California Institute *of* Technology

Annual Report 1999–2000

OUR FOUNDERS' VISION, OUR STUDENTS AND ALUMNI, OUR FACULTY, FACILITIES, AND INNOVATIONS—ALL THESE ELEMENTS COMBINE TO MAKE CALTECH

a national **treasure.**

— David Baltimore

January 2001 marked the end of my term as chair of Caltech's Board of Trustees. I had served in that capacity for seven years—and an eventful seven years they were! I had the privilege of presiding over several significant changes in the Institute's physical plant, its off-campus scientific presence, and its administrative practices and personnel. Thanks to the support of Caltech's many generous friends (several of whom are my fellow trustees) and the vision of its top administrators, the campus was able to add new library, research, and residence facilities. Thanks to the success of the Institute's most recent capital campaign, the Biological Sciences Initiative, the new Broad Center for the Biological Sciences will allow us to assemble an interdisciplinary team of researchers that will keep Caltech at the forefront of this exciting field. And thanks to the stellar work and dedication of its faculty and research staff, Caltech's high-profile ventures, like the W. M. Keck Telescopes and the Laser Interferometer Gravitational-Wave Observatory project, continue to assert the Institute's preeminence in the world of science and engineering.

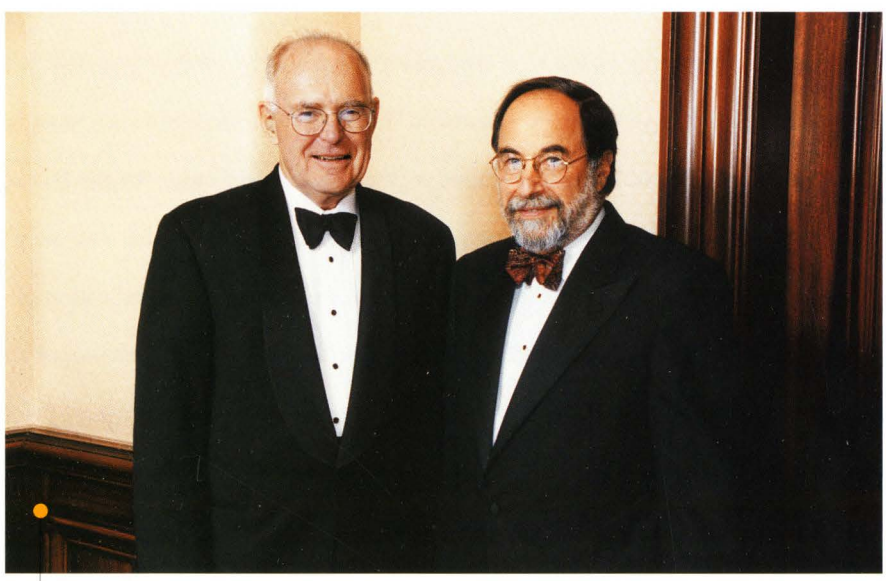
Of course, board chairmen do not operate in a vacuum. My tenure would not have been nearly so rewarding had I not been able to work with such extraordinary colleagues. From my fellow trustees—as dynamic a group of individuals as was ever assembled—to the two Caltech presidents, Tom Everhart and David Baltimore, who held office on my watch, to the faculty who served with me on the presidential search committee, I have had the great good fortune to collaborate with some of the brightest, most creative people alive today. One of those people,

Ben Rosen, has succeeded me as chair, and I have no doubt that the Board, and indeed the Institute, will grow even stronger under his guidance.

Although I will no longer be chairing board meetings, my close relationship to my graduate alma mater will certainly continue undiminished (as Caltech students like to put it, "Once a Techer, always a Techer"). I will always feel fortunate to have had the chance to give something back to a place that has given me so much over the past 50 years. It is a rare pleasure to have been able to help make a positive difference in an institution that makes such a difference in the world.

Gordon E. Moore

Chair, Caltech Board of Trustees, 1994–2000



Chairman Emeritus Moore (left) and Caltech President David Baltimore at Dr. Moore's retirement dinner, January 8, 2001.

Letter *from the* President

Someone recently asked me a thought-provoking question: "Why doesn't Caltech position itself more obviously as the great national university it is?" My first reaction was to point out that we did indeed have high national visibility: hadn't we just spent a year in the spotlight as America's premier university for undergraduate education? Didn't President Clinton choose in January 2000 to announce his proposed research and development budget from the stage of Beckman Auditorium? Hadn't Caltech chemist Ahmed Zewail made headlines as the Institute's 27th Nobel laureate?

On reflection, however, I realized that my questioner had a point. Caltech *has* been nationally and internationally renowned for decades—in the science and engineering community, that is. Too often, however, we have trusted serendipity to make us known to the rest of the world. As a result, as far as the nonscientific public is concerned, we are still one of the nation's best kept secrets. A case in point is a conversation some of my administrative colleagues have reported having with new business contacts. The exchange goes something like this:

New Acquaintance: "Where do you work?"

Caltech Administrator: "Caltech."

New Acquaintance: "Pomona or San Luis Obispo campus?"

With all due respect to the excellent California state polytechnic universities, we should not be mistaken for them in the public's mind. We need to do more to educate the nation about how and why Caltech has come to occupy its unique place among America's educational and research institutions.

The national media do periodically have some success at capturing and reporting Caltech's essence. One of the better attempts appeared in 1986, when *Time* magazine named us,

along with the National Institutes of Health and MIT, one of three "national treasures" among American scientific institutions. Although this assessment was probably news to most of *Time*'s readership, I doubt that it would have surprised anyone familiar with our history. One of the founders of the modern Caltech, the renowned astronomer George Ellery Hale, consciously set out to establish a first-class institution, one that would not merely compete with the best Eastern universities, but would actually improve on their educational and research methods.

His strategy was straightforward: he would put the Institute on the map by populating it with nationally prominent scientists, beginning with MIT chemist Alfred Amos Noyes and University of Chicago physicist Robert Andrews Millikan. With men of this stature on board, it was inevitable that the Institute would not remain a provincial technical school.

In naming Caltech a national treasure, the 1986 *Time* article cited as evidence a variety of attributes that are even more pronounced today. Our undergraduates still personify the term *overachiever*: 64 percent of the 2000 freshman class were valedictorians of their high-school class (up from one-third in 1986). Nor do Caltech students stop achieving once they leave campus. Our alumni can be found at the forefront of every imaginable field, from academia and industry to the arts and diplomacy. We still have an absolutely first-rate cohort of investigators working at the frontiers of knowledge. In fact, two of them—physicist Hideo Mabuchi and computer scientist Erik Winfree—were recognized with MacArthur Foundation "genius" grants last year. And the research projects under way at Caltech are as impressive as ever. In this past academic year alone, for instance, computer scientist Peter Schröder and his collaborators at Bell Labs developed a technique that makes it practical for the first time to transmit detailed three-dimensional data over the Internet and to work with this kind of data on personal computers. The Einstein Papers project, headquartered at Boston University from 1986 to 2000, relocated to Caltech under the direction of historian of science Diana Barkan. Barkan and her colleagues aim to publish the eighth and ninth of a planned 25 volumes of Einstein's writings over the next three years. And astrophysicist Andrew Lange and his international team of investigators released the first

No great creative work, whether in engineering or in art, in literature, or in science, has ever been the work of a man devoid of the imaginative faculty."

— George Ellery Hale

detailed images of the universe in its infancy, when it was 50,000 times younger and 1,000 times smaller and hotter than it is today. The images were obtained by the BOOMERANG balloon-borne observatory, whose first successful flight was reported in these pages two years ago. (For more on the exciting work of Caltech investigators, see the research highlights that follow this letter.)

The descriptions in the *Time* article of the Institute's then-current research also reminded me how far we have come in the past 15 years. In 1986, Caltech biologists were just about to announce the completion of a new invention, the DNA sequenator. Last summer, the International Genome Sequencing Consortium and Celera Genomics jointly announced that a "rough draft" sequencing of the human genome had been completed. Had the sequenator not been available when it was, this monumental task might not have been attempted, and certainly would not have been completed, as soon as it was. That Caltech played an important role in the Human Genome Project is not surprising, given that our focus on biology dates back to 1928, when Thomas Hunt Morgan brought the study of genetics to campus. With the success over the past three years of the Biological Sciences Initiative, that focus is becoming even more intense. Ground was broken in September 2000 for the new Eli and Edythe Broad Center for the Biological Sciences, which on its completion will allow for a substantial expansion of our biological sciences faculty and research facilities.

In 1986, the Institute had just entered into an agreement with the University of California to build the W. M. Keck Observatory on Mauna Kea. Today, the twin Kecks—still the world's largest optical and infrared telescopes—are revolutionizing our understanding of the universe. They are allowing astronomers to map clusters of very distant galaxies, to determine the expansion rate of the universe at varying redshifts, to help solve the riddle of gamma-ray bursters, and to undertake detailed analyses of stars—like brown dwarfs—that were previously beyond observation. Also notable in 1986 was the Voyager spacecraft's flyby of Uranus. The Jet Propulsion Laboratory, Voyager's builder and an operating division of Caltech, has since launched successful missions to Jupiter (Galileo), Saturn (Cassini), Mars (Pathfinder, Global Surveyor), and the sun (Ulysses), to name just a few.

Caltech inventions and discoveries have always had an impact on society; but these days we are increasingly focused on finding ways to move those discoveries from the lab to the

marketplace in less time. Instrumental in this effort is our Office of Technology Transfer (OTT), founded in 1995. Although the Institute has been patenting inventions for some time, our licensing efforts have increased dramatically in the past few years. Currently, more than 30 patent licenses and options are executed each year. Not only does OTT provide a service to Caltech and JPL researchers by protecting the intellectual property developed in their labs, it also benefits the Institute by bringing in an increasingly substantial amount of licensing revenue.

Our founders' vision, our students and alumni, our faculty, facilities, and innovations—all these elements combine to make Caltech a national treasure. But it is another characteristic that truly sets us apart from our peers: **our size.** Among the nation's top-10 universities (as ranked by *U.S. News & World Report*), we are by far the smallest in terms of faculty and student populations. Our full-time professorial faculty number about 290; our undergraduates about 900; and our graduate students about 1,000. By contrast, MIT (to whom we are often compared as the only other primarily science-and-engineering institution consistently in the top 10) has more than 900 professorial faculty, 4,300 undergraduates, and almost 5,700 grad students. MIT and the other top-10 institutions—Princeton, Harvard, Yale, Stanford, Penn, Duke, Dartmouth, and Columbia—also dwarf us in terms of alumni and endowment. Yet, regardless of variations in ranking methodology, Caltech, alone among universities of its size, is included year after year in this elite group. To outsiders, this might seem an amazing feat for such a small school; but I think it is our very smallness that makes such prominence possible.

It would be far better to do some one thing extremely well than to teach such a variety of courses in a mediocre way.

— George Ellery Hale

Unlike larger, more formally structured institutions, Caltech is able to cultivate a **flexible, responsive research style.** Our eclectically organized academic divisions promote communication between investigators in different fields, as well as between faculty and students, and our relative lack of bureaucracy allows new ideas to be acted upon quickly. Combining this sort of environment with some of the nation's best minds has created an institution that is intellectually productive far out of proportion to its size.

No analysis of Caltech's status as a national scientific treasure can ignore a fundamental fact: doing cutting-edge science is not inexpensive. Although the majority of our research is now funded by the federal government, this was not always the case. Prior to the 1940s, Caltech

depended primarily on private dollars to build campus facilities, attract the best faculty and students, and launch and administer research programs. Even today, it is nongovernment funding that allows us to pursue some of our most innovative projects and to meet the expenses federal funding does not cover. Caltech could not have become the first-class institution it is without the continuing generosity of our private donors and friends.

There is one last ingredient that has been essential to Caltech's success throughout the years: the leadership of our Board of Trustees. I was especially reminded of this in January, when Board Chair Gordon Moore stepped down after seven years of service. Always enthusiastic, always intent on promoting his alma mater in ways at once highly idealistic and eminently practical, Gordon epitomized enlightened chairmanship. On his watch, the campus added three new buildings (one of which, the Moore Laboratory of Engineering, was his gift to Caltech) and broke ground for a fourth; the market value of our endowment increased from just under $600 million to more than $1.5 billion; and the campus community made a seamless transition from one presidential administration to another. The entire Caltech community owes Gordon Moore a huge debt of gratitude for guiding us so capably through these eventful times. Although we will miss him at the Board's helm, we have every confidence that his successor, former vice chair (and alumnus) Ben Rosen, will carry on his tradition of leadership.

Finally, it's worth remembering that as great national universities go, Caltech is still young: we have only existed in our present form since 1920. (All of our top-10 peers are older, by anywhere from 35 to 284 years.) Even though Caltech research has already expanded humankind's store of learning far beyond what even Hale, Noyes, and Millikan could have predicted, I believe that we are just hitting our stride. If the accomplishments of our first 80 years are any indication, there is virtually no limit to our future of exploration, discovery, and invention.

