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Caltech News

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In This Issue

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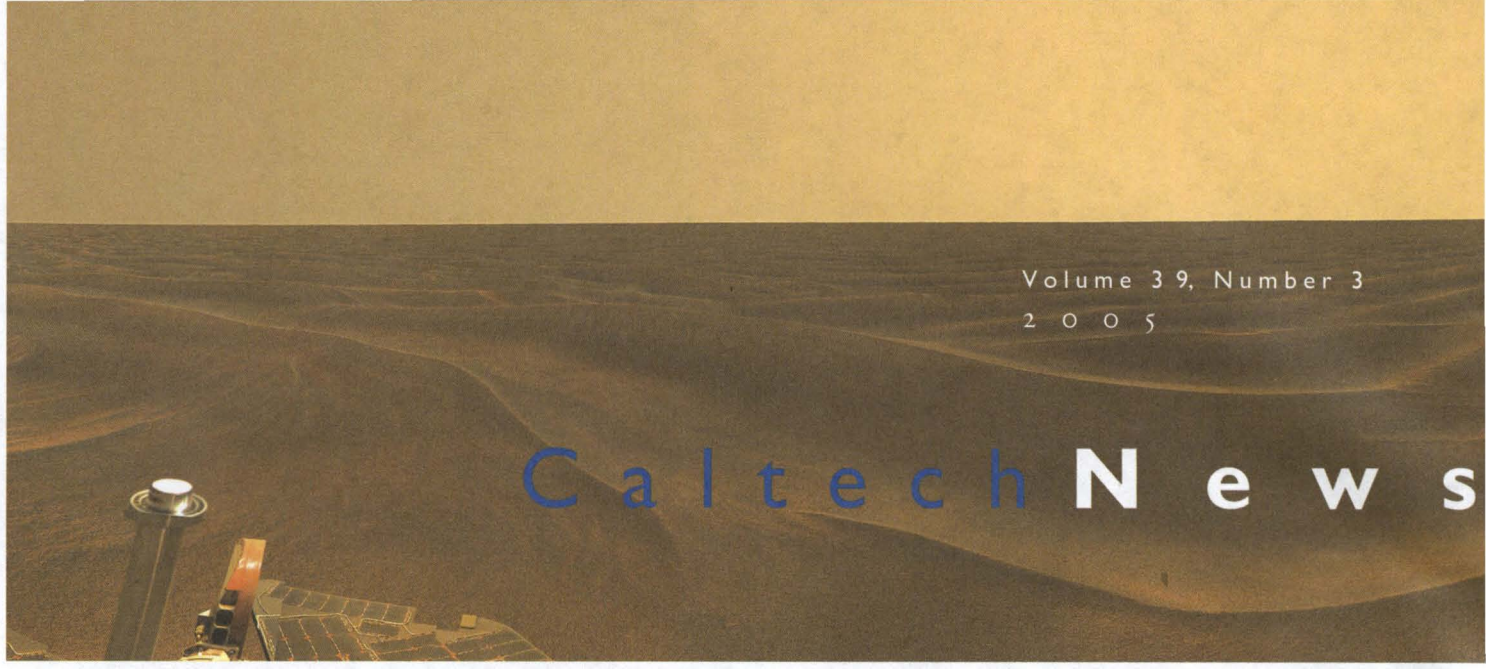

Volume 39, Number 3
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CaltechNews

ON THE COVER
Caltech made headlines twice during the first week of October. Atkins Professor of Chemistry Robert Grubbs (at right) was awarded the Nobel Prize in chemistry, and his fellow Nobel laureate (1975), Caltech president David Baltimore, announced that he will retire next year to focus full time on his research. On October 10, the two newsmakers joined other faculty, students, and staff at a party to congratulate the laureate and celebrate the Institute's 32nd Nobel Prize. Grubbs is the third faculty member to win the chemistry prize in recent years; it went to Noyes Professor Rudy Marcus in 1992 and to Pauling Professor Ahmed Zewail in 1999. For more on the new Nobelist, see Up Front below. For more on the president's plans, see page 4.

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Up Front

Polymer chemist bonds with Nobel Prize

By Rhonda Hillbery

Back in the 1960s when he was a graduate student, Robert Grubbs became intrigued by a then little-understood chemical reaction. "When I started, it was a fundamental question: 'How does this thing possibly happen?'" Speaking like a true research chemist, he adds, "There was no thought then of applications or anything else."

He couldn't foresee that his area of study—metathesis—would transform the field of polymer chemistry and prove to have applications ranging from the prosaic to the profound. It's helped create new drugs, less toxic production processes, and environmentally friendlier pest control. And on October 5, it won Grubbs the Nobel Prize in chemistry. He and his two cowinners were cited specifically "for the development of the metathesis method in organic synthesis."

Organic synthesis involves manipulating the molecular compounds that give rise to life—in other words, those that contain carbon. Metathesis is a reaction in which chemists selectively strip out certain atoms from one carbon compound and swap them with atoms from another compound. The end result is a custom-built molecule that has specialized properties.

Grubbs, 63, has worked in a branch of this field called olefin metathesis—metathesis that involves hydrocarbons, such as ethylene, that contain double bonds. Before he began his research into "how this thing could possibly happen," metathesis was poorly understood and of limited value to scientists. Grubbs's key contribution was to develop a powerful new catalyst for metathesis—"magic dust," he colloquially calls it—that made it possible to create tailor-made molecules.

"My colleagues and I just came up with the molecules. We didn't think about ways of explaining it."

The Nobel citation says that use of the catalyst and its variations have improved industrial and pharmaceutical production processes, making them more efficient and less wasteful, as well as simpler and more environmentally friendly. "This represents a great step forward for 'green chemistry,' reducing potentially hazardous waste through smarter productions," the Royal Swedish Academy of Sciences announced. "Metathesis is an example of how important basic science has been applied for the benefit of man, society, and the environment." As for his catalyst that started it all, Grubbs says, "There are now about 15 variations of the basic structure."

The lanky professor insists that he was surprised by the Nobel, although he admits that "people whisper in your ear." He was spending a month as an Erskine Fellow at the University of Canterbury, in Christchurch, New Zealand, when he received the call from Stockholm at about 10:30 p.m., after a long day of traveling. He and his wife, Helen, were sitting around the fire "keeping warm and finishing a late dinner" when the phone rang. Over the next few hours, the new laureate celebrated with a bottle of port while he fielded a succession of media calls from around the world. Finally, he unplugged the phone and went to bed.

Actually, the laureate wasn't the first in the family to learn the news. That honor went to son Brendan, who has just started an ob-gyn residency at USC Medical School and is temporarily living at his parents' home. "While he's settling in, he's staying in his old place at home," says Grubbs. "So he got to answer the phone call from Sweden, and passed along the phone numbers of how to reach us."

After Grubbs heard from Sweden, his first calls were to his other children. Son Robert B. (Barney) is a polymer chemist and professor at Dartmouth, and daughter Kathleen is a graduate student studying clinical psychology at the University of Hawaii.

