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Right: In the manuscripts room of the Huntington Library, Caltech medieval historian Eleanor Searle studies a 14th-century account roll that details in Latin the day-to-day operations of an English farm in the Middle Ages.

Below: Railroad magnate and philanthropist Henry Huntington in front of the bronze doors of his new Library, in the early 1920s.



A tale of two institutions— Caltech's Huntington connections

By Winifred Veronda

"When I was offered a job at Caltech, I thought of it as a nice little school somewhere over by the Huntington Library," confesses a humanities professor about her introduction to the Institute. She is one of numerous scholars in history and literature who have been lured, over the decades, to Caltech professorial posts because of this proximity and the opportunities that it affords.

Only a mile of residential streets separate these institutions. They are linked by a community of humanists who share research interests and sometimes hold joint appointments. Less well known is the fact that they also share a heritage of leadership from the early decades of the century.

Southern California, with its orange groves, blue skies, and rolling hills, had become a magnet for men with grand dreams, and with the resources to bring them to reality. One in particular, astronomer George Ellery Hale, who established for the Carnegie Institution

of Washington its Mount Wilson Observatory, would play a major role in the creation of both modern Caltech and the Huntington Library.

Hale's dream of a tripartite institution integrating the Mount Wilson Observatories, Throop Institute (which he expected to become a scientific institution of the highest caliber), and a world-renowned research library created from Henry E. Huntington's superb collection of rare books and manuscripts, would never be realized. But his belief that one day Pasadena would be crowned as what he termed "the cultural center of the West," joining science and the arts in happy union, would have a major impact on the region's future.

Hale, who came to Pasadena in 1903, had followed with interest the growing collections of rare works being assembled by Henry Huntington. Inheritor of a railroad fortune, Huntington multiplied his wealth through business holdings and southern Califor-

nia land acquisition and development. By 1903, he had purchased the San Marino Ranch, a working ranch just south of Pasadena.

Interested in rare books throughout most of his life, Huntington accelerated his collecting efforts early in the 1900s, a period when he divided time between New York City and his San Marino property. His purchases concentrated increasingly on Anglo-American civilization since the Renaissance.

His buying habits caused concern in his Los Angeles office, where employees adopted a stock phrase, "We're in mourning," as an indication that Huntington had sent them another large bill to pay for the purchases of books or art.

When Huntington acquired his copy of the Gutenberg Bible on vellum for \$50,000 in 1911, a colleague wrote, "I have known for many years that you were in need of the influence of the

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Huntington Library, San Marino

CAMPUS UPDATE

Trustee Jewel Cobb to speak at this year's commencement

Jewel Plummer Cobb, a member of the Institute's Board of Trustees since 1990, will present the commencement address at Caltech's 99th commencement exercises on June 11. Cobb is president emerita of California State University, Fullerton, and Trustee Professor at California State University, Los Angeles.

Cobb earned her bachelor's degree in biology from Talladega College, in Alabama, in 1944 and her PhD in cell physiology in 1950 from New York University. After two years of post-doctoral research and two as an instructor at the University of Illinois, she became a faculty member in the Department of Surgery in the NYU Postgraduate Medical School. In 1960 she joined Sarah Lawrence College as professor of biology. Her research has focused on how normal and cancer pigment cells grow, and their morphology and genetic expression. Cobb is the author of 36 papers.

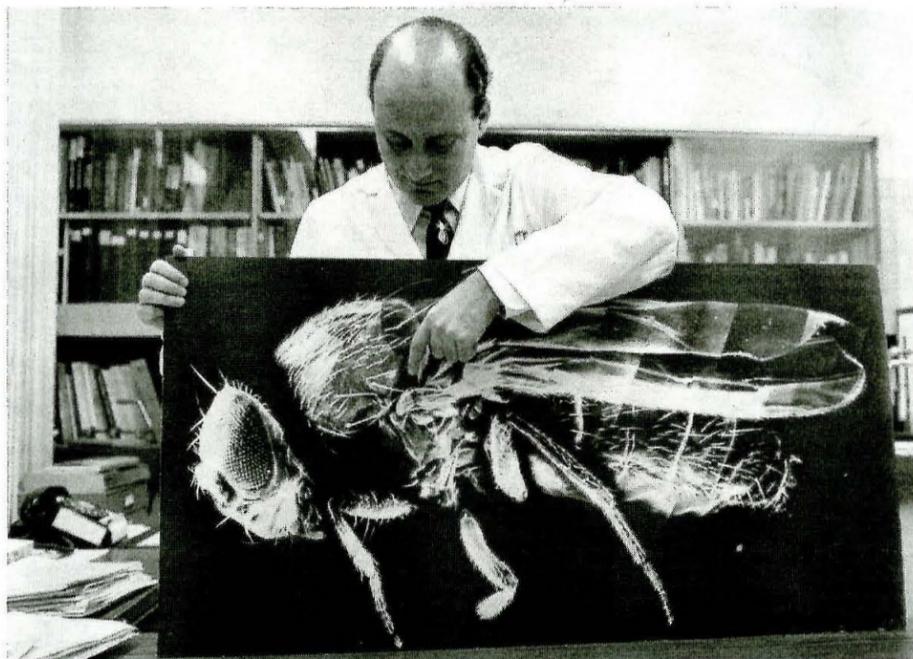
Cobb joined the ranks of university administrators in 1969 when she became dean of Connecticut College. In



Jewel Plummer Cobb

1971 she went to Rutgers University's Douglass College as dean and professor of biology, a position she left in 1981 to assume the presidency of Cal State Fullerton.

Since she retired from that post in 1990, Cobb has been active in promoting the advancement of women and minorities in scientific fields and has authored a number of publications on issues relating to women in science. A fellow of the American Association for the Advancement of Science, Cobb holds 18 honorary doctorates and serves on the boards of many companies, universities, and public-service groups.



Institute neuroscientist ascends to Crafoord Prize on the wings of fruit flies

It was the early 1960s and biologist Seymour Benzer was wondering why his two daughters, raised under the same roof and presumably exposed to the same influences, seemed to have such disparate personalities. "You begin to ask yourself," he said, "are we doing something that different with each child, or is it heredity?"

So Benzer did what any concerned parent in his position would have done. To understand his children better, he took up the study of fruit flies.

Last month the Royal Swedish Academy of Sciences paid tribute to Benzer's fatherly zeal. It awarded him the prestigious Crafoord Prize for his original and pioneering work in illuminating the genetic bases of behavior through studies of *Drosophila melanogaster*, otherwise known as the fruit fly. Benzer, the James G. Boswell Professor of Neuroscience, Emeritus, shares the honor (worth \$330,000) with Oxford scientist William Hamilton. They will receive the award from the king of Sweden at a ceremony this September. The prize is given annually by the academy—the same concern that bestows the Nobel prizes for chemistry and physics—for outstanding research in fields not covered by the Nobels.

The eclectic nature of the Crafoord Prize makes it an honor particularly suited to Benzer. The Brooklyn-born physicist-turned-biologist has practically made a career out of opening up new scientific territory, and then, as the field begins to flourish and others flock to it, moving on to something else.

"When a subject develops very thoroughly," he once remarked, "there's too much you have to know. It gets sort of overwhelming. There's a big attraction in starting something new and being very stupid about it."

Say what he will, Benzer received his PhD from Purdue University, earning several patents for his World War II-

related research in solid-state physics while he was still a graduate student. But he had always been interested in biology, and after two years on Purdue's physics faculty, he took a leave of absence in 1949 to spend two years at Caltech with Max Delbrück's legendary "phage group." That experience, plus two more years at the Pasteur Institute in Paris, completed Benzer's conversion to molecular biology. Back at Purdue with a new title—professor of biophysics—he carried out pioneering research on the fine-structure of the gene that saw him elected to the National Academy of Sciences in 1961, at the relatively early age of 39. A few years later, casting around for something novel to do, and struck by those intriguing differences in his daughters, he began thinking about the genes that govern the development and functioning of the nervous system, and hence are ultimately responsible for behavior.

In its citation, the Swedish Academy credited Benzer with laying much of the foundation for modern neurogenetics. His signal contributions, said the Swedes, have been to establish that specific fruit fly behaviors, such as mating patterns, phototaxis, and even circadian rhythms, can be traced to single genes that govern the development of the fly's nervous system, and to develop techniques that make it possible to thoroughly investigate this relationship.

Or, as Benzer puts it: "You have behavior, and a lot of it is innate, especially in *Drosophila*. If you want to understand behavior in relationship to genes, you make a mutation that knocks out one gene at a time, while keeping the environment the same, and see what that does to behavior."

It's a simple premise, one might even say stupid. And, in fact, Benzer's decision to investigate the behavioral genetics of *Drosophila* caused some commotion in Caltech's biology divi-

sion, which hired him permanently onto its faculty in 1967. Fruit flies, of course, had been a staple of genetics research at the Institute since the heyday of Thomas Hunt Morgan. But what use, some scientists wondered, could they be in the study of so complex a phenomenon as behavior?

Benzer, who by this time had been trained in *Drosophila* techniques by Caltech's resident fly man, Edward Lewis (now the Thomas Hunt Morgan Professor of Biology, Emeritus), saw it differently. *Drosophila* are prolific, easy to maintain, and not hard to mutate. Also, for such a simple creature, they have a respectable repertoire of behaviors. Just *how* respectable Benzer didn't realize until he and his students began treating their specimens with mutagens and studying the amazing number of weird and degenerate offspring that staggered out of the test tubes. The challenge then was to relate these behavioral anomalies to the neural malfunctions that caused them, and to relate those malfunctions to mutations in specific nervous system genes. Benzer and his collaborators developed experimental and analytical techniques to accomplish precisely that, and as the Crafoord citation notes, "he and his many coworkers created a new and very successful research field."

They also created a panoply of mutants whose variety is reflected in some of the names Benzer has awarded to his deviant flies. "Dunce" is unable to remember anything, even by relatively modest *Drosophila* standards. "Drop Dead" is perfectly normal at birth but dies early from a form of brain degeneration that induces a kind of fly dementia. "Wings Up" has wings frozen in a permanent salute like a Christmas angel, the result of a disorder that looks quite a bit like muscular dystrophy.

These resemblances to human afflictions may be more than coincidental. Some of Benzer's most illuminating work has had to do with the discovery that humans and fruit flies share many genes and that the knowledge gleaned from fruit fly research may be applied to studies of how the human brain and nervous system develop, function, or malfunction. In fact, the Caltech scientist, who continues as a fully active researcher, works closely on these problems with his wife, Carol Miller, Caltech visiting associate and chief of neuropathology at USC Medical School, who has made important contributions to understanding such neurological diseases as Alzheimer's.

Benzer now becomes Caltech's second Crafoord laureate, joining Gerald Wasserburg, the John D. MacArthur Professor of Geology and Geophysics, who was honored in 1986. (Alumnus Allan Sandage, PhD '53, won the prize in 1991 for his work in astronomy.) Benzer's previous honors—there have been quite a few—include the Lasker Award in 1971, the National Medal of Science in 1983, and the \$100,000 Wolf Prize in 1991.

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FRIENDS

TRW establishes fund in engineering at the Institute

The TRW Foundation has approved a grant of \$500,000 to establish a TRW Fund in Engineering at Caltech. The five yearly payments of \$100,000, beginning in 1993, will support new faculty and innovative research in the areas of aeronautics, computer science, and electrical engineering.

Said John Seinfeld, the Louis E. Nohl Professor and professor of chemical engineering, and chairman of Caltech's Division of Engineering and Applied Science, "TRW has played a leading role in stimulating creative research at Caltech for many years. I hope that through the fund, TRW will continue to participate actively in the intellectual life of the Institute for many years to come."

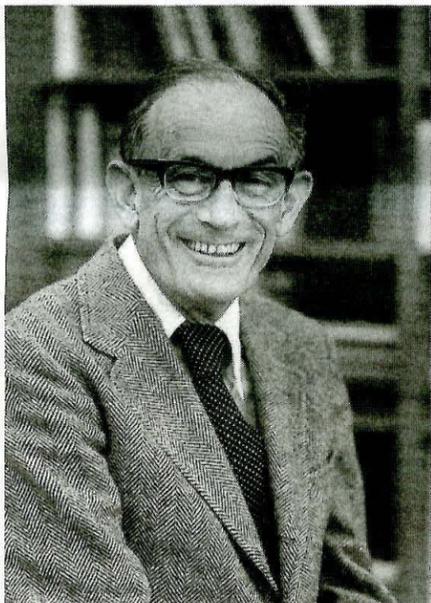
Both Caltech and TRW note that the company's longstanding association with the Institute's departments of aeronautics, computer science, and electrical engineering has aided Caltech and contributed to TRW's leadership in many aerospace and electronic technologies. TRW's past support to the Institute has stimulated growth in several important research areas including fluid and solid mechanics, electronic systems and device technology, and materials science.

Cleveland-based TRW Inc. is an international company that provides high-technology products and services for spacecraft, electronics, and defense systems; automotive systems; and commercial information systems. Founded in 1901, TRW employs more than 60,000 people in 20 countries, including almost 200 Caltech alumni at TRW's Space and Electronics Group in Redondo Beach, California.

Boeing makes gift of Liepmann Chair

The Boeing Company has announced a commitment to establish the Hans W. Liepmann Chair in Aeronautics at Caltech, in recognition of Hans Liepmann, who has been a renowned member of the Institute's aeronautics faculty for more than five decades. Boeing has pledged \$1.5 million to establish the professorship and will donate the sum in increments of \$500,000 annually, beginning in 1996.