David Baltimore

President

BIOLOGY

Riding the Crest

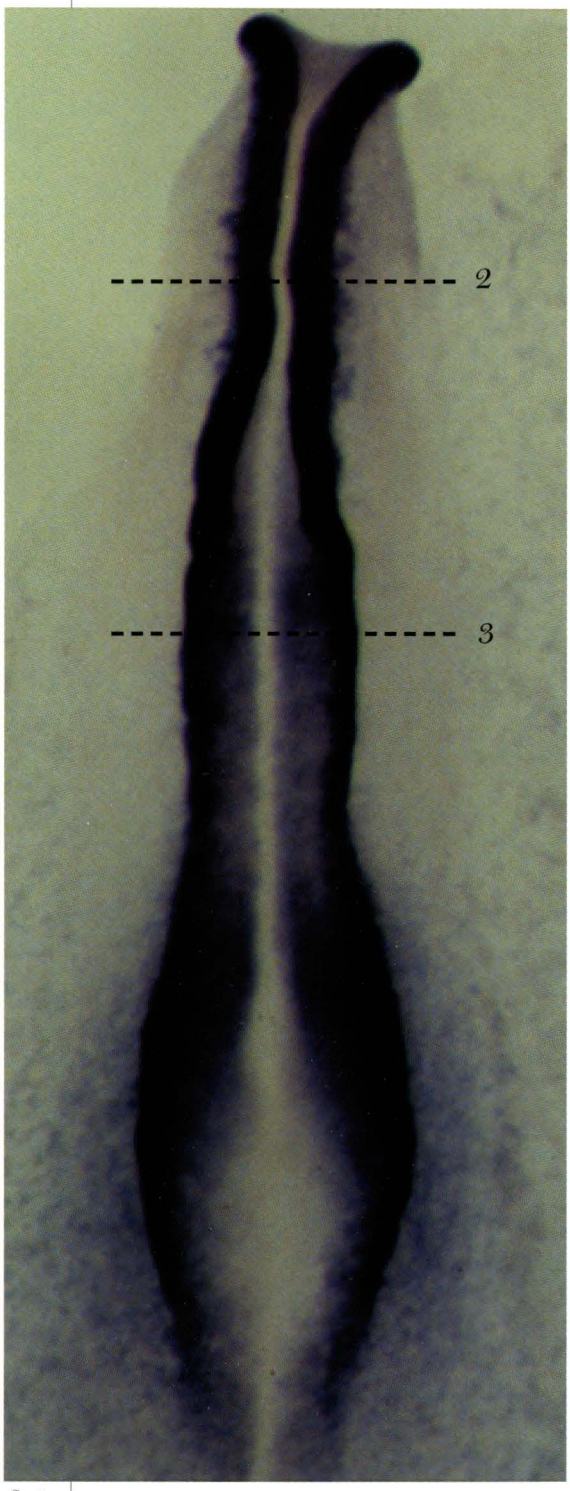


fig. 1

How does a single fertilized egg turn into a complex organism? It's one of the most fundamental, and most challenging, of scientific questions. Professor of Biology Marianne Bronner-Fraser and her colleagues are finding part of the answer by studying neural crest cell production in chicken embryos. These cells, found only in vertebrates, first appear in the organism's developing neural tube, the part of the embryo that will become the brain and spinal cord. Some neural crest cells migrate through other parts of the embryo to form parts of the peripheral nervous system—ganglia, sensory neurons, and the like. Others, however, become quite distinct from the nervous system, forming facial bones and skin pigment. How do these cells, all of which are initially identical, turn into such a variety of tissues? How do they migrate so extensively throughout the embryo? And why do they form in the first place?

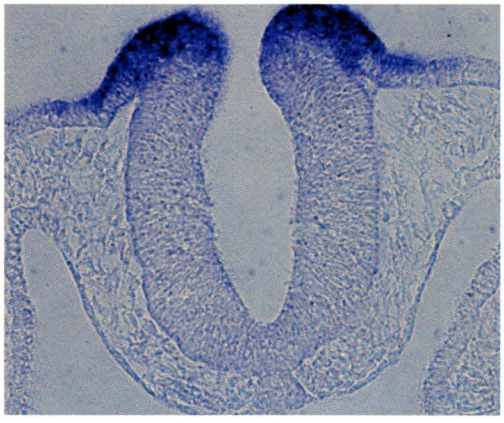
Bronner-Fraser's quest to answer these kinds of questions has led her to investigate neural crest cell production on the molecular level. Neural crest cells form at the border between the developing neural tube and the surrounding skin, and she and her colleagues learned a few years back that such formation depends on a chemical interaction between these two types of tissue. They've now found evidence that at least two different molecules are involved in this chemical signaling process, and that

Marianne Bronner-Fraser
Professor of Biology

the timing of the signaling is critical. Most recently, they identified a protein, Noelin-1, which is secreted in chick embryos during neural crest production. By increasing the amount of Noelin-1 present during neural crest formation, these investigators were able to lengthen the time period during which neural crest cells were produced, evidence that Noelin-1 plays an important role in regulating how the neural tube makes neural crest cells.

Their findings supply another piece of the puzzle of how neural crest cells normally form, which in turn could help scientists better understand what happens when the process goes awry. It is information that could one day help relieve human suffering: abnormal neural crest cells are implicated in such serious birth defects and cancers as neurofibromatosis, neuroblastoma, and melanoma.

fig. 2



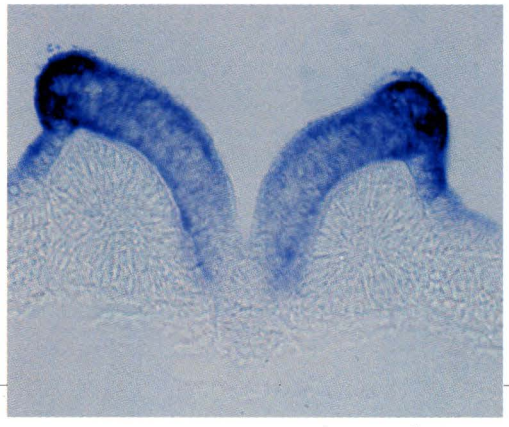


fig. 3

Cross sections from the developing neural tube of an early chick embryo (fig. 1) reveal how Noelin-1 (stained purple) concentrations vary, depending on the stage of development of the tube. (Dotted lines on fig. 1 show where the cross sections pictured in figures 2 and 3 were removed.) Tube closure begins in the head area and proceeds downward toward the tail. As each part of the tube closes, Noelin-1 concentrates at the neural crest–forming region (the border between the neural tube and the surrounding tissue), suggesting its key role in neural crest cell production.

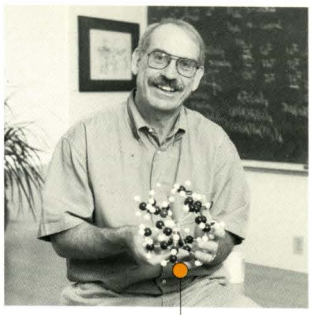
Hunting the Elusive Catalyst

The importance of John Bercaw's research isn't hard to grasp—just think about what it's cost you lately to fill your car with gasoline. Caltech's Centennial Professor of Chemistry has a long-standing interest in developing catalysts that will selectively change natural gases—which are probably as abundant on Earth as petroleum—into the chemicals needed to make plastics, solvents, and especially the alternative fuel methanol. The key word is *selectively*: Bercaw is looking for a catalyst that will let him precisely control the timing of methane-to-methanol conversion.

The giant petrochemical corporation BP thinks Bercaw's work is important, too—so much so that it recently awarded him, his colleague Jay Labinger, and their research team a 10-year, $10 million grant to figure out how to turn methane gas into more user-friendly chemicals. Ideally, the investigators would like to find a catalyst that would let them combine oxygen with methane to produce methanol, or (even better) ethylene or propylene, chemicals that are used to make a host of everyday products.

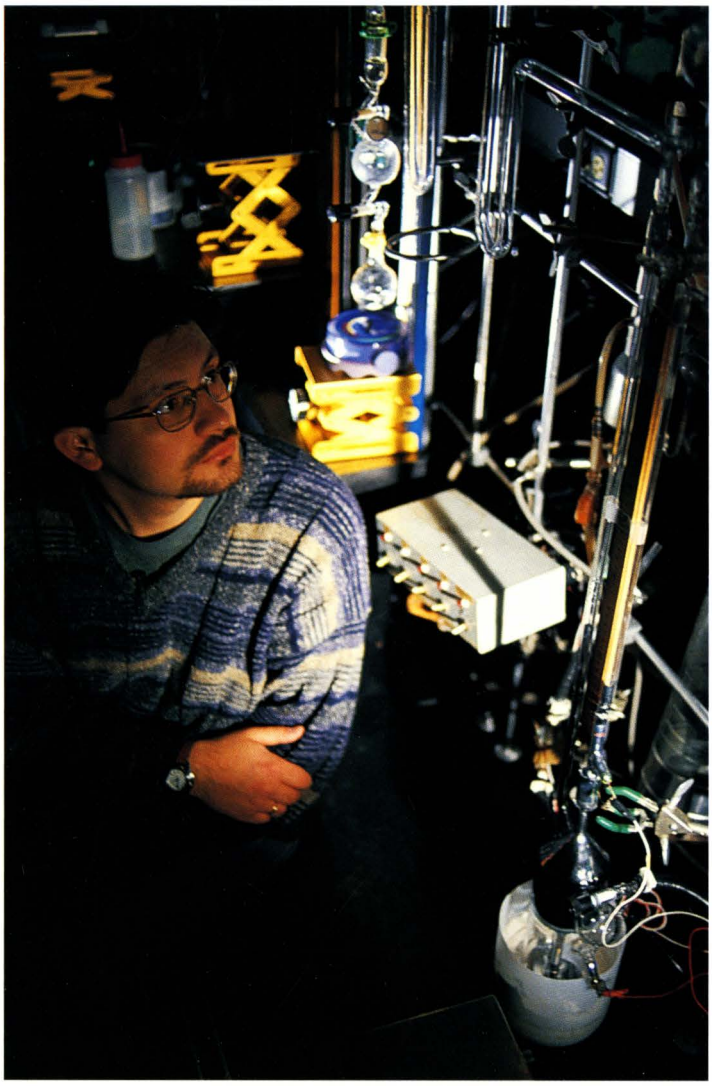
Bercaw and his collaborators have their work cut out for them. It's not difficult to make methane react with oxygen; what's tricky is stopping the reaction part way, before it ends up as carbon dioxide and water. Unfortunately, the usual way of controlling this reaction—by a two-step process that uses steam to turn methane into carbon monoxide and hydrogen, then makes methanol from those two gases—requires considerable energy, and is thus expensive. It leaves the chemists once again hunting for the elusive catalyst that can do the job in one energy-efficient step.

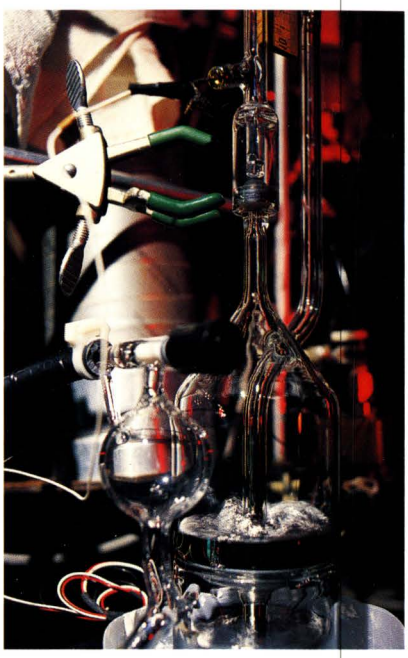
A compound containing a reactive platinum center may turn out to be that catalyst. Russian researchers have reported using that metal to produce methanol from methane with a high degree of selectivity, and the Bercaw lab has been testing their findings for several years. But difficulties persist: the platinum compound quits working after one reaction cycle, and it's not easily recycled using oxygen. Bercaw has continued to experiment with the platinum–methane reaction, however, and he now believes he understands the molecular basis for its selectivity. Although there are no guarantees, he thinks there's a reasonable chance that this work will lead to a more efficient way of making methanol. But a big practical payoff isn't Bercaw's primary goal. "My interest in this problem is really in the fundamental chemistry that underlies everything," he says. "I really enjoy understanding how things work."



John Bercaw
Centennial Professor of Chemistry

In Bercaw's Caltech lab, graduate student Seva Rostovtsev conducts a reaction with oxygen and one of the platinum complexes under investigation.





A rapid throughput energy containment reactor at Los Alamos National Laboratory, where collaborative experiments will be conducted with the Caltech–BP team. This reactor allows safe and rapid screening of potential platinum catalysts for forming methanol from (potentially explosive) mixtures of methane and oxygen.

RAINing All Over the World

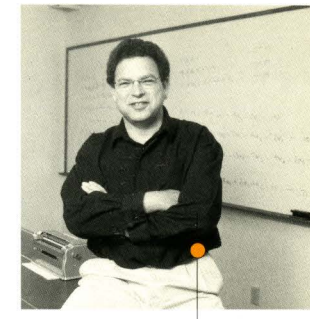
What do JPL space missions and the Chicago Stock Exchange have in common (other than a certain element of risk)? Well, for one thing, both have benefited from research done by Professor of Computation and Neural Systems and Electrical Engineering Jehoshua (Shuki) Bruck and his colleagues. Back in 1995, Bruck realized that the computer systems that ran spaceborne science missions were expensive because they had to be designed and built from scratch for each new mission. He began thinking about how to construct less-expensive systems using readily available, off-the-shelf components—PCs with commercial operating systems, for instance—that would be at least as reliable as the custom-designed variety.

The result was server-clustering software called RAIN—Reliable Array of Independent Nodes—whose prototype use on networked video servers in Bruck's lab (fig. 1) proved it to be remarkably resilient to abuse. Individual computers could be unplugged and otherwise interfered with, yet the system would continue to operate. The secret was innovative algorithms developed by Bruck and his graduate students that allowed connections between servers to reroute, instantaneously and undetectably, whenever a machine went down.

As the Internet grew and developed, and personal computers became tools for communication as well as for computation and data storage, Bruck saw that his server-clustering software had commercial applications. In 1998, he patented and licensed RAIN. Then, with three of his grad students, he launched a new company, Rainfinity (in which Caltech is an equity holder) to develop Rainwall, software that lets gateway servers—computers at the interface between an organization's internal network and the Internet—work cooperatively. Rainwall distributes network traffic evenly among firewall servers (one type of

fig. 1

RAIN was initially tested and demonstrated on a group of networked servers in Bruck's lab.