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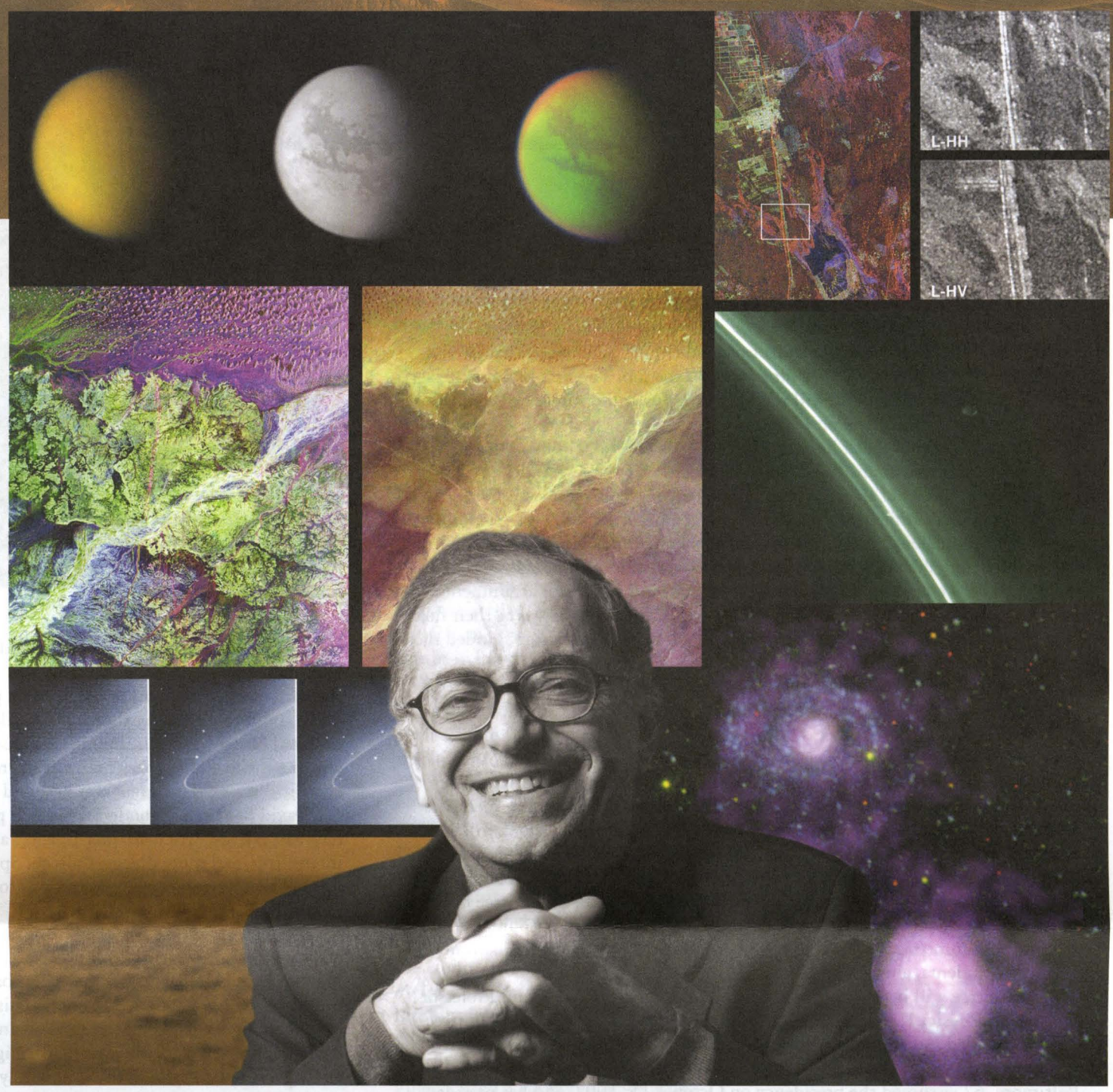

Mr. Elachi's Neighborhood. It's getting more diverse all the time. Clockwise, from bottom left, the first glimpse ever of the surface of Saturn's moon Titan taken by the Cassini spacecraft's Huygens probe; Cassini's time-elapsed images of Saturn's G-ring; spaceborne imaging radar (SIR) view of the Arabian desert's Empty Quarter; Titan imaged at three different wavelengths; SIR image of China's Great Wall; Cassini view of Saturn's F-ring; companion galaxies, imaged in the ultraviolet by the Galaxy Evolution Explorer (GALEX) Telescope. Top: Panoramic view of Mars taken by the Opportunity rover and named "Rub al Khali" ("Empty Quarter" in Arabic) after its terrestrial counterpart.

On Top of the Worlds

It's been almost five years since Charles Elachi, PhD '71, accepted what he calls the "best job in the world," that of directing the Jet Propulsion Laboratory. In fact, the position seems almost tailor-made for the dedicated space scientist, who has spent his entire career at JPL, starting with a part-time job he took while working on his Caltech PhD in the late 1960s. He signed on full-time straight out of graduate school and in the early 1980s, after a series of pioneering contributions in the field of radar remote sensing, began a gradual move into the upper ranks of JPL administration, culminating in his appointment to the executive council in 1987. As director of the space and Earth science programs, Elachi oversaw the planning and development of the lab's flight instruments and numerous flight missions. He also continued to teach a radar remote sensing course on campus and had just concluded a class lecture in January 2001, when Caltech president David Baltimore called him to his office and offered him the JPL director's job.

On Elachi's watch, JPL has achieved some stunning successes, among them the Spirit and Opportunity explorations of Mars, the Cassini mission to Saturn, the Deep Impact mission to Comet Tempel 1, and the cosmic surveys carried out by the Spitzer and GALEX telescopes. His tenure has also been marked by priority shifts and cost-cutting at NASA, developments that have led to the deferral of a few JPL missions and prompted Elachi to enact a hiring freeze this past September in an effort to save jobs and hold down costs.

"In spite of the near-term budget reductions, we still have a healthy portfolio of exciting flight projects," he said in a letter to the JPL community at that time. "Our recent successes have been tremendously helpful in keeping the impact on us to a moderate level. I am confident that the future of the lab remains a positive one."

In this interview, conducted this past summer with Caltech News *editor Heidi Aspaturian, Elachi talks about the extraordinary trajectory that brought him from the mountains of his native Lebanon to the highlands of Mars, and offers his views on the current and future state of JPL and space exploration.*

In previously published interviews, you've talked about how you were interested in space and space exploration from a very young age. You've also mentioned that your parents did not have advanced educations. Yet, you went to the University of Grenoble for your undergraduate work, then came to Caltech for your PhD. How did all this come about?

I grew up in a very small village in the mountains of Lebanon, with probably no more than a thousand people. Our house had a big patio, and at night I used to sleep there—I would pull out a little mattress and some camping gear, and I always used to look at the sky and at those beautiful stars and think, "Are we alone in this place? Or is there somebody else watching us?" To this day, I can remember very clearly when the first Sputnik was launched and how, as a kid, I first heard the sound of the beeping broadcast on the radio. So, from an early age I was fascinated with space exploration, but I never thought that I would end up in a place like JPL.

But, then I did very well in school and was always at the top of my class in math and science. Neither of my parents had gone beyond middle school, but they saw education as extremely important and put everything they could into educating their children. In Lebanon we have a system very much like that in France, where every graduating high-school student takes a national exam to assess their readiness for university. I took that and scored the highest in the country in math and science, which led to my getting a fellowship from the ministry of education to go anywhere in the world to study science or engineering. Having grown up in Lebanon, I was more a product of French schools, so I decided to go to the University of Grenoble, and I majored in telecommunications and physics there.

While I was there, I became friendly with some American exchange students, and eventually somebody said, "Gee, I hope you can come to the U.S. to study." I figured I had nothing to lose so I applied to study in the United States. I was accepted at several universities, but Caltech offered me a very attractive Ford Foundation Fellowship. And, of course, being a naïve college student, I thought, "Gee, it looks like this is in California, next to Hollywood." That seemed very appealing.

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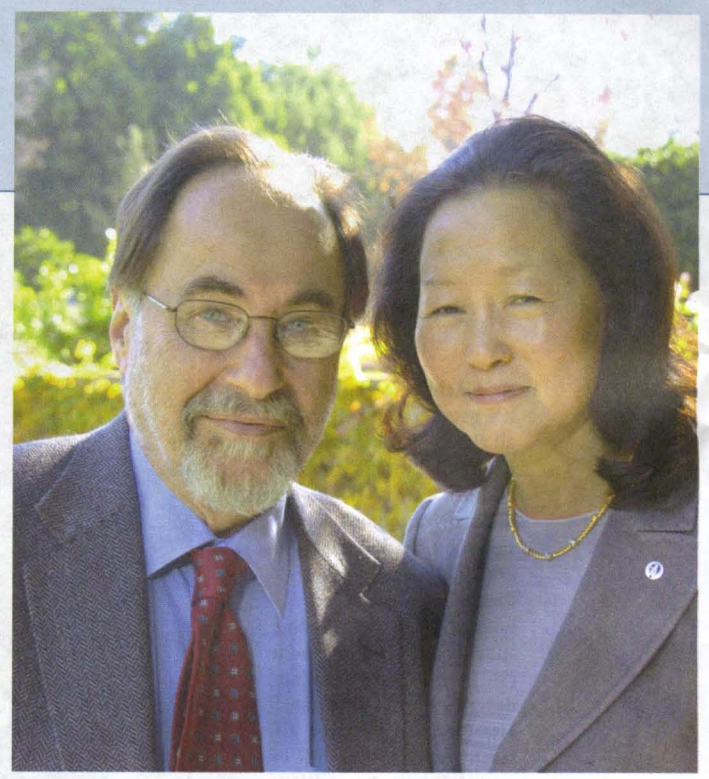

David Baltimore is stepping down from the presidency, but he and his wife, faculty associate in biology Alice Huang, are looking forward to remaining members of the Caltech community.

