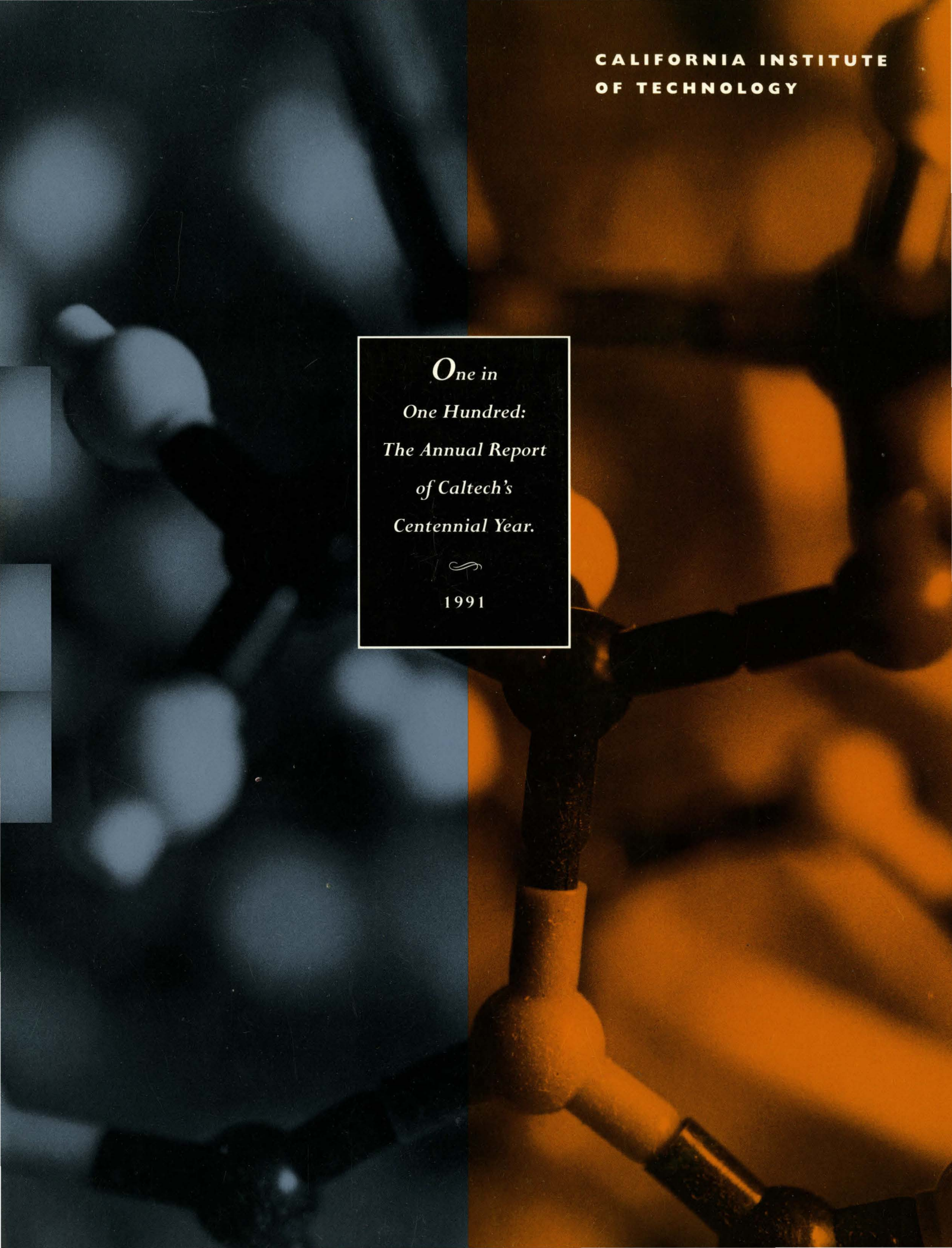


CALIFORNIA INSTITUTE
OF TECHNOLOGY

# *One in One Hundred: The Annual Report of Caltech's Centennial Year.*

1991

The California Institute of Technology is an independent, privately supported university, whose educational mission has not changed since it was stated by the trustees in 1921: "To train the creative type of scientist or engineer urgently needed in our educational, governmental, and industrial development."

**Thomas E. Everhart, President, and Ruben F. Mettler, Chairman of the Board of Trustees.**

In 1991, the Institute completed its first century, and entered its second, in very good condition. Members of our faculty continue to win honors far out of proportion to our numbers. Junior faculty distinguish themselves as recipients of Presidential Young Investigator, Packard, and other awards; senior faculty through major prizes and election to the National Academies. Total research funding at the Institute has been increasing more rapidly than inflation, due to conscientious effort by our faculty, even though research funding in some fields is very tight. Compared to many institutions, our finances remain strong. Sixty-four percent of public four-year institutions, and thirty-four percent of private institutions, had midyear budget cuts last year. While Caltech never has sufficient

resources to take advantage of all our opportunities, we are *not* cutting budgets. We *are* addressing pressing problems, although often not as rapidly as we would like. Our financial campaign, The Campaign for Caltech: A Second Century of Discovery, is progressing satisfactorily, with about $244 million of our $350 million goal pledged or given by December 31, 1991, and 24 months yet to go. This success is due to the dedicated efforts of our excellent trustees, and the support of many foundations, corporations, friends, and alumni who share our aspirations. For all their help, we are sincerely grateful. External perception of the quality of Caltech remains high. During the past year, *U.S. News & World Report* ranked us in the top five universities in the country for undergraduate education. *Money* magazine called us one of the top values in undergraduate education. *Newsweek* chose us to exemplify the best in graduate education worldwide. Our Centennial brought many people to campus. Nearly 2,000 alumni returned for the Caltech Centennial Seminar Day and the All-Class Reunion

**Research is central to the mission of Caltech and plays an integral role in undergraduate and graduate education.**

**President Bush congratulates Jack Prater, member of the 1991 graduating class.**

Weekend. More than 1,100 college and university students from around the country attended EUREKA, the three-day conference on undergraduate research. President Bush addressed our 1991 commencement, attended by more than 9,000 people. The intellectual highlights of our Centennial were the symposia held on campus by each of the academic divisions. These events drew experts from around the world, including several Nobel laureates, to discuss topics of importance to each field. In addition, the campuswide symposium, "Visions of a Sustainable World," drew a large and diverse audience. Finally, the city of Pasadena honored Caltech this fall in a musical tribute organized by city hall, and financed by both the city and a select group of Pasadena businesses. And the Pasadena Symphony saluted Caltech in its opening concert. Both celebrations are evidence of good and improving town-gown relations. A centennial year is a good time to look back, and reflect on the values that have made an institution what it is. Caltech is small, focused, and dedicated to excellence. It has stayed small,

so we can converse across disciplinary boundaries. Intellectual endeavors are focused on selected topics, and in these, we try to be second to none. Members of the campus community function under an honor code. We seek and admit the best students we can find, and search for the best possible faculty to continue our tradition of excellent research and teaching. Institutionally and individually, we take stock periodically, and look in new directions that seem promising. Computation and Neural Systems is a recent new direction that seems very important. Biotechnology, broadly interpreted, is another. Concurrent computation, both the development of new and better methods, and the utilization of the world's most powerful machines to solve problems in science and technology, is another important thrust. With the dedication of the first Keck Telescope, and the start of construction for the second, we have reemphasized the importance of astronomy. With this year's award from the National Science Foundation to construct the world's first laser interferometer gravitational-wave observatory (LIGO),

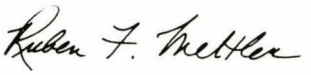
**The twin Keck Telescopes in Mauna Kea, Hawaii, will function in tandem when the second telescope is completed in 1996.**

we have reaffirmed our dedication to discovering new aspects of basic and applied science. In these and other areas, Caltech is advancing the forefronts of knowledge.

There are many worthwhile opportunities to explore in the years to come. Some we will forego, because our small size requires us to focus our resources to be effective. Others we will embrace—and move quickly to implement. Our intensity, focus, and quality will allow us to make important contributions to knowledge and to education in our second century, as we have in the first.

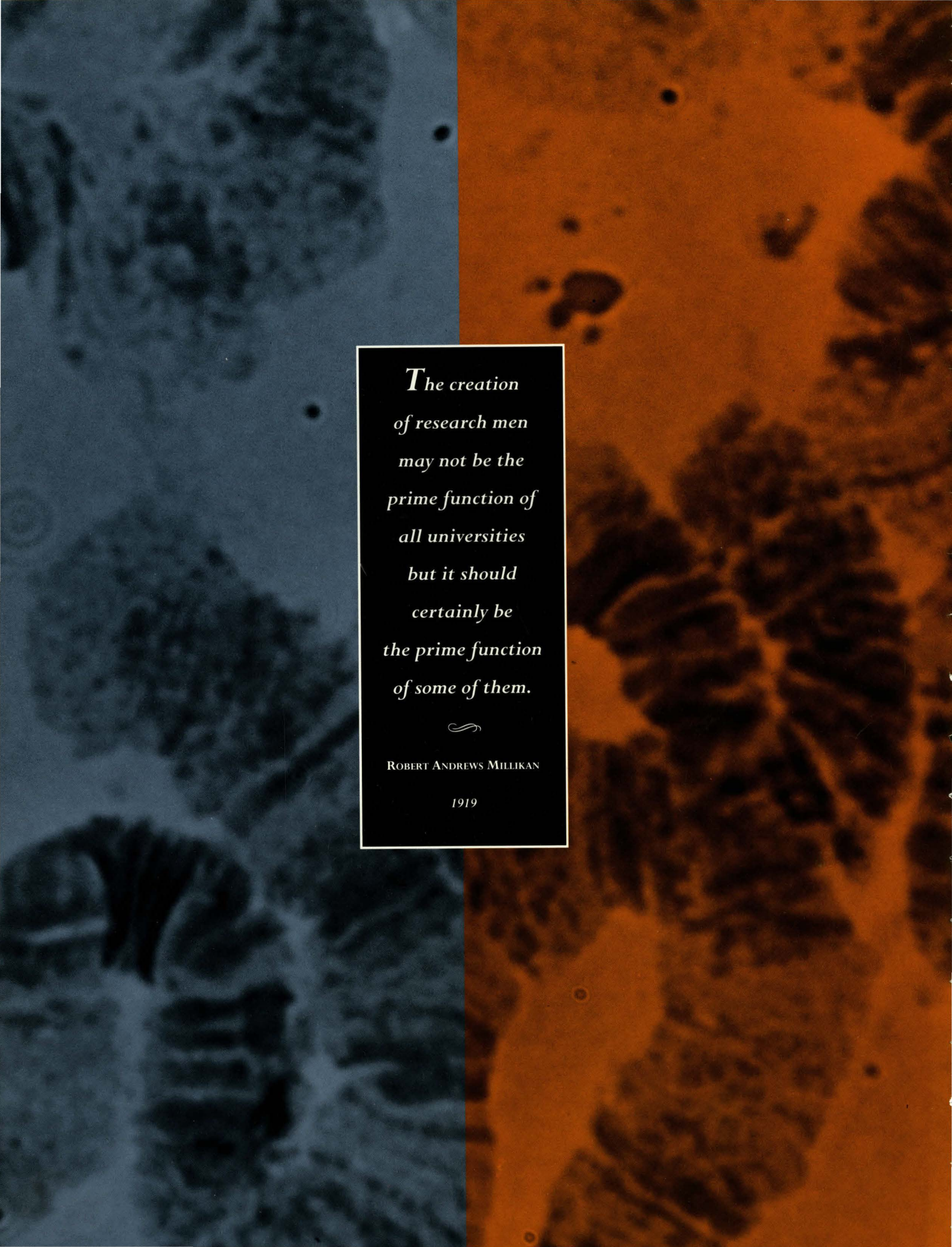
Thomas E. Everhart

President



Ruben F. Mettler

Chairman of the Board of Trustees



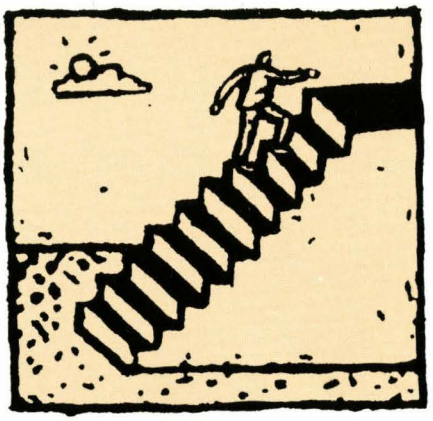
*The creation of research men may not be the prime function of all universities but it should certainly be the prime function of some of them.*

ROBERT ANDREWS MILLIKAN

*1919*

CONNECTIONS OVER TIME. There are times in the history of an institution when the past and future come together as one, when the link between the two is greater than the distance separating them. Such a moment occurred at Caltech in 1991, our centennial year. What connects Caltech, one century to the next? A set of enduring values established at the time of the First World War by George Ellery Hale, Arthur Amos Noyes, and Robert Andrews Millikan. Caltech would be, they envisioned, small in size and great in potential, a community of scholars bound together by respect for each other and a determination to advance the frontiers of science and engineering. Of the many achievements we celebrated during the Centennial, these values were perhaps the most significant. They define the greatness of our past and hold the promise of our future. They are our link over time.