Jehoshua (Shuki) Bruck
Professor of Computation and Neural Systems and Electrical Engineering

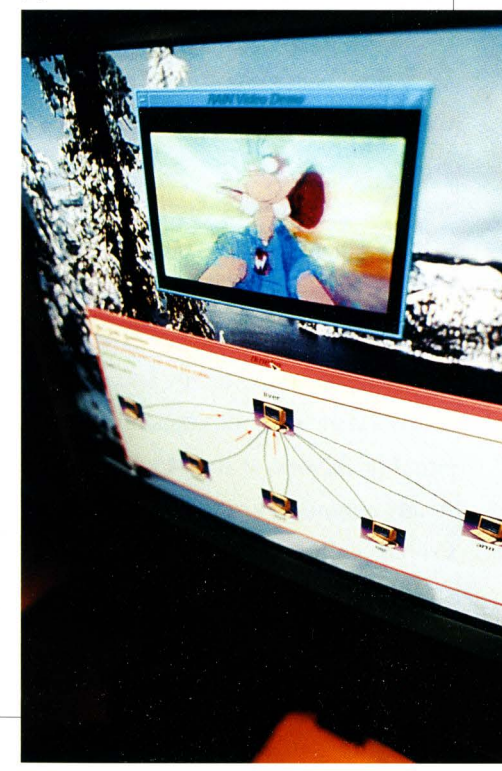
gateway server), thus reducing traffic bottlenecks and increasing the reliability of connections. A second product, Rainfront, also increases firewall availability, but adds Web server load balancing. Rainfinity's first customer, the Chicago Stock Exchange, has since been joined by many other clients—among them Andersen Consulting (now Accenture), Advanced Micro Devices, Home Shopping Network, and Dresdner Bank Group. The company now has more than 90 employees, and offices in San Jose, London, Munich, and Pasadena.

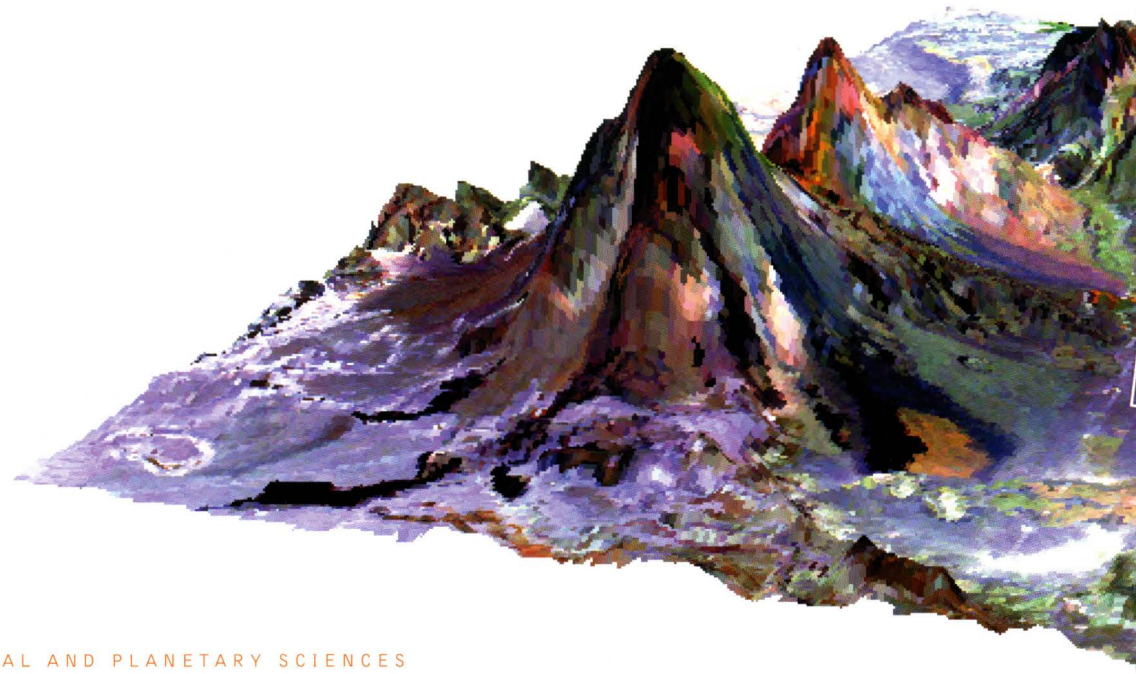
Double lines between the server icons (bottom screen) indicate that all network connections are intact.

fig. 2

Even after one server is unplugged (indicated by a missing line to the second icon from the left), the movie on the top screen plays uninterrupted, thanks to RAIN's seamless rerouting of the connection.

fig. 3





GEOLOGICAL AND PLANETARY SCIENCES

Joann *Versus* the Volcanoes

Imagine that a major north–south highway—Interstate 5, for instance—is the only ground route for transporting essential goods and services up and down a state. Now imagine that the highway runs through a valley of active volcanoes, the eruption of which could bury the highway, severing the state's lifeline.

Such a situation actually exists on the Baja California peninsula. About 400 miles south of the U.S.–Mexico border, near Santa Rosalia, lies a volcanic region that has become a lab-away-from-home for Professor of Geology and Geophysics Joann Stock and her colleagues. Their recent studies of these volcanoes are doubly noteworthy because they were the occasion of the first scientific mission of the MASTER (Modis-Aster) remote sensor developed at the Jet Propulsion Laboratory.

Part of what intrigued Stock about this part of Baja California was that it hadn't been studied much, even though historical documents—like missionary priests' accounts of "mountains on fire"—indicated that the volcanoes had erupted within the last 500 years and thus were probably still active. In the past, she would have begun her investigations in the traditional, time-consuming way, by collecting and analyzing hundreds of rock samples from around the volcanoes. Being able to first send the new sensor over the region in a plane, however, let her see the big picture much more quickly than would have been possible in the past.

MASTER takes photos at much higher resolution than earlier imagers. It is also sensitive to infrared as well as visible light, allowing it to distinguish between different features of the terrain according to the wavelength of light each radiates. This information helps investigators identify the various minerals present, giving them a fairly detailed picture of the geology of an area before their field work even begins. So

Joann Stock
Professor of Geology and Geophysics

fig. 1

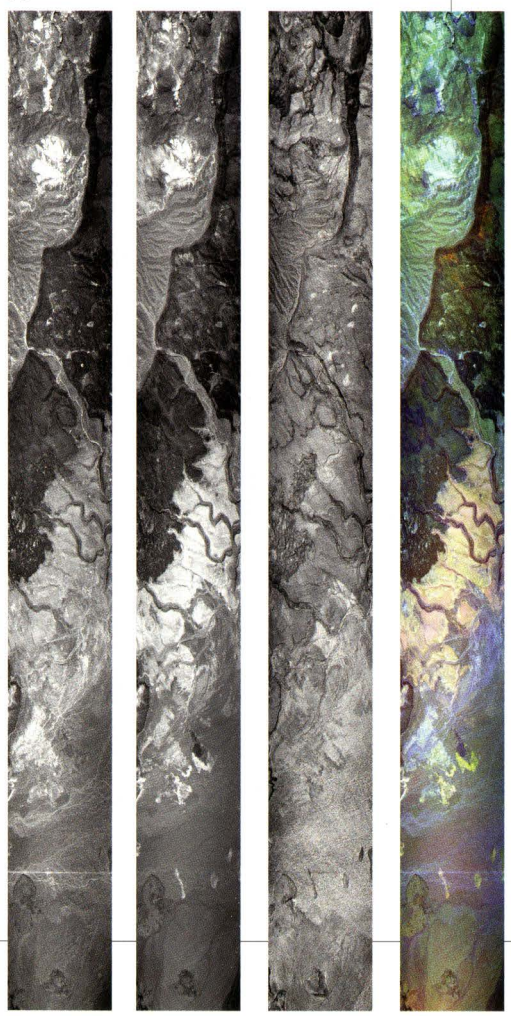


fig. 2

far, the data gleaned by the sensor have revealed what kind of material came out of the volcano, how far it flew through the air, and where it ended up; precise dating of the eruptions may follow.

fig 1. Data collected by the MASTER sensor affords a high-resolution (1 pixel = 5 meters) view of Baja's La Reforma caldera and surrounding structures. Each gray-scale image shows the intensity of electromagnetic light recorded within a different band of visible or infrared light radiated and reflected by the surface geology. Three of the wavelength bands are combined to form a composite image (far right), in which the highest intensity within each individual band is assigned to be either red, green, or blue.

fig 2. A "big picture" view (one pixel = 30 meters) of the region is produced by draping data from the Landsat Thematic Mapper satellite over a digital elevation model. (Outlined area corresponds to MASTER composite image.)

To Find the Mind's *Construction*

What happens in the brain when we have an aesthetic experience? Philosopher Steven Quartz aims to find out.

Steven Quartz
Assistant Professor of Philosophy

What is the nature of the mind? Of the self? How do these things develop? To what extent do our interactions with the world determine who we are? Philosophers began speculating about matters like these long before the methods existed to test their speculations. In the 20th century, developmental psychologists and neuroscientists recast the questions to apply to the brain, and started using new technologies to attack them experimentally. Rarely, however, did the three disciplines exchange ideas. The philosophers' theories of mind, the neuroscientists' discoveries about the brain, and the psychologists' observations about learning and cognition seemed doomed never to intersect.

All that changed about 15 years ago, observes Steven Quartz, an assistant professor of philosophy who also belongs to the Computation and Neural Systems Program and was trained as a cognitive scientist. He entered cognitive science in its early days, attracted by its aim of incorporating various perspectives on the mind into one unified picture. At about the same time, computing was emerging as a ubiquitous scientific tool, providing both the metaphor and the means for this pursuit. If the brain could be likened to a group of massively parallel computers, cognitive scientists reasoned, perhaps its functioning could also be modeled using computers. Quartz's work with these so-called neural network models convinced him that development consists of a very complex interplay between the environment and the brain. "The old 'nature versus nurture' debate now looks like not even the right question to ask," he says. "It's more about the nature of the interaction between the two."

Quartz has just published *Who We Are*, a book about the current state and future implications of cognitive science. He is also thinking about other ways of using technology to stretch the boundaries of philosophy. For one such project, he proposes using MRI machines (to be housed in the Broad Center for the Biological Sciences, now under construction) to observe how our brains change as we gaze at paintings, listen to music, or read poetry. "I think that aesthetic experience has an important role to play in motivating us to engage and explore our environment," he says. "It might turn out that things like early arts education have a profound effect on how our brains get structured, and thus on how we perceive the world."

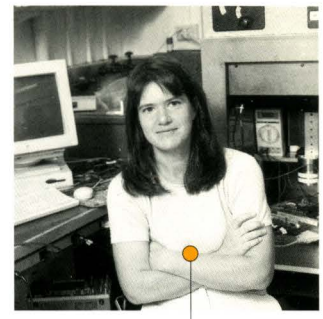
X-ray Vision

It's astronomy's version of the chicken-or-egg riddle: which came first, galaxies or black holes? Until we learn more about the universe in its earliest stages, says Assistant Professor of Physics and Astronomy Fiona Harrison, that riddle will remain unsolved. Harrison hopes to move closer to a solution by studying X-ray emissions in space, because it is thought that most X rays emanate from extremely massive black holes. If black holes are as ubiquitous as some evidence suggests, they are probably related in some fundamental way to the formation of galaxies.

Fortunately, there is a powerful new tool available to aid her investigations: NASA's Chandra X-ray Observatory (named for the Nobel Prize–winning astrophysicist Subrahmanyan Chandrasekhar). Launched and deployed by the space shuttle *Columbia* in July 1999, Chandra flies in an elliptical high Earth orbit, which keeps the satellite above Earth's belt of charged particles 85 percent of the time. As a result, it has clear observing conditions for up to 55 hours at a stretch, much longer than most other satellites, which orbit closer to Earth. Chandra's telescope also "sees" about 4,000 times more sharply than instruments on earlier X-ray satellites.

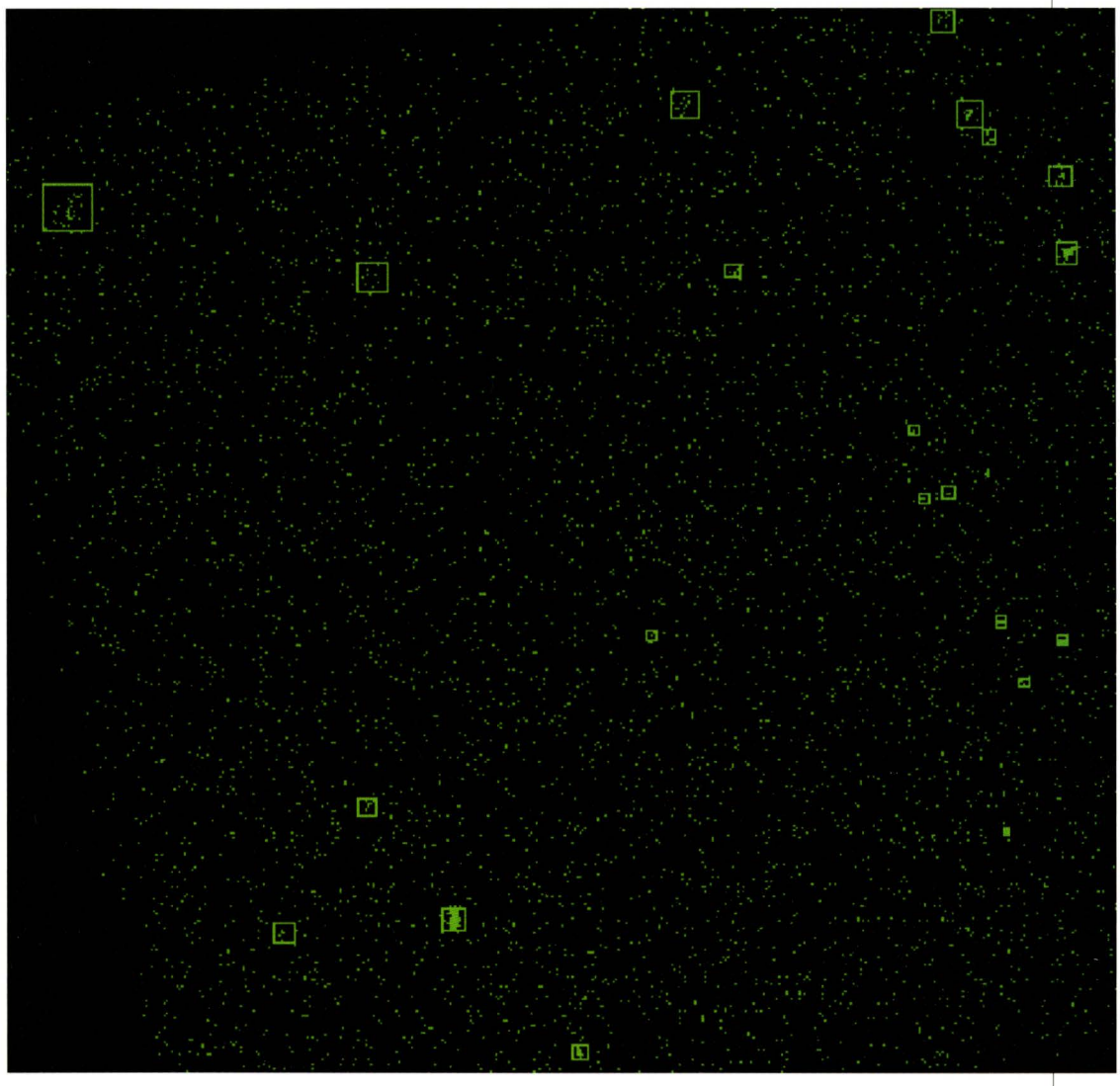
While recently analyzing serendipitous Chandra data—so called because it is acquired incidentally by other researchers who are observing a specific object—Harrison found many previously unknown X-ray sources. She and her colleagues are now using ground-based optical telescopes, like those at the Palomar and W. M. Keck Observatories, to study the new sources in greater detail.