Baltimore to retire as president in '06

David Baltimore, the seventh president of Caltech, has announced that he will retire on June 30, 2006, after nearly nine years on the job. The first biologist to serve as Caltech's president, Baltimore will remain at the Institute, where he intends to focus on his scientific work and on teaching.

"This is not a decision that I have made easily," Baltimore said in an October 3 letter to the campus community and Caltech's Board of Trustees, "but I am convinced that the interests of the Institute will be best served by a presidential transition at this particular time in its history. By next summer we will be well along in the process of implementing our plans to strengthen the financial foundation of the Institute. Although our $1.4 billion campaign is not scheduled for completion until the end of 2007, we have made remarkable progress, and successful attainment of its audacious goals will remain my highest priority. As these endeavors near their final stages, it will be time for the Institute to once again turn to the future, guided most effectively by the revitalizing vision and leadership of a new president."

Baltimore has agreed to remain in the position until a successor is named. Two committees—a faculty search committee and a trustee selection committee—will lead the search and selection process for his successor, which is expected to take several months. Trustee Chairman Kent Kresa has authorized Bren Professor of Biology and Caltech Faculty Chair Henry Lester to appoint the faculty committee, which will be composed, in Lester's words, of "about eight respected and wise members of the faculty." At least one professor from each of Caltech's six divisions will serve on the committee, which will recommend several candidates it feels are eminently qualified to the trustee selection committee, which Kresa will establish and chair.

Lester will seek widespread faculty advice in formulating the committee but will not himself serve on it. He adds that "Chairman Kresa and I will encourage the faculty search committee to seek input from the entire Caltech and JPL community: faculty, staff, students, alumni, and trustees."

The committee will be advised, as needed, by Feynman Professor and Professor of Theoretical Physics Kip Thorne '62, who chaired the faculty search committee that recommended Baltimore's appointment to the trustees in 1997. The Institute's Board of Trustees will make the final selection of Caltech's new president.

Baltimore, 67, assumed the presidency on October 15, 1997, and has presided over many significant events at Caltech during his tenure. Early on, he oversaw the completion of a fund-raising initiative for the biological sciences, marked by the construction and dedication of the Broad Center for the Biological Sciences. He launched the current $1.4 billion capital campaign, which has included receipt of the largest gift to higher education, $600 million from Gordon and Betty Moore and the Gordon and Betty Moore Foundation. With two years yet to run, the campaign has raised almost $1.1 billion. Baltimore's presidency has been marked by a series of successes at JPL (which Caltech manages for NASA), as well as the appointment of a new director, Charles Elachi, PhD '71, in 2001.

His term of office has also seen Caltech acquire the former St. Luke Medical Center in northeast Pasadena; fund the design-development phase of the Thirty Meter Telescope; and establish the Information Science and Technology (IST) initiative. Baltimore has championed contemporary architecture for new buildings on the Caltech campus, choosing James Freed of Pei, Cobb, Freed for the Broad Center, Tom Mayne of Morphosis for the new Cahill Center for Astronomy and Astrophysics, and Rem Koolhaas for the new Walter and Leonore Annenberg Center for Information Science and Technology (the latter two buildings are still in the design phase). He has also worked to increase diversity at Caltech, particularly by bringing more women into administrative roles, and to improve the quality of undergraduate life by appointing Caltech's first full-time vice president for student affairs and initiating a $3 million fund for enhancing student life. During the last year, an important activity for him has been his membership on the Independent Citizens Oversight Committee for the California stem cell initiative.

"It has been a privilege to serve as president of Caltech and a pleasure to work with the dedicated and remarkable Caltech faculty, staff, students, trustees, and alumni," said Baltimore. "During my time in the president's office, I have worked to keep Caltech the unique and highly effective university that was imagined into existence by George Ellery Hale almost 100 years ago. Its dedication to excellence has been undiminished, requiring that it continually be in flux, reaching for the altering frontiers of knowledge. The great gift from Gordon and Betty Moore has provided the resources for maintaining our momentum and was truly a defining event of my time as Caltech's president."

Speaking of his years with the Institute, Baltimore went on to say, "Together, we have accomplished much over the past eight years. We have recruited close to 100 new faculty, 25 new trustees, key senior administrators and vice presidents, and hundreds of highly skilled campus and JPL staff members. I am particularly proud of the quality of the nine classes of students who will have graduated during my tenure here." He added, "Most importantly, we have created new educational opportunities and initiated the exploration of new fields of inquiry, supported by our generous and visionary donors."

Baltimore will remain at Caltech as a professor of biology. In June he was awarded a $13.9 million grant by the Grand Challenges in Global Health initiative for his proposal "Engineering Immunity Against HIV and Other Dangerous Pathogens," which aims to address the challenge of creating immunological methods to deal with chronic diseases. This grant was awarded by the Bill & Melinda Gates Foundation.

"David has been a wonderful Caltech president," said Caltech faculty chair Lester. "His energy, articulate intelligence, and vision have resulted in a stronger, more interesting, and more diverse Caltech. Speaking also as a Caltech biologist, I'm delighted that he will remain on campus to contribute to our research and teaching programs."

Baltimore, who was 37 when he received the 1975 Nobel Prize for his work on the genetic mechanisms of viruses, has contributed widely to the understanding of cancer, AIDS, and the molecular basis of the immune response. As Caltech's president, he has continued to operate his research lab, which has announced many important findings, including establishing a new methodology to help fight cancer, developing a new gene therapy that is highly effective in preventing HIV from infecting individual cells in the immune system, and creating a new methodology for producing transgenic mice. He has also joined with others in proposing a new global effort to create an HIV vaccine. He received the National Medal of Science in 1999 from President Bill Clinton and the Warren Alpert Foundation Scientific Prize in 2001 for pioneering work leading to cancer therapy.

Baltimore's predecessors in the job of leading "modern-day" Caltech were James A. B. Scherer, Robert A. Millikan, Lee A. DuBridge, Harold Brown, Marvin L. Goldberger, and Thomas E. Everhart.

Recognition

Rana Adhikari, postdoctoral scholar in Caltech's Laser Interferometer Gravitational-Wave Observatory (LIGO) Laboratory, has received the 2005 LIGO Thesis Prize. Awarded by the LIGO Lab and the LIGO Scientific Collaboration (LSC), the prize recognizes "the outstanding PhD thesis. . .based on research carried out within LIGO (either the LIGO Laboratory or the LSC)." Adhikari began working with LIGO at the University of Florida, where "he did important work in the design and specification of the input optics for initial LIGO." He continued in LIGO as a graduate student at MIT.

David Anderson, Sperry Professor of Biology and investigator with the Howard Hughes Medical Institute, has been selected to receive a Humboldt Research Award, which honors "the academic achievements of the award winner's lifetime." Bestowed by Germany's Alexander von Humboldt Foundation, the award can amount to a maximum of 75,000 euros.

Don Anderson, PhD '62, McMillan Professor of Geophysics, Emeritus, has been inducted into the Rensselaer Polytechnic Institute Alumni Hall of Fame, which was created "to preserve and celebrate the exceptional heritage of alumni accomplishments throughout the years."

Tom Apostol, professor of mathematics, emeritus, and director of Project MATHEMATICS!, and Mamikon Mnatsakanian, project assistant, have received the Lester R. Ford Award, established in 1964 "to recognize authors of articles of expository excellence published in the *American Mathematical Monthly* or *Mathematics Magazine*." It honors Apostol and Mnatsakanian for their articles "Isoperimetric and Isoparametric Problems," "A Fresh Look

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Kip Thorne named California Scientist of the Year

Kip Thorne '62, Feynman Professor of Theoretical Physics, has been named the California Scientist of the Year by the California Science Center.