THE CHALLENGE OF OUR DAY. Today, our principal institutional challenge is to maintain these values in the unique setting of the late 20th century. How do we achieve that specifically and in specific areas? We believe that Caltech will succeed in the way it always has: by including the best people in our community and giving them the resources they need. On March 11, 1991, we publicly announced a major capital campaign—the third in Caltech's history—to raise $350 million by the end of 1993. It is our hope that funds raised through The Campaign for Caltech will help provide a secure foundation for the people of Caltech. To date, we have been fortunate to receive the following gifts and pledges for endowed



*With each step, the campaign base grows larger and the distance to the top smaller. Gifts and pledges now total $244 million, toward a goal of $350 million.*

professorships, postdoctoral fellowships, graduate fellowships, and undergraduate scholarships. The George Hoag Family Foundation has endowed the George Grant Hoag Professorship, honoring Mr. Hoag's services as a Caltech Trustee. The Ross McCollum—William H. Corcoran Professorship in Chemical Engineering was made possible by a bequest from the estate of Ross McCollum. Another endowed professorship was established by an anonymous donor. The Feynman Professorship was established by a gift from alumnus Michael Scott (BS '65). Trustee Ronald Linde and his wife, Maxine, established the Ronald and Maxine Linde Professorship. The Anna L. Rosen Professorship was established by alumnus and Trustee Benjamin Rosen (BS '54); his brother, alumnus Harold Rosen (MS '48, PhD '51); and his sister, Ruth Rosen Weisler, in honor of their mother. Trustee Benjamin Rosen provided start-up funds for the new Rosen Professor of Biology. James G. Boswell has committed funds to enable the Boswell Professor Emeritus to continue his work for the next five years. The James Irvine Foundation completed a grant for postdoctoral fellowships for underrepresented minorities. The Ralph M. Parsons Foundation completed its commitment to endow prize fellowships in biochemistry. The Henry Luce Foundation awarded fellowships to support female graduate students at Caltech. Trustee Ralph Landau has committed funds to support graduate fellows in chemical engineering for five years. Private gifts made this

last year supported 66 of the 192 Summer Undergraduate Research Fellowships (SURF) participants, including 23 who were supported by endowed SURF scholarships. Other gifts for undergraduates included an endowed full scholarship fund established by Harrison Lingle (BS '43): the Lingle Scholarship fund will be the first merit-based endowed scholarship fund for freshmen to be set up at Caltech. Trustee Earle Jorgensen continued a more than 30-year tradition of providing full tuition for two Caltech students. Trustees James Glanville, James Robison, and Thomas Watson, Jr., made substantial contributions to the McLean Brothers Scholarship Fund. ARCS again provided major funding for scholarships and fellowships. Price Charities established the Arrola DuBridge Scholarship for undergraduate women. As a special campaign commitment to Caltech, the Pacific Telesis Group granted funds to support both undergraduate and graduate students for a two-year period.

GREAT IDEAS. Between a good idea and a great research program often lie obstacles related largely to funding. Caltech,

**COMMON ANCESTRY**

*Biology*

**The brains of rats and fruit flies have more in common than endowing their owners with a predilection for dumpster-diving. Researchers in Caltech's biology division have recently discovered that a fruit-fly gene that controls the differentiation of a specific set of neurons in the fly is very closely related to a gene that is turned on in developing nerve cells in rats. The function of the rat gene isn't yet known, but it is active at a similar time during the developmental process, and its sequence—the coded information it contains—is 85 percent the same as the sequence in the fly.**

**This similarity means two things. First, the gene is very old, dating back to a common ancestor of the rat and the fly. Second, whatever the gene does is very important, because evolution hasn't altered the gene much since that ancestral creature, whereas rats and flies have become very different indeed!**

**If there's one nerve-development gene like this, there are probably others, since nature tends to be conservative—if it finds something that works well, it sticks with it. This raises the possibility that scientists can use other fly genes known to be involved in brain development to find the corresponding genes in mammals. Once the corresponding gene has been found, it can be mutated. If mice carrying the mutation prove to be developmentally impaired, they could become good models for studying human neurological diseases for which no models currently exist, such as Huntington's disease. An extensive body of research has been built up on the fruit fly's nervous system, so this approach looks quite promising.**

**Scientists could also work in the other direction, starting with a known animal gene and searching for its fly equivalent. The fruit fly is far easier to manipulate genetically than mammals are. If an equivalent gene can be found in the fly, it should be easier for researchers to discover what the fly gene does, and the work can be done with reasonable confidence that the result can then be applied back to mammals.**

like most American institutions of higher education, operates today in a tough funding climate, which is defined as much by available resources as it is by changes in how these resources are distributed, especially by government agencies. Caltech receives approximately 50 percent of its funds through research grants and contracts from the federal government. This percentage has remained fairly constant since Caltech first began receiving federal funds for research and student aid in the early 1950s. Over time, we have done well in securing federal funds when research grants are based on the merits of a proposal. Regrettably, more research dollars are being directed by congressional action to specific projects that have not been reviewed for their merit. Total congressional earmarks for unreviewed research almost doubled from 1990 to 1991, from nearly $272 million to more than $493 million. Funding practices like these frequently discriminate against quality. Anything that discriminates against quality hurts Caltech; it hurts all high-quality research institutions in our country. To adapt to the present funding climate and still maintain our traditional focus on pure science and research in fundamental areas, Caltech is raising, through the Campaign, venture funds for research. Trustee Charles Gates has committed funds to endow the Gates Grubstake Fund for new research ideas. IBM Corporation continued its tradition of support for Caltech with a grant to seed new research projects. Trustee Ronald Linde and his wife, Maxine, established the Ronald and Maxine Linde President's Venture Fund, to be

*Endowed venture funds enable Caltech to seed new research projects, which—when sufficiently developed—can be continued in subsequent years with outside support.*

*Scientific investigation is the spring that feeds the stream of technical progress, and if the spring dries up the stream is sure to disappear.*

Arthur Amos Noyes

*1915*

applied to research projects in their early phases. Specific research areas have been identified for funding by the following organizations. The William and Flora Hewlett Foundation has established an endowment for Caltech's Environmental Quality Laboratory (EQL). Environment Now has set up an endowment for environmental studies. Bank of America has committed funds for environmental studies. The Ralph M. Parsons Foundation has made a grant for research in developmental biology. ARCO, Texaco, and Unocal have continued their support for the Center for Air Quality Analysis.

### CLEARED FOR TAKE-OFF

*Chemistry and Chemical Engineering*

**Electrons do more frequent flying than most corporate executives. Electrons leaping from molecule to molecule power life's basic processes. And many important metalloproteins, such as the cytochromes, do their business by dispatching electrons from a metal atom at the heart of the molecule to various sites on its periphery. Researchers at Caltech's Beckman Institute are studying these intramolecular electron transfers in an attempt to discover how the transfer rate varies with the distance to the destination and with the molecular terrain en route. The eventual goal is to mimic nature's exquisitely designed metabolic machinery in man-made reaction systems.**

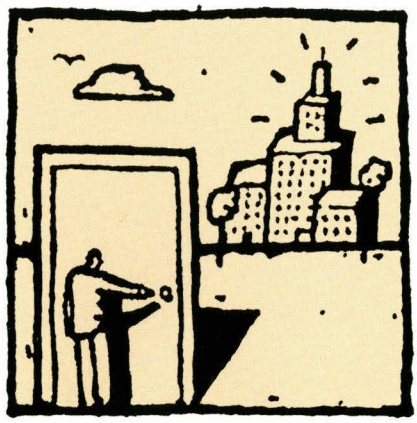
**These studies require some molecular remodeling. First, a ruthenium atom is installed at the destination. The ruthenium atom provides a landing site for the electron and undergoes a spectroscopically detectable change upon its arrival, allowing its time of flight to be measured. Electrons in living cells take wing in response to processes that are hard to duplicate in the laboratory, so the researchers use a laser to excite the central metal atom, causing it to emit an electron. But most biologically important metals, including the iron in a cytochrome, stay excited for mere trillionths of a second—not long enough to emit an electron. Zinc—whose excited state in a cytochrome lasts for several thousandths of a second—can replace iron, but this technique doesn't work for other metals.**

**But now the Caltech group can leave the original metal in place. When the right substituents are added to the ruthenium atom, its excited state lasts about 50 billionths of a second, just long enough to clear an electron for takeoff. So the researchers excite the ruthenium atom, sending electrons in from the outskirts toward the center. If the experiment demands outbound electrons, the researchers add a chemical reagent that makes the ruthenium atom electron-deficient, causing it to steal electrons from the central atom when excited.**

**Now that electrons can be booked onto any itinerary that the researchers want to study, they've discovered that the electrons can travel faster than their current spectroscopic system can follow. Distances of up to 15 atomic diameters as the electron flies can be covered in less than ten billionths of a second. The researchers are now building a system that can handle trillionths of a second.**

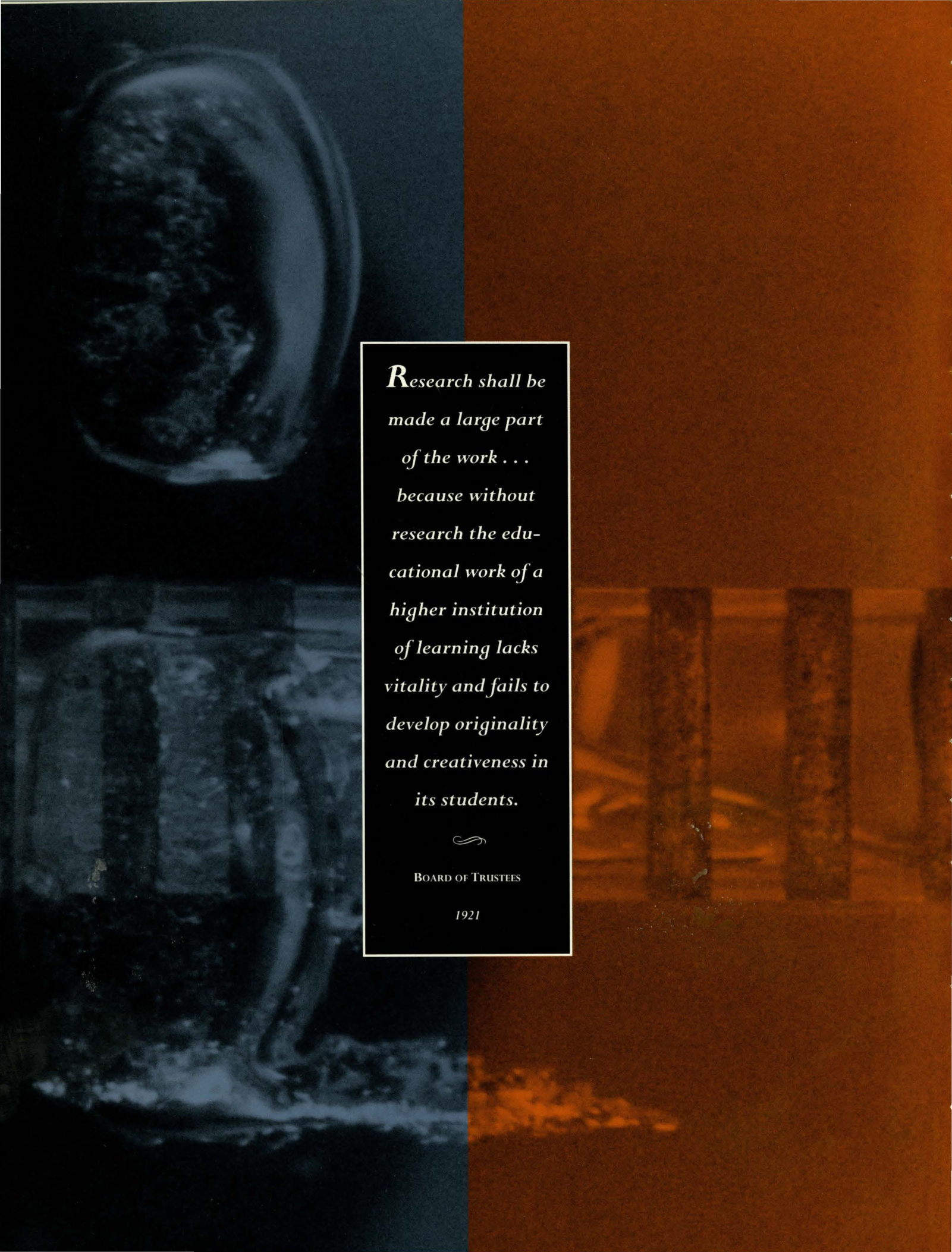
## Settings for Greatness.