The new chair recognizes Boeing's strong relationship with Caltech and Liepmann's many years of assistance to Boeing Aerospace technologies, both through his technical consulting and



Hans Liepmann

through the numerous contributions of his students who work at Boeing.

Liepmann, who is Caltech's Theodore von Kármán Professor of Aeronautics, Emeritus, has been associated with the Institute since 1939. A



The Caltech Associates recently met for the annual changing of the guard, and installed new officers and board members for 1993-94. From left, back row: board members Roland Smoot '50 and Tom Tyson, '54, PhD '67; and secretary, Joseph Herron. Front row: board member Tim Siu, MD; president, George Smith '44, PhD '52; vice president, Delpha Noland; ex officio, Edith Roberts; and vice president, Warren Schlinger '44, PhD '49. Not pictured: treasurer Carl Larson '52, and new board members Hubert (Herb) Dubb '56, Milton Mohr, and Carel Otte, PhD '54.

native of Germany, he earned his doctorate from the University of Zurich in 1938 and immigrated to the U.S. in 1939 at the invitation of Theodore von Kármán, then director of Caltech's Guggenheim Aeronautical Laboratory (GALCIT), to join the lab as a research fellow. He became a citizen in 1945, a full professor in 1949, and served as GALCIT director from 1972 to 1985, the year he became professor emeritus.

"Boeing's longstanding association with Dr. Liepmann, his students, and other Caltech faculty has benefited Caltech and contributed to Boeing's leadership in many areas," said A.D. Welliver, Boeing corporate senior vice president, engineering and technology. "This chair will strengthen Boeing's historical ties to Caltech's aeronautics program and provide a foundation on which to build new relationships with the Institute."

"I was absolutely surprised and very happy when I heard the news," said Liepmann, who lives just a few miles from Caltech and still visits his campus office almost daily. "I have been working with Boeing for many years, and know quite a few people there, but I

was completely surprised and overwhelmed."

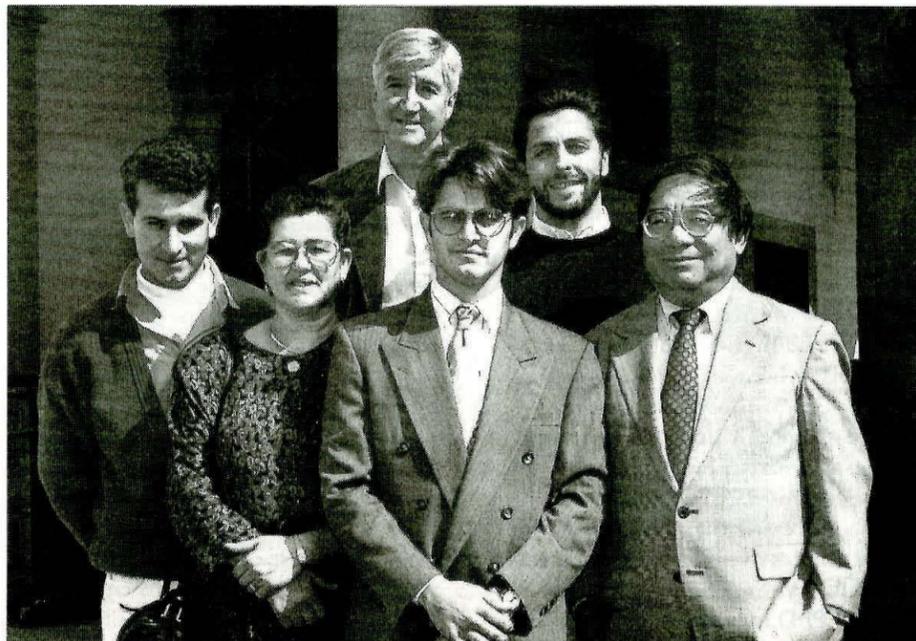
Among the hundreds of Caltech students who profited from Liepmann's lectures and academic counsel is Boeing's past chairman and chief executive officer, Thornton A. Wilson. Today Boeing employs one of the largest concentrations of Caltech graduates anywhere in industry, with more than 90 alumni on staff. The company has consulted frequently with Liepmann and other Caltech aeronautics faculty on questions of aircraft design and has used the Institute's ten-foot wind tunnel in the design of many Boeing airplanes, including the B-29.

The establishment of the Liepmann Chair is the latest of many accolades that have come to Liepmann in the course of his long and distinguished career. These include the National Medal of Science and the Guggenheim Medal (both awarded in 1986), as well as membership in the American Academy of Arts and Sciences, the National Academy of Engineering, and the National Academy of Sciences, and an award from the Caltech student body for excellence in teaching.

Forty-five Caltech Associates joined Professor of Geology Brian Wernicke and Associate Professor of Geology and Geophysics Joann Stock for a "weekend of camaraderie and enlightenment" about the geology and history of Death Valley. Their visit to the rugged mountains and desert expanses of Death Valley was bracketed by viewings of the San Andreas and Garlock faults. Rounding out the trip: a stop at Ubehebe Crater, site of some of California's most recent volcanism.



Junior in chemical engineering José Garcia (center) had plenty of company the day \$1,000 came his way in the form of an NSF Minority Incentive for Excellence Scholarship Prize, awarded for scholastic excellence in science and engineering. Joining Garcia (from left) were his brother Juan; mother, Maria Garcia; Chemistry and Chemical Engineering Division Chair Fred Anson; Professor of Chemical Engineering John Brady; and Hoag Professor of Biophysical Chemistry Sunney Chan.



Hiking to the top of yet another California mountain, George Smith can look back not only at the beautiful state he calls home, but also at a successful career as vice president of Hughes Aircraft Company and director of Hughes Research Laboratories. Here, the new president of the Associates sits atop Mount Montgomery, near the border between California and Nevada, enjoying the view.



The Associates' new president comes full circle

By Hillary Bhaskaran

For the past half-century, George Smith has kept his heart in southern California. His three Caltech degrees (BS '44, MS '48, PhD '52) led him to 35 years and a senior vice presidency at Hughes Aircraft Company, and back to his alma mater to become the new president of the Associates. It's not just Smith's career that has kept him in this region. It's also his close ties to good friends in southern California, including fellow Associates, along with a fondness for the mountains, that make him never want to leave.

Smith's journey to California began in Indiana, his birthplace, and continued in New Mexico, where he got his grammar and high-school education. While his father taught physics at the New Mexico Military Institute, the young Smith built little radio sets and became an amateur radio operator. Years later, his decision to attend Caltech was easier than his decision to opt for physics over electrical engineering. But, says Smith, "as it turned out, I got my PhD in what today would be

applied physics—a hybrid of the two."

At Caltech, Smith's undergraduate-dormitory experience was cut short when the Navy V-12 program took over the student houses in 1943. The program allowed college science and engineering students to continue their education while being groomed for officer-candidate school, and often, for special technical assignments as naval officers. An unforeseen perk of the program, says Smith, was that Caltech "inherited a number of good athletes from Stanford and elsewhere and, as a result, had a first-rate basketball team. Of course, many other schools were decimated with everyone going off to the draft. But for that period of time, Caltech played top-notch basketball, beating teams like USC and UCLA!"

But some of Smith's undergraduate experience fit the norm. Before he moved off campus, Smith had received the traditional lockpicking education—"the first course any Caltech student got, *before* formal instruction." And he had had the opportunity to

serve as a student waiter in Blacker House. While waiting tables, Smith became good friends with Herbert Lassen (BS '43, MS '47, PhD '51), one of many friends he'd see again at Hughes and then in the Associates. Ruben Mettler (BS '44, MS '47, PhD '49) was another of these long-time friends, himself a member of the V-12 program. He was part of Smith's "rather unusual graduating class" of '44, in which Smith and a handful of upperclassmen graduated four months early in order to finish before they were drafted. So the multiple classes of '44 will have that much more to talk about when they meet for their 50th class reunion next year.

In the Navy in Washington, D.C., from 1944 to '46, Smith worked in a classified section that was developing pre-computer electro-mechanical technology for cracking codes. When the war ended, the leader of Smith's group "thought this R&D effort should be continued. He realized that few of his workers would stay on as government

employees, so he founded a small company, Engineering Research Associates," at which Smith worked for the next year. ERA was later purchased by Sperry Rand, where it formed part of the UNIVAC Division, which made a business of building computers.

Returning to Caltech in 1947 for his graduate education, Smith met up with Mettler again as a fellow RA (resident associate) in the student houses. Later, Mettler was the one who recruited Smith to Hughes. Mettler, of course, went on to become chairman and CEO at TRW and now chairs the Caltech Board of Trustees, in addition to being an Associate. The connection doesn't end there. On a double date with Mettler, Smith met Jean, the woman he would soon propose to—only, Jean happened to be *Mettler's* blind date at the time. Well, everything worked out, Smith and Mettler are still good friends, and George and Jean, "a Scripps girl," have been married since 1950. And who was in their wedding party but Lassen and another friend and fellow RA, Carel Otte (MS '50, PhD '54), both of whom are now Associates as well.

Then there were the Caltechers that Smith didn't meet at the Institute, but who later crossed his path at Hughes. One was Richard Feynman, who began teaching at Caltech just as Smith was leaving. Still, Smith saw "the genius" throughout the 15 to 20 years when he was regularly teaching a course at Hughes. One of those years was 1965, and Feynman got *the* call from Stockholm on the weekend before one of his Wednesday-afternoon lectures at the company. "As you can imagine," recounts Smith, "everyone in the labs eagerly awaited the arrival of the new Nobel winner that Wednesday. And lo and behold, a big black limousine pulled up, the driver hopped out and unrolled a red carpet, and out came Feynman in his usual shirt-sleeves and tennis shoes." After being ushered into the packed auditorium for a celebration, Feynman said, "Well, it doesn't seem sensible for me to teach the next installment [of this dry stuff], so how about if I give you a dry run of my Nobel speech?" Saying that he planned to leave the scientific details to his two Nobel corecipients, Feynman proceeded to give a personal account of his research approach. He'd "fallen in love with an idea early on," and he said his commitment to this idea was "like getting married. . . . Maybe if you'd known ahead of time what you were getting into, you'd have done things differently."

Smith also met Tom Everhart at Hughes. At the time, Everhart was a master's student at UCLA and was on a Hughes Master of Science cooperative program. Years later, when Everhart was teaching at Berkeley, he was a consultant for the Hughes Laboratories. He and Smith didn't know each other well but, says Smith, they later "refreshed" their acquaintanceship. This time Everhart came, as part of a three-member consulting team, to do a tech-



Fifty years before he became president of the Associates, Smith appeared as a junior (second row, fourth from the right) in the 1943-44 war-time edition of Caltech's yearbook. Coincidentally, he stood just down the row from Warren Schlinger (second from the left), who is now vice president of the Associates. The yearbook identified the above sophomores and juniors, from left to right, as follows: (bottom row) Mann, Eller, Kettler, Knopoff, Nicholas, Welliver, and Newman; (second row) Weldman, Schlinger, Richeson, Robinson, G. F. Smith, Hunt, Reece, and Yik; (top two rows) Shenfil, Bower, Flynn, Ellis, Bushong, Fein, Kuhn, B. Freeman, H. Schroeder, Talmadge, Darling, and Kaplun.

nical evaluation of Hughes for General Motors, which was thinking of buying the company following the death of its founder, Howard Hughes. Also at Hughes in the early fifties were Simon Ramo (PhD '36 and a Caltech Trustee) and Dean Wooldridge (PhD '36). After being largely responsible for the birth of the modern Hughes Aircraft Company, they went on to become the "R" and "W" in TRW. And as Smith says, "they persuaded a number of people of my vintage" to follow them there, including Mettler and Lassen.

Of course, life at Hughes in the fifties and sixties wasn't just one big Caltech reunion. But it may have been just as exhilarating, as Smith tells it, marked as it was by exciting technological advancements, including major breakthroughs in space and laser technology. In those days, Hughes was able to "take the long view." Speaking of the company's founder, Smith says "Howard Hughes didn't demand big dividends, so most of the earnings were plowed back into the company. Today, [now that Hughes is part of a public corporation,] there is more emphasis on quarterly financial reports and stockholder dividends."

Smith's first assignment at Hughes was to experiment with insulating powders and thin films to devise storage display tubes that, among other uses, would improve the image displayed on aircraft radar screens. "When you look at a radar screen," he explains, "you see a wand sweeping around the screen, and just behind the wand, the radar image quickly fades out." Finding ways to keep that image bright and to reduce the fading kept the young research scientist busy from 1952 to 1957. To manufacture and market the resulting direct-view storage tubes, Hughes established a new division in Oceanside, California.

Of all the research that he participated in, Smith says he had the most fun exploring applications for the ruby laser, which Ted Maiman had invented at the Hughes Laboratories in 1960.

After surveying a number of possible applications, Smith "organized a group of scientists to see if we couldn't use the laser as a range finder, to measure the distance to a target to help aim a missile or a gun." They found that they could, and a major product line in military laser range-finding equipment was born. These and other successes propelled Smith to the position of senior vice president of Hughes, and director of its Research Laboratories in Malibu.

But it was in Westchester that George and Jean Smith made their home, within biking distance of the old Hughes headquarters in Culver City. There they raised three children (a lawyer, a doctor, and, not too surprisingly, an electrical engineer), all of whom inherited their parents' fondness for the outdoors. "For years," Smith recounts, "we'd take week-long backpacking trips in the Sierras with the family. The children all developed a love for the mountains themselves." And the Smiths have kept hiking and biking into their retirement.

