineering Alumni, and received the von Karman Medal from the American Society of Civil Engineers. He is survived by his wife, Barbara, and two children.

HENRY E. KREMERS, of Laguna Beach, on June 9, after a heart attack. He had been division superintendent of Kirkhill Rubber Company in Brea.

1943

WILLIAM CHARLES THOMPSON, JR., of Anaheim on June 5. He was an electrical engineer at DCAS in Azusa.

1944

LESTER S. CHAMBERS, MS, Eng, of St. Petersburg, Florida, in January. He was a retired Rear Admiral in the U.S. Navy. He is survived by his wife, Katherine.

1948

HENRY R. CHOPE, JR., in October 1985. He had been president of The Chope Co. of Columbus, Ohio.

JOHN A. BOPPART, JR., in 1985. He had been vice president of engineering for Garrett Turbine Engine Co. in Phoenix, Arizona.

1957

JOHN A. WISE, of Los Angeles. He had been an IMS applications specialist with Unionbank Computer Corporation.

1960

PAUL W. UTTERBACK, of Virginia Beach, Virginia. He had been a captain in the U.S. Navy.

1983

JOHN L. OSBOURNE in March 1985. He was a research associate at the Nuclear Research Laboratory of the University of Washington.

1986

CONSTANTIN G. ECONOMOU, PhD, of Pasadena, in March, of leukemia. He was a research fellow in chemical engineering at Caltech. In addition to developing new techniques to analyze the suitability of decentralized controllers for multivariable systems, he suggested an alternate way to look at the design of controllers for nonlinear systems. He is survived by his wife, Vaso Leventakou, who accepted his degree posthumously on June 13. A fund has been established in his memory by the chemical engineering faculty, which will award a prize each year to the department's student who completes the most original doctoral thesis. Contributions can be sent to the C. G. Economou Memorial Fund, Office of Memorial Funds, 1-36, Caltech, Pasadena, 91125.

CHRISTOPHER P. LINDSEY, PhD, was killed August 1 in a bicycle accident near Great Falls, Montana, when a truck carrying a wide load struck him from behind. He had been on a cross-country bicycle trip with his wife and 2½-year-old son to celebrate the completion of his doctoral work in applied physics. He was on his way to Boston where he was scheduled to start work at Polaroid Corp. in October. In addition to his work as a graduate student, he was active in outreach work for the Lake Avenue Congregational Church and had his own photography business. He is survived by his wife, Yvonne, a son, Gregory, his parents, three sisters, two brothers, and a grandmother. A memorial fund has been established in his name; for information, contact Jana Mercado, Applied Physics, 128-95, Caltech, Pasadena 91125.

Personals

1936

JOHN WADDELL has been appointed to the San Marino Planning Commission. He has lived in San Marino for 12 years and retired four years ago. He established the Northridge Development Company, which designed and built custom homes, office buildings, and restaurants in Los Angeles and Orange counties. He has been a member of Rotary Club of San Marino, the San Marino City Club, and the Huntington Westerners.

1944

RICHARD V. HENRY, MS '51, was honored by Allegheny International, Inc. (AI), for his outstanding technical leadership during 34 years of service. He is a senior vice president for HTL Industries in Santa Ana, an AI member company that produces mechanical, electromechanical, and electronic products for commercial aviation and military use. He lives in La Canada.

GEORGE G. SHOR, JR., MS '48, PhD, '54, has been nominated second vice president for the international Society of Exploration Geophysicists. Professor of marine geophysics and associate director of the Scripps Institution of Oceanography, he joined

Scripps in 1953. He is currently responsible for seagoing operations and management of the institution's research fleet.