Great ideas are not just a matter of the mind; in science and engineering, they unfold in the setting of sophisticated equipment and facilities. Caltech has long enjoyed the friendship of donors whose enthusiasm for first-rate research is expressed in major gifts for buildings and equipment. A campaign commitment has been made by Intel Corporation



*Opportunity lies just beyond curiosity. The intellectual journey that joins the two is made daily on the Caltech campus, which today comprises more than 100 new and renovated facilities.*

cofounder and Caltech Trustee Gordon E. Moore (PhD '54) and his wife, Betty, to fund a large new electronic materials and structures laboratory that will contain classrooms, laboratories, and office space. Electrical engineers, computer scientists, materials scientists, and applied physicists are among the faculty whose research will be carried out in the new building. During the last year, significant gifts of equipment for research and education were made by Hewlett-Packard, Sun Microsystems, and Thomson Digital Image America. The Charles Lee Powell Foundation continued its long-standing support for the Division of Engineering and Applied Science with significant grants for equipment, fellowships, and research. Gifts from ARCO and the L. K. Whittier Foundation were made for the TERRAscope, a network of advanced seismic recording devices throughout southern California. Work was completed this last year on the Mr. and Mrs. Fred L. Hartley Laboratories of Catalysis and Materials, in Spalding. The improvements were made possible by a gift from the late Fred Hartley, a longtime Caltech Trustee, and his wife, Margaret. Major commitments from the estate of Ellsworth Marsh, the Carl F Braun Trust, and Rocketdyne made possible the construction of a new shock-wave tunnel facility to study hypersonic flight. A gift from the C F Braun Trust, made possible by Trustees John G Braun and Pamela Pesenti, will fund the Braun Athletic Center; the gift will be used to update and greatly expand the existing facility. Trustee Camilla Frost and Honorary Life Trustee



*Research shall be made a large part of the work . . . because without research the educational work of a higher institution of learning lacks vitality and fails to develop originality and creativeness in its students.*

BOARD OF TRUSTEES

*1921*

Dorothy Chandler also made a substantial commitment to the Institute, on behalf of the Chandler family.

INTERACTIONS THAT EXTEND THE BOUNDARIES OF CALTECH. At Caltech, each individual is important and each research area significant. So, too, are the interactions between them. Throughout our history, important contributions to science and engineering have been made by people crossing disciplinary lines, working together to develop new topics of inquiry and new technologies to explore fundamental questions more deeply. The Beckman Institute, which celebrated its first anniversary this last year, is the site of such interdisciplinary work. A gift from Arnold O. Beckman (PhD '28) and his late wife, Mabel, enabled Caltech to construct the Beckman Institute and fund many of its research programs. The guiding idea behind the institute is to put people who design and build molecules, and people who design and build instruments, together in the same space where they can interact continuously.

**CHAMPAGNE OF THE GODS**

*Engineering and Applied Science*

**When Mount Pinatubo devastated Clark Air Force Base, the agent of destruction was a pyroclastic flow—a choking cloud of gas and volcanic dust heated to 1,000 degrees Fahrenheit. The cloud can reach supersonic speeds as it avalanches down the mountainside, knocking loose tons of boulders en route. Caltech aeronautics students and faculty are collaborating with geologists to study the fluid mechanics of these explosions in hopes of mitigating their hazards.**

**Some pyroclastic flows are generated by a process like uncorking a bottle of champagne. Just as a bottle of bubbly gets its fizz from dissolved carbon dioxide, the magma contains an oversupply of water vapor held in solution only by the pressure of the surrounding rock. When a steep mountain slope collapses, the sudden release of pressure allows the dissolved gas to vaporize. Instantaneously, all through the magma—or champagne—microscopic bubbles form, merge, and expand, belching it out of its container.**

**The laboratory simulations use a thick-walled test tube whose top can be sealed with a diaphragm of heavy-duty aluminum foil. The test tube would be filled with liquid supersaturated with gas under high pressure; then a knife blade automatically bursts the diaphragm, venting the tube into a vacuum while the "eruption" was recorded on film or video for clues to the eruptive mechanism.**

**Another set of experiments used tiny glass beads and compressed air to see how particles would ride the blast's pressure wave. The researchers had expected that the evenly expanding gas would pick up a uniform, dense cargo of dust. Instead, the depressurization lofted entire layers of solid-packed beads, a few beads thick, separated by regions of very nearly bead-free air. Traceries of beads rained off the bottom of each layer, enclosing regions of the void below into "bubbles" that drifted up through the packed layers. Thus a building in the flow would feel a series of blows as each blob hit it. Such repeated hammering could be far more destructive than the continuous pressure on which the standard computer simulations of blast damage are based.**

We find that many of our research projects now involve interactions with researchers at other institutions. The Keck Telescopes, one dedicated this past year and the second under construction, were designed by and are being operated by the California Association for Research in Astronomy (CARA), a partnership between the University of California and Caltech. Funds for the telescopes have been provided by the W. M. Keck Foundation. Each of the Keck Telescopes will boast a 10-meter, segmented mirror—the largest optical mirror in the world—and will be used for infrared as well as optical astronomy. The Keck Telescopes are important examples, scientifically and symbolically, of the way Caltech has traditionally pursued great ideas. They show we have the imagination now, as we did in the 1930s and 1940s, to do whatever is necessary to look as far out into the universe as we can.

LIGO (the Laser Interferometer Gravitational-Wave Observatory) is another example of a joint scientific venture, that—like the Keck Telescopes—holds the

**SPIRIT OF GRAVITY**

*Physics, Mathematics and Astronomy*

**Gravitational physics took a great leap forward in 1991 with the approval by Congress of first-year funding of $19.1 million for the construction of LIGO — the Laser Interferometer Gravitational-Wave Observatory. A joint effort of scientists from Caltech and MIT, LIGO will consist of two widely separated gravitational-wave detectors located in the United States. The project, which is being funded through the National Science Foundation, will take about six years to complete and will cost about $200 million.**

**Gravitational waves are ripples in the fabric of space and time produced by violent events in the distant universe, such as supernova explosions or the collision of two black holes. These ripples travel to Earth, bringing with them information about their violent origins and about the nature of gravity.**

**Each LIGO detector is housed in a 4-foot diameter vacuum pipe arranged in the shape of an L with 4-kilometer (2.5-mile) arms. At the vertex of the L and at the end of each of its arms will be test masses hanging from wires and fitted with mirrors. Ultrastable laser beams traversing the vacuum pipes will measure the effect of gravitational waves on the test masses. When a gravitational wave arrives at a LIGO detector, it will decrease the distance between the test masses in one arm of the L, while increasing it in the other. These changes are minute, just $10^{-16}$ centimeters, or one one-hundred-millionth the diameter of a hydrogen atom.**

**Two detectors located at widely separated sites are essential for the unequivocal detection of gravitational waves. Local phenomena such as micro-earthquakes, acoustic noise, and laser fluctuations can simulate a gravitational-wave event at one site, but such disturbances are unlikely to happen simultaneously at two widely separated sites.**

**The LIGO office at Caltech received 19 site proposals from 17 states and evaluated the technical suitability of individual sites and site pairs. The first-year funding approved by Congress will cover the costs of selecting sites for the LIGO facilities, completing the engineering design of the facilities, and undertaking site preparation at one of the two sites. On February 19, 1992, the National Science Foundation announced the selection of Hanford, Washington, and Livingston, Louisiana, as the sites for LIGO's construction.**

*Like buried treasure, the outposts of the universe have beckoned to the adventurous from immemorial times.*

GEORGE ELLERY HALE

*1927*

promise of revealing fundamental information about the universe. Researchers at Caltech and MIT conceived the project, which is designed to be able to detect gravity waves—a phenomenon predicted by Einstein in 1916, but never observed. In May, the Intel Touchstone Delta system (as of this writing the world's fastest, most powerful computer) was dedicated on campus. Although housed at Caltech, the Touchstone Delta system will be operated by the Concurrent Supercomputing Consortium, an organization of more than a dozen prominent research institutions and government agencies. Members of the consortium will use the Delta for various large-scale computations, including: modeling and simulation of global climate change, calculation of the rates of chemical reactions from the first principles contained within quantum theory, visualization of scientific data returned from the Magellan and Galileo spacecraft, and simulations of realistic models of brain circuits. In recent years, Caltech has extended its own interests to those of elementary and secondary schools by producing such educational programs as SEED (Science for Early Educational Development) and the videocourses *The Mechanical Universe, Beyond the Mechanical Universe,* and *Project MATHE-*

### GEOCHEMISTRY GOES PLATINUM

*Geological and Planetary Sciences*

**Platinum, a precious metal in any context, is especially valuable in the world of geochemistry. It has become even more valuable of late due to a more precise method for measuring the radioactive decay of platinum-group elements that was devised by researchers in the Lunatic Asylum Laboratory in the Division of Geological and Planetary Sciences. This technique has made possible a new wealth of research areas: the formation of the cores of planets, the layers in the earth's crust and mantle, the amount of platinum in oceans and the atmosphere, and the relationship of platinum as a catalyst and to environmental problems. The amounts of platinum occurring in nature are so small that such measurements were previously very difficult, if not impossible.**

**Researchers modified a mass spectrometer to measure the negative ions of rhenium oxides, a member of the platinum group. (Previous research had focused on measuring the positive ions of rhenium, using lasers.) The new method is 100,000 times more sensitive and uses smaller data samples than the laser method. Laboratories throughout the world are now converting to negative ion mass spectrometry.**

**In addition, researchers are mining another source of geochemical information—the decay of natural uranium. By building a new, more efficient mass spectrometer, researchers are able to measure concentrations of rare isotopes as small as of $10^{-10}$ in abundance. This new precision has made possible studies of the ages of late Pleistocene and Holocene corals in an effort to measure the times of sea-level change and to discern how they relate to the earth's ice ages. This study could ultimately lead to a better understanding of aspects of global climate change. Also being studied are the rates at which mantle plumes rise into the crust, and the suitability of sites for radioactive waste storage.**

*A great idea, originated by one, can take on still more brilliance in the hands of others. Caltech values collaboration—among its colleagues, neighbors, and friends.*

*MATICS!* This last year, the W. M. Keck Foundation announced a grant to Caltech to fund a high school biology outreach program. The grant will support a five-year program, which will include an intensive summer workshop for high school biology teachers, to be held on the Caltech campus. Caltech's Minority Undergraduate Research Fellowships (MURF) program provides support for talented undergraduates enrolled at other universities. MURF students spend a summer working in a research laboratory on the Caltech campus. The MURF program is aimed at improving the representation of African Americans, Hispanics, Native Americans, Puerto Ricans, and Pacific Islanders in the biological, chemical, and engineering sciences in the United States. The Times-Mirror Foundation has granted funds for an earthquake media and exhibit center in the Seismological Laboratory. This center will provide another opportunity for Caltech to contribute to an improved climate of science education, in this case through the presentation of didactic materials on earthquakes.