Being president of the Associates also keeps Smith busy, especially lately. After joining the group in 1987, Smith was elected to the one-year term as president last January. "The year started off with a bang, with the black-tie dinner for Rudy Marcus," he says. "So far, I've had some Associates business at least every other day, but as I get into a routine, I'm sure things will settle down." Busy or not, he has no regrets. "The Associates activities, both the dinner meetings and trips, are stimulating and great fun," says Smith. "They all feature Caltech professors and provide an exceptional way to keep abreast of what's going on at the frontiers in which Caltech is involved. Also, being a member is a great way to enjoy the company of a delightful group of people with similar interests." Most importantly, says Smith, "this is my opportunity to do a little for Caltech in return for all the great things I've gotten from the school."

Two Caltech biologists explore possibility of nerve-cell regeneration in mammals

A mammal's nervous system, impressive though it is, also has some impressive limitations. The most notable is its inability to repair itself: the human brain can write poetry, compose symphonies, or calculate the self-energy of the electron, but if the nerve cells responsible for such feats are damaged or destroyed, the human body can't replace them. But now two Caltech biologists have discovered that *embryonic* cells in the mammalian nervous system may indeed possess some regenerative capacity.

Writing in the journal *Cell*, Associate Professor of Biology David Anderson and former graduate student in behavioral biology Derek Stemple (now a Helen Hay Whitney Postdoctoral Fellow at Harvard Medical School/Massachusetts General Hospital) report on results they obtained while studying the nervous system of the embryonic rat. Specifically, they found evidence of stem cells—primitive cells that have the potential either to create different types of specialized cells or to make copies of themselves. Although in its early stages, this finding may have implications for the treatment of a wide range of nervous system disorders.

Because they are able to create new cells, stem cells have the ability to replace lost or damaged tissue. All mammals, including humans, have stem cells in the skin, intestine, and blood, all of which the body can repair after an injury. Until recently, however, scientists have assumed that, because the nervous system cannot repair itself, it does not contain stem cells.

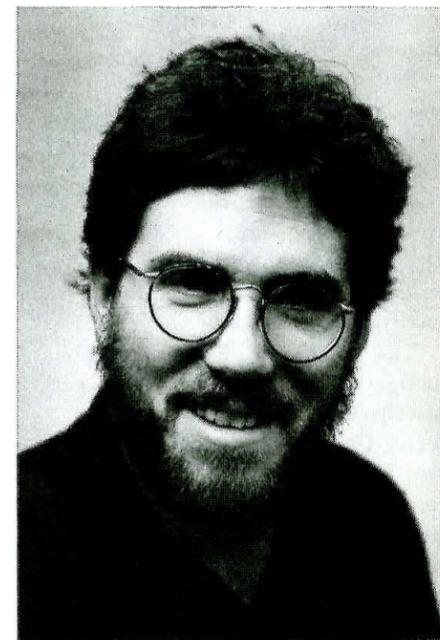
But Anderson and Stemple's work suggests that mammals do contain such cells in their nervous system, at least for a limited period of time. Their work with embryonic rats focused on neural crest cells, a remarkably plastic class of "ancestral" cells. Although they originate in the rat fetus's spinal cord, neural crest cells migrate to new locations throughout the body, where they spawn a wide range of cell types, including not only neurons but also such nonneural offspring as pigment, bone, cartilage, and smooth muscle cells. Stemple and Anderson were able to isolate a number of such cells and, by cloning them, to show that individual neural crest cells could indeed give rise to several different types of descendants.

Such plasticity, or "multipotency," is only one hallmark of the true stem cell. To confirm that they were dealing with the genuine article, Anderson and Stemple also had to show that the crest cells' chameleon-like qualities were heritable—that is, that the cells could also produce multipotent progeny.

To accomplish this, the scientists started a new round of cloning, using

cells from already established, six-day-old clones. (Cells at this stage haven't yet begun to differentiate into neurons or any other cell type.) They found that fifty percent of the second-generation clones survived to start subclones, and that at least half of those subclones retained the capacity to generate neurons, and other less common cell types. "What these results show," says Anderson, "is that multipotent cells are capable of self-regeneration, at least for a limited period of time. Whether this multipotency is eventually lost and if so, how it could be maintained, is the subject of current studies."

What make stem cells multipotent in the first place? Anderson has recently received a major grant from the Seaver Institute to investigate the genetic mechanisms that govern the development of the neural crest cells that he and Stemple studied in their earlier experiment. He hopes to pinpoint the



David Anderson

genes that are responsible for the crest cells' initial plasticity, and to find out how, and at what point in embryonic development, their descendants lose this characteristic and commit themselves and all future generations to life as one specific cell type or another.

"Understanding how the developing nervous system produces so many different types of cells is a central issue in developmental neurobiology," says Anderson, who in addition to his position at Caltech is an associate investigator for the Howard Hughes Medical Institute.

"Equally exciting," says the Caltech biologist, "if we can learn which signals cause the different cells to develop along particular pathways, we could use this knowledge in cell therapy to treat certain diseases or injuries."

Huntington

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Holy Writ, but I did not suppose you would feel the need of \$50,000 of it." (In 1987, a Japanese investor purchased a one-volume edition of the Gutenberg for \$4.9 million. The Huntington's edition is two volumes.)

Discussions between Hale and Huntington about the creation of a research library began early in the century. The Throop Institute and the Mount Wilson Observatory were beginning to attract world-renowned scientists, and Hale hoped for a comparable magnet in the humanities. Along with sound advice about preserving Huntington's collection as "a continual source of literary and historical study" (a point that he pressed on every possible occasion), Hale also offered less practical suggestions—that the library should be housed in a \$4 million replica of the Parthenon, and that expeditions should be sent to Egypt and Greece to search ancient tombs and monasteries for manuscripts to augment its collections.

Sorting through the advice of Hale and others, Huntington by 1919 had evolved a plan for creating the Huntington Library and Art Gallery, with Hale as one of five board members. Hale would be joined on the board in 1927 by Robert A. Millikan, who had headed the rechristened California Institute of Technology since 1921.

The library was planned and would soon be built. Hale and others intimately connected with the project now focused their attention on ensuring that Huntington would provide the resources needed to convert his private collection into a world-class working library complete with journals and other secondary works necessary for research. Resources would have to include Huntington's commitment to a substantial endowment—an issue that caused Hale some concern.

Hale and the others believed that strong support for this goal would come at the conclusion of a search for a library director—a man as distinguished in studies of Anglo-American civilization as Millikan was in physics. Caltech historian William B. Munro and chemist Arthur A. Noyes, along with industrialist Henry M. Robinson, a Caltech benefactor, participated in the search.

The trustees found the man they sought in Max Farrand, whose long teaching career at Stanford and Yale universities had preceded his role as director of the Commonwealth Fund of New York. Farrand joined the Huntington in 1926, and became its director of research in 1927. Meeting with Huntington almost daily, he drove home the point that a great library required a vast array of research tools, as well as fellowship funds to attract

outstanding scholars.

Huntington agreed to provide the endowment, much to the delight of Hale and the other trustees. Farrand congratulated Huntington on "launching the greatest project yet devised for advancement of humanistic studies." Meanwhile, Huntington, apparently slightly overwhelmed, confided to San Marino neighbor George Patton, "Patton, I never had any idea of doing anything of this kind."

Huntington died in 1927, leaving the library and art gallery with an endowment whose market worth was then estimated at \$10.5 million. In establishing it, he could take credit for a remarkable ability to shift his viewpoint from that of a private collector to that of a research scholar. And the trustees could reach toward their goal of a scholar's paradise where the world's leading authorities could study the evolution of Anglo-American civilization.

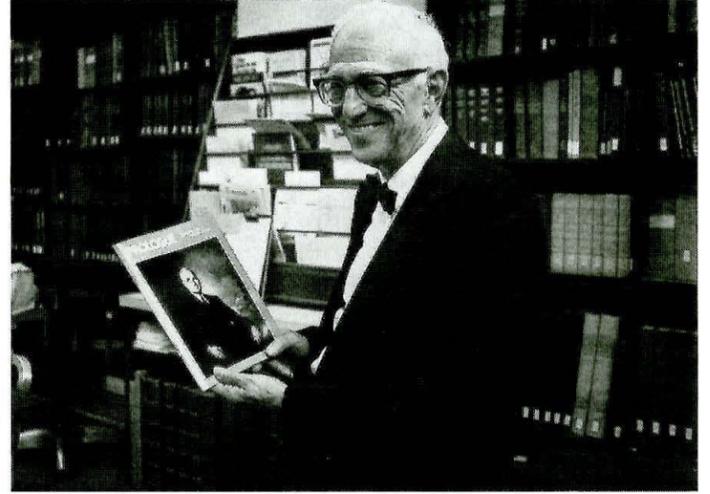
The Athenaeum was erected in 1930, offering membership privileges to scholars at both Caltech and the library—a policy that continues (as does membership in the Caltech Women's Club for wives of Huntington research and administrative staff). Huntington in 1926 had opened the drawing room of his home for the first meeting of The Associates of Caltech, a group of one hundred founders who included many supporters of both institutions. Huntington himself was among the original hundred.

The library continued to grow as a world-class research center under Farrand's leadership. Farrand brought Frederick Jackson Turner to the library in 1927 as its first senior research associate, a move that generated growth in collections on the history of the West. Lee A. DuBridge became a trustee in 1962, continuing the tradition of a Caltech representative on the Huntington board.

Hallett Smith, who now is Caltech professor of English, emeritus, became head of the Institute's Division of the Humanities in 1949, as well as a senior research fellow at the Huntington. Smith, who had become noted for his scholarship in 16th- and 17th-century English poetry and on the works of Shakespeare, had received offers from several major universities. But, he says, "none of them were close enough to the Huntington Library.

"When I came to Caltech," Smith adds, "some of my colleagues in literature thought I must be out of my mind. But the interaction with scientists was fascinating. I loved eating lunch at a round table in the Athenaeum; these were some of the most interesting people I'd ever met." Joining the humanities division in 1947 was J. Kent Clark, now professor of literature, emeritus, who made a temporary visit from Stanford to conduct research at the Huntington on Jonathan Swift, was offered a faculty position at Caltech, and never returned to Palo Alto. Martin Ridge, director of research at the Huntington from 1977

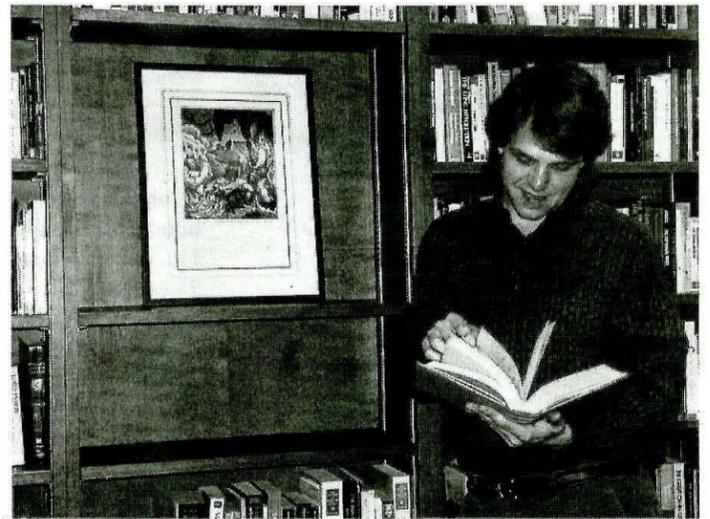
A modern embodiment of the pioneer spirit, Harry Truman is a personal favorite of Caltech history professor Martin Ridge, who uses the Huntington collection extensively in his research on the Old West, the frontier era, and the myths that have grown up around this period in American history. From 1977 to 1991, Ridge also served as the library's director of research.



One of the many Huntington manuscripts that literature professor Jenijoy La Belle has worked with is this 17th-century volume of poetry, compiled in the 1630s by Constance Aston, a young Englishwoman whose literary tastes and wide-ranging personal letters have given La Belle valuable insights into the manners and mores of the period.



Assistant Professor of Literature Kevin Gilmartin stands alongside a 19th-century cartoon, "The Devil, Stealing the Soul of William Cobbett." Cobbett, a Tory turned radical journalist, figures prominently in a book Gilmartin is writing on early 19th-century journalism, aided by an abundance of Huntington source materials.



to 1991, continues as a Caltech professor of history, teaching American biography and Western history. Robert W. Oliver, professor of economics, emeritus, and David C. Elliot, professor of history, emeritus, were among others active at the Huntington in research.

Jenijoy La Belle, a specialist on poet and artist William Blake, joined the faculty in 1969, attracted, she says, by the Huntington's rich Blake collections, and by the presence of Hallett Smith on Caltech's faculty. Huntington materials have provided the resources for several of her publications.

La Belle recalls taking physicist Richard Feynman to the Huntington to acquire a card that would admit him as a reader. She left him alone in the Rare Book Room, and came back several hours later to find him poring over an early work by Isaac Newton. Feynman had been pleased to find a better way to solve a problem (in his head) than one utilized by Newton, but had turned the page and discovered that Newton had

gone on to discover an even more elegant solution.

Despite the shared heritage, as the original nucleus of mutual leaders faded from the scene, ties between the two institutions became less strong. Countering this trend was R. Stanton Avery, who served as chairman of the boards of trustees of both institutions during an interval in the 1970s and 1980s, and who encouraged interaction between the two.

