CALIFORNIA INSTITUTE OF TECHNOLOGY

Annual Report 1993-94

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(as of March 14, 1995)

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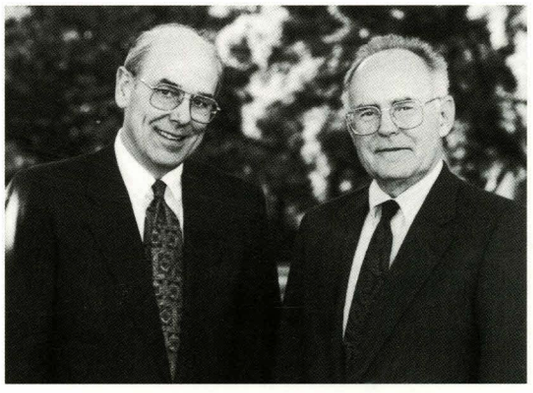


Thomas E. Everhart, President, and Gordon E. Moore, Chair of the Board of Trustees.

With the 21st century less than five years away, and with many dramatic changes occurring in the world recently, the field of visualizing the future has suddenly become crowded. But rather than simply prognosticating, Caltech researchers are helping to shape the future, as they've done for decades. Discovery can improve the human condition in many ways. Educating students in a milieu in which discovery takes place is a Caltech trademark, and Institute professors are introducing not only new courses, but new ways of educating students.

For example, Caltech has been in the forefront of introducing computers as a basic tool for students to use, and they use them proficiently. Caltech introduced the physics educational television series, *The Mechanical Universe*, which has been viewed by more than one million students in this country. It has been translated into six foreign languages, enhancing the teaching of physics around the world. *Project MATHEMATICS!* is a somewhat different videotape series, which teaches concepts of mathematics to precollege students. Over 121,000 videocassettes are in circulation around the country; and at least 9 million students are estimated to have viewed one or more of the tapes. (These videotapes and their manuals are among the fastest selling mail-order items in the Caltech bookstore!) Just becoming commercially available are the first videotapes from the Chemistry Animation Project, designed to teach difficult-to-grasp concepts in chemistry. Using computer animation, like *The Mechanical Universe* and *Project MATHEMATICS!*, the Chemistry Animation Project's videos are created by Caltech undergraduates with the help of a professional animator and designer, and Caltech faculty. Each of these projects improves the speed at which students learn and the depth of their understanding. The tapes teach fundamentals, and can be used many times for many students.

While television can be an effective educational tool, it is passive; students cannot ask it questions, probe a given subject more deeply, or interact with TV in other ways. On the other hand, personal computer learning programs are active, and—like video games before them—captivating. Students can learn at their own pace, and exercises—which can often seem tedious—are experienced as challenging games. As multimedia computing increasingly becomes a reality in American homes, as well as in many schools, students will be learning more, be learning faster, and likely be learning with better comprehension. At an early age, they will be stimulated, audibly and visually, with moving, interactive images, words, and numbers, instead of just static words, numbers, and diagrams on the printed page. They will come to college expecting to continue to learn at a fast pace using such tools. With modem computer networks,

they will be able to access many learning tools, large databases, and information that a decade ago was inaccessible or, in many cases, nonexistent.

It is Caltech's challenge to develop methods that will take advantage of students' increased skills, the increased power of new learning tools, and the vast amount of information that can be accessed. We must do this so that students will learn foundational material well, master this knowledge by making it their own through problem solving, and gain the hands-on skills that have characterized the Caltech education. This generally happens through the personal mentoring of faculty, in the classroom, in the laboratory, or through supervised research. New educational tools will not diminish the importance of student–faculty interactions. But they can augment such relationships, and can be packaged and exported to students elsewhere, just as *The Mechanical Universe*, *Project MATHEMATICS!*, and the Chemistry Animation Project are today.

While the tools of teaching are changing at Caltech, our core curriculum is also being rethought by the faculty. And not only is the content evolving. The entire process of continuous improvement and continual oversight is being addressed. This is essential, because the way students learn, and what they learn, is in such a state of flux.

Just as the Institute has made use of the above technological advances in educating its undergraduates, Caltech is also taking note of the impact of technological developments on the conduct of research. Nowhere is this more dramatically evident than in the biological sciences. In the years ahead, further developments will enable biologists to make major discoveries and achievements that will both increase our knowledge and benefit humanity. Caltech has always had a strong Division of Biology, but if the Institute hopes to maintain its overall leadership in science and engineering, it must focus more attention on the biological sciences. We're currently modernizing all of the undergraduate biology laboratories, adding to our superb biology faculty, and seeking funding for a new building for biology that will promote interactivity between faculty and students. With more opportunities than ever before for discoveries in the biological sciences, this is the right time to build on our strengths.

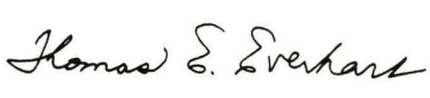
During the past year, we have added two new members to our Board of Trustees: William Gross, BS '81, the chairman and chief executive officer of Knowledge Adventure and Caltech's first Young Alumni Trustee; and Kent Kresa, chairman, president, and chief executive officer of Northrop Grumman Corporation. We welcome their enthusiasm and guidance and appreciate the entire Board's counsel during this period of change. At the same time, we mourn the deaths of four longtime Board members: Life Trustee Lee A. DuBridge, president emeritus of the Institute; Life Trustee Richard R. Von Hagen, president emeritus of Lloyd Management Corporation; Life Trustee Thomas J. Watson, Jr., chairman emeritus of

International Business Machines Corporation; and Frank G. Wells, president and chief operating officer of the Walt Disney Company. We also are saddened by the passing of two of Caltech's most noted Nobel laureates, former faculty members Linus Pauling and Roger Sperry. The dedication and years of service of all these members of the Caltech community are greatly appreciated, and they will be sorely missed.

Throughout its history, Caltech has gone through several periods of transition, perhaps none as dramatic as the period in the 1920s and 1930s, when Robert Millikan enlarged the Institute's focus to new fields, such as biology and aeronautics, and changed Caltech from being like all the other schools to being very distinctive. Now we have to think about substantial change again. While Caltech will continue to remain small, focused, and second to none at what it does, it must evolve, and we must open our minds to how we can do things better. We are in a period of rapid change, a period of great challenges, and also a period of great opportunities. Caltech must be ready to meet these challenges and seize the opportunities.

Part of what makes Caltech unique is that our students and faculty absorb ideas from a broad range of human knowledge, which they then put together in ways that yield significant insights and breakthroughs. Caltech scientists and engineers are making great strides in areas that include understanding the causes of earthquakes, exploring how the brain functions, and creating machines with the senses of sight, hearing, touch, and smell. To allow our students to make similarly exceptional contributions to science, engineering, and society, we must provide them with a vital education that takes advantage of current technology that is more efficient and that is ultimately more valuable.

With the best information tools at their disposal, students' abilities to be creative, to produce new ideas, and to make discoveries can only be enhanced. These tools will help them consolidate and use their knowledge so that they can make further strides in research, further our understanding of natural phenomena, and create more new technologies that can serve humanity. Our goal at Caltech is to see that our students can have such an impact.



Thomas E. Everhart
President

Gordon E. Moore
Chair of the Board of Trustees


XEROX

FOR MORE THAN 100 YEARS, the Institute has emphasized undertaking only a few lines of work and doing them well. The 1993–94 academic year has seen Caltech continue to focus its resources and energy in those areas in which it has the faculty, students, and staff to excel and to make important contributions to knowledge and to education.

Strengthening Our Resources

Amid the constrained economic circumstances confronting higher education today, Caltech has maintained its stable financial condition through conservative fiscal management of its income from its endowment, from government grants, and from gifts made by individuals, corporations, and foundations. As with other universities, however, the Institute's financial obligations continue to rise. Updating equipment and laboratories, ensuring the quality of our faculty and student body, and supporting the freedom for researchers to pursue ideas wherever they lead, all add to Caltech's financial responsibilities. Over the past year, the Institute has sought to meet these responsibilities by planning well and bolstering its development efforts. Caltech remains committed to giving its scientists and engineers the resources and facilities they need to carry out innovative research and superlative instruction.

The capital projects that Caltech has undertaken reflect the Institute's prudent assessment of present resources and future needs, as well as its success in raising funds in support of state-of-the-art laboratory renovations and new buildings. For example, a recent grant from the Ralph M. Parsons Foundation has made possible the major renovation of a chemistry lab devoted to synthetic chemistry. The Howard Hughes Medical Institute has provided substantial funds for the modernization of the undergraduate biology labs, while the W. M. Keck Foundation has given significant support to research in adaptive optics that will open new avenues of research in astronomy. Construction has begun on the new engineering and applied science library, thanks to a pledge from the Sherman Fairchild Foundation. The Gordon and Betty Moore Laboratory of Engineering is nearing completion, with its dedication scheduled for 1995. Among its many research programs, the Moore Lab will also be home to the new Center for Neuromorphic Systems Engineering—established with a five-year grant of $11 million from the National Science Foundation—where Caltech researchers will work closely with their counterparts in business and industry to design and develop devices that possess one or more of the senses of sight, hearing, taste, smell, and touch. Ground was also broken this past year for LIGO (the Laser Interferometer Gravitational-Wave Observatory) in Hanford, Washington, one of the project's two sites (the other is Livingston,

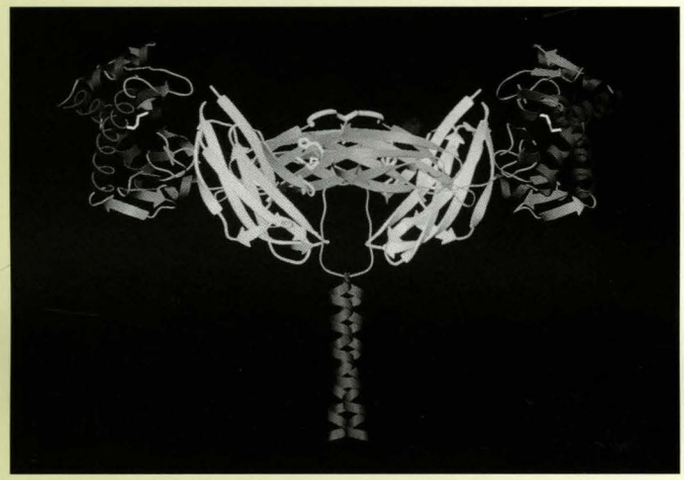
Recognizing the Enemy

A game of espionage is played continually inside a nursing mother's body, with her immune system identifying enemy agents that might threaten her newborn child. Caltech biologists have successfully deciphered the three-dimensional structure of one of the key proteins involved, called the Fc receptor.