FRIENDS OF CALTECH. During the centennial year, we received significant contributions from our friends and neighbors, gifts that will help us realize our goals for the future. The Associates of the California Institute of Technology was founded in 1926 by a group of 100 Pasadena citizens agreeing to contribute to the research and educational programs of

*Every effort shall be made to develop the ideals, breadth of view, general culture and physical well-being of the students of the Institute.*

BOARD OF TRUSTEES

*1921*

Caltech. This last year, members of The Associates continued their long tradition of providing unrestricted funds to the Institute. So, too, did the corporate members of the Industrial Associates, and contributors to the Annual Fund.

The late Hugh Colvin (BS '36) committed funds for a Centennial Challenge to encourage his fellow alumni to increase their giving by matching increased and new giving. Many other Caltech alumni and friends are ensuring the Institute's future by participating in Caltech's planned giving and estate programs. Thirty-seven life-income gifts were made this last year. Many of these gifts will ultimately support Caltech's general endowment. More than 170 individuals who have included Caltech in their estate plans have added their names to the Torchbearers Honor Roll.

ALUMNI AWARDS AND HONORS. The Institute presented its highest honor, the Distinguished Alumni Award, to Caltech graduates during Seminar Day activities. Presented since 1966, the award is bestowed on former Caltech graduate or undergraduate students for "high achievement in science, engineer-

**WHAT ROLE SCIENCE?**

*The Humanities and Social Sciences*

**When the Trustees wrote an educational policy for Caltech in 1921, they emphasized the importance of the liberal arts in the undergraduate education of science and engineering students. They believed the "combination of a fundamental scientific training and a broad cultural outlook" would help students "avoid superficiality and lack of purpose."**

**In 1986, faculty in the Division of the Humanities and Social Sciences organized a program in Science, Ethics, and Public Policy—SEPP—to investigate the "broad cultural outlook" that informs our thinking today on the moral and political implications of research into, and advances in, science and technology. What purposes does science serve in modern society? How does society integrate science and technology into the fabric of human culture?**

**The Caltech SEPP program has three major, connected activities—faculty research and writing in relevant topics; education in the field through undergraduate courses and training of selected graduate students and postdoctoral research fellows; and a regular public seminar series featuring speakers from on and off campus addressing such issues as weapons research and arms control, biotechnology, human reproduction, the environment, and military secrecy. This past year, the SEPP program sponsored a series of lectures on the scientific, legal, ethical, and social implications of the Human Genome Project—a $3 billion, 15-year project to map the entire blueprint of human heredity. The lectures form the core of the book, The Code of Codes: Scientific and Social Issues in the Human Genome Project.**

**Encouraging undergraduates to think through the implications of scientific work is as important today as it was in the 1920s. Encouraging a larger community to discuss these issues—as SEPP does through its programs for Caltech students, faculty, and staff, and members of the general public—acknowledges both the complex relationship between science and society today, as well as the pressing need to engage more people into decisions affecting both.**

ing, business, industry, or public service." Selected to receive the honor in 1991 were John P. Andelin, Jr. (BS '55, PhD '67), assistant director for science, information, and natural resources of the Congressional Office of Technology Assessment; Arthur E. Bryson, Jr. (MS '49, PhD '51), Paul Piggott Professor of Engineering at Stanford University; Navin C. Nigam (PhD '67), director and professor of civil engineering at the Indian Institute of Technology in Delhi, India; and George F. Smith (BS '44, MS '48, PhD '52), retired senior vice president of Hughes Aircraft Co. and retired director of Hughes Research Labs. Honored in 1990 with the Distinguished Alumni Award were Sidney R. Coleman (PhD '62), the Donner Professor of Science at Harvard; Hugh F. Colvin (BS '36), past president of The Associates and retired president and chief executive officer of Unitek (a company later sold to Bristol-Myers); Anthony J. Iorillo (BS '59, MS '60), senior vice president of Hughes Aircraft Co.; and Kurt M. Mislow (PhD '47), the Hugh Stott Taylor Professor of Chemistry Emeritus at Princeton. National Medals of Science were awarded in 1991 to alumni Folke K. Skoog (BS '32, PhD '36) and

**OF MISSIONS AND MILESTONES**

*Jet Propulsion Laboratory*

**The Jet Propulsion Laboratory enjoyed a fruitful year in planetary exploration in 1991, with several of its spacecraft missions achieving important milestones.**

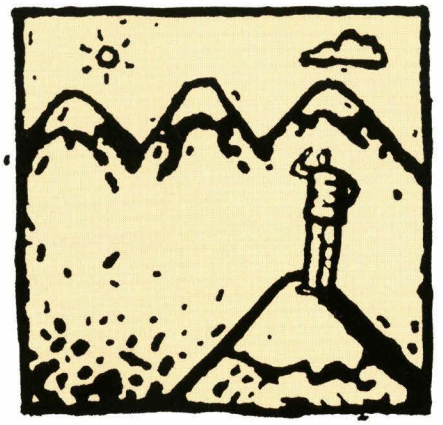
**JPL's Magellan spacecraft, launched in 1989, was concluding its second eight-month mapping cycle at Venus as 1991 came to a close. Magellan's imaging radar returned a staggering amount of data, mapping nearly the entire surface of Earth's cloud-obscured planetary twin.**

**The Jupiter-bound Galileo spacecraft achieved a first in space exploration when it executed a flyby of the asteroid Gaspra in October. The event heightened anticipation of future missions to this class of solar system object such as JPL's Comet Rendezvous Asteroid Flyby, planned for launch later in the decade. The mission team, meanwhile, faced a challenge in that Galileo's high-gain antenna did not open fully during the initial deployment attempt in April 1991, calling for an extensive program of ground analysis and spacecraft maneuvers. The spacecraft will reach Jupiter in 1995.**

**Mission operations continued on Ulysses, a joint NASA/European Space Agency spacecraft designed to study the poles of the sun. Launched in late 1990, Ulysses was bound for a February 1992 encounter with Jupiter; the giant planet's gravity then threw the spacecraft into a solar orbit at a nearly right angle to the ecliptic, the plane in which Earth and the other planets orbit the sun.**

**In addition to its own missions, the Laboratory pursued work on instruments flying on other space platforms. In September NASA launched the Upper Atmosphere Research Satellite carrying JPL's Microwave Limb Sounder instrument. By year's end researchers were reporting that the instrument has provided new evidence on the chemical chain of events leading to atmospheric ozone depletion.**

H. Guyford Stever (PhD '41); James J. Duderstadt (MS '65, PhD '68) received the National Medal of Technology. In 1990 awardees of the National Medal of Science included faculty member and alumnus Edward B. Lewis (PhD '42, MS '43); alumni John McCarthy (BS '48) and Edwin M. McMillan (BS '28, MS '29). Alumnus and Trustee Gordon E. Moore (PhD '54) received the National Medal of Technology.



*Caltech prepares its students to solve problems not yet known. Facing its second century, Caltech searches the distance for possiblities not yet imagined.*

THE PROMISE OF OUR FUTURE. In 1918, Robert Millikan wrote his wife a letter from Washington, D.C., where he and George Ellery Hale were dividing their time between the war effort and designing Caltech. He wrote, "We are planning the future of American science!" Together with Arthur Amos Noyes, they were making plans to make history. This past year, we celebrated that history, and, in the process, discovered a deep connection with those whose achievements in science and engineering proved the founders right: that Caltech can be—in its second century as in its first—an example to the world of what can be accomplished by a community of scholars who are willing to keep their institution small, nonbureaucratic, and dedicated to quality and excellence. Of all that can be remembered from Caltech's first 100 years, these aspirations are valued most. They provide our link with the past; they are the promise of our future.

## Faculty Awards and Honors

*Members of the Caltech faculty continue to win honors far out of proportion to their numbers. In this list of awards and honors, an asterisk before the name indicates that the award was announced during the academic year, 1989-90. All other awards were announced subsequently.*

*National awards and honors*

**American Academy of Arts and Sciences,** Fellow:
Jacqueline K. Barton, *Professor of Chemistry*
John E. Bercaw, *Professor of Chemistry*
Lance E. Davis, *Mary Stillman Harkness Professor of Social Science*
* Thomas E. Everhart, *President; Professor of Electrical Engineering and Applied Physics*
George W. Housner, *Carl F Braun Professor of Engineering, Emeritus*
* Daniel J. Kevles, *J. O. and Juliette Koepfli Professor of the Humanities*
Steven E. Koonin, *Professor of Theoretical Physics*
Carver A. Mead, *Gordon and Betty Moore Professor of Computer Science*
Elliot M. Meyerowitz, *Professor of Biology*
John H. Seinfeld, *Louis E. Nohl Professor and Professor of Chemical Engineering*
Edward M. Stolper, *William E. Leonhard Professor of Geology*

**American Association for the Advancement of Science**, Fellow:
Charles A. Barnes, *Professor of Physics*
Robert A. Cameron, *Senior Research Associate in Biology*
* William A. Goddard III, *Charles and Mary Ferkel Professor of Chemistry and Applied Physics*
Mary B. Kennedy, *Associate Professor of Biology*
* Howard Lipshitz, *Assistant Professor of Biology*
* Elliot M. Meyerowitz, *Professor of Biology*

**National Academy of Engineering**, Founders Award:
George W. Housner, *Carl F Braun Professor of Engineering, Emeritus*

**National Academy of Engineering,** Member:
Charles L. Seitz, *Professor of Computer Science*

**National Academy of Sciences**, Member:
* Michael Aschbacher, *Professor of Mathematics*
* John E. Bercaw, *Professor of Chemistry*
* Barclay Kamb, *Barbara and Stanley R. Rawn, Jr., Professor of Geology and Geophysics*
Amnon Yariv, *Thomas G. Myers Professor of Electrical Engineering and Professor of Applied Physics*

**National Academy of Sciences**, Selman A. Waksman Award:
Melvin I. Simon, *Anne P. and Benjamin F. Biaggini Professor of Biological Sciences*

**National Academy of Sciences**, Watson Medal:
Maarten Schmidt, *Francis L. Moseley Professor of Astronomy*

**National Medal of Science,** Recipient:
Edward B. Lewis, *Thomas Hunt Morgan Professor of Biology, Emeritus*
John D. Roberts, *Institute Professor of Chemistry, Emeritus*
Edward C. Stone, *Vice President; Director of Jet Propulsion Laboratory; Professor of Physics*

**National Science Foundation**, Presidential Young Investigator Award:
Joel W. Burdick, *Assistant Professor of Mechanical Engineering*
S. George Djorgovski, *Associate Professor of Astronomy*
* William G. Dunphy, *Assistant Professor of Biology*
* David G. Goodwin, *Assistant Professor of Mechanical Engineering*
* Julia A. Kornfield, *Assistant Professor of Chemical Engineering*
Guruswaminaidu Ravichandran, *Assistant Professor of Aeronautics*
Yu-Chong Tai, *Assistant Professor of Electrical Engineering*
Stephen Taylor, *Assistant Professor of Computer Science*
* Jonas Zmuidzinas, *Assistant Professor of Physics*

### *State honors*

**California Museum of Science and Industry**, Scientist of the Year:
John J. Hopfield, *Roscoe G. Dickinson Professor of Chemistry and Biology*

### *International awards and honors*

**Astronomical Society of India**, Vainu Bappu Memorial Prize, Corecipient:
Shrinivas R. Kulkarni, *Associate Professor of Astronomy*

**Austrian Academy of Sciences,** Foreign Corresponding Member:
* Barry M. Simon, *International Business Machines Professor of Mathematics and Theoretical Physics*

**Egyptian American Organization,** Outstanding Achievement Award:
* Ahmed H. Zewail, *Linus Pauling Professor of Chemical Physics*

**Indian National Science Academy**, Foreign Fellow:
Peter J. Wyllie, *Professor of Geology*

**Royal Astronomical Society of Great Britain**, Gold Medal:
Gerald J. Wasserburg, *John D. MacArthur Professor of Geology and Geophysics*