1946

JAY W. STUART, MS '48, Eng '51, writes from Gardena, California, "My wife, Nancy, and I were part of an NSPE delegation invited to a three-week tour of the P.R. of China by the Ministry of Machine Building at the end of March. The tour included the factories and sights of Beijing, Changchun, Xian, Shanghai, Suzhou, and Hong Kong . . . The 34-hour overnight, 1,450-mile round-trip from Beijing by a four-person stateroom, early-vintage train was quite a memorable experience." Among the highlights of his trip were visits with H.S. Tsien (PhD '39) and Che-Min Cheng (MS '49, PhD '52). In early 1985, Jay "so-journed for four months at Kennedy Space Center supporting the Shuttle launch of the Spacecom TDRS-B—NASA communication satellite." A defective component aborted this launch and the corrected TDRS-B was the main payload on January's Shuttle disaster.

1948

WILLIAM J. CARROLL, MS '49, of La Canada, was nominated as vice president of Zone IV of the ASCE at its spring convention. He is chairman of the board of James M. Montgomery Consulting Engineers, Inc., of Pasadena. He is a specialist in environmental engineering and has worked on major projects involving water and waste water in the U.S. and foreign countries. He has been active in ASCE since 1948, serving on many local section committees, and was chairman of the national committee on employee conditions; he is currently chairman of the professional conduct committee.

DAVE WILFORD, MS '51, is living in La Mesa, California. He is married and has a son, a daughter, and four grandchildren. He retired on June 18 as chairman of the mathematics department of Grossmont High School after 17 years of teaching. Before starting his teaching career, he spent 18 years in industry where, in addition to other companies, he worked for two years at Shell Chemical, two years at JPL, and seven years at Rocketdyne, where he was project engineer on Apollo booster rockets. His current plans include "travel, renewing friendships, time with grandchildren, and renewed activity with the Alumni Association." He also plans "limited consulting as an avocation rather than as a business—I enjoy problem-solving."

1949

WILLIAM C. ROESCH, PhD, has received the U.S. Department of Energy's Certificate of Appreciation for "his sustained record of exceptional scientific contribution in the radiological sciences, which has significantly enhanced understanding of the physical basis of radiobiological effects" during his 36-year career at Hanford, the government agency's nuclear reservation in Washington state. He recently retired from the Pacific Northwest Laboratories' Biology and Chemistry Department of Battelle, whose Memorial Institute operates the Hanford facility. He began his career with General Electric in 1949 as manager of the radiological physics section and transferred to Battelle in 1965.

1953

GEORGE W. SUTTON, MS, PhD '55, recently joined JAYCOR in San Diego as a division vice president. His responsibilities include survivability and hardening of electro-optical and laser systems. He previously

served as vice president and technical director of Helionetics HLX Laser Inc., vice president of Avco-Everett Research Laboratory, and scientific adviser to the Department of the Air Force in the Pentagon. He lives in La Jolla.

1955

ARMIN D. KAISER, PhD, received an honorary doctor of science degree in May from Purdue University. Kaiser is professor of biochemistry at Stanford, where he helped establish the biochemistry department when he joined the faculty in 1959. He has been elected to the NAS and the AAAS. He recently won the Lasker Award and the Waterford Prize, both for basic medical research.

1956

JIM POAGE, MS, has been named vice provost for computing at Dartmouth College. He had been director of Princeton's computer center since 1970.

1957

RICHARD H. PETERSEN, MS, received an honorary doctor of engineering degree from Purdue University in May. He has been director of NASA's Langley Research Center in Hampton, Virginia, since 1980. Prior to his current position, he was deputy director of the center; he also served as chief of the aerodynamics division at NASA's Ames Research Center at Moffett Field, California. He was awarded the Presidential Rank of Meritorious Executive in 1982 and received NASA's Outstanding Leadership Medal in 1984. He was also the recipient of Purdue's Distinguished Engineering Alumnus Award in 1980.

1959

ALLAN R. PORUSH, MS '60, has joined Dames & Moore in Los Angeles, engineering and environmental consultants. He will head the firm's earthquake engineering group, which specializes in the evaluation of the risks to life and property posed by earthquakes. He had been on the structural engineering staff of C F Braun & Co in Alhambra for 25 years. He lives in Sierra Madre with his wife and two children.