Consider what happens when a virus attacks the mother's body. There are three main characters: the enemy virus, the antibody (the "bodyguard"), and the Fc receptor (the "good spy"). The mother builds up a stockpile of antibodies against the viral invader, and some of these antibodies are passed to the newborn through her milk. Cells in the baby's intestinal wall contain Fc receptors, which bind to the corresponding antibodies and take them to the side of the cell's surface that faces the bloodstream. There the cell drops the antibodies, which go into the bloodstream of the newborn to fight off the virus.

These proteins are difficult to study because the cell manufactures them in minute quantities. So the biologists used a molecular-biological technique called "protein expression," in which they put the protein-encoding gene into a cell in which it is not normally found. This gene then persuaded that cell to manufacture the Fc receptor in bulk. The biologists used X-ray diffraction—a technique that involves first crystallizing the protein molecules, then bombarding them with X rays and recording the pattern that emerges. By analyzing the pattern, the researchers can determine the location of individual atoms and how they interact with one another in the protein's structure. This structure provides a picture of how the other molecules bind to it.

The researchers discovered that the Fc receptor looks like the MHC molecule, another important immune-system protein. The MHC molecule has a big cleft into which protein fragments—either from a virus or from the cell—fit exactly, enabling the MHC molecule to discriminate between friend and foe. But the Fc receptor's cleft is closed and so cannot function as the binding site. The biologists then crystallized a complex between the receptor and the portion of the antibody to which it binds, and found that the antibody binds to the surface of the closed cleft.



A computer-generated "ribbon diagram" depicts an antibody receptor in the orientation it assumes on a membrane.

Studying the Fc receptor's structure and its interaction with antibodies should shed light on the MHC molecules as well, and why one basic structure evolved into two such different modes of operation.

Louisiana); a joint project of researchers at Caltech and MIT, LIGO is designed to detect gravity waves—a phenomenon predicted by Albert Einstein in 1916, but never observed. And plans for Avery House, a new campus residence provided through a generous gift from R. Stanton Avery, are moving along. When it is completed in 1996, Avery House will house 180 undergraduates, 55 graduate students, and a dozen professorial and research faculty and their families.

Caltech has particularly appreciated the continuing generosity of its alumni and friends during these challenging economic times. This generosity reflects the dedication of trustees, alumni, Associates, Industrial Associates, and other individuals, corporations, and foundations.

Notably, the 50th reunion of the class of 1944 presented the largest class gift ever received by the Institute—more than 45 percent of the class participated.

Members of the Caltech Associates contributed more than $9 million to the Institute, covering a variety of restricted and unrestricted areas, including endowed funds for undergraduate scholarships.

Many other Caltech friends and alumni have helped to ensure Caltech's future by participating in the Institute's planned giving and estate programs. For fiscal year 1994, Caltech received more than $10 million in bequest income from 27(estates and more than $5.4 million in life income gifts from 32 individuals. In particular, funds for student aid have been greatly enhanced by the generous bequests of Warren G. Koerner, Cecil L. Killgore, Frank G. Gilloon, and Mrs. J. Gibson Pleasants. Unrestricted endowment has benefited from the estates of Mason A. Logan and Spiros Ponty.

During this past year, Caltech has also experienced success in its efforts to raise funds in support of general endowment. The *Chronicle of Higher Education* ranked the Institute's endowment 27th among those of more than 430 colleges and universities nationwide. During fiscal year 1993–94, Caltech received more than $62.7 million in endowment gifts and pledges. In the particularly important area of endowed professorships, the generosity of Institute supporters has made it possible to establish four new chairs—the Allen and Marilyn Puckett Professorship, the Martin Summerfield Professorship of Applied Physics, the George Van Osdol, Sr., Professorship, and the John K. Northrop Professorship of Aeronautics. Major donors of new, critically needed postdoctoral fellowships included the Donald E. and Delia B. Baxter Foundation, the Della Martin Foundation, and the Weingart Foundation. Trustee Lew Wasserman and his wife, Edie, made the single largest undergraduate scholarship commitment to Caltech in recent years, while alumnus Craig SanPietro also made a significant contribution to undergraduate aid. Former JPL director

Designs for a "Pure" Pain-Killer

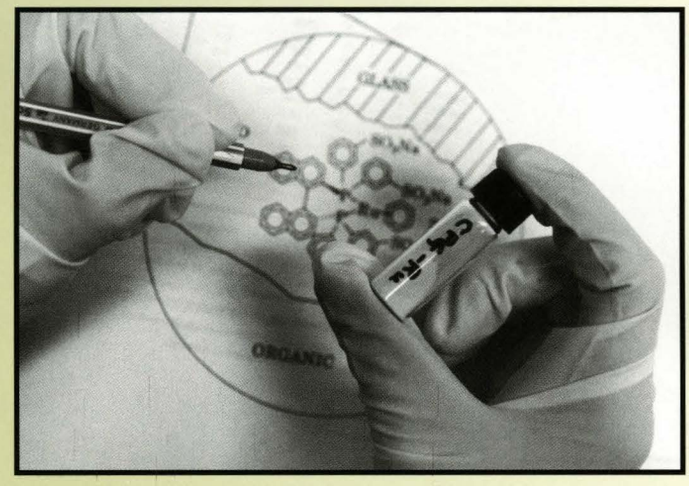
Like right and left hands, molecules often come in mirror-image forms called enantiomers. This poses a problem for chemists trying to design drugs. Many drugs have this kind of "handedness," and their production creates both enantiomers–but only one is the desired, active version. The other may even be toxic! Separating the left- and right-handed versions is difficult, because the two are nearly identical chemically. Chemists would prefer to synthesize only the active one. For more than 20 years, scientists have known that it is possible to create one enantiomer of certain molecules. The first successful attempt occurred in the 1970s, with the development of a catalyst to make the drug L-dopa, used to treat Parkinson's disease.

In a series of experiments completed in early 1994, Caltech chemists designed and synthesized an asymmetric catalyst for producing the anti-inflammatory molecule naproxen–the crucial ingredient in the popular prescription drug Naprosyn and its weaker, over-the-counter form, Aleve.

In the case of naproxen, the right-handed version relieves pain, while the left-handed version is a toxin. The new catalyst, a ruthenium-containing organometallic complex, produces the right-handed enantiomer with 95 percent selectivity.

High selectivity is wonderful, but a successful industrial catalyst needs other attributes as well: it must be very active, and it must be retrievable–it should be easily separated from the final product. How active a catalyst is depends upon its maintaining the precise molecular shape that will hold the reacting chemicals together in the correct orientation for the reaction to occur. But past efforts to attach such catalysts to solids, which could then be filtered out and reused, were only partially successful. In the process of bonding to solids, the catalyst became distorted and lost its active quality.

The breakthrough came when the chemists realized that if the catalyst were dissolved in a liquid (in this case, ethylene glycol) that would not mix with the reaction solvent (chloroform/cyclohexane) but would stick to solid, the liquid would hold the catalyst to the solid surface. It worked–when all the ingredients were stirred together, the ethylene glycol repelled the solvent and clung to the solid as a thin film, taking the catalyst with it. The catalyst retained an appropriate configuration such that it could react easily with the rest of the mixture. By correctly choosing the right solvent and appropriate solid–the chemists were able to set up a system in which the entire catalytic structure automatically assembled itself.



A chemist holds a vial containing a solid catalyst (CPG-Ru) for an asymmetric reaction, which is diagrammed on the paper appearing below it. This is the reaction that selectively produces mirror-image molecules like naproxen, the active ingredient in popular pain-killing drugs such as Aleve.

William Pickering established a graduate fellowship for students from New Zealand, while Trustee Stephen Bechtel and the Charles Lee Powell Foundation each funded much-needed graduate fellowships in engineering. Student research also received support from Teledyne, which endowed a Summer Undergraduate Research Fellowships fund to honor former Teledyne director and Caltech Trustee Arthur Rock.

In addition to expanding the Institute's fund-raising efforts, Caltech has recently established an office of technology transfer. Its purpose is to seek out potential markets and avenues of application for Institute-based inventions, with the aim of increasing revenues for Caltech. In the past the Institute has relied on its researchers to bring their finished inventions to the attention of Caltech's patents and licensing office. As well as encouraging this practice, the new office of technology transfer will actively work to identify inventions with commercial potential while they are still in development on campus.