Eleanor Searle, the Edie and Lew Wasserman Professor of History, Emeritus, came to Caltech in 1979 as the first woman to be hired onto the faculty as a full professor. Searle, who had done the research for her doctorate at the Huntington, had been a lecturer at the Institute in the early 1960s. She and her husband, astronomer Leonard Searle, lived within walking distance of the Huntington for many years while she commuted to UCLA, where she was professor of history. (Meanwhile, Leonard Searle was on the research staff

Campaign Report

LANDAU FELLOWS STAKE OUT NEW TERRITORY

Caltech has received a gift from Board Member Dr. Ralph Landau and his wife, Dr. Claire Landau, to establish the Landau Fellowship Program in Chemical Engineering at the Institute. The chemical engineering department recently named Christopher Dartt to be the second Landau fellow. He joins the first fellow, Daniel Pack.

The aim of the Landau Fellowship Program is to provide support for outstanding graduate students in the field of chemical engineering. Fellows are selected either from applicants for graduate study who have already demonstrated unusual accomplishments and promise, or from first-year Caltech graduate students who have excelled in their performance and whose promise for outstanding research accomplishments is clear. The Landau Fellowship Program will run through 1995 and support up to three graduate students a year for three years each.

While Pack and Dartt are both working in chemical engineering, they are pursuing distinctly different avenues of research.

Pack, 24, a third-year graduate student with a BS degree from the University of Illinois at Urbana-Champaign, is studying the adhesion of proteins to lipids, which are fat molecules that make up cell membranes. Certain lipids have the ability to recognize proteins, which is how molecular messages are transferred from outside to inside the cell.

As part of his research, Pack is designing and utilizing novel artificial lipids, combining his interest in chemistry, to which he was introduced in high school, and biology, which he studied in college.

"The long-term goal of my project is to design a biosensor capable of recognizing a specific protein," Pack says. "That could be of interest in assays to determine if a particular virus or protein is present in a blood sample, for example."

Like Pack, Dartt is attracted by the practical nature of chemical engineering. "I like working with things, rather than chemicals," says Dartt, 23, who received his BS from Princeton University.

Dartt is studying zeolites, which are microporous solid materials that look like talcum powder to the naked eye but are actually crystalline materials with an ordered structure. Because all the pores of a particular zeolite have a uniform size, only certain molecules will fit in the pores, allowing only a very specific chemical reaction to take place.

"I'm trying to make catalysts that are useful for specific chemical reactions," Dartt says. "I'm looking at incorporating transition metals into the zeolite structure. By adding metals you can change the properties of the zeolite so it becomes catalytically active for certain reactions, which is useful for making specialty chemicals and performing reactions that we weren't able to do before."

Dartt says his research might eventually be used by chemical and pharmaceutical companies to make products faster and cheaper. *(continued on page 4)*

SCHLINGERS PLEDGE ONE MILLION IN SCHOLARSHIPS AND FELLOWSHIPS

The Institute's drive to raise \$40 million in scholarship and fellowship endowment in the course of The Campaign for Caltech has received a major boost from the Schlinger Foundation, which has pledged \$1 million over five years for undergraduate scholarships and graduate fellowships in chemical engineering. The announcement of the gift was made by the foundation's president, Caltech alumnus Warren G. Schlinger (BS '44, MS '46, PhD '49). Their \$1 million gift brings the Schlingers' total campaign commitment to \$2.5 million. With his wife, Katharine, Schlinger contributed one of the campaign's earliest leadership gifts, \$1.5 million to establish the Warren and Katharine Schlinger Professorship in Chemistry and Chemical Engineering, in December 1989.

The Schlingers' long association with Caltech – and with the chemical engineering field – dates back to the 1940s.



Daniel Pack studies artificial lipids in his lab, combining his interests in chemistry and biology.

Schlinger was a graduate student on the research team of William Lacey and Bruce Sage, both professors of chemical engineering, who were doing pioneering work involving thermodynamics of petroleum hydrocarbons. Katharine Schlinger was secretary to the chemical engineering department during that time. After earning his PhD, Warren Schlinger spent four more years at the Institute, conducting postdoctoral research and teaching chemical-engineering classes.

Schlinger spent 35 years with Texaco, serving during that time as Texaco's liaison to Caltech. He went on to become manager and associate director of gasification, developing processes to produce clean energy from coal, tar sands, oil shale, and other organic sources. He holds more than 60 U.S. patents in the energy field. Schlinger retired from Texaco in 1987.

Schlinger's brother, Evert, the foundation's secretary-treasurer, shares the family affinity for science, receiving his PhD in entomology from the University of California, Davis, in 1957. He taught on the faculty of UC Riverside and later at UC Berkeley, where he was department chairman and vice chairman of academic affairs before retiring as professor emeritus in 1986.

Katharine Schlinger, active in Pasadena community affairs, has served on the boards of the Pasadena Youth Council, the Coleman Chamber Music Association, and the PTA. The couple are members of the President's Circle of the Caltech Associates, and Schlinger was recently elected to the Associates' board of directors. A life member of the Alumni Association, Schlinger has also served on its board of directors. "We've kept in touch with Caltech all along," he says. "This connection is very important to us."

INSIDE

Graduate students talk about their research.

A conversation with Caltech's dean of graduate studies.

**A MESSAGE FROM THE
CAMPAIGN EXECUTIVE
COMMITTEE**



The Campaign for Caltech: A Second Century of Discovery continues at a successful pace. As of

February 28, with 10 months remaining, we stood at \$312 million of our \$350 million goal, or 89 percent overall.

But these total results don't reveal several severe sector shortfalls. Despite overall figures that show our endowment totals at 84 percent of goal, we are falling short on needed endowments for Postdoctoral Fellowships, Graduate Fellowships, Undergraduate Scholarships (less than 40 percent of goal in each case) and Venture Funds (less than 15 percent of goal). As alumni and close friends you will recognize the enormity of the leveraging opportunities these categories represent for the intellectual and philosophical success of Caltech. I am sure you will understand, too, that, despite the overall figures, we will not be able to declare victory when the campaign ends if we don't meet these vital, ongoing needs.

The shortfalls are more than campaign aberrations. We are committed to a turnaround in these elements in the campaign. I hope you will be inspired by the stories of the donors and recipients of the named fellowships featured in these pages and join us in bringing this campaign to a conclusion we will all consider a success.

**For the Campaign Executive
Committee**

William F. Kieschnick

Vice Chairman,

Caltech Board of Trustees

FIVE WHO ARE FORGING AHEAD

Caltech has 1,152 graduate students, all of whom play a vital part in the Institute's research achievements and contribute to its reputation for scientific and technical innovation.

Caltech's graduate students come from 55 countries, and 22 percent of them are women.

The five who are profiled below represent a typically wide range of experience and interests.

MARKET WATCHER

Yan Chen, the Anna and James McDonnell Graduate Fellow in Humanities and Social Sciences, got a crash course in political upheaval before she started studying it at Caltech. Now in her third year studying contemporary political and economic transitions, Chen was majoring in English literature at Tsinghua University in Beijing when the Tiananmen Square massacre occurred in 1989.

Only one month before the June 4 massacre, Chen had applied for graduate study at Caltech. While Chen wasn't in the square on the day the government troops killed hundreds of civilians, she had participated in demonstrations there during the weeks before the massacre.

As troops started moving into Beijing, Chen remembers that most students weren't expecting to face anything more dangerous than tear gas. So when soldiers started shooting and driving tanks over students, it came as a shock that still shows on Chen's face when she recalls the day's events.

"Four students from my university were killed in the square," says Chen, 26, who grew up in Beijing and southern China. During the year after the massacre, Chen says she wondered whether she would be allowed to leave China to study abroad, since government policies on student travel were constantly changing.

Chen was accepted to Caltech in March 1990, just before three of the Institute's social science professors — John Ledyard, Peter Ordeshook, and Charles Plott — were due to lecture in Beijing. She went to their lectures, met them, and explained her concerns about leaving China. They helped speed through the paperwork and get Chen out of the country that summer.

Chen finished her coursework last year and is now working on her thesis, which concerns the influence of political institutions on economic policies. She is particularly interested in the recent transformations that socialist and communist countries have been making to market economies.

"I try to see what areas to privatize and the sequence to privatize them so there won't be as much fluctuation in people's living standards" as occurs when all controls on prices are lifted at the same time, Chen says. "I propose a more evolutionary approach than the 'Big Bang' theory of doing it over two years, as recommended by the predominant school of economists."

Chen says that one of the most valuable parts of her Caltech education has been to learn about political and economic systems outside of China. "In China, I didn't really know how democracy worked and how economic policies are made in different political systems," she says.

She adds that one of the more enjoyable parts about studying at the Institute has been her contact with students and faculty from around the world. Says Chen, "I now have friends from India, (the former) Yugoslavia, France, Russia, and Hungary."



AEROSPACE CADET

It seems natural that Philippe Adam is studying how to make aircraft fly faster and more efficiently. After all, as the son of a United Nations official, he spent a fair share of his youth flying around the world.

Adam, a first-year graduate student in aeronautics, was born in Guinea on the west coast of Africa. He grew up in Ethiopia, where his father trained translators for the U.N., and spent his teenage years in New York. Since his father is Belgian, he'd spend most of his vacations in

Belgium, and although he's a Belgian citizen, he's never lived there and thinks of himself more as a New Yorker.

"I've always been traveling in planes, following my parents around," says Adam, who is funded through the DeLauer and Russell R. Vought fellowships in aeronautics. That experience, plus an interest in engineering, led him to study aeronautics.

Although he's still in the middle of his aeronautics courses, Adam, 22, already knows that he'll be working with the Shock Tunnel Facility — otherwise known as T5 — studying hypersonics. Located on the top floor of the Guggenheim Laboratory, T5 sends shock waves through a tunnel at speeds of 4-7 km/sec, simulating the flow of air over a spacecraft or other object traveling at hypersonic speeds. The force in the tunnel is so great, it occasionally rocks the building.

Adam first got hooked on hypersonics at Polytechnic University in Brooklyn, New York, where he got a BS in aerospace engineering and a BS in applied mathematics. He worked there on a shock tube about 100 times smaller than the Caltech shock tunnel.

Originally accepted to Caltech in 1988 as an undergraduate, Adam didn't enroll because he couldn't get any financial aid. As a graduate student here, he gets full support.



Adam's thesis will focus on the boundary layer – the thin layer of air just over the surface of a spacecraft such as the space shuttle. He will study how the boundary layer behaves under different conditions, such as temperature. He will also research a highly unpredictable condition called transition, which is what happens to the boundary layer when the spacecraft goes from its optimum streamlined or laminar position, when the air of the layer moves smoothly over the surface of the spacecraft, to the onset of turbulence.

"Laminar flow is understood and there are theories about turbulence, but there are so many factors that affect transition that it's hard to predict when transition will occur and what its effect will be," Adam says. He will analyze the conditions under which an object goes from laminar flow to transition to turbulent flow in hypersonics. "Someone might be able to use that information to design hypersonic vehicles," he says.

MAGNETIC FIELDER

If you're an electrical engineer and you love working outdoors, you may have a bit of a career crisis. That was John Holt's dilemma a few years ago when he decided to leave his job at JPL in radar science and engineering and enroll in the graduate geology program at Caltech.

Holt, a third-year graduate student and the Koons Field Research Fellow in Geology, majored in electrical engineering at Rice University and worked for two years at JPL before he had a change of heart.

"I've had an interest in geology ever since high school, but by college I was already pretty far along in electrical engineering and knew that would get me a good job," says Holt, who grew up in southern Illinois. Besides, he figured that as a geologist all he'd end up doing was getting a job with an energy company looking for oil.

But at JPL he came in contact with scientists who were using aircraft-based imagery to study tropical rain forests and geology, and participated in related field work.

"I found that I was more interested in the science than in the engineering, which I felt was mostly support work," Holt recalls. "I also liked doing field work much better than sitting behind a computer all day."

Holt spends much time outdoors now, in places such as the Mojave Desert, collecting rock samples for paleomagnetic studies. His primary area of research is studying the reversals of the earth's magnetic field.

"Every several 100,000 years or so, the earth's magnetic field reverses," Holt explains. "Sometimes it'll flip, stay there for only a few thousand years, and flip back. No one knows how or why it happens, and it's fundamental to the development of the geologic time scale and the theory of plate tectonics."

The magnetic-field reversals are recorded in sediments, since the magnetic grains orient themselves according to the field as rocks are forming.

"It's kind of like a tape recorder," Holt says. "The rocks are basically recording the earth's magnetic field."

"What I like about the work is that it's real and hands-on, not so abstract like theoretical physics," says Holt, 27. "I like to be able to see and touch what I'm studying, rather than just think about it."

COSMIC THINKER

Rebecca Bernstein decided to be an astronomer more through her interest in physics than because she liked looking at the heavens. In fact, at Princeton University, where she got a BS in physics and first decided to pursue a career in astronomy, she says it was usually so cloudy at night that you couldn't even see the stars.

"I didn't realize there were places you couldn't see stars until I went to Princeton," says Bernstein, who last month was named the Alan T. Moffet Memorial Fellow in Astronomy. The fellowship, named for a Caltech astronomy professor, was established in his memory by his parents.

"I think I was first attracted to physics because it's very easy for a child to see physics in the world around her," Bernstein says. "More so, I think, than other sciences."

Bernstein figures that her interest in science comes from her father and mother, who are chemistry and biology professors, respectively, at Colorado State University in Fort Collins, where she grew up. At Princeton, Bernstein took an entry-level course in astronomy and started to appreciate how she could apply her knowledge of physics to astronomy.

After deciding that she wanted to be an astronomer, Bernstein applied to the SURF program at Caltech and was accepted to work on a project at the Infrared Processing and Analysis Center in 1990. The project involved analyzing data on distance scales, which help in determining the age of the universe. Bernstein also got to do some observing that summer.