Her studies are revealing the nature of the sources that make up the background of X-ray emission in the sky, previously seen as a blurry mass by less-sensitive instruments. The visible light from many of these X-ray sources is very faint, suggesting that they are either extremely far away or enshrouded in extremely dense material that hides the visible light but allows X rays to shine through—or both. Their true identity, as well as what they might reveal about the history or the destiny of the universe, is still a mystery.



Fiona Harrison
Assistant Professor of Physics and Astronomy

fig. 1



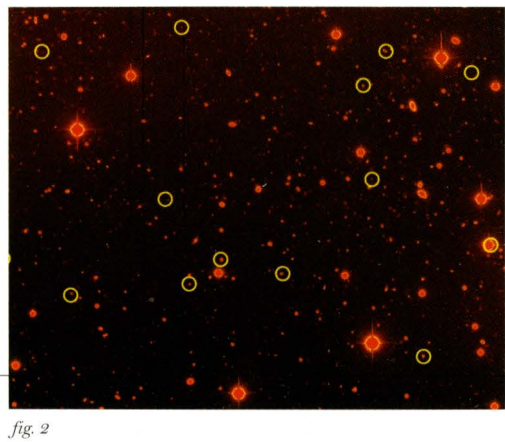


fig. 2

fig 1. An image obtained by the Chandra satellite. Boxes mark the location of high-energy X-ray sources identified in the processing.

fig 2. How the Keck optical telescope "sees" the same Chandra-identified X-ray sources (circled).

The Year *in Review*

THE EVOLVING INSTITUTE

October 1999: The @Caltech Web site debuts. Designed to deliver daily information about campus news and events, @Caltech is anchored by a new campuswide master calendar that will list everything from public and academic events to student club activities. The new site also incorporates the Human Resources Weekly Update and provides a central location for campus community members to post announcements and notices.

November 1999: Renovation of the former graduate student residences Keck and Mosher-Jorgensen begins. The Keck wing, renamed the Center for Student Services, is completed in summer 2000, and becomes the new home of the Caltech Y, the Women's Center, Minority Student Affairs, International Student Programs, and the Career Development Center.

November 12, 1999: The Laser Interferometer Gravitational-Wave Observatory in Livingston, Louisiana, is inaugurated. The opening ceremony includes a keynote presentation by Rita Colwell, director of the National Science Foundation. The observatory, whose twin facility is still under construction in Hanford, Washington, was funded by the National Science Foundation and is slated to begin operations in 2001.

Broad Center groundbreaking

Beckman Auditorium renovation

February 2000: The second Wilson Avenue parking structure opens.

September 2000: Ground is broken for the Eli and Edythe Broad Center for the Biological Sciences. Expected to be completed in 2002, the Broad Center will be the site of up to a dozen key research groups that will expand Caltech's existing strengths and position the Institute for leadership in a number of critical areas of investigation. Principal funding for the building was provided by a gift of more than $20 million from Edythe and Eli Broad. Eli Broad is chairman and CEO of SunAmerica Inc. and has been a Caltech trustee since 1993.

The most extensive renovation of Beckman Auditorium in 36 years is completed. Seats are reupholstered, carpets replaced, and walls repainted, and the stage is extended closer to the audience by several feet.

ADMINISTRATIVE CHANGES

January 1, 2000: Albert Horvath joins the Institute as associate vice president for finance and controller. He comes from New York University, where he served as controller for five years. Before that, he was assistant vice president for finance at Carnegie Mellon University.

April 2000: Sue Borrego, former executive director of the Caltech Y, is named associate dean and director of the Office of Minority Student Affairs.

June 2000: Professor of Mechanical Engineering Richard Murray is named chair of the Division of Engineering and Applied Science. He succeeds John Seinfeld, the Louis E. Nohl Professor and professor of chemical engineering, who had been division chair since 1990.

Athena Castro is appointed executive director of the Caltech Y, succeeding Sue Borrego.

A committee is formed to search for the successor to Edward C. Stone, who will step down next year as director of JPL, a position he has held for 10 years. Stone, who is also the David Morrisroe Professor of Physics at Caltech, plans to return to full-time teaching and research.

July 2000: Professor of Political Science D. Roderick Kiewiet is named dean of graduate studies, succeeding Professor of Geology and Planetary Science Arden Albee, who had held the post for 16 years. Kiewiet also served as dean of students from 1992 to 1996.

Professor of Biology Elliot M. Meyerowitz succeeds Melvin I. Simon, the Anne P. and Benjamin F. Biaggini Professor of Biological Sciences, as chair of the Division of Biology.

August 2000: Mildred S. Dresselhaus resigns from the Caltech Board of Trustees to take up her duties as director of the Department of Energy's Office of Science.

September 2000: Two new trustees are elected to the Caltech Board. Alumnus David L. Lee (PhD '74) is managing general partner of Clarity Partners, an equity and venture capital firm whose investments focus on communications, emerging media, and related technologies.

Dr. Sally Ride is currently a professor of physics at UC San Diego, and also directs research at UCSD's California Space Institute. She became the first American woman in space in 1983, when she flew aboard the space shuttle *Challenger*.

CALTECH AND THE COMMUNITY

October 23, 1999: Caltech launches an outdoor venue to showcase experimental art by young Southern California artists. The site will mount four shows annually, each for a period of two months, with each show devoted to an individual artist. The first show, entitled "Metonym Ocean Size," features photos and text by Jeremiah Day.

November 19, 1999: The Caltech Y inaugurates the Social Activism Speaker Series with a talk by Dolores Huerta, a cofounder of the United Farm Workers of America. The series exposes Caltech students to social activism by bringing to campus speakers who have dedicated their lives to improving society.

President Clinton and Caltech Board Chairman Emeritus Gordon E. Moore.

January 21, 2000: President Bill Clinton visits campus. Speaking to an enthusiastic overflow crowd in Beckman Auditorium, he unveils comprehensive new budget proposals for boosting federal support of science and technology.

February 24, 2000: The 2000 Biology Forum, entitled "Stem Cells: The Science of Regeneration," takes place in Beckman Auditorium. Panelists include Caltech biology professor and Howard Hughes Medical Institute investigator David Anderson; University College London biology professor Jeremy Brockes; USC law professor Alexander Capron; and Caltech biology professor Barbara Wold. The moderator is *Los Angeles Times* science writer Robert Lee Hotz.

April 7–8, 2000: In honor of the Beckman Institute's 10th anniversary (and alumnus and Board Chair Emeritus Arnold Beckman's 100th birthday on April 10), the Institute hosts a two-day symposium, "The Interface Between Chemistry and Biology: Celebrating Arnold Beckman's Vision." The event brings to campus internationally known scientists whose work spans those two disciplines.

August 7, 2000: Caltech sponsors a luncheon and lab tours for national and international journalists who are in Los Angeles to cover the Democratic National Convention.

August 14–20, 2000: The second annual Howard Science Institute, a conference for science reporters cosponsored by the vice provost's office and the Foundation for American Communications, takes place on campus. Twenty-five journalists, some from as far away as South Africa, spend time with Caltech professors, learning how to improve communication between scientists and the press.

August 22–26, 2000: "Defying Nature's End: A Practical Agenda for Saving Life on the Planet," a conference cosponsored by Conservation International's Center for Applied Biodiversity Science and the World Conservation Union, takes place on campus.

Dr. Beckman blows out his birthday candles.

SUPPORTING CALTECH

The Institute received a total of $117,561,000 in cash from private donors in fiscal year 2000. Caltech gratefully acknowledges the following individuals and organizations for their generous support. [*Note: donors whose names are followed by an asterisk are members of the Associates of the California Institute of Technology.*]

- Bequests totaling more than $37.1 million from the estates of 26 individuals. Particularly notable among these gifts was a bequest of more than $16 million from the estate of alumnus *William D. Hacker Jr. ('31)*, which was designated as support for the Division of Biology and for the economics program in the Division of the Humanities and Social Sciences. In addition, the distribution from Mr. Hacker's estate provided for a $1 million loan fund.

  Another remarkable bequest came from the estate of *Dora Donner Ide*, a friend of the Institute. Caltech—just one of 29 nonprofit organizations to benefit from her estate—received in excess of $4.5 million to be added to the Institute's permanent endowment.

- Thirty-seven gifts in the form of charitable trusts, annuities, and other life-income agreements with a total value in excess of $17 million. A number of significant charitable trust gifts were made by *Anthony J. Larrecq ('29)* and his daughters, *Linda Larrecq Yarnes* and *Leonia Larrecq Van Den Heuvel.* Loyal life-income donors *Fred V. Maloney ('35)* and *Marilyn Van B. Wingen* continued to make significant additions to their Caltech charitable trusts and annuities.

- *Gordon (PhD '54) and Betty Moore**—$8 million to the President's Discovery Fund to meet institutional needs, including seed funding for new faculty and major new research initiatives, a distinguished visitors program, and graduate fellowships.

- *Steve and Rosemarie Johnson*—$2 million to endow a senior research fellowship and student prizes in mathematics in honor of Steve's brother, the late Scott Johnson ('83).

- *Alexander and Adelaide Hixon**—$1.1 million to establish the Hixon Writing Center and to endow a prize for outstanding undergraduate writing.

- *Allen (PhD '49) and Marilyn Puckett**—a pledge of $1 million toward the renovation of Guggenheim Laboratory, to name the Puckett Laboratory for Computational Fluid Dynamics within that building.

- *Charles Trimble* ('63, MS '64)*—stock valued at $974,687 for the Charles Trimble Fund.

- *Millard ('40) and Muriel Jacobs**—stock valued at $726,031 to support research in genomics.

- *Alexander Lidow ('75) and Janet Hart*—stock valued at $598,750 to establish the Lidow Discovery Fund.

- *Warren ('44, MS '46, PhD '49) and Katharine Schlinger**—a pledge of $600,000 to endow a graduate fellowship in chemical engineering.

- *Robert T. ('65, MS '66) and Virginia Jenkins**—gifts and pledges of $567,187 for research in neuroscience and for geological field studies.

- *Jean J. Dixon**—a pledge of $300,000 to endow an undergraduate scholarship in honor of her late husband, William J. Dixon ('48, MS '49, PhD '52).

- *Harold W. Lord ('26)*—stock valued at $299,306 to establish an endowed undergraduate scholarship.
- *Li-San Hwang (PhD '65)*—stock valued at $282,150 for the Vito Vanoni Endowed Undergraduate Scholarship Fund.
- *Ruben F. ('44, MS '47, PhD '49) and Donna Mettler**—stock valued at $264,206 for research in neuroscience.
- *Henry C. Yuen (PhD '73)*—$257,000 for the Law and Technology Program, a collaboration with Loyola Law School.
- *The Donald Bren Foundation*—$10 million for the Bren Professorships Endowment Fund.
- *The David and Lucile Packard Foundation*—$2.25 million for two faculty fellowships in science and engineering and one interdisciplinary research award.
- *The Arnold and Mabel Beckman Foundation*—$2.16 million in support of the Beckman Fellows Program at Caltech's Beckman Institute.
- *The Ralph M. Parsons Foundation*—$2 million for the Biomolecular Structures Lab equipment fund.
- *The Steven and Michele Kirsch Foundation*—$450,000 for a Senior Research Faculty Fellowship for Alexander Varshavsky, the Howard and Gwen Laurie Smits Professor of Cell Biology.
- *The Times Mirror Foundation*—a $250,000 gift representing the completion of a five-year effort to raise FEMA-required matching funds for the TriNet Project.
- *Intel Corporation*—completion of a three-year pledge of $2.3 million to support computationally intense interdisciplinary investigations in computer science, electrical engineering, theoretical chemistry, applied physics, and other campus research areas.
- *Amgen*—a pledge of $2 million to establish an Institute professorship in honor of Caltech trustee and retiring Amgen chairman Gordon M. Binder.
- *The Alumni Fund*—Through the Alumni Fund, Caltech alumni donated nearly $6 million to the Institute in fiscal year 2000 (this figure includes all gifts except bequests). An additional $181,488 was received in corporate matching gifts. Forty percent of undergraduate alumni and 29 percent of graduate alumni currently donate to the Alumni Fund.