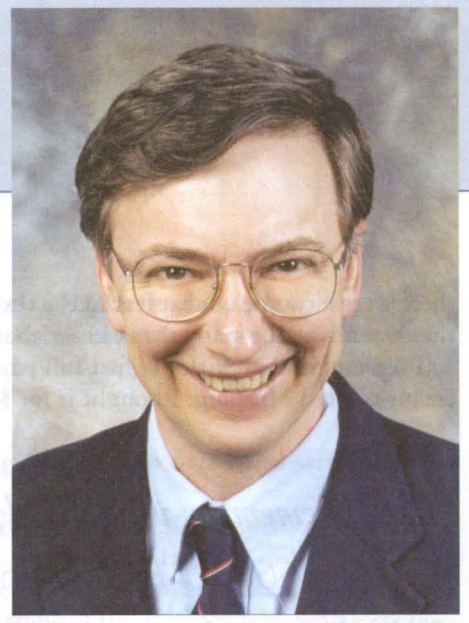
He was honored for being one of the world's leading experts on the astrophysical implications of Einstein's general theory of relativity and, according to the award citation, "for having trained a generation of scientists." Established in 1958, the award honors a nominee whose current research advances the boundaries of any scientific field. Eleven past winners have gone on to become Nobel laureates.

Thorne is internationally recognized as a foremost authority on gravitational waves. His scientific contributions span the full range of topics in general relativity, including black holes, gravity waves, applications of relativity to stellar structure and evolution, and the means of testing general relativity against rival gravity theories. His gravitational-wave work has included predicting the waves' strengths and temporal "signatures" as observed on Earth; cofounding the Laser Interferometer Gravitational Wave Observatory (LIGO)—a multi-institution project; and conducting seminal research in quantum nondemolition measurements.

After earning his Caltech BS, Thorne received his PhD from Princeton in 1965, and returned to the Institute as an associate professor in 1967. He was named professor in 1970, Kenan Professor in 1981, and Feynman Professor in 1991. Approximately 40 physicists have received their PhDs at Caltech under his mentorship. His many honors and awards include election to the American Academy of Arts and Sciences and the National Academy of Sciences, and he has received the American Physical Society's Lilienfeld Prize and the German Astronomical Society's Karl Schwarzschild Medal.

Thorne has authored more than 200 technical articles and reports, and his 1994 book for nonscientists, *Black Holes and Time Warps: Einstein's Outrageous Legacy*, received the American Institute of Physics Science Writing Award, the Phi Beta Kappa Science Writing Award, and the (Russian) Priroda Readers' Choice Award. In 1973 Thorne coauthored the textbook *Gravitation*, from which most of the present generation of scientists have learned general relativity theory.

Thorne now joins a distinguished list of Caltech professors who have been honored as California Scientist of the Year, including planetary scientist and astrophysicist Peter Goldreich, chemist Harry Gray, seismologist Hiroo Kanamori, physicist Andrew Lange, and astronomers Gerry Neugebauer and Maarten Schmidt.



David Rutledge is the new head of engineering and applied science.

Wireless guru plugs into chairmanship

The Division of Engineering and Applied Science is something of an 800-pound gorilla, developing world-changing technology while providing an academic home base for about half of Caltech's undergrads. Now this Institute heavyweight has a new leader.

David Rutledge, the Tomiyasu Professor of Electrical Engineering, took over on September 1. A leader in the wireless telecommunications revolution, Rutledge succeeds Richard Murray, professor of control and dynamical systems. Wireless technology uses radio waves for information exchange and is rapidly changing how people communicate everywhere, from Wall Street to West Timor.

Out of the chute, Rutledge expects to be busy moving forward on the many plans and projects set into motion by his predecessor. "Richard Murray was extremely active and initiated a lot of new activities. I think the first goal is to try to meet the commitments he made." The division has mapped out an unambiguous strategic plan to be the "international leader in science-based engineering research."

Along with its bonanza of students, says Rutledge, "EAS has by far the largest number of faculty, so it's really quite different from other divisions. Becoming chairman is a very serious commitment that restricts teaching and to some extent research as well."

President Baltimore says that Rutledge is a perfect match for the challenges ahead. "Dave has a remarkable record of accomplishment in an area of science—electronics—that has a real impact on our daily lives. He will provide strong leadership at a time when invention and discovery in engineering is occurring at a spectacular pace."

A Texas native who speaks without a trace of a twang, Rutledge wrote a classic textbook, *The Electronics of Radio*, now in its fourth printing. And his work on microwave circuits has opened new avenues in wireless communications, remote sensing, and satellite communications.

Rutledge earned his mathematics BA in 1973 at Williams College and his MA in electrical sciences at the University of Cambridge in 1975 before heading off to work in private industry. Back in his hometown of Fort Worth he designed microwave data-link systems for Lockheed in 1975–76 before enrolling at UC Berkeley, where he earned his PhD in electrical engineering in 1980. "I met my wife there, so I'm very grateful to the University of California," he says. His wife, Dale Yee, also a longtime campus employee, is a computer systems administrator in Moore Laboratory, where she designs and maintains websites and produces computer graphics for publications. They have raised two girls and a boy, all currently attending college or graduate school. Son Robb attended Caltech, majoring in biology and graduating in 2002.

With a faculty that currently numbers around 80, EAS hopes to add as many as 20 new professors in coming years, some of them holding joint appointments with other divisions. The division also will see some of its faculty move into new digs when the Annenberg Center for Information Science and Technology and the Kavli Nanoscience Institute are completed.

The multifaceted nature of these new enterprises reflects the fact that the engineering and applied science division has become a primary locus of interdisciplinary research at Caltech. It currently hosts eight research centers that bring together scientists and engineers from a variety of fields across campus. Rutledge is founding director of one of them, the Lee Center for Advanced Networking, now in its seventh year of operation. The brainchild of Caltech graduate and venture capitalist David L. Lee, PhD '74, whose foundation will fund it for 10 years, the multidisciplinary center is working to develop a future global communication system as dependable and ubiquitous as central heat and running water. Rutledge and his colleagues envision a seamless and reliable global network that would replace today's mishmash of wireless systems plagued by static and lost connections.

Rutledge says that the wireless revolution presents technology challenges that require intensive research collaborations, which the center nurtures through regular seminars and workshops. The Lee Center has also helped build wireless networks on campus, including those in the Moore Laboratory, the Sherman Fairchild Library, Beckman Auditorium, and the Red Door Café.

In current research, Rutledge focuses on integrated-circuit power amplifiers for communications transmitters. "The problem with using transistors for transmitters is that they typically don't have as much power as you'd want," he says. "So we've been interested in technologies to combine transistors. In one situation we've used very large sheets of transistors that act like an antenna that will amplify the power."

He is a founder of a start-up company, Wavestream Wireless, which makes millimeter-wave power amplifiers for satellite communications. Wavestream was spawned by the Lee Center and cofounded by electrical engineering alums Mike DeLisio, PhD '96, and Chad Deckman, PhD '00, who both worked in Rutledge's research group.

Not surprisingly, Rutledge says his new responsibilities will keep him too busy to teach undergraduates this academic year for the first time in his 25 years on campus. In the course of his career, he has advised 35 PhD students and enjoys working with students at all levels, and says that one of his proudest accomplishments is his ASCIT (Associated Students of Caltech) teaching award. "They called and I said, 'You're kidding.' I accepted before they had a chance to change their minds."

In the matter of the Institute budget

Caltech's financial situation has been under review for several months, and on September 27, Caltech president David Baltimore released this statement to the Caltech community.

"Caltech is facing a serious financial challenge: a structural deficit in the general budget that is on the order of $28 million (5.6 percent of the Institute's overall budget). The division chairs, vice presidents, and I have been discussing this issue for several months, and I write now to share with you our general assessment of the problem and how we propose to address it.

"First, some background. This deficit, which concerns only the Institute's general budget (as opposed to the research budgets), is a long-standing problem that has been an inherent part of the Institute's operations for many decades. The shortfall has been evident in some years but in other years it has been masked by windfall revenues and 'fixes' that did not get to the root of the problem. Simply put, we spend too much on the general budget and we have been borrowing money to make up budget shortfalls. By continuing to operate in this manner, the Institute will gradually lose the institutional flexibility required to pursue its world-class research and education enterprise in a changing world. To maintain Caltech's preeminence in scientific research and education, it is essential that we now develop and implement a sounder way of doing business.