NORMAN J. ZABUSKY, PhD, has received the Howard N. Potts Medal for his work in mathematical physics and early creative combinations of analysis and computation, and for his study of the properties of solitons. He is professor of mathematics at the University of Pittsburgh and is on the school's supercomputer advisory committee.

1960

JOHN SHIER served as chairman of the first IEEE Bipolar Circuits and Technology meeting, which was held in Minneapolis in September. He is living in Apple Valley, Minnesota.

IVAN E. SUTHERLAND, MS, recently received an honorary degree from the University of North Carolina at Chapel Hill. He is vice president and technical director of Sutherland, Sproull and Associates Inc. of Palo Alto and is co-founder of Evans and Sutherland, one of the leading manufacturers of computer graphics systems. He is currently a visiting professor at Imperial College in London. He has received many honors, including the Zworykin Award of the National Academy of Engineering, Caltech's Distinguished Alumni Award, and the Steven Anson Coons Award of the Association of Computing Machinery for achievements in computer graphics.

1962

CARL HAMILTON has joined American Medical International as senior vice president of finance and planning. He has been a member of the faculty at USC Graduate School of Business Administration for the last 16 years, most recently as professor of finance and associate dean.

1963

WENDELL W. MENDELL married Pamala Henjum in Nassau Bay, Texas, in March. He has been working at NASA's Johnson Space Center for 23 years; for the past four years, he has been involved in developing concepts for a manned lunar base. He has also edited a book, *Lunar Bases and Space Activities of the 21st Century*, which was published by the Lunar and Planetary Institute in Houston. He lives in League City, Texas.

1965

JON K. EVANS received his PhD in theater arts from UCLA in June.

1977

MELODY HOWE writes from London that she is a copywriter in a sales promotion agency. Since graduation, she has had a variety of experiences, including two years in a doctoral program in developmental psychology at UC Berkeley until she "suddenly got fed up with academics and took a year off to work in a PR agency in Van Nuys running yo-yo, Frisbee, and hula hoop contests for kids." She returned to Berkeley in 1980 and "one day lightning struck"—she was invited to Holland to do some hula hoop demonstrations (she was national hula hoop champion here in 1969) and to organize a Dutch hula hoop contest cross-country tour. "I was assaulted by hordes of exuberant Dutch children eagerly chasing free hula hoops." The Dutch tour led to the same experience in London, where she has been living for three years. "Along the way, I've done a lot of TV, radio, and press interviews and made it into the *Guinness Book of Records* twirling 65 hoops simultaneously."

1981

CHARLES M. RICE, PhD, has been named a Pew Scholar in the biomedical sciences. He is a virologist and assistant professor of microbiology and immunology at Washington University School of Medicine in St. Louis. He will receive \$200,000 over the next four years to encourage research for the advancement of human health. His work involves the study of recombinant DNA technology to unravel the molecular details of how viruses reproduce.

1982

ROBERT J. LANG, PhD '86, married Diane Davis, staff member of the Caltech publications office and former editor of this column on September 13 at Caltech. Lang is a research fellow in applied physics at the Institute. In February, the Langs will travel to Stuttgart, Germany, where Robert will spend ten months as a research fellow at ITT.

1982

CHARLES A. WIGHT, PhD, his wife, Lee Ann, and their daughter, Linda, "are happy to announce the birth of Jennifer Leigh on September 20, 1985." The Wights reside in Salt Lake City where Chuck is an assistant professor at the University of Utah.