"The first time I ever went observing was on the 200-inch telescope at Palomar," she says. The SURF experience helped make Caltech her first choice when she applied to graduate schools.

"It's a good way to recruit graduate students," she says. "It worked for me."

Bernstein, 22, hasn't decided yet what area of research she will pursue, but she's particularly interested in observational cosmology – how the universe and galaxies were formed. Although she's focusing on her courses now, she's been working on a project with Tony Readhead, a professor of astronomy.

"We've been looking at superluminal motion, objects that appear to move faster than the speed of light," Bernstein says. The observational technique they are using is called Very Long Baseline Interferometry, in which up to 15 radio telescopes around the world are linked to get the effect of one very large dish.

"I'm not sure I want to work with VLBI for a thesis project," Bernstein says, "but it's definitely interesting."

GALAXY GAZER

Like many budding astronomers, Patrick Ogle, the William G. Reed Fellow in Astronomy, spent much of his youth standing outside at all hours of the night gazing at stars. He grew up in Northridge, California, and got hooked on astronomy through the encouragement of his father, an engineer who works on sonar devices that detect submarines.

Both father and son were members of the Los Angeles Astronomical Society. Patrick learned about astronomy on a four-inch telescope, and as he got older he got to use his father's eight-inch and 17.5-inch telescopes.

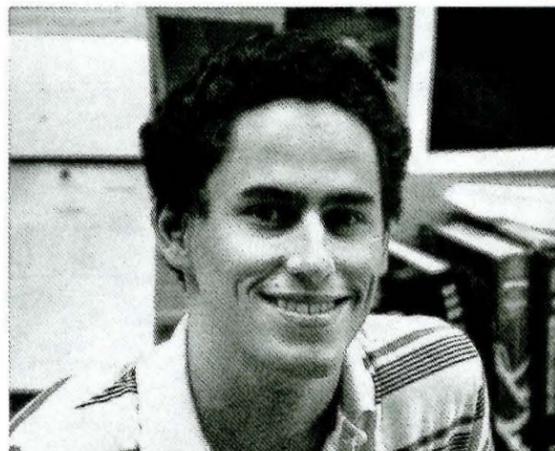
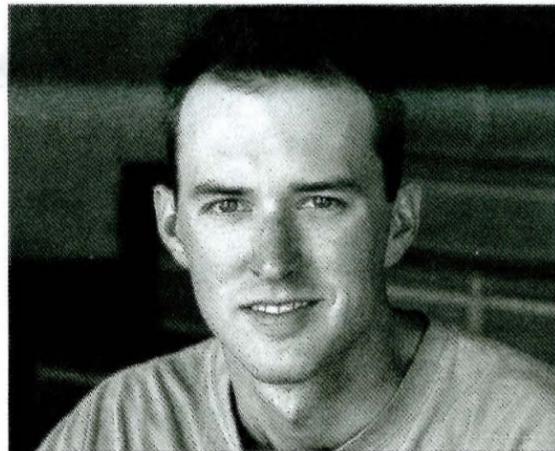
He also helped his father build a small observatory at a cabin at Lake Arrowhead, in the San Bernardino Mountains. "Every new moon we'd go out and look at things," Ogle says.

Ogle, 22, got a BS in physics at Harvey Mudd College, where he was able to use JPL's 24-inch telescope on Table Mountain, studying star-forming regions in galaxies.

A first-year graduate student, Ogle is now immersed in his required astronomy courses, but is anxious to start research so he can use some of Caltech's many telescopes, including the 200-inch Hale Telescope at Palomar and the new W. M. Keck Observatory. He is already working on a small project with George Djorgovski, associate professor of astronomy, doing statistical analyses of the properties of galaxy clusters.

Ogle says his interest in astronomy is mostly philosophical. "I'm interested in the fundamental questions of the creation of the universe and where everything came from. It's an exciting field and there's a lot still undiscovered."

Top Left: Yan Chen
Bottom Left: Phillippe Adam
Below: John Holt
Rebecca Bernstein
Patrick Ogle



The CAMPAIGN for CALTECH

A SECOND CENTURY OF DISCOVERY

CAMPAIGN
TOTAL
REACHES
\$312
MILLION

Recent gifts, including a pledge of \$10,000,000 from a donor who wishes to remain anonymous, have brought The Campaign for Caltech to 89 percent of its overall goal. The \$10,000,000, which will fund the construction of an innovative new student and faculty residence, brings the total that the campaign has raised for new building projects to 101 percent of target.

Progress as of February 28 toward achieving the campaign's three main subgoals — endowment, capital projects, and programs and current operations — is depicted in the chart below. The total target for capital projects includes renovation and plant funds as well as new buildings.



THE MARKET HEATS UP FOR TOP GRADUATE STUDENTS

The best and brightest graduate students in the sciences and engineering are an increasingly hot commodity. Since the number of U.S. undergraduates interested in science has declined in recent years, the leading universities are competing harder than ever to recruit them.

Despite its stature as one of the nation's top schools for science and engineering, Caltech has not been immune to the supply-and-demand crunch for the best graduate students.

"We're competing with the Harvards, Stanfords, and MITs to get our fair share of the very best students from American universities," says Arden Albee, dean of graduate studies, professor of geology, and the Mars Observer project scientist. "The pool of the top students is going down, so almost every student who receives a fellowship offer from us is looking at several fellowship offers."

Compounding the problem is that the amount of fellowship money — from government, corporations, and Caltech's own funds — used to woo these first-year students, is declining. Caltech had funds to support 75 first-year fellowships for academic year 1990-1991, 71 for 1991-1992, 48 for 1992-1993, but only 46 for academic year 1993-1994.

"Quite a number of the year-to-year fellowships seem to be drying up, I assume due to the recession," Albee says.

While graduate students rely on teaching assistantships and research assistantships for support in the latter years of their graduate studies, fellowships typically provide the early support to carry them through their course work. About one-third of all graduate students at Caltech are currently receiving fellowship support.

The U.S. government considers all graduate students to be financially independent of their parents, and therefore Caltech assumes they will all require some form of financial support. With graduate student costs now at more than \$25,000 a year, hardly anyone could afford a PhD from Caltech without support.

Besides the financial benefit to students, Albee says there are basically four reasons why graduate fellowships are important:

1. Endowed fellowships support first-year students so that they have time to concentrate on course work and explore

the options available to them before signing on as a teaching assistant or research assistant for a particular professor.

2. In some areas, such as theoretical physics and math, the nature of the research does not require the use of many research assistants, so fellowships and teaching assistantships must provide most of the support.

3. Fellowships can fill a funding gap so students can finish their theses when a government agency suddenly cuts off a major research grant that was supporting their work or when the theses are in innovative areas with no governmental funding.

4. Many graduate students are married and starting families, so fellowship money can be critical when they have an illness or other special circumstances and need additional support.

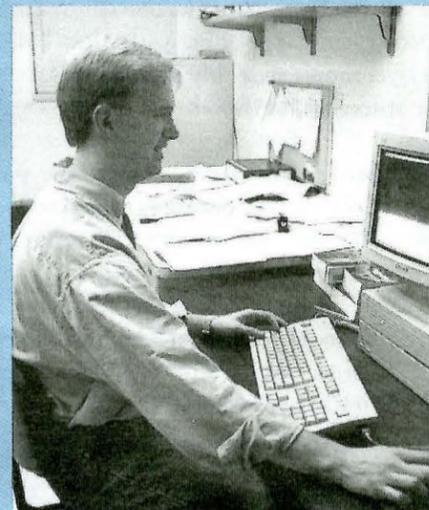
Without fellowships, the most talented graduate students would go elsewhere, and without the best graduate students, Caltech could not continue to do groundbreaking research. Outstanding graduate students are essential for innovative research, Albee says.

"For Caltech to remain on the cutting edge, it must have the very best graduate students," Albee says. "Graduate students play an indispensable role in Caltech's scientific and research achievements."

Once they leave Caltech, graduate students typically go on to leading positions in industry and education. Of Caltech's 21 Nobel Laureates, 10 received their master's degrees or PhDs here. Former Caltech graduate students have also founded major U.S. corporations, including Intel Corp. and TRW.

"Graduate students are our product," Albee says. "We send them out as our missionaries, and we'll stack ours up against anyone else's."

As part of The Campaign for Caltech, the Institute is seeking funding to endow 30 graduate fellowships at \$500,000 each. So far the campaign has raised seven of the fellowships.



Christopher Dartt's research might lead to more efficient production of pharmaceutical and chemical products.

LANDAU FELLOWS ...

(continued from cover)

Both Pack and Dartt aren't sure whether they want to venture into industry or academia when they get their PhDs. Having the Landau Fellowship may help them make their decisions, since a unique component of the fellowship program is that each fellow is encouraged to spend an internship at an industrial laboratory, a national laboratory, or another university.

"That part of the fellowship is really appealing," says Dartt, who plans to do an internship next year with a company. "With an opportunity like that, I'd be able to know what it's like to work in industry."

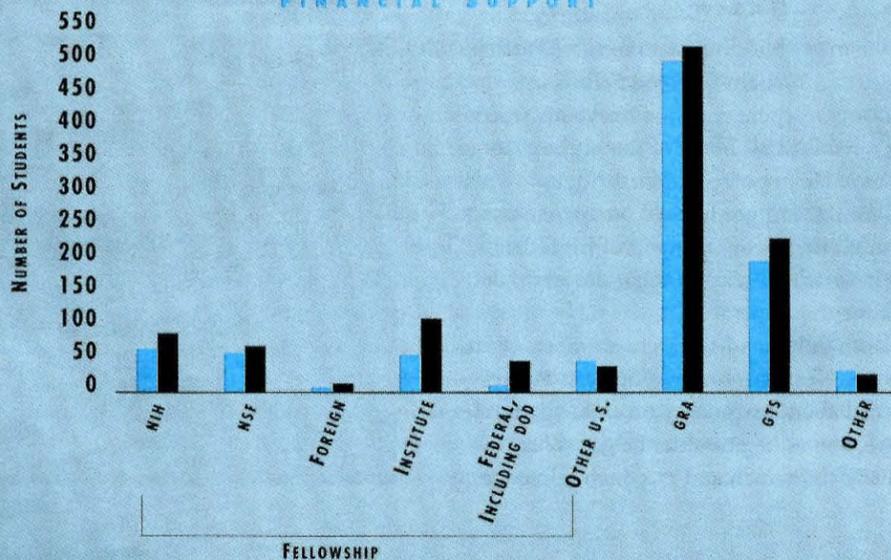
One of the aims of the fellowship program is that the graduate students spend some time with Dr. Landau. Trained as a chemical engineer, Landau holds a BS degree in the field from the University of Pennsylvania and an ScD from MIT.

Landau, who joined the Caltech Board of Trustees in 1982 and was named a Senior Trustee in 1988, holds nearly 50 major patents in the field of organic oxidation chemistry and has published more than 130 papers and six books on technical subjects and economics. He has a teaching appointment at Stanford, where he is consulting professor of economics. Landau is also a Research Fellow of Harvard's John F. Kennedy School of Government, a Life Member Emeritus of the Corporation of MIT, and a Life Trustee Emeritus of the University of Pennsylvania.

Claire Landau received a doctorate in social work from Columbia University in 1957.

About two-thirds of financial support for Caltech graduate students comes from research and teaching assistantships. While fellowship money from some government sources has gone up in recent years, it still represents a small share of total support and is being threatened by budget cutbacks in the federal government.

SOURCES OF FINANCIAL SUPPORT



■ 1987-88
■ 1991-92

of Hale's institution, the Carnegie Observatories, where he is now director, as Hale once had been.) Eleanor Searle wrote her book *Predatory Kinship and the Creation of Norman Power*, published in 1989, based on sources at Cambridge University and the Huntington. Thousands of documents at the Huntington on Battle Abbey, whose history began in the 11th century and continued through the Protestant Reformation, have been a rich resource in her career.

Searle has consistently encouraged closer ties between the institutions, having envisaged a closer relationship between the two as a result of her coming to the Institute. She notes increasing interaction today, including seminars and symposia with participants from both Caltech and the Huntington, and a tendency to ask scholars at the library to teach at Caltech. "The people in literature and history at both institutions are becoming part of one community," she says.

"More and more, Caltech is using the potential afforded by the Huntington to attract scholars," Searle adds. "The best people in English literature and history from all over the world come there. The opportunity to teach at Caltech and do research at the library can be very exciting. And when one scholar comes, then others are attracted. There's a snowballing effect."

Searle has also used the Huntington as a teaching laboratory, taking freshmen to visit furniture collections there as a part of her course in society and material conditions on the Continent before the 1800s.

Kevin Gilmartin, Caltech assistant professor of literature, is among the young scholars attracted by the joint opportunities afforded by the geographic closeness. Gilmartin, whose specialty is early 19th-century romantic literature and political journalism in England, joined the faculty in 1991 because "Caltech offered me the most exciting opportunity to pursue my research. When I came to campus for my job visit, a trip to the Huntington was part of it."

"The nicest thing about the Huntington is the constant stream of scholars coming through," he adds. "Not just the books and the manuscripts, but the people."

In 1981 the Huntington lured Jerome McGann, who was then editing the complete works of Byron, from the University of Virginia to Caltech, where he spent five years as the Doris and Henry Dreyfuss Professor of the Humanities. Zachary Leader, a student of romantic poetry, has remained for an extra year as visiting professor of literature in order to continue research at the Huntington. George W. Pigman III, associate professor of literature, has worked at the Huntington in compiling an edition of *A Hundred Sundry Flowers*, a compendium of pre-Shakespearean literary texts.

William Deverell, now with UC San Diego, has returned to Caltech this year as a visiting assistant professor.