"Although some details still need to be worked out, during the annual retreat of the Institute's academic and administrative leadership [in September] individual actions were proposed that together will solve the problem. In our discussions, no expenditure or segment of the campus community was exempt

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Elachi . . . from page 3

So I went to the director of my school and talked with him and with another professor who had spent a year at Harvard. The Harvard professor just happened to have had as his roommate at Harvard, Charlie Papas, who had gone on to become a professor at Caltech. He said Charlie was working in the same fields that interested me, and that Caltech would be a great place for me. That, along with the idea of being next to Hollywood, sold me. I knew about JPL because I followed the news reports about planetary missions—in fact I knew more about JPL than I knew about Caltech. I even knew that they were in the same town, but I never made the connection that they were affiliated until I arrived at the Institute. So that's the set of circumstances that led me here.

The young Elachi used a bike to get to and from his undergraduate studies at the University of Grenoble, in southeastern France, near the Italian border. Arriving at Caltech for graduate work, he found that a bike had limited utility in southern California and quickly made friends with a student or two who had cars.

Whom did you work with at Caltech? What was the adjustment like for you?

The key people were Charlie Papas—who became my PhD adviser—Roy Gould ['49, PhD '56], and Nicholas George. Gould was doing work on waves in plasma, and Nick George was doing research on optics. I also remember taking a class from Amnon Yariv. In general, technically I did very well because I had acquired a very good math and science background, but I did have to work on my English (my wife still thinks I need to work on it). Also, the fact that Caltech was so family-friendly really made it easy for me. At the time I was accepted, Caltech had a program where they offered to place foreign students with American families for a month—I don't know if that program still exists. I was invited to spend a month living with a family in Palos Verdes. The wife was of Lebanese descent, and her husband had worked at Hughes Aircraft—he was the technical side of the family—so it was a very comfortable situation for me and a great introduction to American culture and society. So that really helped tremendously.

The fact that Caltech is small, with friendly faculty, also helped a lot. I was very impressed that one of my professors invited all of his students to his home for Thanksgiving. That kind of hospitality was not very common in Europe; the professors were on more of a pedestal there and you didn't socialize with them. The fact that the professors here were so easygoing and the social milieu quite relaxed really made the transition very easy. Overall, the whole Caltech experience was a very positive one for me, and I think that is reflected in my attachment to the Institute, even now, 30 years later. I still remember very clearly my arrival in America in August 1968—I had $100, a suitcase, my fellowship at Caltech, and that was it.

How did you happen to come to work at JPL?

During my second summer at Caltech, I decided to see if I could get a job at JPL. I contacted people there and went for an interview. I had already started on my thesis, which was on wave propagation in periodic media, and the group I interviewed with was working on imaging radar and wave propagation and so on. They hired me for the summer to do some modeling on the wave propagation in the ionosphere of Jupiter, and I liked it so much that I asked if it would be possible to get a part-time job during the academic year. They said, "Sure," but then it turned out that I couldn't keep my Ford Foundation Fellowship if I was working. So I dropped the fellowship—it was such fun and so exciting to work at JPL.

Then in 1971, shortly before I graduated, my group told me that they had received funding to do a feasibility study about a mission to Venus. They offered me a permanent position as lead technical person on that project. So as soon as I got my PhD, I started on that mission. I was responsible for writing up the report on that study, which was a $300,000 proposal—a fortune in those days. The idea was to look at the concept of putting a synthetic aperture radar into orbit around Venus and mapping the planet. Fortunately, in a Caltech class I had taken with Nick George, there were a couple of chapters in the textbook about synthetic aperture radar—and that was all, at the start, that I knew about it. So I started from there.

I remember that with my first full paycheck from JPL, I went and bought a cream-colored Mustang. I bought it for $750 from an old lady in Pasadena.

"I still remember very clearly my arrival in America in August 1968. I had $100, a suitcase, my fellowship at Caltech, and that was it."

Radar remote sensing was a small field when you first went into it, but has since evolved into a pretty significant aspect of space exploration. Did you sense this potential when you started?

Not exactly. You almost never are aware of these things when they're happening. At that time, all the people working on radar at JPL used to fit in one office. There were probably about 10 or 12 of us, and we did most of our work on an airborne radar instrument that we put on a jet based at Ames Research Center up in Menlo Park. We used to fly all around the world doing science with that radar, which of course was a great experience. We knew that it would take at least a decade to get our Venus mission approved, and, in the meantime, suddenly there was interest in using radar to do space-based ocean mapping—the SEASAT mission. That was in 1978, and I was a member of the SEASAT team. The team began expanding, and we decided to form what we called a radar science group, which would focus on the science and the theory of the radar observations rather than on building the hardware.

Because of my theoretical background, they made me head of that team, which I mostly built from scratch. I went and hired a couple of geologists, a couple of oceanographers, a couple of people who understood electromagnetic waves, a planetary scientist—they were all effectively recent graduates. So here we all were—a group in which almost all of us, including me, were in our 20s. It was a very exciting time. Many of those people are still at JPL and some are in very senior positions.

Then things got really interesting. The space shuttle was scheduled to start flying just before the first SEASAT flight. NASA's original plan had been that except for the astronauts, the shuttle would fly completely empty the first four times. Then somebody in Washington, D.C., had the bright idea of putting an inexpensive payload that was already available on the second flight. So they solicited proposals from researchers who already had instruments available for flying, and our group decided to submit one. We had, fortunately, built two copies of the SEASAT radar: one to fly and one as an engineering model that was supposed to stay on the ground for testing. We proposed to fly some of that engineering hardware on the shuttle, and our idea went through a peer review and was selected.

So, because you had been scrupulous about building redundancy into your project, you had this option?

That's right. Sometimes that just happens—a decision or development opens whole new doors that you haven't thought about. The upshot was that I ended up being the principal investigator on that instrument—Shuttle Imaging Radar (SIR-A—it was the first in a series), which flew on the shuttle in 1981.

I remember that when the shuttle landed, we had to go to Edwards Air Force Base to get all the data, which we had on an optical recorder, and that we then stayed

After the discovery that SIR-A had penetrated beneath surface sand to reveal ancient river channels in the Sahara desert, Elachi (above right) took part in a field trip to the region in 1982, which succeeded in locating those long-buried channels. At left, he explains the significance of some of the SIR-A images to Britain's Prince Andrew, who visited JPL in the 1980s.

up all night processing the images. The next day NASA flew a bunch of us to D.C. so we could show our footage to the NASA administrator, helping to showcase the value of the shuttle. And within two weeks, they had approved flying our next experiment, SIR-B.

How did you decide what you were going to look at for both these missions?

Our choices were primarily based on geologic interests. We wanted to study the geologic history of a variety of areas: tectonic regions, arid regions, and so forth. But what happened after that was totally unexpected. We had taken many images in the Egyptian desert, and when they came down, some of the USGS people who were doing research into that area looked at the maps and said, "You must have labeled these wrong. There aren't river beds and channels like that in Egypt. We've been on the ground in that region, and there is absolutely nothing." So we double-checked our output and verified that we had it labeled correctly. And then it began to dawn on us that we were actually imaging below the surface.

It had not occurred to anyone ahead of time that this might happen?

No, but once we thought about it, we said, "Of course it's obvious. When you have a dry desert terrain with no water, of course the radar should penetrate." I knew this in theory from my background in electromagnetic waves, but it had never occurred to me before to think about it in this context. But that's what had happened. We were seeing channels and river beds a few meters beneath the surface, dating back to a period when North Africa was wetter than it is now, and during the epoch of the pharaohs, when it was more inhabited.

So we ended up doing a field trip to the region. We actually camped for a couple of weeks in the middle of nowhere in the Sahara, and we did trenching, where we dug down and actually found those river channels. So that was a real voyage of discovery—a combination of armchair adventure, exotic travel, and new science, all wrapped in one package.

What did that do to your perception of this particular project? You must have realized you'd opened a door to the past.

Oh, we did. It was also the kind of thing that got a lot of attention from both the scientific community and the media—we even made the cover of *Science* magazine. Then we started getting approached by a lot of people about whether we would use this technology to find, say, the lost continent of Atlantis, or a missing family treasure that somebody's grandmother had supposedly buried in the backyard. There were all sorts of wacky extremes like that. Then there were the more credible inquiries, like the one that ultimately led us to discover the ancient trade routes across Arabia to the vanished city of Ubar, an ancient frankincense center. We also did some archaeological work in China.