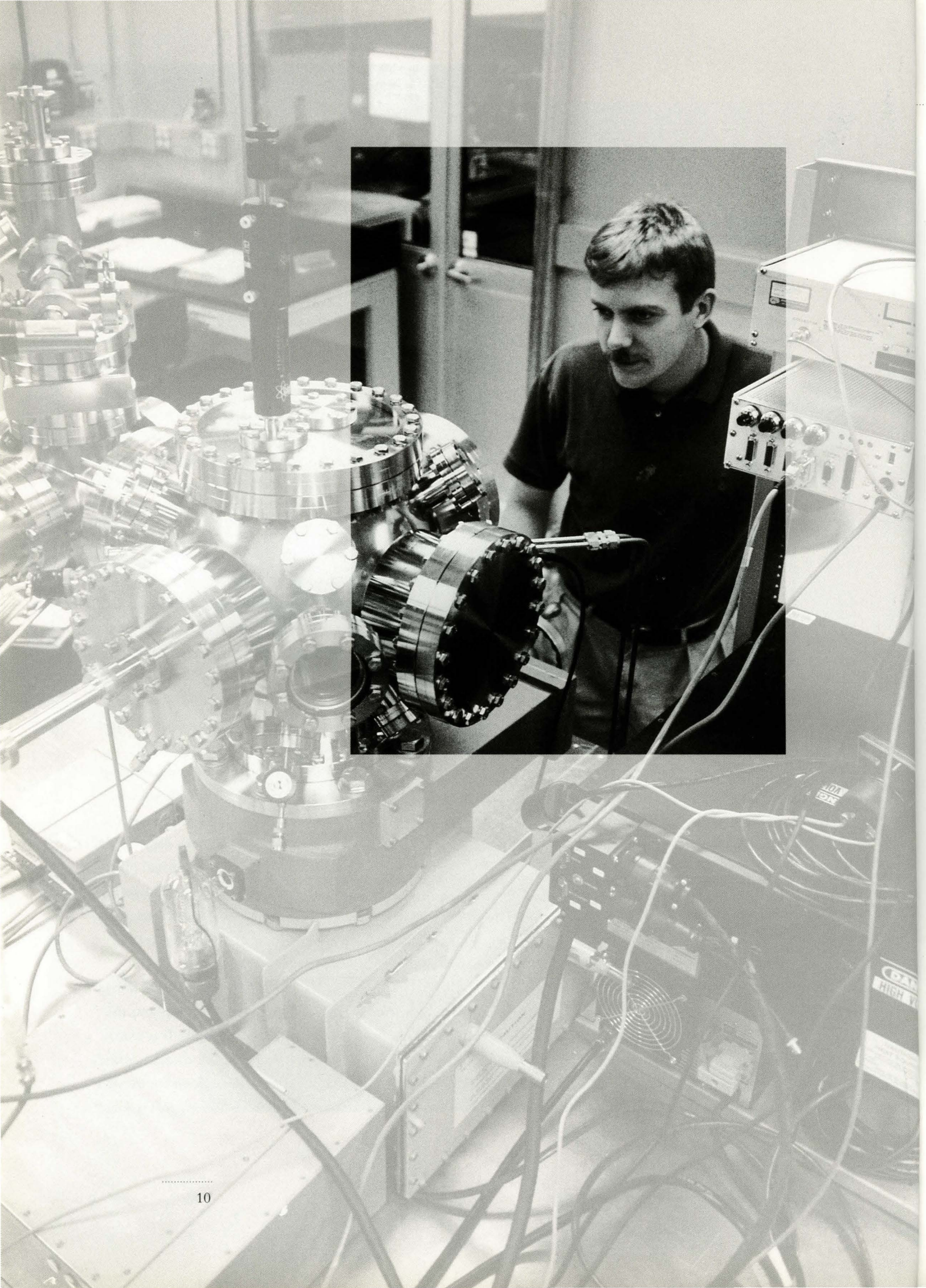
A New Look at the Core Curriculum

Institute faculty and administrators are collaborating with students to evaluate and further improve undergraduate education at Caltech and to develop new courses. Notably, Caltech's core curriculum has been under review for the past year and a half. During that time, the Core Curriculum Committee —made up of key Caltech administrators and the principal professors teaching the current core curriculum— was established to track the quality and content of the core and to maintain an accurate syllabus. Lengthy discussions among faculty and undergraduate representatives resulted in several proposals. In November, the newly formed Core Curriculum Task Force proposed a new core curriculum, which will be planned and designed during this next academic year. The new core is expected to be functioning by fall 1996.

Caltech Graduates

Students graduate from Caltech as scientists, engineers, and scholars with sharp curiosities and well-rounded knowledge. In June 1994, during Caltech's 100th commencement ceremony—at which Caltech President Thomas Everhart and former Chair of the Board Ruben Mettler served as keynote speakers—the university awarded 466 degrees. These included 197 bachelor's, 116 master's, 2 engineer's, and 151 doctor's degrees. Of the BS graduates, 52 percent had plans to go directly into a graduate program, with most choosing science or engineering. At the master's level, 72 percent were continuing in school.

Caltech's more than 18,000 living alumni are a constant testimony to the Institute's accomplishments. It is worth noting that—in addition to their considerable representation among the world's renowned scientists and engineers, key



university administrators, and notable government leaders—Institute alumni have founded a number of companies, with total combined revenues of billions of dollars. Among the largest and most well known are Intel Corporation; Beckman Instruments; TRW Inc.; Compaq Computer; Science Applications International; Silicon Graphics; Embraer Sa (Brazil); and Dames & Moore.

New Division Chairs

During the 1993–94 academic year, two divisions changed leadership. Bren Professor of Chemistry Peter B. Dervan became the new chair of the Division of Chemistry and Chemical Engineering on July 1. He succeeded Professor of Chemistry Fred C. Anson. On September 1, Edward M. Stolper, William E. Leonhard Professor of Geology and executive officer for geochemistry, succeeded David J. Stevenson, professor of planetary science, as chair of the Division of Geological and Planetary Sciences.

Extending the Boundaries of Science Education

The Institute continues to cooperate with the Pasadena Unified School District in the implementation of an innovative, hands-on science program called Project SEED (Science for Early Educational Development). The success of Project SEED culminated in the formation of the Caltech Precollege Science Initiative (CAPSI), which has branched into other areas related to precollege science education. In recognition of its important and noteworthy work, CAPSI received a five-year grant of $6 million from the National Science Foundation in December 1994, which will enable the program to expand into selected school districts throughout California. The NSF grant to CAPSI—the largest ever given to support such outreach educational initiatives—reflects a new emphasis on encouraging professional scientists to become more involved in upgrading the quality of precollege science teaching in the United States.

The Institute also continues to promote the scientific education of America's richly diverse population with the Young Engineering and Science Scholars Program (YESS). Last year, in this summer program, 40 high school juniors entering their senior year attended special lectures and classes in math and science on the Caltech campus.

Since 1979, Caltech has offered its 10-week Summer Undergraduate Research Fellowships (SURF) program, which this past summer enabled more than 230 undergraduate students—some of whom came from other institutions—to work with world-renowned faculty and technical advisors on research proposals that the students had developed.

Patterned after the successful SURF effort, Caltech's Minority Undergraduate Research Fellowships

Robots Stop to Smell the Roses

Machines that can hear, touch, smell, and see may someday be happy partners with industry. At Caltech's just-created "NSF Engineering Research Center" (ERC), to be housed in the Moore Laboratory of Engineering (currently under construction), scientists and engineers hope to design machines with humanlike senses. Such machines could test audio equipment, "feel" fabrics, detect paint odors, and sort machine parts "by sight"–to name a few functions.

These machines would use "artificial neural networks," a design approach in which the system's operations would mimic–in the very broadest sense–the workings of an animal brain. In a computer, the hardware and software are distinct, but in a brain the two are inseparable. Recreating this effect in silicon will require close collaboration between the chip designers and the people who create the algorithms, or data-processing procedures. Such a collaboration will represent a multidisciplinary approach combining engineering rigor with lessons from neurophysiology and anatomy.

On the hardware side, the chips must have tremendous computational power. Typically, visual processing requires machines that are thousands of times more powerful than a top-of-the-line personal computer. Computational power requires electrical power, which causes design problems–the more juice a chip uses, the hotter it gets. ERC will explore fabrication techniques permitting vast computational power with low electrical consumption. For example, the silicon retina–pioneered at Caltech–runs on less than a milliwatt.

Another problem comes from trying to mimic a brain's zillions of three-dimensional connections on a two-dimensional circuit board. One promising solution is to connect the chips by laser beams reflecting off a hologram. A hologram also can store enormous numbers of connections in a tiny space.

On the software side, the traditional artificial intelligence that yields such things as chess-playing machines relies on decision-tree algorithms–answering a series of yes-or-no questions. But sensory processing is holistic–a "seeing" machine would have to recognize the "essence" of a part from any angle, for example. To develop such "gestalt systems," ERC scientists are collaborating with researchers from many fields. For instance, biologists and computer scientists are developing models of how an owl hearing a mouse decides where the mouse is located. In other experiments, neurobiologists are analyzing how a cricket's neural system responds to certain odors. A fluorescent dye injected into the cricket's brain lights up the active neurons, showing researchers how nature designs odor-recognition circuits.

Using these collaborative and novel approaches, Caltech hopes to provide the designs to turn this infant technology into commercial products.

At the rear of this Caltech researcher's brain is a vision-processing center—illustrated in a computer image that has been superimposed on his head. The glowing area at the back of his brain shows an increased blood flow to the region. The flow is activated by the researcher's focusing on a small object, like the model of a baboon's brain that he holds.

(MURF) program provided support for 16 talented undergraduates from schools across the nation to spend a summer working in research laboratories on the Caltech campus. MURF is aimed specifically at improving the representation of African Americans, Hispanics, Native Americans, Puerto Ricans, and Pacific Islanders in the biological and chemical sciences in the United States.

Caltech has attracted a growing number of women to its student body. As of January 1993, women composed 27 percent of the undergraduates and 22 percent of the graduate students. In the class of 1997 alone, more than 30 percent are women—an increase of 5 percent over last year. And in an effort to better meet the needs of campus women and to promote the scientific and technological education and careers of women at Caltech, the Institute last year established a Women's Center on campus.

Reaching Out to the Southern California Community

In various ways, the Institute attempts to form relationships with its neighbors in Pasadena and the larger Southern California community.

For example, last fall the Institute played host to noted playwright Tom Stoppard. As the third James Michelin Distinguished Lecturer at Caltech, Stoppard spent the day at Caltech, giving his evening lecture to a standing-room-only crowd in Beckman Auditorium. In the past two years, Caltech has also welcomed renowned artist David Hockney and architectural critic Vincent Scully as Michelin Distinguished Lecturers.

In an effort to spread knowledge about scientific concerns that affect people on a national and global as well as local level, Caltech biologists joined with biomedical researchers from the USC/Norris Comprehensive Cancer Center this past year in presenting a public symposium in Beckman Auditorium. "Conquering Cancer: From the Lab to the Clinic" offered a panel of six scientists from the Institute and USC/Norris, who discussed the interface between the basic research being done in Caltech's laboratories and the clinical applications of that research taking place at USC/Norris.

In a program that uses market-based incentives to reduce the level of smog in Southern California, Caltech economists have helped start a program called RECLAIM, the Regional Clean Air Market. This program, in which Caltech collaborated with the South Coast Air Quality Management District and the Pacific Stock Exchange, allots tradable credits to the area's largest polluters. The credits allotted allow them to emit at a set level. The system encourages a company that can cut emissions cheaply to do so, so that it can sell its unused credits.