**Royal Society of Chemistry**, Honorary Fellow:
Rudolph A. Marcus, *Arthur Amos Noyes Professor of Chemistry*

**Royal Society of Literature**, Fellow:
John A. Sutherland, *Professor of Literature*

**Alexander von Humboldt Foundation**, Senior U.S. Scientist Award:
Michael R. Hoffmann, *Professor of Environmental Chemistry*

**Wolf Foundation Prize in Medicine,** Recipient:
Seymour Benzer, *James G. Boswell Professor of Neuroscience*

**Wolf Foundation Prize in Physics**, Corecipient:
Valentine L. Telegdi, *Visiting Professor of Physics*

*Over the years, 21 Nobel Prizes have been awarded to Caltech faculty members and alumni. Thirty-six Caltech faculty members and alumni have received the National Medal of Science, and five have won the National Medal of Technology. On the Caltech faculty are 66 fellows of the American Academy of Arts and Sciences, and on the faculty, board of trustees, and professional staff there are 67 members of the National Academy of Sciences and 34 members of the National Academy of Engineering.*

### *Awards and honors from professional societies*

**American Astronomical Society,** Dannie Heineman Prize for Astrophysics:
William L. W. Sargent, *Ira S. Bowen Professor of Astronomy*

**American Astronomical Society,** Newton Lacy Pierce Prize in Astronomy:
Kenneth G. Libbrecht, *Associate Professor of Astrophysics*

**American Astronomical Society,** Helen B. Warner Prize in Astronomy:
Shrinivas R. Kulkarni, *Associate Professor of Astronomy*

**American Chemical Society,** Award in Pure Chemistry:
Nathan S. Lewis, *Professor of Chemistry*

**American Chemical Society,** Garvan Medal:
Jacqueline K. Barton, *Professor of Chemistry*

**American Chemical Society,** Priestley Medal:
* Harry B. Gray, *Arnold O. Beckman Professor of Chemistry and Director of the Beckman Institute*

**American Chemical Society,** Theodore William Richards Medal for Conspicuous Achievement in Chemistry:
* Rudolph A. Marcus, *Arthur Amos Noyes Professor of Chemistry*

**American Chemical Society, Biochemical Technology Division,**
Marvin J. Johnson Award:
* James E. Bailey, *Chevron Professor of Chemical Engineering*

**American Chemical Society (Maryland Section),**
Ira Remsen Memorial Award:
Rudolph A. Marcus, *Arthur Amos Noyes Professor of Chemistry*

**American Chemical Society (North Jersey Section),** Baekeland Award:
Jacqueline K. Barton, *Professor of Chemistry*

**American Chemical Society (Philadelphia Section),**
Edgar Fahs Smith Award:
Rudolph A. Marcus, *Arthur Amos Noyes Professor of Chemistry*

**American College of Physicians Award,** Recipient:
* Leroy E. Hood, *Ethel Wilson Bowles and Robert Bowles Professor of Biology; Director of the Center for the Development of an Integrated Protein and Nucleic Acid Biotechnology*

**American Geophysical Union,** William Bowie Medal:
Don L. Anderson, *Eleanor and John R. McMillan Professor of Geophysics*

**American Institute of Chemists,** Gold Medal:
* Harry B. Gray, *Arnold O. Beckman Professor of Chemistry and Director of the Beckman Institute*

**American Institute of Physics Science-Writing Award in Physics and Astronomy:**
* Bruce C. Murray, *Professor of Planetary Science*

**American Philosophical Society,** Member:
* Don L. Anderson, *Eleanor and John R. McMillan Professor of Geophysics*
* Edward B. Lewis, *Thomas Hunt Morgan Professor of Biology, Emeritus*
* Rudolph A. Marcus, *Arthur Amos Noyes Professor of Chemistry*

**American Society for Mechanical Engineers,** Honorary Member:
* Hans W. Liepmann, *Theodore von Kármán Professor of Aeronautics, Emeritus*

**Association for Unmanned Vehicle Systems National Award:**
* Edward C. Stone, *Vice President; Director of Jet Propulsion Laboratory; Professor of Physics*

**American Society of Civil Engineers,** Honorary Member:
* George W. Housner, *Carl F Braun Professor of Engineering, Emeritus*

**American Society of Civil Engineers,** Nathan M. Newmark Medal:
* Donald E. Hudson, *Professor of Mechanical Engineering and Applied Mechanics, Emeritus*

**Book Editors' Award:**
* Merrill Joan Gerber, Lecturer in Creative Writing

**Council of The Institution of Electronics and Telecommunication Engineers,** SK Mitra Memorial Award:
* P. P. Vaidyanathan, *Associate Professor of Electrical Engineering*

**National Chemistry Honor Society,** Fresenius Award of Phi Lambda Upsilon:
* Nathan S. Lewis, *Professor of Chemistry*

**National Space Club Science Award,** Corecipient:
* Edward C. Stone, *Vice President; Director of Jet Propulsion Laboratory; Professor of Physics*

**Society for Optical and Quantum Electronics,** Einstein Prize for Laser Science, Corecipient:
* H. Jeff Kimble, *Professor of Physics*

*The American Philosophical Society is the nation's oldest and perhaps most prestigious learned society. Benjamin Franklin proposed the establishment of the scientific society in 1743. At that time, philosophy meant knowledge, and the society sought promotion of useful knowledge. Among the former members are 12 U.S. presidents, John James Audubon, Marie Curie, Charles Darwin, Thomas Edison, Albert Einstein, Alexander von Humboldt, Benjamin Rush, George C. Marshall, and John Wesley Powell.*

*Foundation awards*

**Achievement Rewards for College Scientists (ARCS) Foundation, Inc., Los Angeles Chapter,** Man of Science Award:
* Harry B. Gray, *Arnold O. Beckman Professor of Chemistry and Director of the Beckman Institute*
Edward C. Stone, *Vice President; Director of Jet Propulsion Laboratory; Professor of Physics*

**Cancer Research Institute,** William B. Coley Award for Distinguished Research in Fundamental Immunology:
Pamela Bjorkman, *Assistant Professor of Biology and Assistant Investigator, Howard Hughes Medical Institute*

**Chicago Community Trust,** Searle Scholar:
* Gilles J. Laurent, *Assistant Professor of Biology and Computational and Neural Systems*

**Camille and Henry Dreyfus Foundation,** Teacher-Scholar Award:
Andrew G. Myers, *Associate Professor of Chemistry*

**Camille and Henry Dreyfus New Faculty Award:**
Zhen-Gang Wang, *Assistant Professor of Chemical Engineering*

**Franklin Institute,** Edward Longstreth Medal, Corecipients:
Slobodan M. Cuk, *Associate Professor of Electrical Engineering*
R. David Middlebrook, *Professor of Electrical Engineering*

**Albert and Mary Lasker Foundation,** Albert Lasker Basic Medical Research Award:
Edward B. Lewis, *Thomas Hunt Morgan Professor of Biology, Emeritus*

**John D. and Catherine T. MacArthur Foundation,** Fellow:
Jacqueline K. Barton, *Professor of Chemistry*
James F. Blinn, *Lecturer in Computer Science*
James A. Westphal, *Professor of Planetary Science*

**The Minerva Foundation,** Golden Brain Award:
* John M. Allman, *Hixon Professor of Psychobiology and Professor of Biology*

**David and Lucile Packard Foundation,** Fellowship in Science and Engineering:
Shrinivas R. Kulkarni, *Associate Professor of Astronomy*
Yu-Chong Tai, *Assistant Professor of Electrical Engineering*

**Pew Charitable Trusts of Philadelphia,** Pew Scholars Award in the Biomedical Sciences:
* Kai Zinn, *Assistant Professor of Biology*

**Alfred P. Sloan Foundation,** Research Fellow:
* Ursula Hamenstädt, *Assistant Professor of Mathematics*
Gilles J. Laurent, *Assistant Professor of Biology and Computational and Neural Systems*
* Andrew G. Myers, *Associate Professor of Chemistry*
* E. Sterl Phinney, *Associate Professor of Theoretical Astrophysics*
* Nai-Chang Yeh, *Assistant Professor of Physics*
* Kai Zinn, *Assistant Professor of Biology*

**Welch Foundation Award in Chemistry,** Corecipient:
* John D. Roberts, *Institute Professor of Chemistry, Emeritus*

*University honors*

**Barnard University,** Barnard Medal of Distinction:
* Jacqueline K. Barton, *Professor of Chemistry*

**Baylor College of Medicine,** W. H. Helmerich III Award for Outstanding Achievement in Retinal Research:
* Seymour Benzer, *James G. Boswell Professor of Neuroscience*

**Ohio State University,** William Lloyd Evans Award:
* Rudolph A. Marcus, *Arthur Amos Noyes Professor of Chemistry*

**UCLA Department of Chemistry and Biochemistry and the Chemistry Advisory Council,** Seaborg Medal:
John D. Roberts, *Institute Professor of Chemistry, Emeritus*

*The American Academy of Arts and Sciences is one of the oldest honor societies in North America. The Academy was established in 1780 by John Adams and other leaders of the young republic, who chartered the learned society "to cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people."*

## *Institute honors*

**Endowed Professorship**:

John N. Abelson, *George Beadle Professor of Biology*

* Allan J. Acosta, *Richard L. and Dorothy M. Hayman Professor of Mechanical Engineering*

Barry C. Barish, *Ronald and Maxine Linde Professor of Physics*

Sunney I. Chan, *George Grant Hoag Professor of Biophysical Chemistry*

Scott E. Fraser, *Anna L. Rosen Professor of Biology*

James K. Knowles, *William R. Kenan, Jr., Professor and Professor of Applied Mechanics*

Manfred Morari, *Ross McCollum-William H. Corcoran Professor of Chemical Engineering*

* Edward M. Stolper, *William E. Leonhard Professor of Geology*

Kip S. Thorne, *Richard P. Feynman Professor of Theoretical Physics*

Mark B. Wise, *John A. McCone Professor of High Energy Physics*

**Associated Students of the California Institute of Technology (ASCIT)**, Award for Teaching Excellence:

Yaser S. Abu-Mostafa, *Associate Professor of Electrical Engineering and Computer Science*

* Joel W. Burdick, *Assistant Professor of Mechanical Engineering*

Sunney I. Chan, *Professor of Chemical Physics and Biophysical Chemistry*

* John J. Feiler, *Graduate Student in Physics*

Melany L. Hunt, *Assistant Professor of Mechanical Engineering*

* Valentina A. Lindholm, *Lecturer in Russian*

* Robert J. McEliece, *Professor of Electrical Engineering*

Bruce C. Murray, *Professor of Planetary Science*

John P. Preskill, *Professor of Theoretical Physics*

* Jane G. Raymond, *Member of the Professional Staff, Chemistry*

* Robert L. Ripperdan, *Research Fellow in Geobiology*

Thayer Scudder, *Professor of Anthropology*

* Kerry J. Vahala, *Associate Professor of Applied Physics*

David B. Wales, *Professor of Mathematics*

## Centennial Events

*Symposia.* The Centennial symposia were organized by each of the six academic divisions and JPL.

### Division of Biology

Seymour Benzer, the James G. Boswell Professor of Neuroscience, was honored on his 70th birthday, with a symposium. Benzer is widely known for his pioneering work with fruit flies. The list speakers read like a roll-call of achievement in molecular and neural biology. Speakers included Sidney Brenner, Francis Crick, and Renato Dulbecco.

### Division of Chemistry and Chemical Engineering

A tribute was paid to Linus Pauling on his 90th birthday with the symposium "The Chemical Bond: Structure and Dynamics." In work done at Caltech, Pauling determined the nature of the chemical bond. He won the Nobel Prize twice: for chemistry, in 1954 and for peace, in 1962. Of the seven speakers for the one-day event, six were Nobel laureates.

### Division of Engineering and Applied Science

GALCIT, the Graduate Aeronautical Laboratories of the California Institute of Technology, was formed more than 60 years ago. During the 1920s and '30s, under the direction of Theodore von Kármán, researchers at GALCIT helped establish the principles of modern aviation and jet flight. As part of "von Kármán Month" during Caltech's Centennial, more than 200 people attended the GALCIT reunion to hear about active research areas and to take lab tours. Aeronautics also sponsored a symposium on fluid mechanics.