While all this was happening, in the early '80s, we got approval for the Venus mission, which was eventually named Magellan. But then the Reagan administration cancelled it, along with a lot of other missions, and we had to struggle to figure out whether we could convince Washington to revive the mission if we scaled it back to make it less expensive. We did, and it ended up being launched in May 1989. By then we had flown radar instrumentation on two shuttle flights, and we had flown SEASAT.

A series of synthetic aperture radar mosaics of Venus, taken by the Magellan orbiter, were mapped onto a computer-simulated globe to create this image of the planet in 1991. Originally cancelled as part of the Reagan administration's budget cuts, the mission was restored, says Elachi, "after we scaled it back to make it less expensive," and launched in 1989.

Looking back at your involvement with radar imaging, including your work on the Cassini mission to Saturn, is there a particular highlight?

I would have to say it was really the SIR-A work, partly because it was my first mission and partly because it took us in so many unexpected directions. It had a special attraction, like your first experience in anything that you do. Here we were—a group of very young people who suddenly became key players in the space shuttle, which at the time was THE major NASA mission. And then came the science—the big discovery about the subsurface radar penetration in Egypt. So that one mission had all these aspects that made it unique. Magellan was very exciting from the standpoint of the science—getting the first high-resolution images of a planet, where we had essentially no idea of what was happening on the surface. As for Cassini, I was the key advocate for putting a radar instrument on the mission. But by then, I was in a senior JPL leadership role, so it was, in the end, perhaps, less of a hands-on role. However, now that Cassini is in orbit around Saturn, new discoveries are being made every time we get a radar image strip from Saturn's moon Titan.

How did your move into higher-level lab administration come about?

After the success of SIR-A, I was asked to become program manager for all the radar activity at JPL. Then, after we flew SIR-B in 1984, I was asked to head the lab's science division. Then in 1987, Lew Allen, who was director at that time, asked me to join the executive council, which essentially helps lead the lab. That came about because JPL was getting so involved in doing advanced instrumentation that the lab decided to create a director for space science and instruments, with oversight over all of that work at JPL. They asked me if I was interested in that job, and that's when I moved from doing full-time research to actually being more involved in JPL leadership.

It must have become clear at some point that you'd be leaving more and more of the science behind. How did you react to that?

That was a tough challenge. For a long time, I insisted on keeping an office in the building where I had been doing my radar research, and I worked very hard to spend one day a week there, so that I could continue my science. I also kept my connection with Caltech—for a number of years I maintained a position as a research fellow on campus, working with Papas, and then I started teaching a class on the physics of remote sensing. It gradually became harder to continue my research, but I continued the teaching, because it was both a lot of fun and a way to keep up with new ideas. I now take a lot of pride that many of my students are key members of the JPL team.

What were the circumstances that led to your accepting the job as head of JPL?

While I was on the executive council of JPL, there were changes and additions to the scope of my responsibilities. For a while it was purely science and instruments that I was overseeing. Then some flight missions were moved into that directorate, although not the Mars missions because Mars had its own directorate. As time went on, the directorate grew to the point where we decided to divide it. So my directorate kept Earth science and astrophysics, but not the planetary missions. The great advantage of all this for me was that when the search committee interviewed me for the job of JPL director, I had gained experience and familiarity in all the different aspects of what we do at the lab. I remember when someone came to my class to tell me that David Baltimore would like to see me afterward. It was on Friday, January 26, 2001. When I entered his office he said, "I am going to make this brief. I and the Board of Trustees would like you to become the next director of JPL." We walked out of his office, and there was a group outside with a bottle of champagne. Then on January 31, Baltimore and Dan Goldin, the NASA administrator, who flew from D.C. for the occasion, made the public announcement at a JPL all-hands meeting.

Continued on page 8 . . .

Elachi, then-NASA director Sean O'Keefe (directly behind Elachi), and Mars Exploration Rover project manager Pete Theisinger '67 (front, right) react with joy as Opportunity lands safely on Mars on January 24, 2004. Behind Theisinger (front to back) are NASA officials Ed Weiler, Firouz Naderi, and Orlando Figueroa.

Elachi . . . from page 7

As director, you've overseen some outstanding successes—the Spirit and Opportunity missions to Mars, Cassini's arrival at Saturn, and the Spitzer and GALEX space-based observatories. What has this meant to you personally?

It has really brought home to me how important it is in our work to be prepared for the ups and the downs. I was sitting in the mission operation room when the Mars Climate Orbiter failed in 1999, and I was in that same room when we landed Spirit and Opportunity on Mars in 2004. In the early days of JPL's Ranger and Surveyor missions, we had several failures, and in 1992, we lost the Mars Observer, a billion-dollar project. We also had monumental successes, like the Voyager, Galileo, Cassini, and Topex missions. As I keep telling my people, space exploration is not easy. You have to accept that there are periods when you are going to have setbacks. It's one of the unique aspects of JPL that when that happens, we don't bury our heads in the sand and feel sorry for ourselves. We immediately jump in and learn from our mistakes. When I became director, we had just come from a period of setbacks, including the loss of both the Mars Climate Orbiter and the Mars Polar Lander. Effectively our reputation was on the line.

When you say "reputation," do you mean in the eyes of the public?

It was in the eyes of everybody—the public, NASA, the JPL employees. For many of us here at the lab, these failures came as a big shock, particularly since we were looking ahead to launching two space-based observatories and two Mars rovers—extremely complex, challenging missions. And I can tell you that although we had some nerve-racking moments during that first year or two after my appointment, I had no doubt that we were going to be successful. We had the best, most dedicated people in the world working on those projects, and when these missions succeeded, the public could clearly see how true that was. On the Mars missions, particularly, the whole world was watching, which made those successes even more memorable and rewarding. In the last five years we have launched 10 successful missions and now we have 18 spacecraft exploring across the solar system.

What lessons do you think may have been learned and implemented from the loss of the Orbiter and Polar Lander?

Immediately after those missions failed, we all collectively sat down with Ed Stone, who was then JPL's director, and said, "Okay, what are we going to learn from this?" One of the key things to emerge was that we had perhaps underappreciated how challenging it had become to do some of these missions in NASA's new "faster, cheaper, better" environment. We had been successful with so many planetary missions, and when that happens, the danger is that you let your guard down. What we learned is that we can never do that with planetary missions—they're not like flying an airplane every day. You have to treat every mission as if it was the first one you'd ever done.

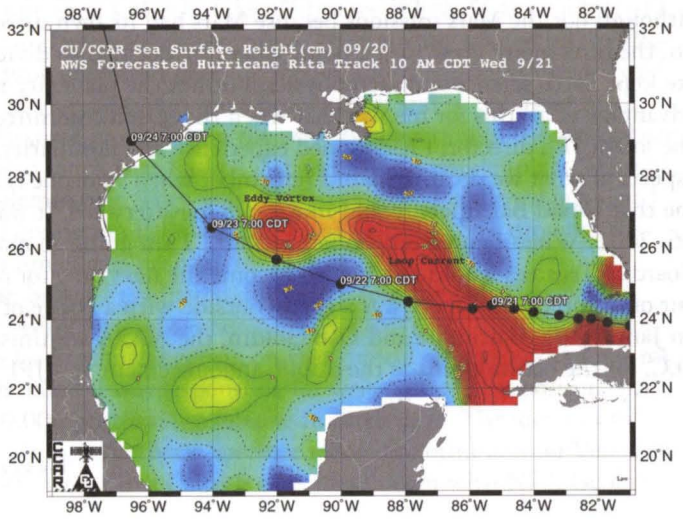
We also realized that under NASA's new guidelines, our number of missions had been increasing significantly, and that in this environment we had not yet developed sufficient expertise to properly support and evaluate each and every thing we were doing. So at the end of Ed Stone's era, which had also had great successes such as the Mars Pathfinder and Galileo, and at the start of mine, we tried to put safeguards in place. The first was to establish a supporting infrastructure to help project managers. This involved taking a highly disciplined approach to implementing projects and making sure that we had the appropriate checks and balances to catch errors and verify that we'd made the necessary corrections. Doing this required more funding, but it was well worth it. We also put more emphasis on mentoring, so that new project managers could benefit from the expertise of more experienced ones. So that was the foundation of our new approach, and even now, after these recent successes, my biggest concern continues to be that we shouldn't let our guard down.