In another effort to help enhance the quality of life in California, Caltech

A Most-Watched Celestial Drama

The collision of comet Shoemaker-Levy 9 with Jupiter this past July turned out to be a "box-office" bonanza for Caltech researchers from several disciplines. They took front-row seats with other scientists from around the world to observe this Jovian drama, and they reaped volumes of data. Although one of the greatest celestial shows in recorded history has ended, the data may yield greater insights into the composition and evolution of our solar system.

When first discovered at Palomar Observatory near San Diego in March 1993, the fragments of Shoemaker-Levy 9 were already spread across some 160,000 kilometers of space but caught in Jupiter's huge gravity field. The comet would crash into the giant planet July 16–22 the following year, according to researchers' calculations. The scientists also predicted that, unfortunately for Earth-based viewers, the comet would strike Jupiter's far side–just out of direct view. Luckily, the planet rotates fast enough that each impact point would come into view a little later.

Caltech geophysicists began to create detailed computer models of how the impacts would play out. They predicted correctly that comet fragments would create bright flashes as each one hit the planet's atmosphere, and that the fragments' kinetic energy would ultimately heat a Texas-sized region of Jupiter's hydrogen clouds to nearly the temperature of the sun's surface.

Caltech planetary scientists and geophysicists also became involved in the interpretation of Hubble images of the impact sites, especially the remarkable ring-like cloud created after the largest impacts. It is likely that this feature is due to an atmospheric wave travelling outward from the impact and may tell researchers more about Jupiter's atmospheric structure.

Meanwhile, scientists from Caltech's physics, mathematics and astronomy division worked with other researchers who were observing Jupiter in the near-to-mid-infrared wavelengths with the 200-inch Hale Telescope at Palomar Observatory. They looked for evidence of impact flashes reflected from the faint rings around Jupiter, or from the halos of gas and dust around the trailing comet fragments.

These four images of Jupiter and the impact of fragment W of Comet Shoemaker-Levy 9 were taken at intervals of $2^1/_3$ seconds, using visible light, by the Galileo spacecraft, on July 22, 1994. The first image shows no impact. In the next three images, a point of light appears, brightens so much as to saturate its picture element, and then fades again seven seconds after the first picture.

And astronomers at Caltech's Owens Valley Radio Observatory viewed Jupiter near the 3-mm wavelength, which allows scientists to see dozens of kilometers below the visible cloud tops to a level where disturbances caused by the comet are more likely to be noticeable.

From this and other related projects (see the JPL highlight), scientists are hoping for a windfall of information about what Jupiter is made of and, ultimately, how our solar system came into being.

has participated in Project California, a venture inaugurated in 1993 that is dedicated to securing and revitalizing the state's economic future through the creation of advanced technologies that will in turn create new industries and jobs. President Everhart is senior president of the California Council on Science and Technology, the group—made up of representatives from five universities—that oversees Project California.

Continuing its pioneering role in earthquake science, the Institute has played a major role in the development of CUBE, the Caltech-USGS Broadcast of Earthquakes, a network that rapidly evaluates data from hundreds of seismic stations, pinpoints the locations, magnitudes, and times of earthquakes, and spreads the information within minutes to CUBE participants through statewide and nationwide paging systems. This system proved itself on January 17, 1994, during the magnitude 6.7 earthquake in Northridge, California. In support of such technology, Pacific Bell and GTE have provided grants to Caltech's Seismological Laboratory to test a real-time digital earthquake monitoring network—a "communications superhighway"—to create an even faster method of monitoring earthquakes.

Caltech Rankings

Perhaps few things speak so well of the reputation and preeminence that the Institute maintains in the realm of engineering and science research and instruction than the following list:

Science Watch ranked Caltech second in neuroscience research, 1988–92;

Money Guide placed Caltech eighth in its 1994 College Value Rankings, and first in the West;

Of the highest-impact U.S. universities (1981–93)—ranked by frequency of "top 10 appearances in 21 fields"—*Science Watch* ranked Caltech fifth;

Among America's best graduate schools, Caltech ranked sixth, according to a 1994 *U.S. News & World Report* survey. This is how Caltech ranked in the following subjects:

Geology	#1
Physics	#1
Chemistry	#2
Biology	#5
Mathematics	#8
Computer Science	#10
Economics	#18

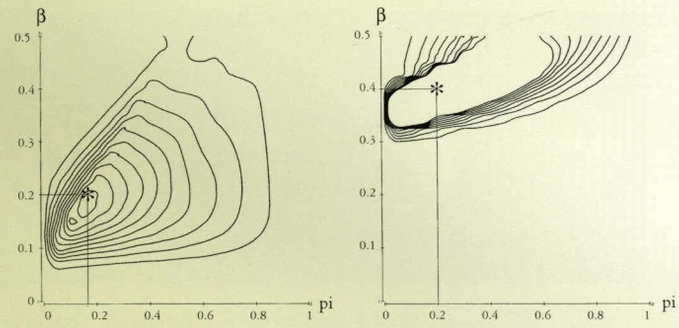
It's All in the Game

When experimental economists test the predictions of game theory, they turn to the laboratory. There, they use experimental games with monetary incentives to induce subjects to play seriously. For such experiments Caltech researchers are developing new statistical approaches to evaluate how well certain theories can account for laboratory data. Researchers worldwide are taking notice of this new approach and applying it to predict what happens in markets, elections, and other situations.

Game, **in game theory, is the term for a formal mathematical description of a decision-making situation. The situation could be an abstract game like chess, or it could be the U.S. economy modeled as a game. But attempts to apply the simplest game theoretic models, such as the ones pioneered by 1994 Nobel Prize winners Harsanyi, Nash, and Selten, to real-world settings have proved difficult. Until now, economists have lacked good methodologies for understanding why the models succeed or fail in real-world applications.**

The main reason, according to Caltech economists, is that in real-world events, there is too much background noise–too much going on–which makes it difficult to measure the variables. Caltech economists have developed two methodological innovations to understand the effects of such noise. The first innovation is to study simple games in controlled laboratory environments, where the noise level is quite low. The second is to use statistical models, which allow for errors by the players, thus making the models more realistic.

This has allowed Caltech economists to make several important findings based on the idea that subjects make two kinds of errors: choosing the wrong action or guessing incorrectly what their opponent will do. One finding is the extent to which subjects make one kind of error rather than the other. Another is that within the two main types of errors are a number of subtypes; thus, the nature of errors can be categorized into a small number of types specific to individual players. The third finding is a set of techniques for determining the optimal experimental design for identifying these errors.



*These contour graphs illustrate the two optimal design calculations for game-theory experiments conducted at Caltech. The optimal design involved choosing two game parameters. One parameter (beta) affects the players' payoffs and the other parameter (pi) affects the players' information. The optimal design for the initial experiments is marked with an * on the left graph. Data from the initial experiment led to the revised design, marked in the right graph.*

What researchers have also found is that people really do act rationally–their use of evidence and information follows closely (but not exactly) what the laws of probability predict–but that everyone makes a few mistakes. Statistically building this human factor into the rational model of traditional game theory improves economists' ability to predict behavior in games. The next step is to see if the improved predictability in the laboratory can be carried over to more complicated settings.

THE QUALITY OF CALTECH'S 275 PROFESSORIAL FACULTY REMAINS UNEQUALED. Many faculty and trustees are members of prestigious academies: 63 faculty and 4 trustees are members of the National Academy of Sciences, while members of the National Academy of Engineering include 26 faculty and 11 trustees. As of November 1994, Caltech had 69 faculty members who were fellows of the American Academy of Arts and Sciences.

National awards and honors

American Academy of Arts and Sciences, Fellow:
ROBERT H. GRUBBS, *Victor and Elizabeth Atkins Professor of Chemistry*
SHRINIVAS R. KULKARNI, *Professor of Astronomy*

Fulbright Grant, Recipient:
ROBERT A. ROSENSTONE, *Professor of History*

National Academy of Engineering, 1994 Founders Award:
RALPH LANDAU, *Caltech Senior Trustee*

National Academy of Sciences, Member:
EDWARD M. STOLPER, *William E. Leonhard Professor of Geology and Chair of the Division of Geological and Planetary Sciences*

National Endowment for the Humanities, Summer Stipend Recipient:
ROBERT A. ROSENSTONE, *Professor of History*

U. S. Navy, Robert Dexter Conrad Award:
CARVER A. MEAD, *Gordon and Betty Moore Professor of Engineering and Applied Science*

International awards and honors

Asahi Newspaper Company, 1993 Asahi Prize:
HIROO KANAMORI, *John E. and Hazel S. Smits Professor of Geophysics and Director of the Seismological Laboratory*

Austrian State of Steiermark, Grosses Ehrenzeichen des Landes Steiermark:
MANFRED MORARI, *Ross McCollum-William H. Corcoran Professor of Chemical Engineering and Executive Officer for Control and Dynamical Systems*

Chemical Institutes in Germany, Bonner Chemiepreis:
AHMED H. ZEWAIL, *Linus Pauling Professor of Chemical Physics*

Gairdner Foundation, 1994 Gairdner Foundation International Award (Canada), Corecipient:
PAMELA BJORKMAN, *Assistant Professor of Biology and Assistant Investigator, Howard Hughes Medical Institute*

Science and Technology Foundation of Japan, 1994 Japan Prize, Corecipient:
WILLIAM H. PICKERING, *Professor of Electrical Engineering, Emeritus*

Local awards

Pasadena Historical Museum, History Maker Award:
JOHN D. ROBERTS, *Institute Professor of Chemistry, Emeritus*

Awards and honors from professional societies

American Chemical Society, 1995 Award in Polymer Chemistry, Recipient:
ROBERT H. GRUBBS, *Victor and Elizabeth Atkins Professor of Chemistry*

American Chemical Society (Division of Analytical Chemistry), Award in Electrochemistry:
FRED C. ANSON, *Professor of Chemistry*

American Geophysical Union (Planetology Section), 1994 Fred Whipple Award:
DAVID J. STEVENSON, *Professor of Planetary Science*

American Institute of Chemists, Inc., 1994 Chemical Pioneer, Corecipient:
JOHN D. ROBERTS, *Institute Professor of Chemistry, Emeritus*

American Institute of Physics, 1994 Science Writing Award in Physics and Astronomy:
KIP S. THORNE, *Richard P. Feynman Professor of Theoretical Physics*