  Donations in connection with the Linde Challenge continue to accumulate, with more than $924,000 received as of December 2000. (Caltech trustee *Ronald Linde (MS '62, PhD '64)* and his wife, *Maxine*, will match gifts donated to the challenge through May 31, 2001, on a one-to-one basis, up to a total of $1.25 million.)
- *Members of the Caltech Associates*—$7.7 million in restricted and unrestricted gifts in fiscal year 2000. These contributions, when added to gifts over $1 million and the present value of trusts, resulted in total Associates donations of more than $19.1 million for the same period.

STUDENT LIFE

The 2000 Commencement speaker, science fiction writer Ray Bradbury (left), with Professor of Planetary Science and Geology Bruce Murray.

June 9, 2000: Caltech's 106th Commencement. Degrees awarded: 202 bachelor's; 113 master's; 1 engineer's; 127 doctoral.

Plans of BS graduates: Eighty-six members of the class of 2000 planned to attend graduate or professional schools. Top school choices were MIT, Princeton, Stanford, and UC Berkeley. The majority entered programs in science or engineering fields; seven were accepted into medical schools; and one is attending dentistry school. Two students will pursue graduate study in music.

As in past years, Caltech graduates had considerable success in competing for fellowships.

2000 Fellowship Winners

(members of the class of 2000, unless otherwise noted)

National Science Foundation Fellowships:
James A. Bresson
Damian N. Burch
Ming Ming Chen
Andrew M. Childs
Daniel L. Levy
Yi-Ping Liu
Matthew S. Tiscareno ('98)
Ricky Tsee-Wai Tong
Jim Yuk-Fai Wong

Graduate Students
Matthew J. Allen
Xavier I. Ambroggio
Catherine M. Oertel
James M. Zahler

Amasa Bishop Fellowships:
Micah S. S. Sittig (class of 2001)
Eric P. Tuttle (class of 2001)

Fulbright Fellowships:
Juna A. Kollmeier
Troy J. Lee
Michael Machczynski (graduate student)

Hertz Fellowships:
Andrew M. Childs
Gretchen Larsen ('97)
Kartik Srinivasan

Howard Hughes Predoctoral Fellowships in Biological Sciences:
Daniel L. Levy
Ming Ming Chen

Henry Luce Fellowship:
Sam L. Wilcke

NSEP (National Security Education Program) Undergraduate Fellowships:
Philip Fung (class of 2002)
Micah S. S. Sittig (class of 2001)
Angela K. Snow (class of 2002)

Rotary Scholarship:
Brian R. Patton

Thomas J. Watson Fellowship:
Zhao Huang

Of the bachelor's degree recipients who chose not to attend graduate school, 81 accepted full-time employment. (The average starting salary for these individuals was $65,700, plus an average signing bonus of $7,000; one graduate received two job offers, each with a salary in excess of $100,000.) Other graduates chose to pursue less traditional paths. One is training for her commercial pilot's license; another will work as a drilling assistant on the National Science Foundation's Antarctic Research Project; and three others have joined either the Peace Corps or Americorps.

Plans of PhD graduates: Fifty-six accepted academic employment—10 as tenure-track faculty and 46 as postdoctoral scholars. Thirty-eight found employment in industry at an average salary of $78,667 plus an average signing bonus of $11,167. At least two new PhDs planned to start their own companies.

RANKINGS

Caltech PhD programs placed as follows in *U.S. News & World Report*'s 2000 national rankings of graduate schools:

Geology—1
Physics—1
Chemistry—2
Biological Sciences—5
Mathematics—8
Computer Science—11
Economics—14

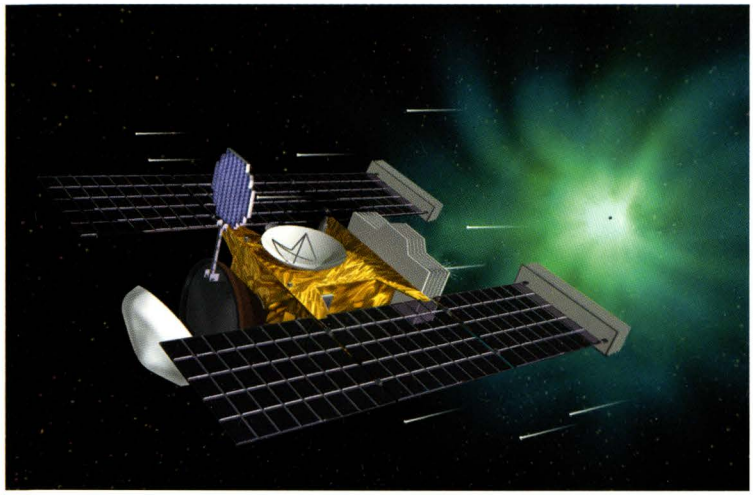
U.S. News & World Report also ranked Caltech's undergraduate program first in terms of value, reflecting what the magazine considered the optimum combination of academic quality and net cost of attendance.

JPL HIGHLIGHTS

The Jet Propulsion Laboratory's long-lived Galileo spacecraft, still orbiting Jupiter, collaborated with another spacecraft, Cassini, to study the giant planet jointly during Cassini's flyby of Jupiter in December 2000. Cassini is on its way to Saturn, where in 2004 it will release a probe called Huygens—provided by the European Space Agency—that will descend to the surface of the moon Titan. In a separate finding, Galileo's magnetometer relayed the strongest evidence yet that a liquid ocean exists underneath the icy crust of Jupiter's moon Europa.

Ground controllers managed to recover the Deep Space 1 spacecraft after its navigation system failed, and prepared it for an extended mission flying by comet Borrelly in 2001. Meanwhile, the Stardust spacecraft began collecting interstellar dust en route to its own comet flyby. The sun-orbiting Ulysses spacecraft had a serendipitous comet encounter as it flew through the tail of Comet Hyakutake. Mars Global Surveyor scientists obtained evidence that there was flowing water on the red planet's surface in the recent past. NASA approved a JPL proposal to send twin rovers to Mars during a 2003 launch opportunity.

Two key JPL instruments on NASA's Terra satellite—the Multi-Angle Imaging Spectroradiometer (MISR) and the Advanced Spaceborne Thermal Emission Reflection Radiometer (ASTER)—began monitoring Earth's surface and atmosphere. The Quick Scatterometer satellite and the joint U.S.–French TOPEX/Poseidon satellite continued to return high-quality data on near-surface ocean winds and global sea-surface heights, respectively. Scientists used TOPEX data to conclude that temperatures in the Pacific Ocean may fluctuate on a century-long timescale, as well as on the shorter temperature cycles that were previously known.



Stardust spacecraft

National awards and honors

American Academy of Arts and Sciences, Fellow:

Paul W. Sternberg, *Professor of Biology and Investigator, Howard Hughes Medical Institute*

American Association for the Advancement of Science, Fellow:

Jacqueline K. Barton, *Arthur and Marian Hanisch Memorial Professor and Professor of Chemistry*

Alice S. Huang, *Faculty Associate in Biology*

John H. Seinfeld, *Louis E. Nohl Professor and Professor of Chemical Engineering*

David J. Stevenson, *George Van Osdol Professor of Planetary Science*

Armand R. Tanguay, Jr., *Visiting Associate in Electrical Engineering*

National Academy of Engineering, Member:

Frances H. Arnold, *Dick and Barbara Dickinson Professor of Chemical Engineering and Biochemistry*

National Academy of Sciences, Lounsbery Award:

Elliot M. Meyerowitz, *Professor of Biology and Chair of the Division of Biology*

Member:

Douglas C. Rees, *Professor of Chemistry and Investigator, Howard Hughes Medical Institute*

2000 Award for Initiatives in Research:

Kenneth A. Farley, *Professor of Geochemistry*

National Medal of Science, Recipient:

John D. Baldeschwieler, *J. Stanley Johnson Professor and Professor of Chemistry, Emeritus*

National Science and Technology Council, Presidential Early Career Award for Scientists and Engineers:

Michael E. Brown, *Assistant Professor of Planetary Astronomy*

Fiona A. Harrison, *Assistant Professor of Physics and Astronomy*

Jonas C. Peters, *Assistant Professor of Chemistry*

Office of Naval Research, Young Investigator:

Hideo Mabuchi, *Assistant Professor of Physics*

Sigma Xi, 2000 John P. McGovern Science and Society Award:

David L. Goodstein, *Professor of Physics and Applied Physics, Frank J. Gilloon Distinguished Teaching and Service Professor, and Vice Provost*

International awards and honors

American Academy in Berlin, Berlin Prize:

Caroline M. Fohlin, *Assistant Professor of Economics*

Committee on the International Prize for Biology, International Prize for Biology:

Seymour Benzer, *James G. Boswell Professor of Neuroscience, Emeritus*

French Academy of Sciences, Foreign Member:

Peter B. Dervan, *Bren Professor of Chemistry*

German Biochemical Society, 2000 Hoppe-Seyler Award:

Alexander J. Varshavsky, *Howard and Gwen Laurie Smits Professor of Cell Biology*

Kuwait, State Award in Applied Science:

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

Moscow Mathematical Association, 1999 Young Mathematician's Prize:

Alexander B. Soshnikov, *Olga Taussky and John Todd Instructor in Mathematics*

Pontifical Academy of Sciences, Academician:

Ahmed H. Zewail, *Linus Pauling Professor of Chemical Physics and Professor of Physics*

Royal Danish Academy of Sciences and Letters, Foreign Member:

Ahmed H. Zewail, *Linus Pauling Professor of Chemical Physics and Professor of Physics*

Royal Society, Foreign Member:

Harry B. Gray, *Arnold O. Beckman Professor of Chemistry and Director of the Beckman Institute*

Executive Board of Editors for Tetrahedron Publications, Tetrahedron Prize:

Peter B. Dervan, *Bren Professor of Chemistry*

Awards and honors from professional societies

American Astronomical Society, Division for Planetary Sciences,
Harold C. Urey Prize in Planetary Science:

Michael E. Brown, *Assistant Professor of Planetary Astronomy*

American Chemical Society, ACS Award for Creative Advances in
Environmental Science and Technology:

Michael R. Hoffmann, *James Irvine Professor of Environmental Science and Executive Officer for Environmental Engineering Science*

American Chemical Society, Division of Polymer Chemistry,
Herman F. Mark Polymer Chemistry Award:

Robert H. Grubbs, *Victor and Elizabeth Atkins Professor of Chemistry*

American Chemical Society, Southern California Section, Richard C. Tolman Medal:

Peter B. Dervan, *Bren Professor of Chemistry*

American Institute of Aeronautics and Astronautics,
Daniel Guggenheim Medal and Certificate:

Frank E. Marble, *Richard L. and Dorothy M. Hayman Professor of Mechanical Engineering and Professor of Jet Propulsion, Emeritus*

American Institute of Chemical Engineers, 2000 Professional Progress Award
for Outstanding Progress in Chemical Engineering:

Frances H. Arnold, *Dick and Barbara Dickinson Professor of Chemical Engineering and Biochemistry*

American Philosophical Society, Member:

Harry B. Gray, *Arnold O. Beckman Professor of Chemistry and Director of the Beckman Institute*

American Physical Society, Sakurai Prize:

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

American Political Science Association, 2000 Ralph J. Bunche Award, Corecipient:

J. Morgan Kousser, *Professor of History and Social Science*

American Sociological Association, Otis Dudley Duncan Award:

James Z. Lee, *Professor of History*

American Technion Society, Harvey Prize:

Harry B. Gray, *Arnold O. Beckman Professor of Chemistry and Director of the Beckman Institute*

Econometric Society, Fellow:

Colin F. Camerer, *Rea A. and Lela G. Axline Professor of Business Economics*

Franklin Institute, Benjamin Franklin Medal in Chemistry:

Robert H. Grubbs, *Victor and Elizabeth Atkins Professor of Chemistry*

IEEE Circuits and Systems Society, CAS Golden Jubilee Medal:

P. P. Vaidyanathan, *Professor of Electrical Engineering*

Institute of Electrical and Electronics Engineers, Third Millennium Medal:

Robert J. McEliece, *Allen E. Puckett Professor and Professor of Electrical Engineering*

R. David Middlebrook, *Professor of Electrical Engineering, Emeritus*

David B. Rutledge, *Professor of and Executive Officer for Electrical Engineering*

Leslie Fox Prize Competition, 18th Biennial Conference on Numerical Analysis,
First Prize, Corecipient:

Niles A. Pierce, *Assistant Professor of Applied Mathematics*

Northeast Victorian Studies Association, Sonya Rudikoff Award:

Alison Winter, *Associate Professor of History*

Program in Early American Economy and Society, Award, Corecipient:

Lance E. Davis, *Mary Stillman Harkness Professor of Social Science*

Social Science History Association, Sharlin Memorial Award:

James Z. Lee, *Professor of History*

Society for Clinical and Experimental Hypnosis, 1999 Arthur Shapiro Award:

Alison Winter, *Associate Professor of History*

Society for Experimental Mechanics, 2000 Lazan Award:

Wolfgang G. Knauss, *Professor of Aeronautics and Applied Mechanics*

Transplantation Society, Medawar Prize:

Ray D. Owen, *Professor of Biology, Emeritus*

Foundation awards

Charles A. Dana Foundation, Dana Clinical Hypotheses Program in Brain–Body Interaction Grant:
Paul H. Patterson, *Professor of Biology*

Gairdner Foundation, 1999 Gairdner Foundation International Award, Corecipient:
Alexander J. Varshavsky, *Howard and Gwen Laurie Smits Professor of Cell Biology*

General Motors Cancer Research Foundation, 2000 Alfred Sloan Prize, Corecipient:
Alexander J. Varshavsky, *Howard and Gwen Laurie Smits Professor of Cell Biology*

Haynes Foundation, 2000 Faculty Fellowship:
Jeffrey A. Dubin, *Associate Professor of Economics*