The critical message that I think comes out of all this is that when you do exploration, you never know what surprises you are going to get. There's no way you can plan for all of them. Some are pleasant and some are not. The key thing is to learn from them, move on to the next step, and not shy away from doing something bold because we are afraid a mistake will happen, or that we will fall on our face. It's not exploration when the only sure safety comes from staying on the ground. You can be 100 percent successful by doing absolutely nothing.

Under NASA's new administrator, Mike Griffin, there has been a clear shift in the agency's priorities, along with renewed emphasis on cost-cutting. What lies ahead for JPL? How do you see its role evolving over, say, the next decade?

I think that Mike Griffin came to NASA with a couple of fundamental objectives. One is to phase out the shuttle, because just staying in Earth's orbit is not a viable or visionary program for human space exploration. He's indicated that we need to go beyond, to the moon and then to Mars. His second idea is that while doing space science is a fundamental element of NASA, there has been a bit of imbalance in how that research is supported. The overwhelming successes on Mars have drawn a lot of interest and funding into the Mars program, some of which, unfortunately, has come at the expense of other disciplines. Even at JPL, we have been concerned that the funding for Earth science and astrophysics was taking a major hit.

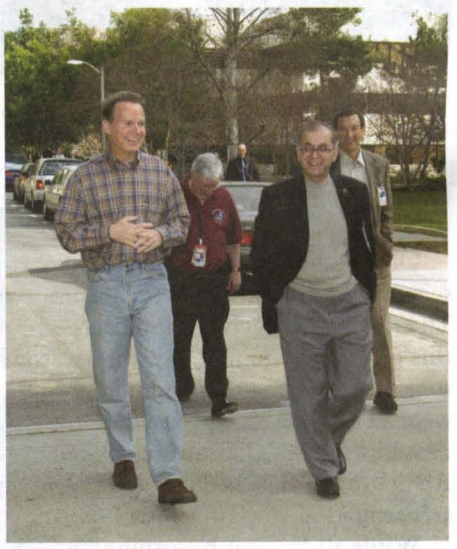
So Mike wants to rebalance to make sure we have a broad science program. I agree with his basic principle, even though I love Mars and the excitement of going there. But there are other places that are pretty exciting—Jupiter's moon Europa, and Saturn's moon Titan—and, like Mars, hold out the possibility that life might have evolved there. Another aspect of this search-for-life question is investigating how nearby stars formed and whether they have planetary systems. So from that standpoint, I am feeling positive about what Mike Griffin is doing, as long as we are keeping a strong, balanced science program, which he promised. I think JPL will fare very well in that environment because we already do a fair amount of Earth science and astrophysics. We have Topex/Poseidon and Jason doing oceanography from space. We have the Spitzer telescope imaging the universe in the infrared, and GALEX, which is studying it in the ultraviolet. I think that NASA's advocacy of a balanced program will play to our advantage in the long term, even though there are some negative impacts in the short term.



Altimeter data from the JPL/NASA satellites Topex/Poseidon and Jason contributed to this sea surface height map of the Gulf of Mexico as Hurricane Rita roared toward the Louisiana and Texas coasts on September 21, 2005. Earth-observing instruments and studies are a key element of JPL's missions program.

In a lecture that you gave on campus about two years ago, you foresaw four major developments in space science by 2014. They were robotic outposts on Mars; the first steps toward searching for the building blocks of life on planets within and outside the solar system; taking what you call the stellar family portraits; and an Interplanetary Internet information network. Do you still stand by that forecast?

Yes, I think these are still feasible projections. There's always a margin for error in these predictions. Some things happen a bit earlier than you think they will, and some a bit later. But there is no doubt in my mind that we will be looking at these developments in the next decade. We are already moving rapidly



Local congressman David Dreier (left) makes a visit to JPL, accompanied by Elachi, Mars Exploration Rover project manager Pete Theisinger (in red shirt) and Richard O'Toole, manager of the lab's office of legislative affairs.

The Mars Exploration Rover Spirit captured this haunting image of sunset on Mars as the sun sank below the rim of Gusev crater on May 19, 2005. Launched in January 2004 for a projected 3-month reconnaissance of the planet, both rovers have continued operating long past their JPL handlers' expectations.

toward a permanent scientific presence on Mars that will provide us with a much deeper understanding of the planet and that we hope will answer the question of whether life ever evolved there. We currently have two orbiters circling Mars, which will be joined by a third one in 2006. We have two landers on its surface. We never expected that they would go on working this long. It's even possible that one or both of them might survive until we send the next lander. That's Phoenix, which is scheduled to be launched in 2007, and then we will send the Mars Science Laboratory rover in 2009.

As for searching for the chemical compounds of life in neighboring solar systems—as well as on Titan and Europa in our own system—we might not have all the missions in place by 2014, but we will definitely undertake some of them in the next decade. Before 2015, we will have the Space Interferometry Mission to study nearby stars, as well as the Terrestrial Planet Finder, and they will provide us with what I call the family portraits—a detailed look at neighboring stars and their planetary systems.

We are making real progress on the Interplanetary Internet, and I do think that by the next decade, people will be able to access our planetary spacecraft from their home computer. Whether it will happen in 2012 or, say, 2016, remains to be seen. But these things are clearly within our reach. And of course the new technology we develop for these missions, we will also apply to studies of Earth to help us better understand earthquakes on a global basis, tectonic motion, ocean circulation, and other phenomena.

"It's not exploration when the only sure safety comes from staying on the ground. You can be 100 percent successful by doing absolutely nothing."

In terms of your professional career, you're essentially the product of two cultures: Caltech—the ultimate research university—and NASA, a federal government agency. As director of JPL, how do you perceive those two institutions, and how do they affect your approach to the job?

JPL and Caltech are really a unique combination. I usually tell people how fortunate the lab is to have the two greatest parents in the world that you can imagine: NASA, which gives us the opportunity to reach for the stars, and Caltech, which anchors us in a foundation of academic excellence and integrity. You can't do better than that when you are engaged in scientific exploration—really, it creates a very fortunate situation for us and for the country. As part of NASA, we take very seriously the fact that we are in a sense a public trust, supported by the taxpayers. We are here not only to do what we want, but to do what both the broad scientific community and the country want to do in exploring space.

As for Caltech, I think that our connection with a leading academic institution is tremendously helpful. One-third of the Institute's faculty is involved in what we do at JPL, and they bring with them a lot of originality and imagination. A lot of new ideas and technology grow out of that relationship. We also have a unique resource in the Institute's graduate and undergraduate students—some of the brightest young people in the world come here and interact with us and help keep our outlook fresh. You know how old—that is, older—people tend to become more traditional and conservative in their thinking, but this way we have all these youthful perspectives coming in. The engagement of the Caltech president and Board of Trustees is not to be underestimated—here we have some of the most successful people in the world helping to oversee what we do, and taking a genuine, serious interest in our work. They get monthly reports on our activities, and spend a day twice a year at JPL, getting a firsthand look at what's going on. I meet with David Baltimore every other week and get calls from trustees regularly and sometimes I call them to ask for advice or assistance—they're a great resource in that regard.

Overall, I find it amazing that this country and its government have entrusted planetary and deep-space exploration to a university, and to a private one at that. That combination is rare—you don't see it in any other country—but for JPL and our nation, it's been largely a recipe for success. So hopefully, the American public sees it in the same way and can appreciate the value of bringing academia, industry, and the government together as a team to do what would be very hard for any of these partners to do individually.

How about the elected officials, particularly congressional representatives, with whom you work? Are their views and votes influenced by this same appeal of space exploration?

In general, I find that selling what we do is relatively easy, first because people are genuinely excited about space, and second because our work has a variety of spinoffs. Just to name two, numerous technological advances have grown out of the space program, and a healthy space program helps sustain public interest in science. I think there's a widespread belief, particularly among members of Congress, that space exploration is something that will draw young people into science and technology. That's what happened to me—the Apollo program got me excited about going into science. It's certainly in the national interest to have a scientifically literate population and to stimulate enthusiasm for studying science and engineering among young people. The economic welfare of our country is grounded in our technological leadership, and anything that helps us retain that edge is obviously beneficial. It is important to note that at almost every mission encounter, many members of Congress come and join us at JPL to be part of these events. Our two local congressmen, David Dreier and Adam Schiff, are great friends and genuine supporters of what we do, and take great pride in what JPL does.