### Division of Geological and Planetary Sciences

Mantle plumes, the currents that move in the semi-solid region between the Earth's core and crust, was the topic of a three-day symposium sponsored by the division. Internationally known experts were invited to speak at what was described as the first conference where scientists in the many disciplines studying plumes came together to exchange ideas.

**CENTENNIAL OUTREACH PROGRAM, PASADENA PUBLIC SCHOOLS**

*Caltech graduate students lectured in Pasadena public schools as part of the Centennial science education outreach program. The Caltech students gave lectures on earth science and vulcanism as part of a program aimed at combating science illiteracy and at encouraging students not to shun science as a college major or career possibility. The program included campus visits for most of the 300 public school students participating in this centennial event.*

**Division of Humanities and Social Sciences**

"New Directions in Economics," the symposium sponsored by the division, included speakers Roger Noll, Stephen Ross, Mark Satterthwaite, and Vernon Smith, who had all received their BS degrees from Caltech. The division also cosponsored a conference with the Huntington Library on "Caltech and the Huntington, Partners in Scholarship," a one-day event with speakers from both institutions.

**Division of Physics, Mathematics and Astronomy**

William A. Fowler, Institute Professor of Physics, Emeritus and Nobel prizewinner in 1983 for his studies of the nuclear reactions of importance in the formation of the chemical elements of the universe, was honored on the occasion of his 80th birthday with a symposium on astrophysics. A second symposium, also organized by the division, addressed "The Origin and Evolution of the Large-Scale Structure in the Universe." For this second event, Stephen Hawking, renowned Cambridge University physicist, presented a lecture on the origin of the universe.

**Jet Propulsion Laboratory**

Caltech and JPL jointly sponsored "Caltech and the Universe," a two-day symposium about space science attended by four Caltech presidents—past and present. Distinguished speakers from the campus and JPL community, NASA, and industry shared their views and expertise. Two special events honored the contributions of Theodore von Kármán, considered the founder of JPL because his tests of liquid propellant rockets were made near the site of the present lab.

**"Visions of a Sustainable World"**

Multidisciplinary in its scope and developed by faculty from the various divisions, this symposium featured key leaders from industry, government, and academia who offered their unique perspectives on the sustainability of human activities on Earth and how such sustainability might be approached during the coming century.

*"Women in Science" Lectures.* Caltech recognized the contributions of women to science with three special lectures. Dr. Anne Fausto-Sterling, professor of biology, Brown University, spoke on "Gender and Science". "LINE-1. Family of Human Transposable Elements" was presented by Dr. Maxine Singer, president, Carnegie Institution of Washington. Dr. Sandra Harding, professor of philosophy and director of women's studies, University of Delaware, addressed "How the Women's Movement Benefits Science: Two Views."

**EUREKA**

*Among educational events unique to the Centennial year was the EUREKA conference, the fifth national conference on undergraduate research. (EUREKA is an acronym for Excellence in Undergraduate Research: Experience, Knowledge, and Achievement.) More than 1,100 college and university students from around the country attended the event, which provided an opportunity for 850 students to present papers on their research and discuss their ideas. Keynote speakers included Louis Sullivan, Secretary of the U.S. Department of Health and Human Services; Leroy Hood, the Bowles Professor of Biology; Evelyn Fox Keller, director of women's studies and professor of rhetoric at University of California at Berkeley; and science-fiction author Ray Bradbury.*

FINANCIAL REPORT. This financial report of the California Institute of Technology has been prepared from the Institute's accounting records and reflects the Institute's financial position as of September 30, 1991, and the results of its operations for the year then ended. These statements have been reviewed by the Board of Trustees Audit Committee, whose members are designated by an asterisk in the list of board members on page 48 of this annual report.

The ***Balance Sheet*** portrays the assets, liabilities, and fund balances for each major fund group as well as the total for the Institute. Total net assets increased from $810.1 million to $958.9 million, reflecting principally an increase in campus properties and gifts. The balance sheet now reflects cumulative depreciation on Institute buildings, land improvements, and equipment in accordance with a required change in accounting practice (the year ending in 1990 was also restated to conform with the change adopted in 1991). In addition, unconditional pledges for major construction projects, approved by the Board of Trustees, have been recorded to better reflect Institute receivables, and revocable trusts are now included as investments and liabilities to reflect the total trust portfolio managed by the Institute.

The ***Statement of Changes in Fund Balances*** reflects the impact of revenue, expenditures, and transfers in the fund balances, thus portraying the sources and uses of funds by major category. Gifts totaled $145.9 million for fiscal year 1991, an increase of $110.2 million from fiscal year 1990. $28.8 million was realized as the net gain from disposal of investments in fiscal year 1991, compared with $14.9 million for fiscal year 1990.

The ***Statement of Operating Expenditures*** provides the detail of current fund expenditures for educational and related purposes. Total expenditures for fiscal year 1991 for the campus, $230.2 million, increased $25.1 million or 12.2 percent over fiscal year 1990. Expenditures for direct costs of sponsored research at the Jet Propulsion Laboratory, $1,071.3 million, increased $35.9 million or 3.5 percent.

***Current Funds*** are those funds available for operating purposes. They are classified as unrestricted—available for any purpose; or restricted—to be used for purposes specified by the sponsor or donor. They include tuition and fees, investment income, gifts, and grants or contracts from federal and private sponsors.

***Loan Funds*** for students are provided by gifts from private donors and participation in the gov-

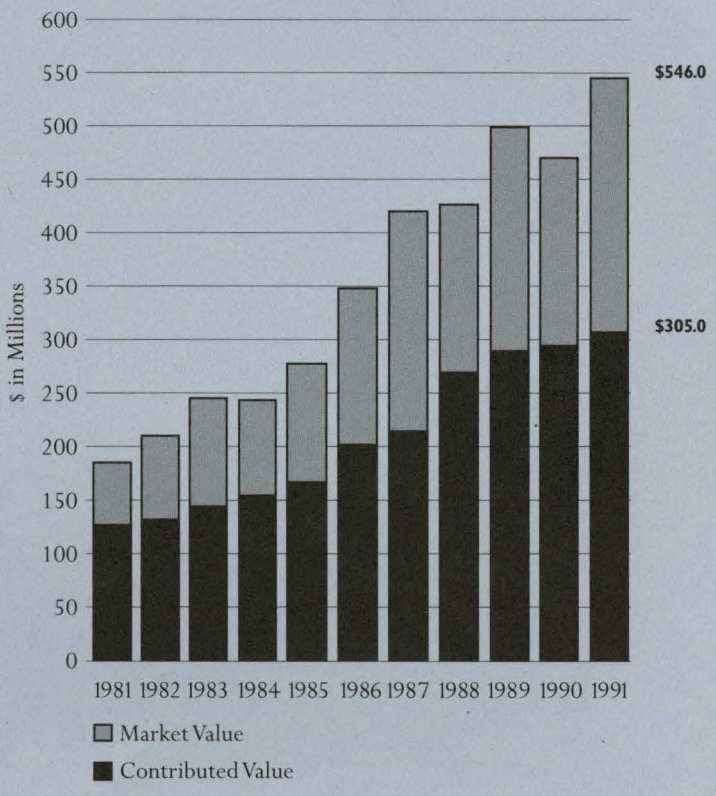
ernment's Perkins Loan Program, and are subject to repayment with interest after graduation. As repayments are made, the principal and accumulated interest become available for loans to other students.

***Endowment and Similar Funds*** include both the principal of funds set aside as endowment in accordance with the donors' wishes, which are invested to produce income and capital appreciation, and also the principal of discretionary and expendable funds, which are designated by the Board of Trustees to function as endowment.

Investment objectives for Caltech's endowment funds focus on three principles: 1) preservation of capital, 2) ability to meet current income targets, and 3) appreciation of capital to foster future income growth. In this way, the Institute endeavors to provide a stream of investment return which, after inflation, will strike a fair balance between current and future support of its instruction and research programs.

The market value of the Institute's endowment at September 30, 1991, was $546.0 million, compared to $466.9 million at September 30, 1990. In addition to U.S. equities and fixed income securities, the fund has diversified investments in real estate, international securities, and venture capital partnerships. The following graph indicates the growth in endowment over the last ten years.

***Endowment***




***Life Income and Annuity Funds*** consist of gifts received to establish living trusts for which the Institute is trustee, or annuity agreements. Payments are made to beneficiaries and annuitants during their lifetimes in accordance with the terms of these agreements.

Life income and annuity agreements are a source of meaningful additions to the Institute's endow-

| | *1981* | *1986* | *1991* |
|---|---|---|---|
| Current funds expenditures *(in thousands)* | | | |
| Instruction and departmental research (including libraries) | $28,478 | $ 46,458 | $ 79,459 |
| Organized research | 33,781 | 53,120 | 83,082 |
| Scholarships and fellowships | 3,540 | 8,178 | 12,055 |
| Institutional and student support | 11,399 | 20,031 | 31,331 |
| Plant operation, maintenance, and utilities | 6,587 | 10,988 | 14,765 |
| Total operating expenses | 83,785 | 138,775 | 220,692 |
| Auxiliary enterprises | 3,870 | 5,731 | 9,521 |
| Total | $87,655 | $144,506 | $230,213 |
| Inflation adjusted (1981 dollars) | $87,655 | $117,676 | $155,235 |
| Capital expenditures, campus *(in thousands)* | $19,967 | $ 44,579 | $ 46,512 |
| Jet Propulsion Laboratory, direct expenditures *(in millions)* | 396.6 | 832.5 | 1,071.3 |
| Total gifts and nongovernment grants *(in thousands)* | 22,271 | 84,920 | 150,164 |
| Endowment and similar funds at market value *(in millions)* | 184.3 | 347.9 | 546.0 |
| Investment income *(in millions)* | 19.8 | 25.0 | 34.6 |
| Tuition rate *(in thousands)* | 5.2 | 9.9 | 13.3 |
| Student enrollment (first term) | | | |
| Undergraduate | 844 | 845 | 810 |
| Graduate | 865 | 994 | 1,051 |
| Total | 1,709 | 1,839 | 1,861 |
| Degrees granted | | | |
| B.S. | 206 | 197 | 186 |
| M.S. | 136 | 162 | 160 |
| Eng. | 1 | 3 | 2 |
| Ph.D. | 129 | 133 | 154 |
| Total | 472 | 495 | 502 |

## SUMMARY OF CHANGES IN FUND BALANCES

*(in thousands)*

*Year Ended September 30, 1991*

### Additions

*(Excluding Reimbursement of Direct Costs at the Jet Propulsion Laboratory)*

| | |
|---|---|
| ***Gifts and Nongovernment Grants*** — Includes gifts and grants from private sources for education and research, and physical facilities. | $150,164 |
| ***United States Government Grants and Contracts*** — Reimbursement from various government agencies for direct costs of research, instruction, and student support. | 79,328 |
| ***Plant Acquisitions*** — Additions to campus plant for land, buildings, and equipment, and retirement of indebtedness. | 75,169 |
| ***Indirect Costs and Management Allowance*** — Recovery of indirect costs and management allowance under federally sponsored programs at the campus and the Jet Propulsion Laboratory. | 48,042 |
| ***Investment Income*** — Endowment income and investment income of other funds, including earnings from short term investments. | 34,553 |
| ***Realized Gains*** — Net realized gains on investments sold. | 28,822 |
| ***Tuition and Fees*** — Tuition and fees assessed students. | 24,394 |
| ***Auxiliary Enterprises*** — Revenues from sales by food services, student housing, and bookstore. | 10,933 |
| ***Other*** — Income from sales and services, and other miscellaneous revenue. | 12,314 |
| ***Total Additions*** | $463,719 |

### Deductions

*(Excluding Direct Costs at the Jet Propulsion Laboratory)*

| | |
|---|---|
| ***Research*** — Expenditures for activities specifically organized to produce research outcomes supported by federal and private sponsors. | $ 83,082 |
| ***Instruction*** — Expenditures for activities that are part of the instructional program including departmental research. | 79,459 |
| ***Plant Fund*** | |
| Expenditures for buildings, equipment, and renewals, plus retirement of plant assets. | 31,554 |
| Payments on revenue bonds and advances for plant purposes, including interest. | 29,987 |
| Depreciation of campus properties. | 19,438 |
| ***Institutional and Student Support*** — Expenditures for business and financial affairs, student services, institute relations, and general administration. | 31,331 |
| ***Plant Operations*** — Expenditures, including utilities, for the operation and maintenance of the campus grounds and facilities. | 14,765 |
| ***Scholarships and Fellowships*** — Awards made to students enrolled in formal course work with no requirement that they perform services or repay the awards. | 12,055 |
| ***Auxiliary Enterprises*** — Expenditures, including maintenance, of auxiliary enterprises. | 9,521 |
| ***Other*** — Includes payments to life beneficiaries with life income and annuity agreements, and miscellaneous other charges. | 3,691 |
| ***Total Deductions*** | $314,883 |
| ***Increase in Fund Balances*** | 148,836 |
| ***Total*** | $463,719 |

ment and other funds. This form of deferred giving has proved attractive to many donors who wish to support the activities of the Institute and receive income on their gifts during their lifetime while obtaining a charitable income tax deduction for their gifts. Upon termination of beneficiary agreements, the principal is transferred to the endowment or other fund groups as designated by the donor.