American Physical Society (Laser Topical Group), Distinguished Traveling Lecturer:
H. JEFF KIMBLE, *Professor of Physics*

American Physical Society, Fellow:
JOHN F. BRADY, *Professor of Chemical Engineering and Executive Officer for Chemical Engineering*

American Physical Society, 1994 Otto Laporte Award:
PHILIP G. SAFFMAN, *Professor of Applied Mathematics*

American Physical Society, James Clerk Maxwell Prize in Plasma Physics:
ROY W. GOULD, *Simon Ramo Professor of Engineering*

American Psychological Association, Outstanding Lifetime Contribution Award:
ROGER W. SPERRY, *Board of Trustees Professor of Psychobiology, Emeritus*

American Society of Civil Engineers, 1994 John G. Moffatt–Frank E. Nichol Harbor and Coastal Engineering Award:
FREDRIC RAICHLEN, *Professor of Civil Engineering*

Angeles Girl Scout Council, Grace Award:
KATE HUTTON, *Member of the Professional Staff in Geological and Planetary Sciences*

Doing More with Less

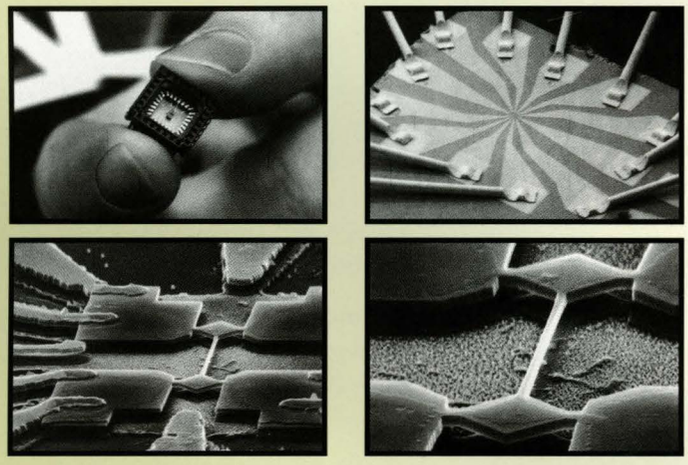
What do a television screen, a fiber-optic phone line, and a digital watch all have in common? Well, yes, they do all convey information, but more importantly, they all sprang from the field of condensed-matter physics. This branch of physics historically has had the greatest impact on our daily lives, spawning the above-mentioned inventions, and many others. Condensed-matter physicists at Caltech are exploring the behavior of matter in three and fewer dimensions, and at temperatures typically below −450 degrees Fahrenheit.

In one group, physicists are exploring the properties of nanodevices—structures so minute that their basic nature changes. The physicists have created devices smaller than the space an electron occupies in ordinary semiconductors. In these so-called "quantum dots" and "quantum wires," current flow can proceed one electron at a time, as if in a one- or zero-dimensional world. In other studies, these researchers are focusing upon mechanical properties in this domain of the ultrasmall. For example, at extremely low temperatures, the vibrations of miniature mechanical resonators—objects resembling guitar strings of nearly atomic dimensions—are governed by Heisenberg's uncertainty principle. The extraordinary properties of these devices may form the basis for new detectors to make force and position measurements limited solely by quantum fluctuations.

Another group is trying to find out what happens to atoms on the surface of a solid when they are restricted to moving in two-dimensional space. To do this, the physicists study films of atoms only a few layers thick on a graphite base. Most atoms in a solid object lie in its interior, completely surrounded by their fellows. But a two-dimensional object is all surface and no interior. The atoms can only interact with each other in two dimensions, and their behavior changes in fundamental ways—creating checkerboard-like crystal patterns, for example, where atom-containing squares alternate with empty ones.

Yet another Caltech research group is studying the behavior of high-temperature superconductors—substances that have zero electrical resistance at the relatively "warm" temperature of 77 Kelvin (−321 degrees Fahrenheit). The physicists are particularly interested in the effects of large, constant magnetic fields, which create roving tangles of magnetic flux lines. By creating "defects" in the superconductor with high-energy heavy-ion bombardment, the researchers are able to reduce the motion of magnetic flux lines and increase the superconductor's ability to endure larger magnetic fields and applied electric currents.

By exploring these strange and beautiful states of matter, physicists hope both to understand the fundamental laws that govern solids at tiny scales and to create useful devices that operate in the larger world.



Shown (with increasing magnification) is a unique microchip designed and built at Caltech for physics experiments involving ultraminiature mechanical resonators. When "plucked," this single-crystal, 400-atom-wide semiconductor "string" resonates at radio frequencies. Current research is focused both upon the fundamental mechanical properties of nanostructures and exploration of new electromechanical approaches to signal processing, among other applications.

Astronomical Society of the Pacific, 1994 Catherine Wolfe Bruce Gold Medal:
WALLACE L. W. SARGENT, *Ira S. Bowen Professor of Astronomy*

Intercollegiate Men's Choruses, Inc., President:
DONALD CALDWELL, *Director of Men's Glee Club*

Society for Experimental Mechanics, Murray Medal:
WOLFGANG G. KNAUSS, *Professor of Aeronautics and Applied Mechanics*

Society for Industrial and Applied Mathematics, Theodore von Kármán Prize:
HERBERT B. KELLER, *Professor of Applied Mathematics*

Foundation awards

California Earthquake Safety Foundation, Alfred E. Alquist Award:
CLARENCE R. ALLEN, *Professor of Geology and Geophysics, Emeritus*

Camille and Henry Dreyfus Foundation, Teacher-Scholar Award:
PAMELA BJORKMAN, *Assistant Professor of Biology and Assistant Investigator, Howard Hughes Medical Institute*

John Randolph Haynes and Dora Haynes Foundation, 1994 Faculty Fellowship:
R. MICHAEL ALVAREZ, *Assistant Professor of Political Science*

Howard Hughes Medical Institute, Investigator:
WILLIAM G. DUNPHY, *Assistant Professor of Biology*
STEPHEN L. MAYO, *Assistant Professor of Biology*

W. M. Keck Foundation, Award for Engineering Teaching Excellence:
YASER S. ABU-MOSTAFA, *Professor of Electrical Engineering and Computer Science*

McKnight Endowment Fund for Neuroscience, McKnight Senior Investigator Award:
SEYMOUR BENZER, *James G. Boswell Professor of Neuroscience, Emeritus*

McKnight Endowment Fund for Neuroscience, McKnight Neuroscience Investigator Award:
KAI ZINN, *Assistant Professor of Biology*

John Merck Fund, John Merck Scholarship in the Biology of Developmental Disabilities in Children:
ERIN M. SCHUMAN, *Assistant Professor of Biology*

Nevada Bell Company, 1995 Nevada Medal:
CHARLES ELACHI, *Lecturer in Electrical Engineering and Planetary Science*

John M. Olin Foundation, Inc., Faculty Fellow:
R. MICHAEL ALVAREZ, *Assistant Professor of Political Science*

David and Lucile Packard Foundation, Faculty Fellowship:
JOHN E. CARLSTROM, *Associate Professor of Astronomy*

Searle Scholars Program, 1994 Searle Scholar:
STEPHEN L. MAYO, *Assistant Professor of Biology and Assistant Investigator, Howard Hughes Medical Institute*

Alfred P. Sloan Foundation, Research Fellow:
ERIN M. SCHUMAN, *Assistant Professor of Biology*

From the Silk Road to Shoemaker Levy

The expertise of Caltech's Jet Propulsion Laboratory was trained on Earth in 1994, as missions to study the home planet came to the forefront.

In April and October, JPL's Spaceborne Imaging Radar-C/X-B and Synthetic Aperture Radar (SIR-C/X-SAR) instrument flew twice on NASA's Space Shuttle. A joint project with the German and Italian space agencies, SIR-C/X-SAR provides data to scientists in Earth disciplines as diverse as hydrology, geology, oceanography, and ecology. Its data have also been used by researchers in novel undertakings such as a study of the gorilla habitat of Central Africa, and an effort to pinpoint the location of China's fabled Silk Road.

Launched two years ago jointly with the French space agency, the TOPEX/Poseidon spacecraft provided new findings about the possible impact of global warming on the polar ice caps.

In other work sponsored by NASA, JPL's Atmospheric Trace Spectroscopy (ATMOS) experiment flew on the Space Shuttle in November, relaying information critical to understanding ozone depletion.

Planetary exploration, JPL's traditional core specialty, also offered a number of mission activities in 1994.

The Galileo spacecraft, due to arrive at Jupiter in December 1995, was the only direct observer of the impacts of fragments of comet Shoemaker-Levy 9 on the dark side of Jupiter in July 1994. Galileo transmitted images, revealing impacts that reached temperatures of more than 8,000 kelvins (14,000 degrees Fahrenheit)—hotter than the surface of the sun.

Galileo also provided a key discovery in early 1994 when it transmitted an image captured in August 1993 during its flyby of the asteroid Ida. The image provided the first-ever evidence of a moon orbiting an asteroid.

In October 1994, the Magellan spacecraft ended a highly successful orbital mission at Venus. During its more than 15,000 orbits of Venus, Magellan used imaging radar to map more than 98 percent of the planet's surface and made high-resolution gravity maps of 95 percent of the surface.

The astronomical community, meanwhile, was ecstatic with the performance of the Wide-Field and Planetary Camera 2, a replacement camera for the Hubble Space Telescope, installed by spacewalking astronauts in December 1993. In 1994, the camera, designed and built by JPL, was used to make major discoveries, such as finding the first direct evidence for the existence of a black hole, and making possible new measurements of the age and size of the universe, based on stars in a neighboring galaxy.