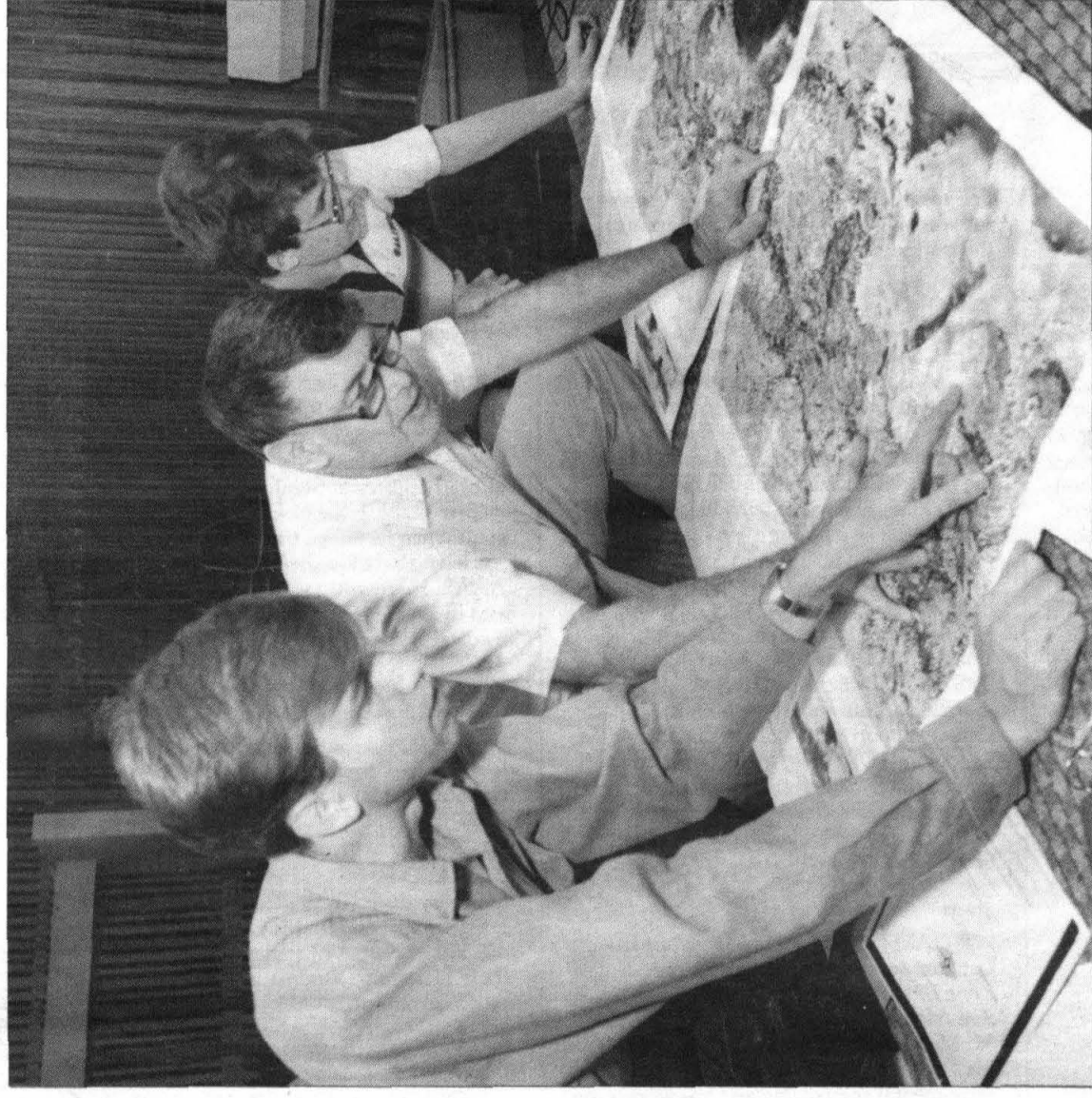
CALTECH NEWS



Norman Gjostein of Ford Motor Company leads a luncheon seminar for Summer Undergraduate Research Fellowship (SURF) students on the role of advanced technology in the automobile industry. At his right is SURF Fellow Gerald Wong. Gjostein, who is director, systems research laboratories, Ford Motor Company, was one of 18 leaders from government, business, or the Caltech faculty who met during the summer with small groups of SURF students to talk about topics ranging from leadership characteristics, entrepreneurship, and career development, to interesting research projects that are underway.

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Where to land on Mars? The prospect of eventual human flight to that planet creates the need to know. Bruce Murray and two SURF students seek insights. See page 4.

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