Steven and Michele Kirsch Foundation, Investigator Award:
Alexander J. Varshavsky, *Howard and Gwen Laurie Smits Professor of Cell Biology*

Albert and Mary Lasker Foundation, 2000 Albert Lasker Award in Basic Medical Research, Corecipient:
Alexander J. Varshavsky, *Howard and Gwen Laurie Smits Professor of Cell Biology*

John D. and Catherine T. MacArthur Foundation, Fellowship:
Hideo Mabuchi, *Assistant Professor of Physics*
Eric Winfree, *Assistant Professor of Computer Science and Computation and Neural Systems*

McKnight Endowment Fund for Neuroscience, McKnight Investigator Award:
Gilles J. Laurent, *Associate Professor of Biology and Computation and Neural Systems*

National Academy of Education/Spencer Foundation, Spencer Postdoctoral Fellowship:
J. Douglas Smith, *Instructor in History*

David and Lucile Packard Foundation, Fellowship:
Rahul Pandharipande, *Associate Professor of Mathematics*
Stephen R. Quake, *Associate Professor of Applied Physics*

Passano Foundation, Passano Award, Corecipient:
Giuseppe Attardi, *Grace C. Steele Professor of Molecular Biology*

University honors

Cambridge University, Honorary Professor of Observational Astrophysics:
Richard S. Ellis, *Professor of Astronomy and Director, Palomar Observatory*

Edinburgh University, 2001 Science Festival Lecturer:
Anneila I. Sargent, *Professor of Astronomy; Director, Owens Valley Radio Observatory; and Director, Interferometry Science Center*

Haverford College, Spring 2001 Philips Visitor:
Anneila I. Sargent, *Professor of Astronomy; Director, Owens Valley Radio Observatory; and Director, Interferometry Science Center*

Massachusetts Institute of Technology, Physics Department, 2000 David Harris Lecturer:
Shrinivas R. Kulkarni, *Professor of Astronomy and Planetary Science and Executive Officer for Astronomy*

New York University, Center for Japan–U.S. Business and Economic Studies at the Stern School of Business, Ninth Sanwa Award:

Caroline M. Fohlin, *Assistant Professor of Economics*

Ross University, Faye Rabiner Award:

Ahmed H. Zewail, *Linus Pauling Professor of Chemical Physics and Professor of Physics*

University of Chicago, 2000 Shubitz Prize in Cancer Research:

Alexander J. Varshavsky, *Howard and Gwen Laurie Smits Professor of Cell Biology*

Institute honors

Endowed Professorships:

Frances H. Arnold, *Dick and Barbara Dickinson Professor of Chemical Engineering and Biochemistry*
Jesse L. Beauchamp, *Charles and Mary Ferkel Professor of Chemistry*
Jed Z. Buchwald, *Doris and Henry Dreyfuss Professor of History*
Richard C. Flagan, *Irma and Ross McCollum Professor of Chemical Engineering*
Donald V. Helmberger, *Smits Family Professor of Geological and Planetary Sciences*
Christof Koch, *Lois and Victor Troendle Professor of Cognitive and Behavioral Biology*
Anthony Leonard, *Theodore von Kármán Professor of Aeronautics*
Henry A. Lester, *Donald Bren Professor of Biology*
Axel Scherer, *Bernard Neches Professor of Electrical Engineering, Applied Physics, and Physics*

Associated Students of the California Institute of Technology (ASCIT), 2000 Teaching Awards:

Juan E. De Castro, *Lecturer in Spanish*
Dennis A. Dougherty, *Professor of Chemistry*
Bradley W. Filippone, *Professor of Physics*
Joseph L. Kirschvink, *Professor of Geobiology*
Kip S. Thorne, *Richard P. Feynman Professor of Theoretical Physics*

Lifetime Achievement Awards:

William B. Bridges, *Carl F Braun Professor of Engineering*
Steven C. Frautschi, *Professor of Theoretical Physics and Master of Student Houses*

2000 Teaching Awards, Honorable Mentions:

John M. Allman, *Frank P. Hixon Professor of Neurobiology and Professor of Biology*
Gregory T. Smedley, *Instructor in Mechanical Engineering Design*
J. Douglas Smith, *Instructor in History*
Katherine Stevenson, *Olga Taussky and John Todd Instructor in Mathematics*

Graduate Student Council, 2000 Teaching Awards:

Markus Keel, *Olga Taussky and John Todd Instructor in Mathematics*
Anthony Leonard, *Theodore von Kármán Professor of Aeronautics*
Hideo Mabuchi, *Assistant Professor of Physics*

Richard P. Feynman Prize for Excellence in Teaching, Recipient:

Donald S. Cohen, *Charles Lee Powell Professor of Applied Mathematics*

Financial Report Letter

Fiscal Year 2000

With a strong financial base, Caltech continues to build upon its international leadership in science and engineering research and education. Without this base, Caltech could not take the necessary risks and make the critical investments that continue to change our knowledge of the world. I am pleased to report that again this year Caltech strengthened its financial foundation.

Net Assets—Our Current and Future Financial Stability

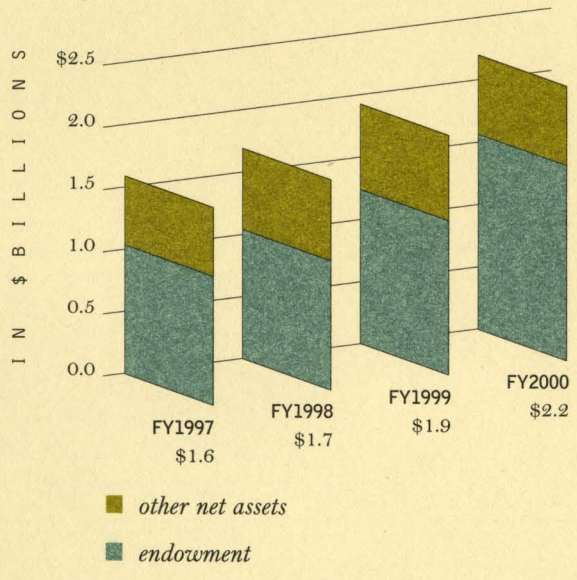
Net assets characterize the Institute's near- and long-term financial stability. During fiscal year 2000, Caltech's net assets grew by $308 million, or 16%, to a total of $2.2 billion. Endowment was the primary reason for this growth.

Through a combination of new gifts and market appreciation, the value of Caltech's endowment grew to more than $1.5 billion as of September 30. The endowment provides a stream of annual income for current programs and needs. However, to preserve the future value of the endowment, only a portion of the investment return is allocated for operations each year. The Institute's Board of Trustees closely monitors both the spending allocation and the investment strategy.

Additionally, Caltech saw the net value of its portfolio of trusts, annuities, and other investments increase by $34 million, or 39%.

Both Moody's and Standard and Poor's have recognized the strength and quality of our financial reserves and have assigned Caltech Aaa/AAA debt ratings.

Net Asset Growth
1997 to 2000



Revenues and Expenses—Opportunities and Challenges

A summary of the Institute's revenues and expenses is presented below. Caltech has been extremely successful at generating an increasing level of sponsored research dollars, both through the Jet Propulsion Laboratory (JPL) and campus-based research. In fact, JPL's budget is completely funded by federal resources, while the campus is also significantly funded by external sponsors, including the federal government, foundations, and corporate gifts. Federal research requires an infrastructure, which by its nature is highly complex and extremely expensive.

SUMMARY OF REVENUES AND EXPENSES *(excluding JPL)*

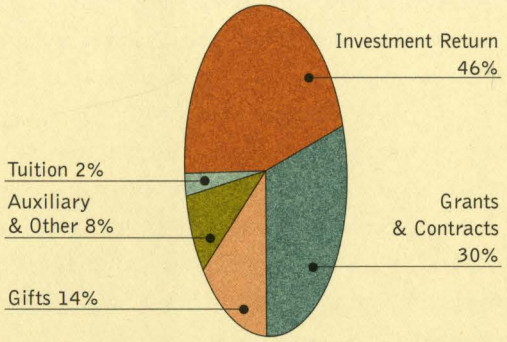
Operating and nonoperating activity in all net asset categories
(in millions)

	2000	*1999*
Revenues		
Net tuition and fees	$ 16	$ 16
Investment return	364	235
Gifts	109	131
Grants and contracts	236	226
Auxiliary enterprises and other	61	41
Total Revenues, Gains, and Other Support	$ 786	$ 649
Expenses		
Instruction and academic support	134	124
Organized research	172	169
Institutional support	69	64
Plant operation and maintenance	26	35
Auxiliary enterprises and other	26	27
Total Expenses	$ 427	$ 419
Write-off of fixed assets	51	0
Total Increase in Net Assets	$ 308	$ 230

Revenues

Campus revenues grew by 21% to $786 million during fiscal year 2000. As demonstrated in the accompanying chart, the largest single revenue source, and the primary driver of our net asset growth, is the return on our investment portfolio.

Campus Revenues by Source
Fiscal Year 2000



Looking more closely at the operating portion of total revenues highlights two major funding sources. The first and largest of these is sponsored research, the majority of which is received from U.S. government sponsors. Sponsored research has more than doubled in the past decade, thanks to our faculty, who are among the most productive in the country. During fiscal year 2000, research revenue grew by 4% to $236 million. Growth in research revenue has slowed in the past few years, since there is virtually no excess capacity on the campus and our faculty count has remained essentially constant.

Gifts, in the form of new expendable gifts and the payout of income from endowment investments from prior gifts, are Caltech's other major source of operating revenue. For the second consecutive year, new gifts (cash and pledges) topped the $100 million mark. With an alumni base of approximately 20,000, it is remarkable that such a level of support has been achieved for two consecutive years. Our alumni and friends have been extremely generous, enabling Caltech to remain a leader in higher education and research.

Our investment returns were again extremely healthy, a reflection of the nation's strong economy and our investment strategies and managers. Caltech's endowment pool achieved a total return of 26.3% (net of investment management fees) during the past year, well in excess of its policy performance benchmark. Caltech has consistently outperformed the majority of university endowments, ranking in the upper quartile in the past year, and longer five- and ten-year periods.

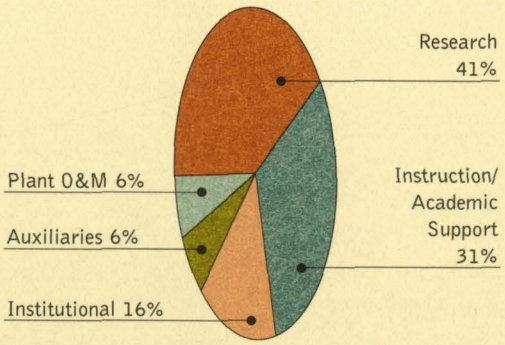
Tuition revenue represents a much less significant part of the financial picture at Caltech than at peer institutions. This reflects both our deliberately stable enrollment and our comparatively low tuition and fees. While these strategies may constrain revenue, they have successfully maintained our ability to attract the highest-caliber students in the world.

While Caltech's revenue sources are limited, they are stable and strong. The creativity and productivity of our faculty have ensured a steady flow of sponsored research revenues, despite the uncertainties of the federal budget. The strength of our mission has resulted in significant increases in gifts received. The wisdom of the Board's investment strategy has resulted in significant investment growth and additional support to annual operations. In spite of these positives, we will aggressively seek to increase our traditional sources of revenue and to tap new sources around the activities that we do best.

Expenses

In the past year, total campus expenses grew by only 2% to $427 million. This slowed expense growth reflects the completion of our new systems implementation efforts of the prior two fiscal years.

Campus Expenses by Function
Fiscal Year 2000

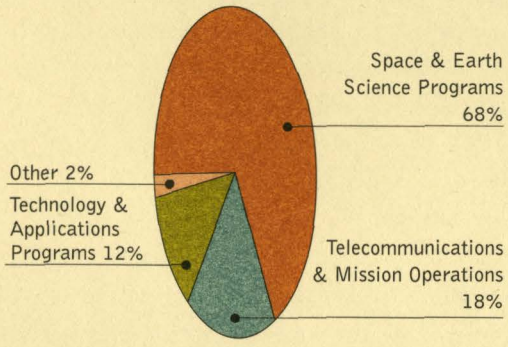


Our commitment to cutting-edge research has resulted in amazing discoveries and inventions. However, supporting the type of research conducted at Caltech is extremely expensive. Facilities must be kept functional, equipment must be state-of-the-art, labs must be managed and maintained, and, most importantly, we must attract and retain the top researchers and graduate students in each field. Additionally, the administrative requirements attached to federal research funds are numerous and complex.

We are committed to maintaining an extremely low 3-to-1 undergraduate student-to-faculty ratio, which fosters interactions between faculty and students that are not possible at other universities. This, too, is expensive but important in making Caltech a special place.

In light of these realities, we continually manage our expenses to ensure that research and instruction activities are well supported. The accompanying chart demonstrates that over 70% of our operating expenses relate to research and instruction/academic support. We also work diligently to keep our administrative costs reasonable so that maximum funding can flow to activities critical to our mission.

JPL
Program Office
Distribution
Fiscal Year 2000



JPL Operations Overview

JPL is a Federally Funded Research and Development Center, owned by the National Aeronautics and Space Administration and operated as a division of Caltech.

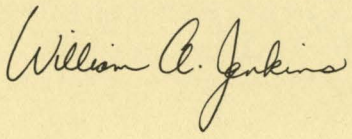
JPL is responsible for a broad spectrum of space science missions and instruments and is the nation's lead center for the robotic exploration of space and for deep-space systems. A summary of JPL's $1.2 billion budget for fiscal year 2000 is provided. The space and earth science programs account for the majority of JPL's funding, followed by the telecommunications and mission operations, and technology and applications programs. The financial organization at JPL is committed to providing outstanding service in support of the projects and programs of the Laboratory.