The Institute's life income and annuity agreements consist of pooled income funds, annuities, and taxable and nontaxable unitrusts. Investment assets include cash equivalents, equities, and fixed income securities (including tax-exempt municipal bonds, where appropriate), real estate, and various royalty interests. The Institute functions as trustee, with the majority of the marketable securities managed by a major institutional investment advisory firm. The Institute does not charge a trustee fee at present. At September 30, 1991, the market value of the life income and annuity funds was $83.6 million.

***Plant Funds*** consist of funds that have been received for, or designated by the trustees for, facilities. The group is divided into two categories: unexpended plant funds and investment in plant. Unexpended plant funds are available for expenditure for land, buildings, and equipment. As these funds are used, they are transferred to funds invested in plant. This transfer records the original cost of the Institute's physical facilities.

The ***Notes to Financial Statements*** are an integral part of the financial statements and provide significant information on accounting policies, investments, campus properties and plant funds, funds held in trust, retirement and deferred compensation plans, pledges, and revenue bonds.

The California Institute of Technology maintains its accounts in accordance with the guidelines suggested by the American Institute of Certified Public Accountants and the National Association of College and University Business Officers.

David W. Morrisroe

*Vice President for Business and Finance and Treasurer*

## BALANCE SHEET

*(in thousands)*

*Exhibit 1*

| | *September 30, 1990* |
|---|---|
| | *Total All Funds** |
| ASSETS | |
| Cash | $ 1,001 |
| Accounts receivable: | |
| United States government (note B) | 170,730 |
| Pledges (note H) | |
| Other | 1,773 |
| Student accounts and notes receivable | 11,772 |
| Investments (note C) | 509,617 |
| Interfund advances | |
| Prepaid expenses and other assets | 8,888 |
| Campus properties net of depreciation (note D) | 324,954 |
| | $1,028,735 |
| LIABILITIES and FUND BALANCES | |
| Accounts payable and accrued expenses (note B) | $ 175,681 |
| Deferred student revenue | 9,336 |
| Revocable trust funds and agency funds | 13,411 |
| Annuities payable | 1,080 |
| Revenue bonds payable (note I) | 19,165 |
| Fund balances | 810,062 |
| | $1,028,735 |
| Fund balances (Exhibit 2): | |
| United States government grants refundable | $ 4,674 |
| Institute funds— | |
| Unrestricted | 8,277 |
| Discretionary endowment: | |
| Unrestricted | 63,652 |
| Restricted | 69,181 |
| Endowment principal | 287,199 |
| Other restricted | 88,637 |
| Invested in plant | 288,442 |
| | $ 810,062 |

*See accompanying notes to financial statements*

**Restated to conform with presentation adopted in 1991*

*September 30, 1991*

| *Total All Funds* | *Current Funds* | *Loan Funds* | *Endowment and Similar Funds* | *Life Income and Annuity Funds* | *Plant Funds* | *Agency Funds* |
|---|---|---|---|---|---|---|
| $ 1,124 | $ 475 | $ 58 | | $ 363 | | $ 228 |
| 171,339 | 171,339 | | | | | |
| 72,750 | | | | | $ 72,750 | |
| 4,173 | 4,111 | | | 4 | | 58 |
| 13,081 | 4,458 | 8,623 | | | | |
| 587,972 | 26,085 | 2,247 | $441,795 | 68,768 | 46,985 | 2,092 |
| | 13,480 | | 4,483 | | (17,963) | |
| 12,334 | 9,045 | | | 1 | 3,274 | 14 |
| 352,028 | | | | | 352,028 | |
| $1,214,801 | $228,993 | $10,928 | $446,278 | $69,136 | $457,074 | $2,392 |
| $ 178,714 | $175,461 | | $ 279 | $ 373 | $ 2,545 | $ 56 |
| 10,329 | 10,329 | | | | | |
| 15,307 | | | | 12,971 | | 2,336 |
| 1,553 | | | | 1,553 | | |
| 50,000 | | | | | 50,000 | |
| 958,898 | 43,203 | $10,928 | 445,999 | 54,239 | 404,529 | |
| $1,214,801 | $228,993 | $10,928 | $446,278 | $69,136 | $457,074 | $2,392 |
| $ 5,052 | | $ 5,052 | | | | |
| 9,488 | $ 3,666 | | | | $ 5,822 | |
| 62,767 | | | $ 62,767 | | | |
| 70,946 | | | 70,946 | | | |
| 312,286 | | | 312,286 | | | |
| 193,988 | 39,537 | 5,876 | | $54,239 | 94,336 | |
| 304,371 | | | | | 304,371 | |
| $ 958,898 | $ 43,203 | $10,928 | $445,999 | $54,239 | $404,529 | |

## STATEMENT of CHANGES in FUND BALANCES

*(in thousands)*

***Exhibit 2***

| | Year Ended September 30, 1990 |
|---|---|
| | *Total All Funds** |
| Fund balances at beginning of year (Exhibit 1) | $783,595 |
| Revenues and other additions: | |
| Student tuition and fees | 22,327 |
| Investment income | 34,418 |
| Net gain on disposal of investments | 14,873 |
| Gifts | 35,689 |
| United States government grants and contracts— | |
| Reimbursement of direct costs | 70,060 |
| Recovery of indirect costs and management allowance | 45,809 |
| Other grants and contracts | 3,277 |
| Auxiliary enterprises revenues | 10,342 |
| United States government advances | 302 |
| Campus property acquisitions (including $25,233 in campus operating expenditures) | 50,636 |
| Retirement of indebtedness | 1,214 |
| Other | 6,058 |
| Total revenues and other additions | 295,005 |
| Expenditures and other deductions: | |
| Campus operating expenditures (Exhibit 3) | (205,151) |
| Campus property acquisitions and renewals | (37,146) |
| Retirement of indebtedness | (1,214) |
| Retirement and disposal of campus properties | (2,473) |
| Interest on advances for plant purposes | (999) |
| Interest on revenue bonds payable | (1,610) |
| Payment to life beneficiaries | (2,804) |
| Depreciation of campus properties | (16,970) |
| Other | (171) |
| Total expenditures and other deductions | (268,538) |
| Transfers among funds: | |
| Gifts allocated | |
| Investment gains and income allocated | |
| Allocations for plant purposes | |
| Terminated trust for annuity agreements | |
| Other | |
| Total transfers among funds | |
| Increase for the year | 26,467 |
| Fund balances at end of year (Exhibit 1) | $810,062 |

*See accompanying notes to financial statements*

**Restated to conform with presentation adopted in 1991*

*Year Ended*
*September 30, 1991*

| *Total All Funds* | *Current Funds* | | *Loan Funds* | *Endowment and Similar Funds* | *Life Income and Annuity Funds* | *Plant Funds* |
|---|---|---|---|---|---|---|
| | *Unrestricted* | *Restricted* | | | | |
| $810,062 | $ 3,634 | $ 38,610 | $10,136 | $420,032 | $42,521 | $295,129 |
| 24,394 | 24,377 | | | | | 17 |
| 34,553 | 11,302 | 18,736 | 354 | | 3,075 | 1,086 |
| 28,822 | | | | 28,307 | 495 | 20 |
| 145,923 | 8,056 | 19,545 | | 8,339 | 12,871 | 97,112 |
| 79,328 | | 79,328 | | | | |
| 48,042 | 48,042 | | | | | |
| 4,241 | 1,110 | 3,131 | | | | |
| 10,933 | 10,933 | | | | | |
| 396 | | | 396 | | | |
| 48,819 | | | | | | 48,819 |
| 26,350 | | | | | | 26,350 |
| 11,918 | 2,117 | 7,298 | 153 | | 92 | 2,258 |
| 463,719 | 105,937 | 128,038 | 903 | 36,646 | 16,533 | 175,662 |
| (230,213) | (106,588) | (123,625) | | | | |
| (29,249) | | | | | | (29,249) |
| (26,350) | | | | | | (26,350) |
| (2,305) | | | | | | (2,305) |
| (1,589) | | | | | | (1,589) |
| (2,048) | | | | | | (2,048) |
| (3,075) | | | | | (3,075) | |
| (19,438) | | | | | | (19,438) |
| (616) | | | (143) | | (473) | |
| (314,883) | (106,588) | (123,625) | (143) | | (3,548) | (80,979) |
| | (2,183) | | | 2,183 | | |
| | 14,977 | (4,477) | | (10,500) | | |
| | (10,606) | (207) | | (3,904) | | 14,717 |
| | | 20 | | 1,247 | (1,267) | |
| | (1,505) | 1,178 | 32 | 295 | | |
| | 683 | (3,486) | 32 | (10,679) | (1,267) | 14,717 |
| 148,836 | 32 | 927 | 792 | 25,967 | 11,718 | 109,400 |
| $958,898 | $ 3,666 | $ 39,537 | $10,928 | $445,999 | $54,239 | $404,529 |

## STATEMENT of OPERATING EXPENDITURES

*(in thousands)*

*Exhibit 3*

| | Year Ended September 30, 1990 | 1991 |
|---|---|---|
| Educational and general: | | |
| Instruction and departmental research | $ 69,457 | $ 79,459 |
| Organized research | 74,728 | 83,082 |
| Scholarships and fellowships | 10,530 | 12,055 |
| Institutional and student support | 28,701 | 31,331 |
| Plant operation, maintenance and utilities | 13,065 | 14,765 |
| Total educational and general | 196,481 | 220,692 |
| Auxiliary enterprises | 8,670 | 9,521 |
| Total campus operating expenditures | $ 205,151 | $ 230,213 |
| Direct costs of sponsored research at Jet Propulsion Laboratory (fully reimbursed by the United States government) | $1,035,394 | $1,071,292 |

*See accompanying notes to financial statements*

# NOTES to FINANCIAL STATEMENTS

## *Note A — Summary of Significant Accounting Policies*

*Basis of accounting and reporting*
The financial statements of the California Institute of Technology, a not-for-profit educational organization, have been prepared in accordance with the principles of accrual basis fund accounting for colleges and universities. Under these principles, Institute resources are accounted for by the use of separate funds so that visibility and control are maintained for the benefit of the Institute and its sponsors. Funds that have similar objectives and characteristics have been combined into fund groups. Within each fund group, fund balances restricted by outside sponsors for specific purposes are so indicated and are distinguished from unrestricted funds that are available for use in achieving any Institute objective.

*Investments*
Institute investments are stated at their approximate market value at date of gift, or at cost if purchased by the Institute, less applicable amortization and depreciation of real estate, unless there has been an impairment of value not considered temporary.

All investments of endowment and similar funds are carried in an investment pool unless special considerations or donor stipulations require that they be held separately. Pool share values are computed periodically based upon the total market value of the investment pool and the total number of pool shares invested.

Income on investments of endowment and similar funds is recorded as current fund revenues for the purposes specified by the donor. Such income is supplemented, where necessary, by transfers of additional amounts so as to result in a total return from the investment pool equivalent to 5% of the average market value of the pool over a three-year period. This total return concept is authorized by the California Uniform Management of Institutional Funds Act, which allows the prudent use of realized appreciation on investments, thus permitting greater flexibility in investment strategy.