Deverell originally came to the Institute as the Fletcher Jones Fellow at Caltech and the Huntington Library. A specialist on the American West, he is the author of a book, *Railroad Crossing*, published from Huntington materials. This spring he is co-teaching a seminar with Doug Flammig, assistant professor of history, who has been conducting research on race relations in Los Angeles during this century. Flammig's work is enhanced by growing collections of materials at the Huntington on 20th-century southern California social history and race relations, a trend encouraged by younger Caltech scholars. Robert Ritchie, the W. M. Keck Foundation Director of Research at the Huntington, is a visiting associate at the Institute.

One of the first individuals to teach at Caltech while fulfilling a major Huntington role was not a specialist in literature or history, but an art historian. Robert Wark, curator of the Huntington art collection from 1956 to 1990, taught a course for 30 years in which Caltech students were introduced to the visual arts. Wark, who won an ASCIT award for teaching excellence in 1982, used the art gallery for field trips on which students would analyze paintings in detail, comparing brush work and other techniques and generally "exercising their vision."

"It was as if scales would fall off their eyes," he says. "Many of them had never looked closely at a piece of art before." One student, a chemistry major, became so enthralled by the paintings that he went on to specialize in art conservation, and today is a leader in the field.

Shelley Bennett, curator of British and continental art, continues Wark's teaching tradition with three classes at the Institute. These involve frequent trips for study at the art gallery, and papers based on interaction with a piece of art there.

"I try to help the students understand how a painting relates to the history and social context of its time," she says. "I want them to understand that these weren't created as sofa pictures."

"Caltech students are particularly rewarding to teach," she adds, "because of their quick minds and keen level of interest. They're always eager to grasp new information and new experiences."

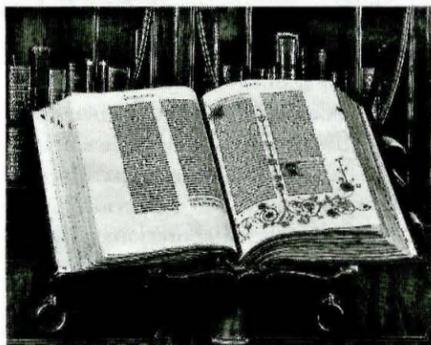
The Huntington Library has remained a scholar's paradise, as its founders dreamed it would, attracting 1,800 each year from all over the world. John Sutherland, professor of literature at Caltech before returning to England earlier this year as the Lord Northcliffe Professor of Modern English Literature at University College London, is among those who chose the Institute because of its proximity to the library. A specialist in 19th-century Victorian fiction, Sutherland echoes the sentiment of colleagues that "dying and going to heaven must be like working at the Huntington every day."

One of the great research libraries of the world, the Huntington's collections

now contain 2.2 million manuscripts, 336,000 rare books, and 290,000 reference books concentrated in the fields of British and American history, literature, and art, and stretching in time from the 11th century to the present. The American West has grown in strength as a focus among the collections, as has the history of Los Angeles and southern California. The history of science also ranks high in importance, particularly in 20th-century astronomy and Renaissance science. (A portion of the Hale papers and those of the Mount Wilson Observatory are there, for example.)

"If you want access to English history," says Martin Ridge, "there are four or five places where it's worth being. And here at the Huntington is one of them."

"Caltech and the Huntington are the best in the world at what they do," says William Deverell. "There's no reason why they shouldn't work together even more closely, and strengthen the ties that have existed from the beginning." Surely George Ellery Hale would find those words to his liking.



The acquisition that started it all: the Gutenberg Bible that Huntington purchased in 1911, around the time Hale decided Huntington was destined to become a patron of culture.

"in disciplines vital to America's future." The Institute, which landed in the top ten of all six fields rated by the magazine, was ranked second in chemistry, fifth in biology, eighth in mathematics, and tenth in computer science. In a related survey of professional graduate programs, *U.S. News* ranked Caltech's graduate program in engineering eleventh in the nation.

NAE names two faculty, four alums to membership

Manfred Morari, Caltech's McCollum-Corcoran Professor of Chemical Engineering, and Fredric Raichlen, professor of civil engineering, have been elected to the National Academy of Engineering (NAE), an honor bestowed upon those who have demonstrated "unusual accomplishment in new and developing fields of technology" and have greatly contributed to engineering theory and practice. Election to the NAE is one of the highest honors that can be accorded an American engineer. The election of Morari and Raichlen brings to 28 the number of Caltech faculty who belong to the Academy. Eleven trustees are also members.

Morari, a 1984 Presidential Young Investigator, develops innovative techniques for the automatic control of chemical processes. His current accolade specifically honors his "analysis of the effects of design on process operability and the development of techniques for robust process control." Morari graduated from the Swiss Federal Institute of Technology, received his PhD from the University of Minnesota, and joined Caltech in 1983. He currently serves as executive officer for chemical engineering.

Raichlen was elected for his "contributions to coastal engineering research and practice related to tsunamis, harbor oscillations, and wave defense of submarine pipelines." Using giant wave pools, he simulates the effects of potentially destructive waves on harbors and other coastal constructions. Before joining Caltech in 1962, Raichlen received his BE at Johns Hopkins University and his master's and doctoral degrees at MIT.

Four Caltech alumni were also welcomed into the Academy this year. Named as members were Sidney Leibovich '61, the Samuel B. Eckert Professor of Mechanical and Aerospace Engineering at Cornell; Richard Petersen, MS '57, executive director of the Virginia Air and Space Center; and Alvin Trivelpiece, PhD '58, director of the Oak Ridge National Laboratory. Che-Min Cheng, PhD '52, director emeritus of the Institute of Mechanics, Beijing, was elected a Foreign Associate.

CAMPUS UPDATE

Continued from page 2

First Citings

The journal *Science Watch*, which tracks trends and performance in basic research, has ranked Caltech first in the nation in the biological sciences and ninth in the physical sciences, for the decade 1981 to 1991. The rankings are based on the number of times papers by Institute scientists were cited by other researchers.

Caltech also received first-place honors for its graduate programs in geology and physics from *U.S. News and World Report* (March 22), which for the first time this year began hand-capping academic achievement in the sciences, based on an evaluation of key graduate programs around the country

ALUMNI

Chapter Activities

I left my CPU in San Francisco

It was Valentine's week when Dr. Joel Birnbaum, the vice president of R&D and director of the HP Labs at Hewlett Packard, spoke to the San Francisco Chapter about the world's ongoing love affair with computers. In his talk "Pervasive Computing," Birnbaum described how extraordinary advances in, and growing interdependence among, communications and measurement systems and computing technology, will lead to major changes in everyday life, in areas ranging from business to education to the conduct of national policy. The likely outcome of all these developments, he said, will be a new kind of multifaceted, multipurpose national information structure.

Boston looks closely at microscopy

Thanks to dazzling advances in microscope technology, biologists may be about to get their most detailed look yet at an exciting range of biological phenomena. New England alumni got their first look at how these techniques work and how they're likely to affect biomedical research when Jean-Paul Revel, Caltech's Ruddock Professor of Biology, spoke to the Boston Chapter recently on "Revolutions in Microscopy." Revel talked about how a new class of microscopes that use digital imaging techniques instead of lenses have already produced images that rank with those from electron microscopes. Alumni also had the chance to view pictures made by the Atomic Force Microscope, a digital imager that has resolved details in DNA strands and shows great promise as a tool in the human genome project.

Arizona dips its toe in El Niño

The notorious warm-water ocean phenomenon El Niño not only brought rain all winter to California, it also brought JPL senior research scientist David Halpern to Arizona this past February. Speaking on "El Niño and Climate" to alumni groups from Phoenix and Tucson, Halpern talked about the role of El Niño—which forms when an equatorial stretch of the Pacific turns unusually warm—in generating variations in global climate, and discussed the associated social and economic repercussions. And he reiterated what rain-drenched and forecast-weary Californians have long suspected—that El Niño, while repetitive, appears to follow no predictable pattern except that of showing up unpredictably.

D.C. Chapter gets the word on space-age archaeology

The use of space-age technology to uncover ancient civilizations is opening

previously unimagined new vistas in science and archaeology, Institute alumnus and JPL scientist Charles Elachi told the Washington, D.C., alumni in a February talk entitled "In Search of Lost Civilization." Elachi, PhD '71, and the assistant director for Space Science and Instruments at JPL, spoke about how high-resolution imaging satellites, operating in a range of wavelengths, are being used to search for evidence of ancient ruins and long-buried human settlements in various parts of the world, and described JPL's involvement in the recent discovery of the lost Arabian city of Ubar.

New threat to Old Masters the topic at Tri-State

The smog that routinely blots out Pasadena's picturesque San Gabriel Mountains does the same thing to scenic vistas in paintings, only in those cases the damage is permanent. But Tri-State Chapter members got a clear view of the work that Caltech environmental engineer and alumnus Glen Cass is doing to safeguard valuable and vulnerable works of art when Cass spoke in New York recently on the topic "Protection of Museum Collections from Damage Due to Air Pollution." Cass, PhD '78, described the approaches he has developed to assess, analyze, and alleviate the impact of air pollutants on museum collections, and talked about his collaborations with a number of museums in these efforts.

Neural transplants addressed in San Diego

"Better Brains through Neural Transplants" was the topic when Caltech Professor of Biology Paul Patterson spoke this past March to the San Diego Chapter. Patterson discussed how new insights into the processes of neuron growth and development are leading to new methods of treating neurological disorders that are caused by nerve cell deterioration or death. These treatments include fetal brain tissue grafts and the injection of proteins that nourish neurons and stimulate their growth.

Chicago gets taken to the market

With much of the world's economy in upheaval, it's reassuring to consider the extent to which this turmoil can be traced to individuals who believe they are acting rationally. Harkness Professor of Economics and Political Science Charles Plott provided some insights into this interesting state of affairs when he spoke to the Chicago Chapter last month on "Individual Rationality and the Behavior of Markets." Plott, a pioneer in the field of experimental laboratory economics, described how laboratory simulations are shedding new light on human behavior in economic situations, and explained what is being learned about the relationship between rationality and strategy choices.

From the Alumni Association president

By Le Val Lund

Save the date of Saturday, May 15, 1993 for the Alumni Association's 56th Annual Seminar Day! Class reunions honoring the classes of '43, '48, '53, '58, '63 and '68 will be held during Seminar Weekend.

As Caltech classes of years past get ready to meet, Alumni Association members are being asked for their ideas about educating Institute students of the future. Last fall, Caltech created an Academic Policies Committee for the purpose of reviewing the undergraduate core curriculum. Chaired by Anthony Leonard, professor of aeronautics, the committee consists of 19 members representing both students and faculty. Over the next several months, the committee will be reviewing the Institute's undergraduate curriculum requirements to see what additions and modifications might need to be made to the current core curriculum structure. Alumni Association representatives are providing input to the process (see related article, below).

Just as alumni have a role to play in shaping student life, the Alumni Association Board of Directors welcomes suggestions and ideas from students in planning Association activities, and includes student representatives on the board. This year, ASCIT President Amit Mehra serves on the Undergraduate Admission and Student/Faculty/Alumni Relations (SFAR) committees. Graduate student in chemical engineering Rob Johnson is a member of both the SFAR and Membership committees.

Undergraduates will also be involved in the Association's upcoming Seminar Day. Three students who participated in the 1992 SURF (Summer Undergraduate Research Fellow-

ship) program will join 15 faculty members in presenting research. For those alumni who will not be able to visit campus for Seminar Day, I'd like to remind you that the 14 Caltech alumni chapters around the country offer an additional, and more frequent, opportunity to get together with your fellow alumni and to hear the latest about what's going on at the Institute. Take a look at the "Chapter Activities" section of *Caltech News* for an update on recent chapter activities, and watch the "Alumni Activities" calendar for news of future chapter events.

Your comments about the Alumni Association and its activities are welcome and can be sent to the Association President, Caltech Alumni Association, Mail Code 1-97, Pasadena, CA 91125, (818) 356-6592 or by electronic mail to the Association President c/o judyamis@pcmail.caltech.edu

Core Curriculum input sought

The faculty/student Committee on Academic Policies is studying possibilities for restructuring the core requirements for undergraduates—currently 255 units of mathematics, physics, chemistry, humanities, social sciences, and physical education, normally taken the first two years—and would like alumni input. Contributions should be sent to Tony Leonard, 301-46, Caltech, or via email to tony@galcit.caltech.edu

JPL geologist Ron Blom brought a bit of frankincense along when he spoke last month to the Houston Chapter about JPL's role in discovering the lost Arabian city of Ubar, hub of the ancient world's frankincense trade. Shown sampling the aromatic spice are (from left) Michael Callaghan '52, guest Quoc Phom, Frank Matthews '64, Blom, and Sid Schafer, MS '36. Frankincense was as prized in antiquity as oil is today, an analogy Houston-area alumni could readily appreciate.





Most folks' brain cells could probably use some nourishment after assimilating a few Seminar Day talks, and the Seminar Day Box Lunch break not only offers such sustenance, it's also a perfect opportunity to catch up with former classmates and meet fellow alumni for the first time. Among the presentations at the Alumni Association's 56th Annual Seminar Day on May 15 will be the keynote address, "Electron Transfer and Stockholm," by 1992 Nobel Laureate Rudy Marcus.

ALUMNI ACTIVITIES

April 8, *Santa Cruz Area Monthly Luncheon*, Peachwood's at Pasatiempo Inn, noon. For reservations, call Bob Shacklett at 408/722-6021. Lunches are held the second Thursday of each month. The May lunch will be on May 13, and the June lunch on June 10.