The Kliuchevskoi volcano, on Russia's Kamchatka Peninsula, began to erupt on September 30, 1994. In this image, Kliuchevskoi can be seen in the lower left corner as the bright white peak surrounded by slopes. The image was acquired by the Spaceborne Imaging Radar-C and X-band Synthetic Aperture Radar aboard the Space Shuttle ***Endeavour,*** *October 1, 1994. Shown is an area approximately 18.5 miles by 37 miles.*

University honors

Columbia University College of Physicians and Surgeons, W. Alden Spencer Award, Corecipient:
RICHARD A. ANDERSEN, *James G. Boswell Professor of Neuroscience*

New York University, Center for Japan–U. S. Business and Economic Studies, Sanwa Award, Corecipient:
LANCE E. DAVIS, *Mary Stillman Harkness Professor of Social Science*

Institute honors

Distinguished Alumni Awards:
HORACE W. BABCOCK, '34
RICHARD G. BREWER, '51
YUAN-CHENG FUNG, PHD '48
IRA HERSKOWITZ, '67
GLENN A. SCHURMAN, MS '47, PHD '50

Endowed Professorships:
THOMAS K. CAUGHEY, *Richard L. and Dorothy M. Hayman Professor of Mechanical Engineering*
EDWARD C. STONE, *David Morrisroe Professor of Physics; Vice President; Director of the Jet Propulsion Laboratory*

Associated Students of the California Institute of Technology (ASCIT), Award for Teaching Excellence:
CHERYL M. ANDERSON, *Teaching Assistant in Chemical Engineering*
ERICK M. CARREIRA, *Assistant Professor of Chemistry*
JOHN K. ELWOOD, *Teaching Assistant in Physics*
STEVEN C. FRAUTSCHI, *Professor of Theoretical Physics and Executive Officer for Physics*
MELANY L. HUNT, *Assistant Professor of Mechanical Engineering*
JULIA A. KORNFIELD, *Assistant Professor of Chemical Engineering*
TSUTOMU OHSHIMA, *Karate Instructor*
P. P. VAIDYANATHAN, *Professor of Electrical Engineering*

Lawrence and Audrey Ferguson, Prize for Graduate Teaching:
DAVID J. ANDERSON, *Associate Professor of Biology and Associate Investigator, Howard Hughes Medical Institute*

Teaching-Assistant Award for Undergraduate Instruction:
MICHELLE L. APPERSON, *Graduate Student in Biology*
CHRISTOPHER C. BYRD, *Graduate Student in Biology*

Faculty Award:
CHARLES J. BROKAW, *Professor of Biology*

Richard P. Feynman Prize for Excellence in Teaching, Recipient:
THOMAS A. TOMBRELLO, JR., *Professor of Physics*

Graduate Student Council, 1994
GSC Teaching Awards:
NORMAN H. BROOKS, *James Irvine Professor of Environmental and Civil Engineering*
BARBARA IMPERIALI, *Assistant Professor of Chemistry*
GARY A. LORDEN, *Professor of Mathematics and Vice President for Student Affairs*
SCOTT E. PAGE, *Assistant Professor of Economics*
PAUL W. STERNBERG, *Associate Professor of Biology and Associate Investigator, Howard Hughes Medical Institute*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This financial report of the California Institute of Technology has been prepared from the Institute's accounting records. It reflects the Institute's financial position as of September 30, 1994, and results of its operations for the year then ended. These statements have been reviewed by the Audit Committee of the Board of Trustees, whose members are designated by an asterisk in the list of board members on the inside back cover of this report. 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.

The Institute maintained its strong financial position during fiscal year 1994 despite the current national economic environment. Caltech owes this strength to a substantial endowment fund and sound investment policies. The exceptional quality of its teaching and research programs continue to generate strong support from private donors and government funding agencies. The following highlights fiscal year 1994:

- Individuals, foundations, and corporations have continued to generously support the Institute. Contributions received totaled $54.6 million.

- United States government contracts and grants at the Campus totaled $119.5 million, as compared with $111.2 million in fiscal year 1993. Of that amount, $87.7 million was for costs that directly relate to specific research projects. The balance of $31.8 million was recovery of indirect costs, such as facilities operation and maintenance, utilities, libraries, and support staff that cannot be directly attributed to specific research projects. Caltech continued to experience moderate growth in this area despite significant reductions in the overall growth rate of federal research budgets and increasing competition for these limited funds.

- The market value of Caltech's endowment was $591.9 million at September 30, 1994, compared to $605.8 million at September 30, 1993. The fund is sizable for a small institution like Caltech with a current undergraduate and graduate student body of just under 2,000. Income from endowment totaled $21.7 million, of which $15.1 million was derived from restricted and $6.6 million from unrestricted funds.

Decade in Review

in millions

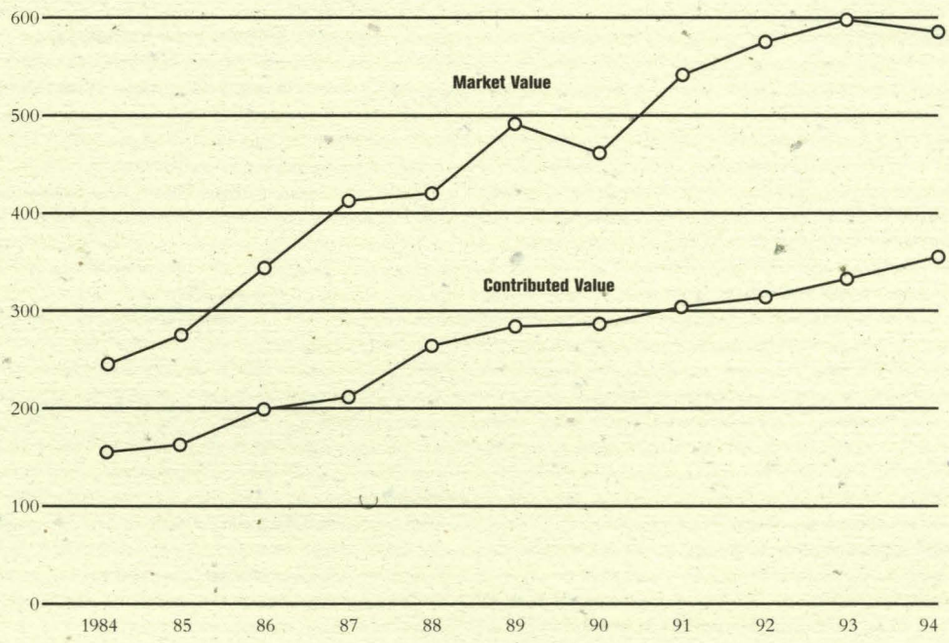
	1984	*1989*	*1994*
Operating expenditures			
Instruction and departmental research	$ 41.3	$ 62.3	$ 88.7
Organized research	39.2	70.5	87.0
Scholarships and fellowships	6.2	9.8	15.0
Institutional and student support	15.7	25.8	39.0
Plant operation, maintenance, and utilities	10.0	12.4	17.1
Total educational and general	$ 112.4	$ 180.8	$ 246.8
Auxiliary enterprises	4.8	7.7	9.9
Cumulative effect of change in accounting principle for postretirement benefits			17.0
Total campus	$ 117.2	$ 188.5	$ 273.7
Inflation adjusted (1984 dollars)	$ 117.2	$ 157.0	$ 189.6
Jet Propulsion Laboratory direct expenditures	$ 505.2	$1,057.1	$1,022.5
Endowment and Similar Funds			
Market value	$ 247.0	$ 499.8	$ 591.9
Total return (5-year average)	11.6%	16.2%	5.8%
Campus Properties			
New construction	$ 1.2	$ 32.2	$ 27.7
Renovations and alterations	13.0	15.4	11.5
Maintenance and repairs	.4	3.8	7.1
Gifts, Grants, and Bequests			
For current operations	$ 25.5	$ 21.0	$ 28.4
For endowment	10.0	5.2	17.7
For facilities	11.6	2.5	9.3
For life income and annuity	2.8	.8	5.2
Student Information			
Tuition rate (in thousands)	$ 8.7	$ 11.6	$ 15.9
Enrollment (first term)			
Undergraduate	829	854	911
Graduate	936	987	1,049
Total	1,765	1,841	1,960
Grant aid as a percentage of total costs for undergraduate students	41.0%	47.2%	51.4%
Student loans granted	$ .8	$ 1.2	$ 2.2
Student loans outstanding	5.0	7.2	12.2
Degrees granted			
B.S.	213	233	197
M.S.	147	151	116
Eng.	2	2	2
Ph. D.	123	134	151
Total	485	520	466

The endowment investment policy of the Institute is to: 1) provide income to support Institute operations, 2) achieve long-term appreciation of assets, and 3) preserve endowment principal. With this policy, 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 following graph shows the growth trend in endowment over the last ten years:

■ The market value of the life income and annuity funds was $92.9 million compared with $104.8 million at September 30, 1993. Life income and annuity agreements are a source of meaningful additions to the Institute's endowment and other funds. This form of deferred giving has proved attractive to many donors who wish to support the activities of the Institute. Donors receive income on their gifts during their lifetime, while also obtaining a charitable tax deduction for their gifts.

ENDOWMENT
millions of dollars



Fiscal year end

Summary of Changes in Fund Balances

Year ended September 30, 1994
(in thousands)

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

United States Government Grants and Contracts	$ 87,722
Reimbursement from various government agencies for direct costs of research, instruction, and student support.	
Gifts and Nongovernment Grants	60,727
Includes gifts and grants from private sources for education and research, and physical facilities.	
Indirect Costs and Management Allowance	58,685
Recovery of indirect costs and management allowance under federally sponsored programs at the campus and the Jet Propulsion Laboratory.	
Plant Acquisitions	56,685
Additions to campus plant for land, buildings, and equipment, and retirement of indebtedness.	
Realized Gains	51,289
Net realized gains on investments sold.	
Tuition and Fees	30,895
Tuition and fees assessed students.	
Investment Income	30,670
Endowment income and investment income of other funds, including earnings from short-term investments.	
Auxiliary Enterprises	11,620
Revenues from sales by food services, student housing, and bookstore.	
Other	12,363
Income from sales and services, and other miscellaneous revenue.	
Total Additions	$ 400,656

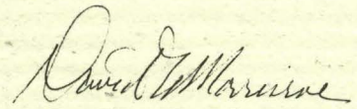
Deductions
(Excluding Direct Costs at the Jet Propulsion Laboratory)

Instruction	$ 88,700
Expenditures for activities that are part of the instructional program, including departmental research.	
Research	86,995
Expenditures for activities specifically organized to produce research outcomes supported by federal and private sponsors.	
Plant Fund	
Expenditures for buildings, equipment, and renewals, plus retirement of plant assets.	57,818
Depreciation of campus properties.	18,534
Payments on revenue bonds and advances for plant purposes, including interest.	6,532
Institutional and Student Support	39,023
Expenditures for business and financial affairs, student services, Institute relations, and general administration.	
Plant Operations	17,065
Expenditures, including utilities, for the operation and maintenance of the campus grounds and facilities.	
Scholarships and Fellowships	15,038
Awards made to students enrolled in formal course work with no requirement that they perform services or repay the awards.	
Auxiliary Enterprises	9,942
Expenditures, including maintenance, of auxiliary enterprises.	
Other	
Includes payments to life beneficiaries with life income and annuity agreements, and miscellaneous other charges.	7,918
Cumulative effect of change in accounting principle for postretirement benefits.	16,977
Total Deductions	$ 364,542
Increase in Fund Balances	36,114
Total	$ 400,656

■ Total net assets increased from $1,038.8 million to $1,075.0 million. The increase is due primarily to increases in campus properties and endowment principal. Major plant additions include substantial completion of Phase I and the beginning of Phase II of the W. M. Keck Observatory in Hawaii.