The Future—A Delicate Balance

Since its founding in 1891, Caltech has risen to its level of prominence by focusing on the things it does best. This vision of being the preeminent institution of basic scientific research has served us well. It has helped Caltech become recognized as not only a world-class research university, but as a national treasure. It has enabled the unique and collaborative partnership between Caltech and NASA—the Jet Propulsion Laboratory—that continues to make breakthrough discoveries as the leader in unmanned space exploration. So much has been accomplished. Yet the arrival of the year 2000 reminds us that much is still to be done, promising young researchers and students are yet to be mentored, and new discoveries await.

While we speak of our past with great pride, we are not satisfied merely with our history. Caltech strives to push the scientific boundaries to accomplish even greater successes. To continue forward, we must work to strengthen our already strong financial base, increase our revenue flows, and build new sources of revenue. From an expense perspective, we will continue our fiscal discipline, increase investments in our core activities, and manage our resources with the care and professionalism that Caltech deserves.

The financial challenges of a research university require a delicate balance. We must focus our resources on the things we do best. We must generate the financial support necessary to accomplish our goals. We must carefully navigate a regulatory environment of constant change and complex rules. We must provide facilities and support to our faculty and students that enable them to excel. It is indeed a delicate and difficult balance. While these tasks are necessarily measured in financial terms, they are of far broader benefit to our country and the world.



William A. Jenkins
Vice President for Business and Finance

Balance Sheets

September 30, 2000 and 1999

(in thousands)

	2000	1999
ASSETS		
Cash and cash equivalents	$ 867	$ 645
Accounts receivable, net		
United States government	197,890	199,251
Other	20,953	22,364
Contributions receivable, net	52,813	43,869
Investments	1,780,695	1,420,059
Prepaid expenses and other assets	103,734	101,661
Deferred United States government billings	165,810	150,522
Property, plant and equipment, net	571,440	623,138
Total assets	$2,894,202	$2,561,509
LIABILITIES		
Accounts payable and accrued expenses	$ 281,829	$ 286,829
Deferred revenue and refundable advances	22,954	21,528
Annuities, trust agreements and agency funds	87,574	73,137
Bonds and notes payable	143,291	148,821
Accumulated postretirement benefit obligation	168,022	148,942
Total liabilities	$ 703,670	$ 679,257
NET ASSETS		
Unrestricted	$1,596,653	$1,362,324
Temporarily restricted	157,883	123,405
Permanently restricted	435,996	396,523
Total net assets	$2,190,532	$1,882,252
Total liabilities and net assets	$2,894,202	$2,561,509

See Accompanying Notes to Financial Statements

Statements of Activities

For the Years Ended September 30, 2000 and 1999

(in thousands)

	2000	1999
CHANGES IN UNRESTRICTED NET ASSETS:		
Revenues		
Tuition and fees (net of student financial aid of $19,710 and $18,261, respectively)	$ 15,723	$ 15,597
Investment return	346,382	227,489
Gifts	42,440	20,284
Grants and contracts		
Jet Propulsion Laboratory—direct	1,243,932	1,303,978
Other U.S. government—direct	152,773	146,862
Non-U.S. government—direct	7,255	9,435
Indirect cost recovery and management allowance	75,936	69,718
Auxiliary enterprises	21,454	22,169
Other	39,673	18,966
Net assets released from restrictions	11,659	15,660
Total unrestricted revenues	$1,957,227	$1,850,158
Expenses		
Instruction and academic support	$ 134,185	$ 123,704
Organized research		
Jet Propulsion Laboratory	1,243,932	1,303,978
Other campus research	171,902	169,265
Institutional support	69,423	63,959
Plant operation and maintenance	26,191	35,114
Auxiliary enterprises	25,831	24,957
Loss on write-off of property, plant and equipment	51,434	0
Loss on extinguishment of bonds payable	0	2,488
Total unrestricted expenses	$1,722,898	$1,723,465
Increase in unrestricted net assets	$ 234,329	$ 126,693
CHANGES IN TEMPORARILY RESTRICTED NET ASSETS:		
Gifts	$ 35,237	$ 28,087
Investment return	10,900	5,780
Net assets released from restrictions	(11,659)	(15,660)
Increase in temporarily restricted net assets	$ 34,478	$ 18,207
CHANGES IN PERMANENTLY RESTRICTED NET ASSETS:		
Gifts	$ 32,049	$ 83,098
Investment return	7,424	2,190
Increase in permanently restricted net assets	$ 39,473	$ 85,288
Increase in Total Net Assets	$ 308,280	$ 230,188
Total Net Assets at Beginning of Year	1,882,252	1,652,064
Total Net Assets at End of Year	$2,190,532	$1,882,252

See Accompanying Notes to Financial Statements

Statements of Cash Flows

For the Years Ended September 30, 2000 and 1999

(in thousands)

	2000	1999
CASH FLOWS FROM OPERATING ACTIVITIES		
Total increase in net assets	$ 308,280	$ 230,188
Adjustments to reconcile total increase in net assets to net cash provided by/(used in) operating activities		
Depreciation and amortization	57,499	37,498
(Increase)/decrease in accounts and contributions receivable	(6,172)	2,058
(Decrease)/increase in accounts payable and accrued expenses	(5,000)	13,665
Loss on extinguishment of bonds payable	0	2,488
Contributions restricted for long-term investment	(32,049)	(83,098)
Realized and unrealized gains on investments	(316,663)	(209,009)
Increase in deferred U.S. government billings	(15,288)	(13,608)
Increase in prepaid expenses and other assets	(2,073)	(10,080)
Increase in deferred revenue and refundable advances	1,426	602
Increase in accumulated postretirement benefit obligation	19,080	17,754
Loss on write-off of property, plant and equipment	51,434	0
Net Cash Provided By/(Used In) Operating Activities	$ 60,474	$ (11,542)
CASH FLOWS FROM INVESTING ACTIVITIES		
Proceeds from sales of investments	$ 1,108,765	$ 715,143
Purchases of investments	(1,142,814)	(743,905)
Capital expenditures	(56,870)	(98,616)
Net Cash Used In Investing Activities	$ (90,919)	$ (127,378)
CASH FLOWS FROM FINANCING ACTIVITIES		
Contributions restricted for long-term investment	$ 32,049	$ 83,098
Proceeds from issuance of bonds payable	0	93,075
Repayment of bonds payable	0	(43,075)
Net (repayments)/borrowings on line of credit	(6,000)	6,000
Contributions received for split-interest agreements	17,299	7,339
Payments made under split-interest agreements	(12,681)	(7,319)
Net cash provided by financing activities	$ 30,667	$ 139,118
Net increase in cash	$ 222	$ 198
Cash at beginning of year	645	447
Cash at end of year	$ 867	$ 645
SUPPLEMENTAL DISCLOSURE		
Interest paid	$ 7,875	$ 6,928

See Accompanying Notes to Financial Statements

For the Years Ended September 30, 2000 and 1999
(in thousands)

Note A — DESCRIPTION OF THE CALIFORNIA INSTITUTE OF TECHNOLOGY

The California Institute of Technology (the Institute) is a private, not-for-profit institution of higher education based in Pasadena, California. Founded in 1891, the Institute provides education and training services, primarily for students at the undergraduate, graduate, and postdoctoral levels, and performs research, training, and other services under grants, contracts, and similar agreements with sponsoring organizations, primarily departments and agencies of the government of the United States of America.

Note B — SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Basis of Presentation — The accompanying financial statements include the accounts of the Institute and the Jet Propulsion Laboratory (JPL), a Federally Funded Research and Development Center managed by the Institute for the National Aeronautics and Space Administration (NASA). The Institute and JPL are exempt from federal income taxes under the provisions of Internal Revenue Code Section 501(c)[3]. The Institute is also generally exempt from payment of California state income, gift, estate, and inheritance taxes.

The financial statements of the Institute have been prepared on the accrual basis of accounting, in accordance with accounting principles generally accepted in the United States of America.

The Institute prepares its financial statements in accordance with the provisions of the American Institute of Certified Public Accountants' Audit and Accounting Guide, "Not-for-Profit Organizations," and is required to classify its net assets into three categories according to donor-imposed restrictions or provisions of law: permanently restricted, temporarily restricted, and unrestricted. Permanently restricted net assets include gifts, charitable remainder unitrusts, pooled income funds, gift annuities, other split-interest agreements, and contributions receivable in which donors have stipulated that the principal be invested in perpetuity. Generally, donors permit the unrestricted use of all or part of the investment return on these assets. Capital gains or losses, both realized and unrealized, related to permanently restricted investments are reported as unrestricted revenue unless their use is restricted by donor-imposed stipulations. Temporarily restricted net assets include gifts for which donor-imposed restrictions have not been met (primarily for future capital projects), charitable remainder unitrusts, pooled income funds, gift annuities, other split-interest agreements, and contributions receivable on which the donor has placed certain restrictions. These restrictions are removed either through the passage of time or certain actions that are taken by the Institute to fulfill the restrictions. Expirations of temporary restrictions on net assets due to the fulfillment of donor-imposed restrictions and/or the passage of time are reported as reclassifications from temporarily restricted to unrestricted net assets. Unrestricted net assets are those not subject to donor-imposed restrictions.

Cash and Cash Equivalents — Resources invested in money market funds and short-term investments with original maturities of three months or less, when purchased, are classified as cash equivalents, except that any such investments held by external investment managers are classified as investments.

Investments — Investments are stated at fair value (Note C). The fair value of marketable fixed income and equity securities and short-term investments is based on quoted market prices for those of similar financial instruments. The fair value of alternative investments, including limited partnership and similar interests, is based on information provided by external investment managers as of the most recent valuation date prior to year-end. The fair value of real estate and other investments is estimated by professional appraisers or Institute management. Mortgages and notes receivable are carried at cost, which approximates fair value. Purchases and sales of securities are recorded on trade dates, and realized gains and losses are determined on the basis of the average cost of securities sold.

The Institute engages a number of outside parties to manage its marketable securities and private equity investment portfolios. The Institute's investment strategy incorporates certain financial instruments which involve, to varying degrees, elements of market risk and credit risk in excess of amounts recorded in the financial statements. Some of the Institute's money managers use interest-rate futures contracts to modify the interest-rate sensitivity of investments in fixed income securities. Management believes that the risk associated with these derivatives is not material to the Institute as of September 30, 2000.

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. Pooled endowment and similar funds are invested on a total return basis to provide both income and investment appreciation. The Institute utilizes a pooled endowment spending policy that establishes allocations for current spending, consistent with an annual budget plan approved by the Board of Trustees. The spending policy allows the expenditure of a prudent amount of the total investment return over a period of time that preserves the future purchasing power of endowment principal.

Fair Value of Financial Instruments — For those financial instruments for which it is practical, the following methods and assumptions are used to estimate fair value:

Cash and cash equivalents – Cost approximates fair value.

Accounts receivable – Amounts receivable under contracts and grants are carried at cost, which approximates fair value. Student accounts and notes receivable are carried at cost, less an allowance for doubtful accounts. Determination of the fair value of student accounts and notes receivable could not be made without incurring excessive costs.

Bonds and notes payable – The fair value of revenue bonds payable is estimated based on quoted market prices for the bonds or similar financial instruments and approximated $116,031 and $113,388 at September 30, 2000 and 1999, respectively.

Property, Plant and Equipment — 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 made available for this purpose from various sources. Property acquired under both federal and non-federal grants in which title does not ultimately vest in the Institute is not recorded.

Split-Interest Agreements — The Institute's split-interest agreements with donors consist primarily of irrevocable charitable remainder trusts for which the Institute serves as trustee and charitable gift annuities. Assets held in these trusts are included in investments at fair value. Contribution revenues are recognized at the dates the trusts are established after record-

ing liabilities for the actuarially-determined present value of the estimated future payments to be made to the beneficiaries. The actuarial liability is based on the present value of future payments discounted 7.6% for the years ended September 30, 2000 and 1999, and 1990 Group Annuity Mortality Tables. The liabilities are adjusted during the term of the trusts for changes in the fair value of the assets, accretion of discounts, and other changes in the estimates of future benefits.

The Institute is also the beneficiary of certain trusts held and administered by others. The present values of the estimated future cash receipts from the trusts are included in Prepaid Expenses and Other Assets in the Balance Sheets. Contribution revenues are recognized at the dates the trusts are established. Distributions from the trusts are recorded as investment income and the carrying value of the assets is adjusted for changes in the estimates of future receipts.

Jet Propulsion Laboratory — The Institute manages JPL under a cost-reimbursable contract with NASA. JPL land, buildings, and equipment are owned by the United States Government and excluded from the Institute's financial statements. Receivables and liabilities arising from JPL operating activities are reflected in the Institute's financial statements. The direct costs of organized research and the related reimbursement of these costs arising from JPL activities are segregated in the Statements of Activities. The management allowances earned under the contract also are included in the Statements of Activities.

Revenue Recognition — The Institute's policies are as follows:

Tuition and Fees – Student tuition and fees are recorded as revenues in the year during which the related academic services are rendered. Student tuition and fees received in advance of services to be rendered are recorded as deferred revenues.

Investment Return – Investment income and realized and unrealized gains and losses are recorded on trade date and reported as increases or decreases to the appropriate net asset category.

Gifts – Gifts from donors, including contributions receivable (unconditional promises to give), are recorded as revenues in the year received. Contributions receivable are reported at their discounted present values, and an allowance for amounts estimated to be uncollectable is provided. Donor-restricted gifts which are received and spent within the same year are reported as unrestricted revenue. Gifts of long-lived assets with no donor-imposed time restrictions are reported as unrestricted revenue in the year received. Gifts restricted to the acquisition or construction of long-lived assets are reported as temporarily restricted revenue. The temporarily restricted net assets resulting from these gifts are reclassified to unrestricted net assets when the donor-imposed restrictions are fulfilled.

Grants and Contracts – Revenues from grants and contracts are reported as increases in unrestricted net assets, as allowable expenditures under such agreements are incurred.