April 15, *San Francisco Peninsula Monthly Luncheon*, Ming's Restaurant in Palo Alto, noon. For reservations call Hugh Dubb at 415/362-3800 or 408/773-9100. Lunches are held the third Thursday of each month. The May lunch will be on May 20, and the June lunch on June 17.

April 26, *Washington, D. C., Chapter Dinner/Meeting*, with Ellen Rothenberg, associate professor of biology.

April 26, *Tri-State Chapter Dinner/Meeting*, with Hal McGee '73.

April 30, *Graduate Underground Social Hour*, Alumni House.

May 13, *Class of 1943, 50th Reunion Dinner*, the Athenaeum.

May 14, *Half-Century Club Reception and Luncheon*, the Athenaeum.

May 14, *Class of 1948, 45th Reunion Dinner*, the Athenaeum.

May 14, *Class of 1953, 40th Reunion Dinner*, the Athenaeum.

May 14, *Class of 1968, 25th Reunion Dinner*, the Athenaeum.

May 15, *56th Annual Seminar Day and Dinner*, on the Caltech campus.

May 15, *Class of 1958, 35th Reunion Dinner*, the Athenaeum.

May 15, *Class of 1963, 30th Reunion Dinner*, the Athenaeum.

May 15, *Class of 1983, 10th Reunion Dinner*, the Athenaeum.

May 22, *San Gabriel Mountains All-Day Geology Field Trip*, with Bruce Carter '68, PhD '80.

May 23, *Barbecue Honoring Class of '93*, Alumni House.

May 25, *San Francisco Chapter Dinner/Meeting*, with guest speaker, Federico Faggin of Synaptics, Inc.

May 29 and June 5, *San Francisco Chapter Tours of the Lick Observatory*.

June 8, *Orange County Chapter Dinner/Meeting*, with Caltech President Thomas Everhart.

June 24, *Caltech Big Bear Solar Observatory Tour*.

July 12-21, *Iceland Travel/Study Program*, with Robert Sharp '34, Robert P. Sharp Professor of Geology, Emeritus, and Susan Kieffer PhD '71, Regents Professor of Geology, University of Arizona.

August 7, *Mt. Wilson Observatory Tour*.

August 17-23, *Asbland Shakespeare Festival*, with Jenijoy La Belle, professor of literature.

For information regarding the above, please contact Arlana Bostrom for chapter events (818/356-8363), Patsy Gougeon for Seminar Day/reunions (818/356-8366), and Helen Shafran for travel/study and local programs (818/356-8364).

Seven are named Distinguished Alumni

Seven Caltech graduates will be recognized with Caltech's highest honor, the Distinguished Alumni Award, at the Alumni Association's 56th Annual Seminar Day on May 15. Receiving the award are Trent Dames '33, MS '34; Philip Mwangi Githinji, MS '61, Eng '63; Thomas Hudspeth '41; John McCarthy '48, William Moore '33, MS '34; Stephen Ross '65; and Alvin Tollestrup, PhD '50.

Trent Dames is cofounder of the Los Angeles-based engineering consulting firm of Dames & Moore, which he established as a start-up company with fellow alumnus William Moore in 1938, four years after they both left Caltech with BS and MS degrees in civil engineering. From modest beginnings Dames & Moore has grown today into a top-ranked international organization, providing comprehensive environmental and specialized consulting and engineering services for a worldwide clientele. The company maintains offices and affiliates throughout the U.S., and in nineteen other countries. Dames retired from the company in 1989, after more than five decades serving as the firm's "Mr. Inside," in which capacity he was responsible for providing administrative leadership as the company expanded and for establishing and overseeing management policy. He has held a variety of leadership positions in the American Society of Civil Engineers, as well as serving on a number of regional, state, and national advisory councils. In 1975, he received the Construction Industries Achievement Award, in recognition of his services to the industry and of his role in advancing the science of design, construction, and materials.

Philip Mwangi Githinji has for many years been a leading engineer and educator in Kenya. After receiving his master's and engineer's degrees from Caltech, he spent two years with AiResearch Manufacturing Company before returning to Kenya, where he joined the University of Nairobi as a lecturer in the department of mechanical engineering. The university awarded him a PhD for his research into the drying of pyrethrum flowers, a source of natural insecticide. He rose to professor of mechanical engineering and served as chairman of the department from 1974 to 1983. Since 1983 he has been principal of the College of Architecture and Engineering (1983-1985), deputy vice-chancellor (vice president) for administration and finance at the University of Nairobi (1985-1987), and vice-chancellor (president) of Kenyatta University (1987-1992). He has over the years been active in the promotion of engineering in Africa, and has chaired a number of engineering and research committees and councils in Kenya and in the African region. The president of Kenya decorated him

with the award of the Elder of the Order of the Burning Spear (1986), and he was elected a fellow of the Kenya National Academy of Sciences (1986) and a fellow of the Institution of Engineers of Kenya (1978).

Thomas Hudspeth is a chief technologist at Hughes Space and Communications Company (HSC). He has also been known to amateur radio operators as W6LHN since 1934. He started his career at General Electric in 1941, where he was a test engineer on rotating assignment throughout the company. He joined Hughes five years later, starting out as a member of the technical staff working on radar systems. In the early 1960s, he and Harold Rosen demonstrated the capability of Syncom, the world's first geosynchronous satellite, from the top of the Eiffel Tower. Hudspeth was named a chief scientist in 1970, and he assumed his current position in 1992. A life member of the IEEE in its Microwave Techniques Technical Group, he has been awarded two L.A. Pat Hyland patent awards—Hughes's highest recognition for inventors—and HSC's patent award. He has more than 20 patents to his name. And, even today, amateur radio buffs can still find him at W6LHN.

John McCarthy is professor of computer science at Stanford University, and was director of Stanford's artificial intelligence laboratory from 1965 to 1980; he is also Charles M. Pigott Professor in the School of Engineering. He is one of the founders of artificial-intelligence research. His work has emphasized what information and what modes of reasoning are required for intelligent behavior. He originated the LISP programming language for computing with symbolic expressions, was one of the first to propose and design time-sharing computer systems, and pioneered in the use of mathematical logic to prove the correctness of computer programs. His current work involves the formalization of context in mathematical logic. He has received the A. M. Turing award of the Association for Computing Machinery (1971), the first Research Excellence Award of the International Conference on Artificial Intelligence (1985), the Kyoto Prize (1988), and the National Medal of Science (1990). He is a member of the American Academy of Arts and Sciences, the National Academy of Engineering, and the National Academy of Sciences.

William Moore, the other half of Dames & Moore, has for the past 55 years been recognized as a leader in the engineering field, as well as the most visible representative of the company he and Caltech classmate Trent Dames founded in 1938. Playing the role of "Mr. Outside" to cofounder Dames' *Continued on page 10*

Alumni awards

Continued from page 9

"Mr. Inside," Moore has served as the firm's technical strategist, international ambassador, and trouble-shooter. After earning his BS and MS in civil engineering from the Institute, he worked as a staffer with the US Coast and Geodetic Survey before deciding to test the waters of entrepreneurship. Moore has served as national director and vice president of the American Society of Civil Engineers and held a number of other leadership positions on engineering and technical councils and advisory boards. Among his honors are the first Arthur M. Steinmetz Award, in recognition of his distinguished career in consulting engineering; the Golden Beaver Award; and the American Consulting Engineers Council's Special American Bicentennial Amicus Award.

Stephen Ross, the Sterling Professor of Economics and Finance at Yale University, has been a member of the economics faculty since 1977. He is renowned for originating the Arbitrage Pricing Theory, which he developed further with Professor Richard Roll of UCLA. As a principal in Roll and Ross Asset Management Corporation, Ross manages assets in U.S. and international markets. He also conducts research in the financial markets, and is a director of CREF (College Retirement Equity Fund) and a director of General Reinsurance Company and Managing Director of WP Capital Management Limited Partnership (a Wasserstein Perella, Roll & Ross Company). A fellow of the Econometric Society and a member of the American Academy of Arts and Sciences, Ross is a past president of the American Finance Association, and is associate editor of several economics and finance journals. The author of numerous articles in finance and coauthor of an introductory finance textbook, Ross holds the Graham and Dodd Award for financial writing. Other honors include the Pomerance Prize for excellence in options research, and the University of Chicago's Leo Melamed Prize for the best research by a business school professor.

Alvin Tollestrup is a physicist with the Fermi National Accelerator Lab (Fermilab) in Batavia, Illinois, and is internationally recognized for his work in experimental high-energy physics. He is known for the design and construction of Fermilab's Collider Detector Facility (CDF), which probes the structure of matter through the study of proton-antiproton annihilations and supports the research efforts of more than 30 institutions and 400 physicists. Before joining Fermilab in 1975, Tollestrup was a professor of physics at Caltech, where he helped to construct the electron synchrotron, a high-energy accelerator that played an instrumental role in characterizing the structure and

properties of quarks, the fundamental building blocks of matter. At the CERN high-energy physics laboratory in Geneva, Tollestrup led a group whose work helped confirm the V-A theory of beta decay proposed by Murray Gell-Mann and the late Richard Feynman, and thus contributed significantly to the understanding of the weak nuclear interaction. Tollestrup is a recipient of the National Medal of Technology for creating the superconducting magnets for the TEVATRON, the nation's highest-energy accelerator. In 1989, he received the R.R. Wilson Prize from the American Physical Society for his work on the TEVATRON.

For the Record

In the February 1993 issue of *Caltech News*, the name of G. Edward Bryan '54 was inadvertently omitted from the slate of nominees proposed to serve three-year terms on the Alumni Association Board of Directors. Elections will take place at the April meeting of the board; the new terms of office will commence in June 1993.

PERSONALS

1939

JOSIAH E. SMITH, MS '40, ENG '48, of Ashburn, Virginia, writes, "I have qualified for the National Senior Olympics, which will be held in Baton Rouge in June 1993. I would like to hear from other CIT alumni who will be there. My events are in track and field (the 800-meter run and the long jump) for age group 75-79."

1944

DONALD KEATING, of Lake Forest, California, participated in the Senior Olympics in Long Beach, California, in November 1992. He won a gold medal in the discus, a silver medal in the shot put, and a silver medal in the javelin.

1949

JOSEPH A. DOBROWOLSKI, a consulting engineer specializing in concrete design and construction, has coauthored the third edition of McGraw-Hill's *Concrete Construction Handbook*, which "has been completely revised and updated to reflect the entire range of modern concrete technology and the latest construction industry practices." Dobrowolski is a Fellow of the American Society of Civil Engineers and of the American Concrete Institute. He lives in Altadena, California.

1951

ROBERT E. COBB, of Dallas, Texas, retired last August after 40 years with Mobil Oil. He writes that he's looking forward to traveling "where I want to go."

1952

ROGER D. SCHAUFLE, MS, retired vice president, engineering, and vice president/general manager, commercial advanced products, Douglas Aircraft Company, has been elected a Fellow by the Society of Automotive Engineers. He has been honored for his major contributions to a number of Douglas commercial aircraft, including the DC-8, DC-9, DC-10, MD-80, and MD-11; he was specifically responsible for the overall aerodynamic design of the DC-9 and DC-10, in which all aerodynamic performance guarantees involving range, payload, takeoff distance, landing distance, and stalling speed were met.

1955

ALLEN E. FUHS, MS, PhD '58, chief consultant, Monterey Consulting Services, has been elected a Fellow by the Society of Automotive Engineers. He has been honored for his design of the Orion, a 250-pound communications satellite, which has served as a model for the satellite projects of most major aerospace companies, and for his contributions to Pegasus, the first new commercial launch vehicle in 20 years. He has also been recognized for his contributions to teaching.

JAMES KING, JR., MS, PhD '58, of Pasadena, California, has been named assistant laboratory director for technical divisions at the Jet Propulsion Laboratory. He succeeds KIRK M. DAWSON, BS '61, MS '62, who was earlier named JPL associate director. King had been deputy assistant director in the Office of Technical Divisions since January 1988, and he had previously served as technical manager for space science and applications, program manager for astronomy and astrophysics, and program manager for atmospheric science. He also served for two years in managerial positions in the Office of Manned Space Flight and the Office of Space Sciences, at NASA headquarters. He has been widely published in science journals, and he is a member of Sigma Xi, the American Physical Society, the American Chemical Society, and the American Association for the Advancement of Science.

1958

MARTIN CONNEALLY, MS '59, an engineer with Sears, Roebuck and Co., has been the recipient of the Over The Rainbow Association's First Annual Special Service Award. He has been honored for having "spent countless hours of his own time in designing and installing the innovative personal lifts now used by many residents of Hill Arboretum. These mechanisms, as much as any other accomplishment of Rainbow, signify the new independent lifestyle now open to many who never before could even imagine being able to lift themselves out of bed without assistance." Three of Conneally's sons have graduated from Caltech: TONY, BS '83; THADDEUS, BS '84; and THOMAS, MS '84. His daughter-in-law, Jeanine, works for Caltech's Office of Student Affairs.

1959

WILLIAM R. GRAHAM, of McLean, Virginia, has become president of C-COR Electronics, Inc. (NASDAQ: CCBL), State College, Pennsylvania, as of January 1, 1993. He continues as a director of Watkins Johnson Corporation, Palo Alto, California. He was formerly chairman of the board and chief executive officer of Xsirius, Inc., and chairman of the boards of its subsidiaries, Xsirius Superconductivity, Inc., and Advanced Photonix, Inc. (AMEX: API).