■ Caltech provided $15.0 million in scholarships and fellowships. The cost of a Caltech education would be beyond the means of many qualified students without grant and loan assistance. Of the total spent for student aid at Caltech, 32% came from government sources and 68% from Institute funds. Caltech's contribution permits the Institute to continue its policy of admitting students based on their merit and promise rather than on their ability to pay. Increasing endowment for student aid and fellowships continues to be a major objective for Caltech..

The following pages present a Balance Sheet, Statement of Changes in Fund Balance, and Statement of Operating Expenditures, along with Notes to Financial Statements which comprise the Institute's formal financial statements. They provide more detail about the status at fiscal year-end and transactions during the fiscal year. Also included is Price Waterhouse LLP's Report of Independent Accountants.



David W. Morrisroe
Vice President for Business and Finance and Treasurer

BALANCE SHEET

Exhibit 1

September 30, 1993

(in thousands)

		Total All Funds
ASSETS		
Cash	$	550
Accounts receivable:		
United States government (notes B and I)		194,631
Pledges (note G)		24,975
Other		1,220
Student accounts and notes receivable		14,701
Investments (note C)		630,186
Interfund advances		
Prepaid expenses and other assets		13,912
Campus properties net of depreciation (note D)		435,672
Total Assets	**$**	**1,315,847**
LIABILITIES AND FUND BALANCES		
Accounts payable and accrued expenses (notes B and I)	$	192,545
Deferred student revenue		12,218
Revocable trust funds and agency funds (note E)		18,627
Annuities payable		4,521
Revenue bonds payable (note H)		49,100
Total Liabilities	**$**	**277,011**
Fund balances (Exhibit 2)		1,038,836
Total Liabilities and Fund Balances	**$**	**1,315,847**
Fund balances detail:		
United States government refundable	$	5,798
Institute funds:		
Unrestricted		18,666
Discretionary endowment:		
Unrestricted		64,448
Restricted		67,210
Endowment principal		344,063
Other restricted		172,918
Invested in plant		365,733
Total Fund Balances	**$**	**1,038,836**

See accompanying notes to financial statements

September 30, 1994

	Total All Funds	*— Current Funds — Unrestricted*	*Restricted*	*Loan Funds*	*Endowment and Similar Funds*	*Life Income and Annuity Funds*	*Plant Funds*	*Agency Funds*
	$ 1,250	$ 394	$ 340	$ 236		$ 106		$ 174
	231,677	3,929	227,748					
	20,975						$ 20,975	
	2,152	1,288	565			82		217
	15,755	3,749	3	12,003				
	649,243	6,906	4,246	1,963	$ 516,722	81,476	35,475	2,455
			21,591		4,333		(25,924)	
	15,862	9,265	3,556			1	3,023	17
	460,689						460,689	
	$ 1,397,603	**$ 25,531**	**$ 258,049**	**$ 14,202**	**$ 521,055**	**$ 81,665**	**$ 494,238**	**$ 2,863**
	$ 240,269	$ 8,394	$ 229,538		$ 410	$ 398	$ 1,456	$ 73
	12,336	12,224	112					
	17,094					14,304		2,790
	4,854					4,854		
	48,100						48,100	
	$ 322,653	**$ 20,618**	**$ 229,650**		**$ 410**	**$ 19,556**	**$ 49,556**	**$ 2,863**
	1,074,950	4,913	28,399	$ 14,202	520,645	62,109	444,682	
	$ 1,397,603	**$ 25,531**	**$ 258,049**	**$ 14,202**	**$ 521,055**	**$ 81,665**	**$ 494,238**	**$ 2,863**
	$ 6,131			$ 6,131				
	18,543	$ 4,913					$ 13,630	
	64,623				$ 64,623			
	68,111				68,111			
	387,911				387,911			
	140,037		$ 28,399	8,071		$ 62,109	41,458	
	389,594						389,594	
	$ 1,074,950	**$ 4,913**	**$ 28,399**	**$ 14,202**	**$ 520,645**	**$ 62,109**	**$ 444,682**	

STATEMENT OF CHANGES IN FUND BALANCES

Exhibit 2

(in thousands)

	Year Ended September 30, 1993 *Total All Funds*
Fund Balances at Beginning of Year	**$ 988,440**
REVENUES AND OTHER ADDITIONS	
Student tuition and fees	$ 29,539
Investment income	32,522
Net gain on disposal of investments	38,627
Gifts	55,935
United States government grants and contracts:	
Reimbursement of direct costs	81,676
Recovery of indirect costs and management allowance	53,484
Other grants and contracts	5,513
Auxiliary enterprises revenues	11,350
United States government advances	447
Campus property acquisitions (including $20,361 in campus operating expenditures)	73,402
Retirement of indebtedness and internal advances	1,383
Other	10,192
Total Revenues and Other Additions	**$ 394,070**
EXPENDITURES AND OTHER DEDUCTIONS	
Campus operating expenditures (Exhibit 3)	$ (248,949)
Campus property acquisitions and renewals	(54,713)
Retirement of indebtedness and internal advances	(1,383)
Retirement and disposal of campus properties	(5,231)
Interest on advances for plant purposes	(1,919)
Interest on revenue bonds payable	(2,972)
Payment to life beneficiaries	(3,420)
Depreciation of campus properties	(22,618)
Other	(2,469)
Total Expenditures and Other Deductions	**$ (343,674)**
TRANSFERS AMONG FUNDS	
Gifts allocated	
Investment gains and discretionary endowment allocated	
Investment income allocated	
Allocations for plant purposes	
Terminated trust and annuity agreements	
Other	
Total Transfers Among Funds	
Increase for the Year	**$ 50,396**
Fund Balances at End of Year (Exhibit 1)	**$ 1,038,836**

See accompanying notes to financial statements

Year Ended
September 30, 1994

Total All Funds	*— Current Funds — Unrestricted*	*Restricted*	*Loan Funds*	*Endowment and Similar Funds*	*Life Income and Annuity Funds*	*Plant Funds*
$ 1,038,836	**$ 4,867**	**$ 42,651**	**$ 13,076**	**$ 475,721**	**$ 63,993**	**$ 438,528**
$ 30,895	$ 30,878					$ 17
30,670	10,953	$ 13,296	$ 569		$ 3,082	2,770
51,289				$ 46,292	4,927	70
54,559	7,925	14,335	111	17,683	5,225	9,280
87,722		86,097				1,625
58,685	58,685					
6,168	1,500	4,668				
11,620	11,620					
448			448			
55,178						55,178
1,507						1,507
11,915	3,722	7,712	186			295
$ 400,656	**$ 125,283**	**$ 126,108**	**$ 1,314**	**$ 63,975**	**$ 13,234**	**$ 70,742**
$ (273,740)	$ (123,612)	$ (150,128)				
(46,191)						$ (46,191)
(1,507)						(1,507)
(11,627)						(11,627)
(2,102)						(2,102)
(2,923)						(2,923)
(3,082)					$ (3,082)	
(18,534)						(18,534)
(4,836)			$ (258)		(4,578)	
$ (364,542)	**$(123,612)**	**$ (150,128)**	**$ (258)**		**$ (7,660)**	**$ (82,884)**
	$ (3,304)	$ (255)		$ 3,559		
	16,250	7,530		(23,780)		
	488	(488)				
	(11,898)	(49)		(6,349)		$ 18,296
				7,458	$ (7,458)	
	(3,161)	3,030	$ 70	61		
	$ (1,625)	**$ 9,768**	**$ 70**	**$ (19,051)**	**$ (7,458)**	**$ 18,296**
$ 36,114	**$ 46**	**$ (14,252)**	**$ 1,126**	**$ 44,924**	**$ (1,884)**	**$ 6,154**
$ 1,074,950	**$ 4,913**	**$ 28,399**	**$ 14,202**	**$ 520,645**	**$ 62,109**	**$ 444,682**

STATEMENT OF OPERATING EXPENDITURES

Exhibit 3

(in thousands)	*Year Ended September 30, 1993*	*Year Ended — September 30, 1994 —*		
	Total	*Total*	*Unrestricted*	*Restricted*
Educational and general:				
Instruction and departmental research	$ 85,589	$ 88,700	$ 53,755	$ 34,945
Organized research	82,481	86,995		86,995
Scholarships and fellowships	15,303	15,038	4,162	10,876
Institutional and student support	39,912	39,023	38,688	335
Plant operation, maintenance, and utilities	15,992	17,065	17,065	
Total Educational and General	**$ 239,277**	**$ 246,821**	**$ 113,670**	**$ 133,151**
Auxiliary enterprises	9,672	9,942	9,942	
Cumulative effect of change in accounting principle for postretirement benefits (note I)		16,977		16,977
Total Campus Operating Expenditures (Exhibit 2)	**$ 248,949**	**$ 273,740**	**$ 123,612**	**$ 150,128**
Direct Costs of Sponsored Research at Jet Propulsion Laboratory (fully reimbursed by the United States government)	**$ 1,086,082**	**$ 1,022,522**		**$ 1,022,522**

See accompanying notes to financial statements

September 30, 1994

NOTE A - SUMMARY of SIGNIFICANT ACCOUNTING POLICIES

Basis of Accounting and Reporting – The financial statements of the California Institute of Technology (the "Institute"), 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 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 distinguished from unrestricted funds available for use in achieving any Institute objective.