*Campus properties and plant funds*
Campus properties are recorded at cost of construction or acquisition, or at appraisal value at date of gift, less accumulated depreciation, computed on a straight-line basis over the estimated useful lives. The depreciation method of accounting for campus properties was adopted by the Institute in fiscal 1991 (note D). The Institute provides for the renewal and replacement of its campus properties from funds designated for this purpose. Expenditures for maintenance and repairs are generally charged to current funds as plant operation and maintenance expenditures.

*Annuities*
Annuities payable to certain donors of the Institute are recorded at the present value of the liability calculated under an actuarial method which takes into account the life expectancies of the recipients.

*Jet Propulsion Laboratory*
The Institute manages and operates the Jet Propulsion Laboratory (JPL) under a cost reimbursable contract with the National Aeronautics and Space Administration. JPL land, buildings, and equipment are owned by the United States government and are excluded from the Institute's financial statements. However, liabilities arising from JPL activities are those of the Institute and are reflected in its financial statements as are receivables arising from such activities (note B). The volume of activity at JPL is reflected in the Statement of Operating Expenditures (Exhibit 3).

*Tax-exempt status*
The Institute is a tax-exempt educational organization under federal and state income, gift, estate, and inheritance tax laws.

## *Note B — United States Government Contracts*

The Institute has many contracts with the United States government that provide for reimbursement of costs incurred at JPL and the Campus. These contracts gave rise to a substantial portion of the accounts payable and accrued expenses in the current funds at September 30, 1991 and 1990, and in turn to accounts receivable from the United States government. Accounts payable and accrued expenses (and related receivables) for JPL amounted to approximately $163,000,000 at September 30, 1991 and 1990.

## *Note C — Investments*

Institute investments, at carrying values (see note A), comprise the following:

| | *September 30,* | |
|---|---|---|
| | *1990* | *1991* |
| Marketable securities— | | |
| Debt securities (approximate market value of $180,043,000 in 1990 and $242,301,000 in 1991) | $183,428,000 | $232,765,000 |
| Equity securities (approximate market value of $268,509,000 in 1990 and $335,737,000 in 1991) | 213,553,000 | 233,341,000 |
| | 396,981,000 | 466,106,000 |
| Short-term commercial obligations | 37,344,000 | 31,983,000 |
| Settlements in process— | | |
| Receivables for securities sold | 2,718,000 | 28,060,000 |
| Payables for securities purchased | (656,000) | (9,675,000) |
| Real estate, less amortization and accumulated depreciation of $2,326,000 in 1990 and $2,291,000 in 1991 | 36,114,000 | 36,190,000 |
| Mortgages, notes, and other securities | 37,116,000 | 35,308,000 |
| | $509,617,000 | $587,972,000 |

Prior year balances have been restated to include revocable trust investments (note E).

Investments shown above include the investment pool as follows:

| | September 30, 1990 | 1991 |
|---|---|---|
| Investment pool assets at year end— | | |
| At carrying value | $362,498,000 | $395,657,000 |
| At approximate market value | $404,824,000 | $489,024,000 |
| Pool share value at market | $ 19.10 | $ 21.89 |
| Annualized income earned per pool share | $ 1.04 | $ 1.05 |

During the current fiscal year, the Institute was authorized to manage a major foundation's investment portfolio with an approximate market value of $140,000,000 at September 30, 1991. These investments are not included in the amounts shown above.

### *Note D — Campus Properties and Plant Funds*

*Campus properties consist of the following:*

| | September 30, 1990 (Restated) | 1991 |
|---|---|---|
| Land | $ 10,141,000 | $ 10,761,000 |
| Land improvements | 8,093,000 | 8,617,000 |
| Buildings | 268,106,000 | 282,170,000 |
| Equipment | 203,070,000 | 234,374,000 |
| | 489,410,000 | 535,922,000 |
| Less accumulated depreciation | (164,456,000) | (183,894,000) |
| | $324,954,000 | $352,028,000 |

Effective October 1, 1990, the Institute adopted Statement of Financial Accounting Standard No. 93, "Recognition of Depreciation by Not-For-Profit Organizations." The Institute's financial statements of prior years have been restated to reflect adoption of depreciation accounting of campus properties retroactively. Depreciation has been calculated, using the straight line method, with life years of 20, 40, and 10 for land improvements, buildings, and equipment, respectively. The effect of the change in accounting was to decrease the plant funds balance as of September 30, 1990 by $164,456,000 and to reduce the funds balance as of September 30, 1991 by an additional $19,438,000 for fiscal 1991 depreciation of campus properties.

Balances for Total All Funds and Plant Funds as of September 30, 1990 have been restated as the result of the change in accounting for depreciation of campus properties as follows:

| | Total All Funds Balance | Plant Funds Balance |
|---|---|---|
| Balances, as previously reported | $974,518,000 | $459,585,000 |
| Adjustment for the cumulative effect on prior years of adopting depreciation accounting | (164,456,000) | (164,456,000) |
| Balances, as restated | $810,062,000 | $295,129,000 |

The W. M. Keck Foundation previously provided funding of $70 million toward the construction of a 10-meter telescope in Hawaii. That telescope has been essentially completed at a cost of approximately $89 million, which is included in campus properties at September 30, 1991. This telescope will be operational in 1992.

In April 1991, the Foundation awarded the Institute $74.6 million toward the construction of a second telescope at the same location. As of September 30, 1991, $8.6 million had been received and approximately $1.0 million had been expended and included in campus properties, and the unexpended portion of $7.6 million is included in investments of the Plant Fund. The balance of the pledge of $66 million is shown as a receivable in accordance with the policy indicated in note H.

### *Note E — Funds Held in Trust*

The Institute is the income beneficiary of certain funds, recorded at a nominal value, which are held in trust by others and which had current market values, estimated by the Institute, of approximately $17,200,000 and $15,400,000 at September 30, 1991 and 1990, respectively. The income derived from these funds amounted to $795,000 and $843,000 for the years ended September 30, 1991 and 1990, respectively. This income has been included as investment income in the Statement of Changes in Fund Balances (Exhibit 2).

In addition, the Institute is the trustee for several revocable trusts in which it has a remainder interest and for which it makes income payments for life to the grantors of the trusts. These trusts totaling $12,971,000 and $11,171,000 at September 30, 1991 and 1990, respectively, have been included as assets and liabilities in the financial statements, effective September 30, 1991, with restatement of September 30, 1990 balances.

## *Note F — Retirement Plans*

The Institute has three retirement plans covering substantially all of its employees that are funded by periodic transfers to the respective insurance companies. Academic and senior administrative staff are covered by a defined contribution pension plan, while non-academic staff are covered by two defined benefit pension plans. Retirement benefits under these defined benefit pension plans are based on years of service and career average compensation and accrue partially on a fixed dollar basis, and partially on a variable dollar basis. The Institute's defined benefit plan funding policy is to contribute amounts sufficient to maintain retirement plan assets at levels adequate to cover all accrued benefit liabilities.

The net pension cost for the year ended September 30, 1991, and the funded status at September 30, 1991, for the defined benefit plans are as follows:

*Net Pension Cost*

| | *Campus* | *JPL* |
|---|---|---|
| Service cost—benefits earned during the year | $ 2,317,000 | $ 9,832,000 |
| Interest cost on projected benefit obligation | 2,800,000 | 12,974,000 |
| Actual return on plan assets | (3,336,000) | (15,454,000) |
| Net amortization and deferral | 529,000 | 2,459,000 |
| Net pension cost | $ 2,310,000 | $ 9,811,000 |
| *Funded Status* | | |
| Actuarial present value of benefit obligations— | | |
| Accumulated benefit obligation, including vested benefits of $53,462,000 and $261,364,000 | $54,444,000 | $265,588,000 |
| Projected benefit obligation | $58,544,000 | $283,181,000 |
| Plan assets at fair value | 57,075,000 | 277,084,000 |
| Projected benefit obligation in excess of plan assets | 1,469,000 | 6,097,000 |
| Unrecognized net gains or (losses) | (1,538,000) | (2,049,000) |
| Unrecognized net asset at October 1, 1987, being amortized over 16 and 18 years, respectively | 65,000 | 631,000 |
| Accrued (prepaid) pension cost | $ (4,000) | $ 4,679,000 |

The weighted-average discount rate and assumed rate of increase in future compensation levels used in determining the actuarial present value of the projected benefit obligation are 7.75% (1990–8.25%) and 6%, respectively. The expected long-term rate of return on assets is 8%.

Pension costs for the defined contribution plan for academic and senior administrative staff for the year ended September 30, 1991, were $4,694,000 for the Campus, and $17,293,000 for JPL.

All pension costs for JPL are included in direct costs of sponsored research.

## *Note G — Deferred Compensation Plan*

The Institute has a deferred compensation plan whereunder eligible employees may elect to defer a portion of their normal salary, generally until retirement. The Institute's liability for future benefits payable to active employees under this plan, which approximated $32,040,000 and $29,910,000 at September 30, 1991 and 1990, respectively, is matched by Institute investments in an annuity contract with a major insurance company. It is expected that any payments by the Institute to employees would be matched by payments from the insurance company to the Institute. The amounts representing future benefits payable and the matching investments are not reflected in the financial statements.

## *Note H — Pledges*

Effective October 1, 1990, the Institute adopted the policy of recording as a receivable and as revenue in plant funds, unconditional pledges received with respect to funding of major construction projects approved by the Board of Trustees and deemed fully collectible. This accounting change, adopted prospectively, provides more appropriate disclosure of total assets and plant fund balances. The recording of these pledges is in substantial conformity with the accounting standard proposed by the Financial Accounting Standards Board. The effect of this change in accounting on the fiscal 1991 financial statements was to increase plant fund revenues and the year-end plant fund balance by $72,750,000. Previously, the Institute recognized revenue as cash was received.

At September 30, 1991, the Institute had additional pledges on hand (principally for restricted purposes), but not recorded, totaling approximately $55,000,000, of which $13,000,000 is expected to be collected in 1992. It is not practicable to estimate the net realizable value of these pledges.

### *Note I — Revenue Bonds*

On May 29, 1991, the Institute issued $50,000,000 in California Educational Facilities Authority Revenue Bonds for the purpose of financing and refinancing the acquisition, construction, and completion of certain educational facilities, and to advance refund the outstanding $18,700,000 principal amount of the Institute's Series 1985 bonds. Proceeds of $20,833,900 were used to purchase U.S. Government securities which were deposited in an irrevocable trust with an escrow agent to provide for the future debt service of the Series 1985 bonds. The Series 1991 bonds are repayable with interest, from the general revenues of the Institute over a 30-year period. Interest rate varies from 4.8% to 6.4%. Required principal and interest payments are approximately $4,000,000 a year for the fiscal years 1992 through 2005, approximately $3,000,000 a year for fiscal years 2006 through 2016, and approximately $2,000,000 a year thereafter until 2021, when the bonds will be fully redeemed.

### *Note J — Contingencies*

The Institute is a defendant in various legal actions incident to the conduct of its operations. The Institute's management does not expect that liabilities, if any, for these legal actions will have a material effect on the Institute's financial position.

## REPORT of INDEPENDENT ACCOUNTANTS

*Price Waterhouse*

To the Board of Trustees of
California Institute of Technology

In our opinion, the accompanying balance sheet and the related statements of changes in fund balances and of operating expenditures (Exhibits 1 through 3) present fairly, in all material respects, the financial position of California Institute of Technology (the "Institute") at September 30, 1991, and the changes in fund balances and the operating expenditures for the year then ended, in conformity with generally accepted accounting principles. These financial statements are the responsibility of the Institute's management; our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit of these statements in accordance with generally accepted auditing standards which require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements, assessing the accounting principles used and significant estimates made by management, and evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for the opinion expressed above.

As discussed in Note D to the financial statements, in fiscal 1991 the Institute adopted a new accounting policy requiring depreciation of its campus properties. Financial statements for prior years were restated to apply the new method retroactively. Also, as discussed in Note H to the financial statements, in fiscal 1991 the Institute has prospectively changed its accounting policy for recording of major unconditional pledges.

Price Waterhouse

Los Angeles, California
December 27, 1991

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*(as of March 10, 1992)*

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