Expenses — Expenses are generally reported as decreases in unrestricted net assets. The financial statements present expenses by functional classification in accordance with the overall educational and research mission of the Institute.

Depreciation expense is allocated directly based upon the nature of the underlying assets. Interest expense on external debt is allocated to the functional categories that have benefited from the proceeds of such debt.

Accounting Estimates — The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America requires management to make estimates and judgments that affect the reported amounts of assets and liabilities and dis-

closures of contingencies as of the date of the financial statements and revenues and expenses recognized during the reporting period. Actual results could differ from those estimates.

Reclassifications — Certain amounts in the 1999 financial statements have been reclassified to conform to the current year's presentation.

Note C — INVESTMENTS

Institute investments consisted of the following at September 30:

	2000	*1999*
Government fixed income securities	$ 141,654	$ 193,167
Corporate fixed income securities	185,055	96,192
Domestic equity securities	840,151	764,932
International equity securities	216,281	203,278
Limited partnerships/alternative investments	255,985	78,550
Short-term investments	116,348	48,024
Real estate mortgages, notes, and other	25,221	35,916
Total investments	$1,780,695	$ 1,420,059

At September 30, investments were categorized as follows:

	2000	*1999*
Consolidated endowment pool	$1,504,971	$ 1,191,523
Separately invested endowments	66,585	67,701
Trusts, annuities and other	209,139	160,835
Total investments	$1,780,695	$ 1,420,059

Investment return for the years ended September 30, 2000 and 1999, was as follows:

	2000	*1999*
Interest and dividend income	$ 48,043	$ 26,450
Net realized gains	199,884	57,840
Net unrealized appreciation	119,826	153,299
Less: Management fee	(3,047)	(2,130)
Total investment return	$ 364,706	$ 235,459

At September 30, 2000 and 1999, the Institute had committed to invest $131,280 and $100,725, respectively, with alternative investment managers and/or limited partnerships over approximately the next ten years.

Note D — PROPERTY, PLANT, AND EQUIPMENT

Property, plant, and equipment consists of the following at September 30:

	2000	*1999*
Land and land improvements	$ 40,560	$ 39,641
Buildings (including construction in progress)	395,398	368,876
Equipment	472,254	561,773
Property, plant, and equipment — cost	908,212	970,290
Less: accumulated depreciation	(336,772)	(347,152)
Property, plant, and equipment — net	$ 571,440	$ 623,138

Depreciation has been calculated with estimated useful lives of 20, 40, and a range of 3 to 50 years for land improvements, buildings, and equipment, respectively.

During the current year, the Institute completed a physical inventory of certain equipment used in research activities. The physical inventory indicated a difference between the amounts recorded in the financial statements and the equipment inventory records. Accordingly, the Institute wrote off approximately $51,434 in equipment, net of accumulated depreciation. This amount has been included in the Statement of Activities for the year ended September 30, 2000.

Note E — CONTRIBUTIONS RECEIVABLE

Contributions receivable consist of unconditional promises to give to the Institute in the future and are recorded after discounting the present value of the future cash flows at the risk-free rate appropriate to the pledge at the date of the gift. A discount rate of 4.50% was used in both 2000 and 1999. At September 30, contributions receivable are expected to be realized as follows:

	2000	*1999*
Within one year	$ 21,201	$ 17,993
Between one year and five years	27,904	29,129
More than five years	10,474	880
Subtotal	59,579	48,002
Less allowance for uncollectible pledges	(1,633)	(1,387)
Less discount	(5,133)	(2,746)
Total	$ 52,813	$ 43,869

Contributions receivable at September 30, 2000 and 1999, have the following restrictions:

	2000	1999
Endowment for programs, activities, and scholarships	$17,413	$11,617
Building construction	27,637	20,554
Education and general	14,529	15,831
Total	$59,579	$48,002

Note F — BONDS AND NOTES PAYABLE

Bonds and notes payable as of September 30 were as follows:

Issuer	*Description*	*Interest rate*	*Principal outstanding* 2000	1999
California Educational Facilities Authority (CEFA)	Series 1994 revenue bonds due January 2024	Variable-weekly reset (4.15% at 9/30/00; 3.40% at 9/30/99)	$ 30,000	$ 30,000
	Series 1998 revenue bonds due October 2028 (net of issue discount of $6,574)	4.25% to 4.50%	97,291	96,821
Bank of America	Revolving bank credit facility (unsecured) with a limit of $50,000, expires June 2001	Variable-LIBOR + 0.2% (6.87% at 9/30/00; 5.58% at 9/30/99)	16,000	22,000
Total bonds and notes payable			$143,291	$148,821

In October 1998, CEFA issued $103,865 of revenue bonds on behalf of the Institute (with an original issue discount of $7,044) for the purpose of financing the acquisition, construction, and completion of additional academic, research, administrative, and maintenance facilities, and to advance refund the $43,075 outstanding principal amount of the CEFA Series 1991 bonds. The Series 1998 bonds are repayable with interest from the general revenues over a 30-year period. The bonds are subject to an early redemption premium if redeemed prior to October 1, 2010. The early extinguishment of the Series 1991 bonds resulted in a loss of $2,488, which is reflected in the Statement of Activities.

Principal repayments on bonds and notes payable for the next five years and thereafter are as follows:

Year ending September 30	*Principal amount due*
2001	$ 16,000
2002	-
2003	-
2004	-
2005	-
Thereafter	127,291
Total	$ 143,291

Note G — ALLOCATED EXPENSES

Campus operating expenses for the years ended September 30, 2000 and 1999, included the following allocated expenses:

	2000			
	Operating	*Allocations*		
	Expenses	*Depreciation*	*Interest*	*Total*
Instruction and academic support	$ 119,668	$ 12,676	$ 1,841	$ 134,185
Organized research	134,669	34,315	2,918	171,902
Institutional support	67,435	1,011	977	69,423
Plant operation and maintenance	20,856	4,969	366	26,191
Auxiliary enterprises	20,043	4,058	1,730	25,831
Total	$ 362,671	$ 57,029	$ 7,832	$ 427,532

	1999			
	Operating	*Allocations*		
	Expenses	*Depreciation*	*Interest*	*Total*
Instruction and academic support	$ 115,573	$ 6,639	$ 1,492	$ 123,704
Organized research	141,166	25,869	2,230	169,265
Institutional support	62,494	654	811	63,959
Plant operation and maintenance	31,876	2,934	304	35,114
Auxiliary enterprises	22,254	1,402	1,301	24,957
Total	$ 373,363	$ 37,498	$ 6,138	$ 416,999

Note H — COMPONENTS OF NET ASSETS

The following presents the net asset categories by purpose as of September 30:

	2000			
	Unrestricted	*Temporarily Restricted*	*Permanently Restricted*	*Total*
Operating funds	$ 52,658			$ 52,658
Contributions receivable		$ 36,802	$ 16,011	52,813
Student loan funds			12,229	12,229
Invested in plant	409,010	25,362		434,372
Life income and annuity funds		36,797	36,359	73,156
Endowment and other funds functioning as endowment	1,134,985	58,922	371,397	1,565,304
Total	$1,596,653	$157,883	$435,996	$2,190,532

	1999			
	Unrestricted	*Temporarily Restricted*	*Permanently Restricted*	*Total*
Operating funds	$ 27,667			$ 27,667
Contributions receivable		$ 33,441	$ 10,428	43,869
Student loan funds			11,208	11,208
Invested in plant	480,213	9,971		490,184
Life income and annuity funds		34,991	35,625	70,616
Endowment and other funds functioning as endowment	854,444	45,002	339,262	1,238,708
Total	$1,362,324	$123,405	$396,523	$1,882,252

Note I — RETIREMENT PLANS

Institute retirement plans, covering substantially all of its employees, 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 that was 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) a successor defined benefit pension plan which could be elected by participants who attained age 55 and had 10 or more years of service and (2) the defined contribution plan for all other employees. Substantially all 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 benefit for the successor defined benefit plan for the years ended September 30, 2000 and 1999, was as follows:

	2000	1999
Service cost — benefits attributed to service during the year	$ 200	$ 253
Interest cost on projected benefit obligation	2,698	2,280
Actual return on plan assets	(6,175)	(4,167)
Amortization and deferral	3,213	1,359
Net periodic pension benefit	$ (64)	$ (275)

The reconciliation of funded status as of September 30, 2000 and 1999, was as follows:

	2000	1999
Projected benefit obligation at beginning of year	$ 33,276	$36,698
Service cost	200	253
Interest cost	2,698	2,280
Benefits paid	(2,387)	(2,083)
Actuarial (gain)/loss	4,381	(3,872)
Projected benefit obligation at end of year	38,168	33,276
Fair value of plan assets at beginning of year	38,221	36,137
Actual return on plan assets	6,175	4,167
Benefits paid	(2,387)	(2,083)
Fair value of plan assets at end of year	42,009	38,221
Funded status	3,841	4,945
Unrecognized net actuarial gain	(1,448)	(2,617)
Prepaid benefit cost	$ 2,393	$ 2,328

Annual discount rates of 7.75% (7.50% in 1999), an expected return on plan assets of 8.00% (8.00% in 1999) and a 4.75% (5.00% in 1999) annual rate of increase in compensation were assumed.

Pension costs for the defined contribution plan for the year ended September 30, 2000, were $12,176 ($10,783 in 1999) for the campus and $36,377 ($34,480 in 1999) for JPL.

Note J — POSTRETIREMENT AND POSTEMPLOYMENT BENEFITS OTHER THAN PENSIONS

The Institute provides certain postretirement health and life insurance benefits. The Institute's policy is to amortize any actuarial deferrals resulting from changes in the accumulated postretirement benefit obligation over the average future working lifetime of its employees.

Amounts included in the Statements of Activities are summarized as follows:

	2000	*1999*
Service cost — benefits attributed to service during the year	$ 7,487	$ 6,968
Interest cost on accumulated benefit obligation	16,559	14,705
Amortization of actuarial deferral	3,247	4,152
Net	$27,293	$25,825

The reconciliation of unfunded status as of September 30, 2000 and 1999, was as follows:

	2000	*1999*
Benefit obligation at beginning of year	$226,090	$218,519
Service cost	7,487	6,968
Interest cost	16,559	14,705
Retiree contributions	1,654	1,455
Benefits paid	(9,867)	(9,526)
Actuarial (gain)/loss	12,335	(6,031)
Accumulated postretirement benefit obligation	254,258	226,090
Remaining actuarial deferral	(86,236)	(77,148)
Total	$168,022	$148,942

The Institute expects to recover approximately one-half for the campus and all for JPL of this postretirement obligation through future charges to United States government grants and contracts. The amount relating to JPL of $133,545 ($119,045 in 1999) is included in the Balance Sheet as part of accounts payable and accrued expenses. A deferred United States government billing of the same amount has been recorded because certain provisions set forth in the Institute's contract with NASA provide for reimbursement of such costs if the contract should ever be terminated. The Institute also has recorded a deferred United States government billing of approximately $32,265 ($31,477 in 1999) relating to accrued vacation benefits that are covered by similar contract provisions. Although these deferred billing amounts may not be currently funded, and therefore may need to be funded as part of future NASA budgets, the Institute believes it has the contractual right to insist that such funding be made available.

An annual discount rate of 7.75% (7.50% in 1999) and a 9.00% (5.50% in 1999) annual rate of increase in the per capita cost of covered health care benefits for retirees were assumed for 2000. The cost trend rate is assumed to be 8.00% in 2001, 7.50% in 2002, 7.00% in 2003, 6.50% in 2004, 6.00% in 2005, and 5.50% in 2006 and beyond. The health care cost trend rate has a significant effect on the amounts reported. A one-percentage-point change in assumed health care cost trend rates would have the following effects:

	1% Increase	*1% Decrease*
Effect on total of service and interest cost components	$ 4,925	$ (3,812)
Effect on postretirement benefit obligation	41,503	(33,263)

Note K — CONTINGENCIES

The Institute receives funding or reimbursement from governmental agencies for various activities, which are subject to audit, and is a defendant in various legal actions incident to the conduct of its activities. Except as specifically discussed below, management does not expect that liabilities, if any, related to these audits or legal actions will have a material impact on the Institute's financial position.

In February 1997, the Office of Inspector General of NASA issued a subpoena for a large number of financial records relating to the operation of JPL. The Institute has provided the requested financial records and Institute representatives have had ongoing discussions with appropriate government officials. Government officials have made no claims against the Institute but their investigation of the financial records has not been concluded. The Institute is unable to predict whether any claims may be made, or if made, the ultimate resolution thereof.

The Institute is also a defendant in a civil lawsuit seeking to recover damages arising out of the alleged discharge of toxic materials at or near JPL. The Institute has denied all of the plaintiffs' material allegations, has asserted various affirmative defenses and has asserted claims against the United States government for indemnification. The Institute intends to defend this case vigorously and to press its indemnification claims.

The Institute has been named as a potentially responsible party (PRP) by NASA under the Comprehensive Environment Response, Compensation and Liability Act, as amended. As a PRP, the Institute may be jointly liable for contribution towards clean-up costs, estimated to be in excess of $100 million, of the NASA/JPL Superfund site. The Institute believes that it will have recourse to the government for any liabilities it may incur in connection with being named a PRP for that site.

Officials of the Institute presently are not able to predict the impact, if any, that final resolution of the matters discussed in the preceding three paragraphs will have on the Institute's financial position or operating results.

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REPORT OF INDEPENDENT ACCOUNTANTS

To the Board of Trustees of
California Institute of Technology

In our opinion, the accompanying balance sheets and the related statements of activities and of cash flows present fairly, in all material respects, the financial position of the California Institute of Technology ("the Institute") at September 30, 2000 and 1999, and the changes in its net assets and its cash flows for the years then ended in conformity with accounting principles generally accepted in the United States of America. 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 audits. We conducted our audits of these statements in accordance with auditing standards generally accepted in the United States of America, 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 audits provide a reasonable basis for our opinion.

PricewaterhouseCoopers LLP

November 29, 2000

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