Investments – Institute investments (note C) 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 they be held separately. Pool share values are computed periodically based upon the total market value of the investment pool and 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 formulating investment strategies.

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 (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 unrestricted 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 and management allowance with the National Aeronautics and Space Administration. JPL land, buildings and equipment are owned by the United States government and excluded from the Institute's financial statements. However, liabilities arising from JPL operating activities are those of the Institute and 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 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, 1994 and 1993, and in turn to accounts receivable from the United States government. Accounts payable and accrued expenses (and related receivables) for JPL amounted to approximately $197 million and $181 million at September 30, 1994 and 1993, respectively.

NOTE C - INVESTMENTS

Institute investments, at carrying (note A) and market (note J) values, comprise the following (in thousands):

	— September 30,—			
	— Carrying Values —		— Market Values —	
	1993	1994	1993	1994
Marketable securities:				
Debt securities	$ 248,130	$ 222,708	$ 269,495	$ 218,673
Equity securities	282,889	339,457	415,458	428,162
Total Marketable Securities	**$ 531,019**	**$ 562,165**	**$ 684,953**	**$ 646,835**
Short-term commercial obligations	38,722	32,467	38,767	32,994
Real estate, mortgages, notes, and other	60,445	54,611	102,340	94,949
Total Investments	**$ 630,186**	**$ 649,243**	**$ 826,060**	**$ 774,778**

Investments shown above include the consolidated investment pool assets as follows (in thousands, except per share values):

	— September 30,—	
	1993	1994
Carrying value	$ 423,818	$ 463,995
Market value	$ 546,567	$ 526,792
Pool share value at market	$ 23.63	$ 21.77
Annualized income earned per pool share	$ 0.84	$ 0.81

The Institute also manages a major foundation's investment portfolio with an approximate market value of $247 million at September 30, 1994. These investments are not included in the amounts shown above.

NOTE D - CAMPUS PROPERTIES AND PLANT FUNDS

Campus properties consist of the following (in thousands):

	— September 30,—	
	1993	1994
Land and land improvements	$ 20,899	$ 21,180
Buildings	279,277	306,627
Equipment	362,639	378,559
Campus Properties – cost	**$ 662,815**	**$ 706,366**
Less accumulated depreciation	(227,143)	(245,677)
Campus Properties – net	**$ 435,672**	**$ 460,689**

Depreciation has been calculated, using the straight line method, with life years of 20, 40, and 10 for land improvements, buildings and equipment, respectively. Depreciation, including retirement and disposal of campus properties, of $30.2 million and $27.8 million was recorded for fiscal 1994 and 1993, respectively.

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 had current market values, estimated by the Institute, of approximately $17.8 million and $18.6 million at September 30, 1994 and 1993, respectively. The income derived from these funds amounted to approximately $858 thousand and $893 thousand for the years ended September 30, 1994 and 1993, 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, valued at trustor's basis at date of establishment, or at cost, if purchased by the Institute, totaling $14.3 million and $16.0 million at September 30, 1994 and 1993, respectively, in which it has a remainder interest and makes income payments for life to the grantors of the trusts.

NOTE F – RETIREMENT PLANS

The Institute has 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. Non-academic staff were covered by a defined benefit pension plan terminated effective December 31, 1993. The Institute provided two plans, effective January 1, 1994, for employees who were participants in the terminated defined benefit pension plan: (1) the defined contribution pension plan and (2) a successor defined benefit pension plan for participants who attained age 55 and had 10 or more years of service. Approximately 97% of the participants in the terminated defined benefit pension plan irrevocably elected to participate in the defined contribution pension plan.

Retirement benefits under the terminated defined benefit pension plan and the successor defined benefit plan are based on years of service and career average compensation and accrued 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, 1994, and funded status at September 30, 1994, for the terminated defined benefit plan and successor defined benefit plan are as follows (in thousands):

	Campus	*JPL*
NET PENSION COST		
Service cost – benefits earned during the year	$ 446	$ 1,575
Interest cost on projected benefit obligation	3,785	18,179
Actual return on plan assets	(4,043)	(18,862)
Net effect of curtailment/settlement of plans	26	(1,065)
Net pension cost	$ 214	$ (173)
FUNDED STATUS		
Actuarial present value of accumulated benefit obligations, including vested benefits of $5.3 million and $17.9 million, respectively	$ 5,288	$ 17,871
Projected benefit obligation	$ 5,326	$ 18,234
Plan assets at fair value	(5,175)	(12,861)
Projected benefit obligation in excess of plan assets	$ 151	$ 5,373
Unrecognized net gains/(losses)	(40)	(105)
Accrued pension cost	$ 111	$ 5,268

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 8.25% (6.5% in 1993) and 5% (5% in 1993), respectively. The expected long-term rate of return on assets is 8%.

Pension costs for the defined contribution plan for the year ended September 30, 1994, were $7.3 million ($5.3 million in 1993) for the Campus, and $26.7 million ($19.8 million in 1993) for JPL.

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

Deferred Compensation Plan – The Institute has an inactive deferred compensation plan whereunder eligible employees elected to defer a portion of their normal salary, generally until retirement. The Institute's liability for future benefits payable to employees under this plan, which approximated $32.0 million and $31.8 million at September 30, 1994 and 1993, 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 G – PLEDGES

The Institute records as a receivable and as gift 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. The Institute had $21.0 million in recorded pledges remaining to be collected as of September 30, 1994.

At September 30, 1994, the Institute had additional pledges on hand (principally for restricted purposes), but not recorded, totaling approximately $88 million, of which $28 million is expected to be collected in fiscal year 1995. It is not practicable to estimate the net realizable value of these pledges.

NOTE H – REVENUE BONDS PAYABLE

On May 29, 1991, the Institute issued $50 million 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 principal amount of the Institute's Series 1985 bonds. The Series 1991 bonds are repayable with interest, from the general revenues of the Institute over a 30-year period. Interest rates vary from 4.8% to 6.4%. Required principal and interest payments are approximately $4 million a year for the fiscal years 1992 through 2005, approximately $3 million a year for fiscal years 2006 through 2016, and approximately $2 million a year thereafter until 2021, when the bonds will be fully redeemed.

On October 27, 1994, the Institute issued $30 million in California Educational Facilities Authority Revenue Bonds for the purpose of financing and refinancing the acquisition, construction, and completion of certain educational facilities.

NOTE I – POSTRETIREMENT AND POSTEMPLOYMENT BENEFITS OTHER THAN PENSIONS

The Institute provides certain health and life insurance benefits to retirees. Effective for fiscal 1994, the Institute adopted Financial Accounting Standard No. 106, "Employers' Accounting for Postretirement Benefits Other Than Pensions," which requires accrual of actuarially calculated postretirement benefit costs to the years during which employees render qualifying service. The Institute has elected to fully recognize the Campus transition obligation which is reflected in the financial statements, effective October 1, 1993. Previously, such costs were expensed only as actual claims were paid, which approximated $1.4 million for Campus in fiscal year 1993.

The following sets forth the postretirement benefit plans' financial status (in thousands):

	Campus	*JPL*
Accumulated postretirement benefit obligation as of October 1, 1993	$ 33,664	$ 110,451
Net periodic postretirement benefit cost included the following components:		
Service cost – benefits attributed to service during the year	$ 948	$ 2,603
Interest cost on accumulated benefit obligation	2,699	8,929
Total	$ 3,647	$ 11,532
Claims Paid	$ (1,943)	$ (4,540)
Accumulated postretirement benefit obligation as of September 30, 1994	$ 35,368	$ 117,443
Retirees	$ 18,618	$ 53,056
Fully Eligible Employees	8,152	36,666
Other Active Employees	8,598	27,721
Total	$ 35,368	$ 117,443

The Institute expects to recover approximately 52% for the Campus and will recover 100% for JPL of this postretirement obligation through future charges to United States government grants and contracts. The amount of campus recovery will be adjusted annually to reflect actual federal recovery rates. The Campus transition obligation of $35.4 million and the related recoverable amount of $18.4 million are included in Exhibit 1 as accounts payable and accrued expenses and United States government accounts receivable, respectively. The JPL postretirement obligation is excluded from the financial statements as only liabilities (and related assets) arising from current JPL operating activities are recorded.

An 8.25% discount rate and a 12% annual rate of increase in the per capita cost of covered health care benefits for retirees were assumed for 1994. This cost trend rate is assumed to decrease at a rate of 1% per year leveling off at a rate of 5% in 2001 and thereafter. The health care cost trend rate has a significant effect on the amounts reported. As of September 30, 1994, a 1% increase in the assumed cost trend rates in each year would increase the accumulated post retirement benefit obligation by $5.1 million and $18.0 million, and the net periodic postretirement benefit cost for the year by $0.6 million and $2.1 million for the Campus and JPL, respectively.

The Institute also provides certain benefits to former or inactive employees after employment. In November 1992, the Financial Accounting Standards Board issued Standard No. 112, "Employers' Accounting for Postemployment Benefits." The standard is effective for the Institute's fiscal year 1995 and requires the accrual basis of accounting for recognizing the cost of postemployment benefits. The Institute does not believe that implementation of this standard will have a material effect on its financial condition.

NOTE J - DISCLOSURES ABOUT FAIR VALUE OF FINANCIAL INSTRUMENTS

For those financial instruments for which it is practical, the following methods and assumptions were used to estimate the fair value:

Cash - The carrying value is the fair value.

Student Accounts and Notes Receivable – Due to the nature and terms of these financial instruments, which can be subject to significant restrictions, it is not practical to estimate their fair value.

Investments – The fair value of marketable securities and short-term commercial obligations is estimated based on quoted market prices for those or similar financial instruments. The fair value of real estate, mortgages, notes, and other investments is estimated by professional appraisers or Institute management.

Revenue Bonds Payable – The fair value of revenue bonds payable is estimated based on the quoted market prices for the bonds or similar financial instruments, and approximates the carrying value.

NOTE K - 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 LLP

To the Board of Trustees of the
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 the California Institute of Technology (the "Institute") at September 30, 1994, 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 I to the financial statements, the Institute changed its method of accounting for postretirement benefits other than pensions, effective October 1, 1993.

Price Waterhouse LLP

Los Angeles, California
December 30, 1994

Design: Denton Design Associates Photography: cover, 1, 4, 8, 10, 18, 24, Robert Paz

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