1966

H. GERARD SCHWARTZ, JR., PhD, has been appointed by the board of the American Society of Civil Engineers (ASCE) to fill the remaining year of James W. Poirot's vice presidency; Poirot was elected president of the society last August. Schwartz, who is vice president/corporate principal-environmental for the St. Louis-based Sverdrup Corp., and president of Sverdrup Environmental, Inc., had been director of the ASCE's District 16. In the past, he has been president of the ASCE's St. Louis Section, and chair of the society's national Technical Activities Committee.

1970

RICHARD D. PASHLEY, MS, PhD '74, has been named a vice president of Intel Corp.'s Semiconductor Products Group. Previously general manager of Intel's Memory Components Division, which is based in Folsom, California, he will continue to oversee all aspects of Intel's flash-memory business, including technology development, design, manufacturing, assembly, testing, marketing, and customer support. A 20-year veteran of Intel, he holds eight patents and has more than 20 publications to his credit. In 1976 he developed Intel's patented HMOS-process technology (HMOS is the acronym for high-performance metal-oxide semiconductor). This technology has been used in hundreds of Intel products, including semiconductor memories, microprocessors, and microcontrollers.

RONALD J. POGORZELSKI, PhD, of Santa Barbara, California, has been elected president of the Antennas and Propagation Society, one of 37 member societies and councils of the Institute of Electrical and Electronics Engineers. He is director of the engineering research operation of General Research Corporation, in Santa Barbara. He will serve a one-year term as president of the society, which has roughly nine thousand members internationally who work in the areas involving the radiation, propagation, and scattering of electromagnetic waves, in diverse applications ranging from medical imaging to communication satellites. He has over 20 years of professional experience in these areas, and he has been heavily involved in society activities, including a three-year term as editor of its technical journal, the *IEEE Transactions on Antennas and Propagation*.

EDWARD A. SCHROEDER IV, a professor at Nazareth College of Rochester, in Rochester, New York, frequently sends shipments of books to southern Africa, including to the University of Namibia, Lesotho, and the Technikon of the Northern Transvaal. He sends out an announcement of books needed at the start of each term, places a Cape of Good Hope Foundation box in the faculty room, and makes his collections with the cooperation of professors, custodians, and the local post office.

1972

TIM HIGHT, of Los Gatos, California, has recently returned to Santa Clara University, where he is an associate professor in the department of mechanical engineering; he had spent a seven-month sabbatical in Perth, Australia, with his wife, Amy, and his three children, aged two, five, and six. He writes that he was able to devote time to research on computer modeling of the human shoulder complex, as well as enjoy the people and the countryside around Perth. At Santa Clara, he supervises all mechanical-engineering senior design projects, a challenge he thoroughly enjoys.

1974

LOU SCHEFFER, MS '75, developed a strong interest in Africa after a 1989 alumni safari to Kenya and Tanzania. He has now set an all-time record for book shipments to South Africa by sending 20 tons of books and journals collected from friends and colleagues in California's Silicon Valley. The 10,000 volumes were valued at nearly \$300,000, and the books were mostly new and mostly scientific and technical.

FREDERICK J. SIGWORTH, professor of cellular and molecular physiology at the Yale University School of Medicine, has been presented a Javits Neuroscience Investigator Award by the National Institute of Neurological Disorders and Stroke. The award recognizes his outstanding contributions to the neurological sciences. With the award, he will conduct research on ion channels, which are responsible for functions like the timing of the heartbeat, the control of muscle contraction, and the secretion of insulin, and which also play important roles in vision and hearing. Sigworth earned his PhD from Yale in 1977 and joined the Yale medical faculty in 1984 after working for five years as a research associate in the laboratory of Erwin Neher at the Max Planck Institute in Göttingen, West Germany. There he participated in the development of the "patch clamp" technique for which Neher and a colleague received the Nobel Prize in 1991. He is the holder of three patents.

1976

THOMAS A. GERARD, MS, of Alexandria, Virginia, has completed a 22-year career with the Army Corps of Engineers and is now working as an environmental engineer for SRA Technologies, Inc., a contract research firm in Alexandria.

1979

KOLEEN (MATSUDA) FRENCH writes, "Our second baby, Deborah Yumi French, was born October 24, 1992, in Virac, Catanduanes, a remote island province in the Philippines. We have been working in the Philippines since 1988 to train rural village pastors. We will spend 1993 in the U.S. and return to the Philippines in 1994."

PAUL MAGLIOCCO, of Los Gatos, California, writes, "After 13 years at Megatest Corporation, I recently left to join Topometrix Corporation as VP of engineering. Topometrix is a two-year-old company developing and selling scanning probe microscopes."

1981

RICHARD B. HOLMES, of Woodland Hills, California, has returned from the Boston area, where he worked at AVCO Research Laboratory. He is currently with Rockwell, and in 1992 received a Rockwell Engineer of the Year nomination. His name is cited in the 11th edition of *Who's Who in the World* because of his contributions in engineering and science, including the experimentally verified prediction of a new class of particles—these particles are described as optical phonons with spin, including spin-two phonons. He has published in scientific journals several articles about these phonons. He has also written a book.

1984

STEPHEN M. LICHTEN, PhD, and Marsha D. Galinsky report the birth of a daughter, Molly Jessica Lichten, on November 5, 1992. The family lives in Pasadena.

1985

JOHN H. MORRISON, of Cambridge, Massachusetts, writes, "In January, I finished my PhD in physics, at MIT. I am now searching for a job."

OBITUARIES

1927

THOMAS S. SOUTHWICK, MS '29, of San Antonio, Texas, in 1991.

1928

JULIEN F. PHILLIPS, EX, of Glendale, California, on January 1. He is survived by his wife, Alice.

1933

ALFRED H. CLIFFORD, PhD, of New Orleans, Louisiana, on December 27, 1992. He is survived by a son, Karl, and a brother, Henry.

ROBERT G. HERLIN, of Palacios, Texas, on February 15. He worked for Texaco, Inc., for 26 years, advancing to the position of chief design engineer. He married Jean Trull in 1938, and he and his family moved to Palacios in 1959, where he managed Trull family businesses such as Blessing Dryer and Warehouse and Farmers Canal Company. He spent 32 years on the Palacios Library Board, 27 of them as president. He also served as chairman of the Matagorda County Appraisal District Review Board, was a member of the Palacios School Board, and served as president of the Palacios Rotary Club. He was Palacios Man of the Year in 1984. He is survived by his wife, Jean; three daughters, Susan Broadhead, Sarah Olfers, and Margaret Harter; a son, Bruce; and 13 grandchildren.

1934

JAMES R. CAMPBELL, of South Laguna, California, on December 9, 1992. He is survived by his wife.

1938

DARRELL W. OSBORNE, PhD, in December 1989.

1940

JAMES E. LU VALLE, PhD, of Palo Alto, California, on January 30. Before coming to Caltech, he earned his chemistry BS and MS degrees at UCLA, where he was an early African-American student leader and helped found the graduate student association; the Graduate Student Union building there bears his name. He was also a member of the UCLA track team, and as a member of the U.S. team at the Berlin Olympics won the bronze medal in the 400 meters. After graduating from Caltech, he had a long and varied career in chemical research centered around the study of the photographic process, starting at Eastman Kodak in Rochester, New York, and later as director of research at other companies. He was a visiting scholar at Stanford University. After retiring from industry he became director of the undergraduate laboratories in the chemistry department at Stanford, where he remained for seven years. He also did consulting, as well as conducting his own research on the biomolecular basis of memory. He was a member of Phi Beta Kappa and Sigma Xi, as well as other professional societies. He was president of the Eichler Swim and Tennis Club for several years. He is survived by his wife, Jean; his two sons, John and Michael; his daughter, Phyllis Lu Valle-Burke; and his sister, Mayme McWhorter.

1942

FRED M. ASHBROOK, of Irvine, California, on December 22, 1992. He spent five decades working in the field of radar, starting at the MIT radiation laboratory. After a few years, he moved to the Naval Ordnance Test Station—later the Naval Weapons Center—at China Lake, California. There he became a branch leader in charge of developing the range instrumentation and electronics needed to track the flight of experimental missiles. In 1956, he was appointed to head a division of more than a hundred scientists and engineers who were developing testing and range-monitoring equipment for the China Lake test ranges and for satellite- and missile-tracking facilities around the world. In 1970 he became head of the center's electronic-countermeasures division, where he helped develop systems to frustrate enemy radar operators. As part of the program to design aircraft that would be invisible to radar, he contributed to the development of what came to be known as stealth technology.

In recognition of this and his 46 years of technical leadership, he received the Navy Department Meritorious Service Award. Following his retirement in 1991, he became an accomplished woodworker and silversmith, and at 68 he took up scuba diving. He is survived by his wife, Marjorie, sons Fred Martin and Don, and grandchildren Daniel and Sara.

1945

OTIS E. LANCASTER, ENG, of State College, Pennsylvania, on November 17, 1992. He is survived by his wife.

1946

FRED P. ROBINS, of Visalia, California, on January 13; he was 69. After graduating from Caltech, he received his teaching credential at Claremont Graduate School, then taught for five years in the Trona Unified School District. He moved to Visalia in 1953 and taught engineering and mathematics at the College of the Sequoias until 1992. He is survived by his wife, Barbara; his daughters, Jan Johnson, Linda Leach, and Donna; his sister, Winifred Van Ginkel; his twin brother, Alfred; and four grandchildren.

1947

ARTHUR T. BIEHL, MS, PhD '49, of Salkum, Washington, on January 14; he was 68. He was in on the beginning of the radiation lab at Livermore and served on its board of directors, and he worked at the Pentagon as assistant to the Secretary of Defense. He was also director of the Scientific Advisory Board to the U.S. Air Force, which gave him many awards for civilian service. With associates, he started a number of scientific enterprises, including General Nuclear, SAIC, and RDA. He designed and raced ultralight sailboats and at one point had a fling at commercial salmon fishing. Five years ago he learned to fly, and together with his wife, Marjorie, flew to Barrow, Alaska. He is survived by his wife; two sons, Carl and Eric; and two grandchildren.

JAMES A. G. DIACK, MS, of Pointe Claire, Quebec, on October 14, 1992. He was a retired brigadier general of the Canadian Forces. He is survived by his wife, Sybil.

HARRY F. IMSTER, MS, ENG '48, of St. Louis, Missouri, on August 25, 1992. He is survived by his wife.

W. EDWARD MORLEY, MS, of Bay Village, Ohio, on February 19, 1992. He is survived by three children, Linda, Kevin, and Robert, and by three grandchildren.

1948

YU-WEI TANG, PhD, director of plant hormone research at the Shanghai Institute of Plant Physiology of the Academia Sinica (Chinese Academy of Sciences). "Tang returned to China from Caltech to accept this position and remained in it for the rest of his life," said Caltech Professor of Biology Emeritus James Bonner, who had known Tang since his days at the Institute. "The research contributions that he made as a Caltech graduate student provided a never-ending source of stimulus for others to pursue work in the same field, and he continued to carry out notable work after his return to China. During the Cultural Revolution, he was beleaguered but not beaten by the Red Guard." Tang is survived by two sons, one daughter, and three grandsons.

JAMES R. THORPE, JR., of Santa Fe, New Mexico, on November 14, 1992. He is survived by his wife, Barbara.

1949

PAUL W. HUBAY, of Manhattan Beach, California, on January 21. He was a manufacturer's representative for the aerospace industry and was president of Peninsula Industries until his death. He is survived by his wife, Ruth; two daughters, Katherine Peterson and Davey Hubay; and two grandsons, Joseph and William Hubay-Dies.

CLEMENT J. SAVANT, JR., MS '50, PhD '53, on January 25; he was 66. He worked in the electronics and aerospace industries for over 25 years and started two electronics companies. Later he developed and operated a large property-management company. His primary avocation was teaching, and for the past 18 years he was associated with Cal State Long Beach and Cal State L.A. as a professor of electrical engineering. He coauthored 11 textbooks. He is survived by his wife, Barbara, and by many children and grandchildren.

1952

VICTOR GATES, of Ventura, California, on November 17, 1992; he was 74. He spent 29 years with Western Electric Company, which later became AT&T Technologies. He worked there as a supervising electrical engineer, and he was a life member of the International Association of Electrical and Electronic Engineers. He is survived by his wife, Kathleen; his daughter, Opal Root; and three grandchildren and three great-grandchildren.

1961

RICHARD T. BROCKMEIER, MS, PhD '66, of Holland, Michigan, on February 1. Brockmeier joined the Hope College physics faculty in 1966 and was named full professor in 1972. He was very interested in astronomy, and he had been a licensed pilot, and held an amateur radio license. He had been a Danforth Fellow, a Woodrow Wilson Fellow, and a Caltech Institute Scholar, and he was a member of the American Physical Society, the American Association of Physics Teachers, and the American Association for the Advancement of Science, among others. He had five publications in nuclear physics. He is survived by his wife, Helen; a son, Jonathan; and a daughter, Mary Beth.

1968

MELVIN HERBERT SCOTT, JR., MS, of Noblesville, Indiana, on January 4; he was 48. He had been a mechanical engineer for Lockheed Aircraft and Boeing Aircraft. He is survived by his son, Matthew; his mother, Annabelle White; his stepfather, Ernest White; and a sister, June Barber.

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The historic links that George Ellery Hale and Henry Huntington forged between Caltech and the Huntington Library are still going strong today.

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For his pioneering work with mutant flies, Caltech neuroscientist Seymour Benzer is awarded a different kind of Swedish prize.

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Alumnus George Smith's election as the new president of the Caltech Associates is just the latest in his long line of associations with the Institute.

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A Caltech biologist finds "stem cells" that may one day help stem certain nervous system disorders.

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