So, if a kid were to come up to you and say, "I want to have a career like yours," or even, "I want to be where you are now," what advice would you give?

I would say, great. Anything is possible if you put your mind to it and work hard at it. I usually tell the kids, "Make sure you are good at your science and math. Make sure you have ambition. Make sure you have a passion for what you do. Don't shy away from attempting great things even though you might fail. That's how you learn." One thing that I tell people has probably helped me to where I am today is this: I can't think of a single day when I didn't look forward to coming to work here, and when I didn't look forward to going home and telling my wife and my two daughters about the exciting things we're doing here. You have to have that excitement about what you are doing, along with the technical savvy and the passion to do exploration. Another key thing is to acknowledge that you are always part of a much larger effort involving many talented, hardworking people. What JPL achieves does not happen because of me. It happens because of 5,000 people who know what they are doing and are passionate about it. We all feel bad when any one of us fails, and when anyone succeeds, we're all part of that success.

What about your job as director has turned out to be most revealing or unexpected?

I think it was the breadth of the things that you have to handle. It's not only doing the strategic thinking, leadership, and the planning for missions. There are issues with parking, with personnel, and with travel, to name a few. And they all have to be addressed. Not necessarily directly by me, but as part of the ongoing management of this place. The employees here look to the lab director and to their senior managers for hands-on leadership of all aspects of the lab. Over a single day, my responsibilities can range from meeting with Nobel Prize winners to landing on Mars, to calling congressmen, to dealing with parking.

That's the second time you've mentioned parking. Is it easier to land on Mars than to manage on-lab parking ?

Oh yes. As I always tell people, parking is one problem I still don't have a solution for. And most likely I never will. I will leave it as a challenge for my successor.

Plenty of room to park here. In 1992, JPL geologist Ron Blom (foreground) and Elachi joined an archaeological expedition in the Omani desert to search for the lost Arabian city of Ubar. Scrutinizing radar images of Oman taken by SIR-B, Blom and JPL colleagues had identified ancient roads, possibly leading to the legendary city, buried a few meters under the sand.

there's only **one.caltech**

THE CAMPAIGN

Campaign Highlights

Keeping the Institute at the forefront of education and scientific discovery, benefactors continue to partner with Caltech to support the objectives of the "There's only one. Caltech" campaign. As of September 30, $1,074,958,962 has been raised toward Caltech's $1.4 billion goal.

Postdoctoral appointments have become increasingly important in the careers of scientists and engineers. The Henry Luce Foundation awarded two Clare Boothe Luce Postdoctoral Fellowships, totaling $277,000, to Caltech to fund new postdoctoral appointments for women. By allowing Caltech to recruit and support two talented young women, the Luce Fellowships contribute to the Institute's commitment to increase the number of women in the natural sciences and engineering.

In response to a collaborative proposal on bridging brain, mind, and behavior submitted by Hixon Professor of Neurobiology John Allman, the James S. McDonnell Foundation awarded $1.8 million to support a comparative and developmental study on the Von Economo neurons (VENs). One of the goals of the three-year study is to determine whether there is a possible link between VENs and social disabilities in autism spectrum disorders. According to Allman, if the researchers' hypothesis proves to be correct, an impairment of the VEN system would compromise social functioning. The lack of quick social intuition is a key deficit in autism spectrum disorders.

Corporate friends have helped Jeroen Tromp, McMillan Professor of Geophysics and director of the Institute's Seismo Lab, build one of the 10 most powerful computer clusters to model the complex actions of seismic events within the earth's interior. Gifts of equipment from Dell and Myricom and a grant from Intel Corp. are credited with making the $5.8 million project possible. Helping researchers unlock the mysteries of powerful and often devastating earthquakes, the 204 8-processor "machine," popularly known as a Beowulf cluster, will provide the computing power to create three-dimensional simulations of seismic events, Tromp says. A grant from the National Science Foundation also contributed to the project.

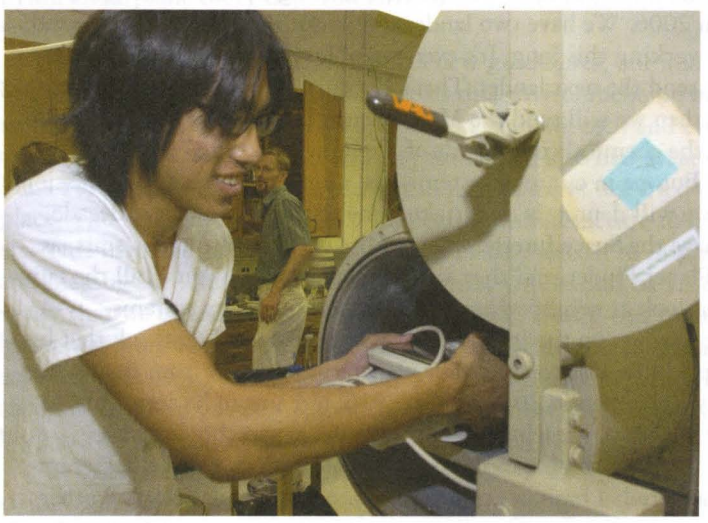
With lead funding provided by a pledge from Warren Schlinger '44, MS '46, PhD '49, and his wife, Katie, the Warren and Katharine Schlinger Laboratory for Chemistry and Chemical Engineering will stand as the centerpiece of Caltech's Division of Chemistry and Chemical Engineering. The Institute retained the services of GPR Planners Collaborative, Inc., to work with the division's faculty planning committee to complete the process of assessing the needs of the new building. Caltech's development office is pursuing additional funding to push the project forward. In fact, the Institute recently received a $5 million contribution to support construction from Wilton W. Webster '49, bringing the total funds raised for the project to $24.6 million toward a $35 million goal.

Bequests allow donors to make a more substantial contribution than might be within their means during their lifetime, and such support often comes from unexpected sources. For example, Jean R. Irvin—a Caltech friend with a strong interest in space exploration—named the Institute in her living trust as the remainder beneficiary of her estate. Thanks to Jean's thoughtful planning, the Institute received approximately $1.1 million to support research related to space exploration at JPL. Likewise, Texas entrepreneur Michael Mathes wasn't directly affiliated with the Institute. However, he held Caltech's strong technical program in high regard and left nearly $7.4 million to the Institute to establish the Michael Mathes Endowed Scholarship Fund.

As Caltech begins the fourth year of the campaign, the tragedy of Hurricane Katrina has put a national focus on the importance and inspiring nature of philanthropy. Institute faculty, staff, and students have joined or initiated several relief efforts; campus personnel are assisting Caltech students from the hurricane-affected region; and members of the Caltech-JPL community are applying their expertise and technology to survey and recovery operations. An important factor in the long-term economic viability of the Gulf Coast region will depend on the far-reaching actions of dedicated individuals, like those in the Caltech community, who strive to benefit society through cutting-edge research and education.

Your ongoing support of Caltech's priorities is invaluable. Please contact Caltech's Development Office at 1-877-CALTECH, or visit http://one.caltech.edu, to find out how you can join us in the "There's only one. Caltech" campaign.

KERRY ETHERIDGE



Nathan Chan '08 (the Carolyn Ash SURF Fellow) loads a scale into the airlock of an oxygen-free glovebox in order to weigh chemicals that react quickly with oxygen. In his SURF project, "Oxidation States of Trace Elements and Their Effects on Water Chemistry around Lake Powell," Chan worked with Caltech professor Janet Hering, an aquatic chemist, and graduate student Richard Wildman.

Riding the Research Wave

This summer Caltech once again provided students from around the world with an exceptional opportunity to conduct original, independent research in the Institute's SURF (Summer Undergraduate Research Fellowships) program. Along with nearly 300 Caltech students, 126 students from other institutions in the United States and overseas took part, working on projects that ranged from designing software for a future Mars rover, to investigating the dynamics of singing and burping sands, to developing models to better predict ups and downs in the stock market. More than 300 students worked with academic mentors on the Caltech campus; another 85 SURFed with JPL technical staff; and about two dozen did their work at such venues as the City of Hope, the University of Texas, Brown University, Harvard Medical School, and the CERN particle-physics laboratory in Geneva, Switzerland.

As part of their immersion in the research experience, campus and JPL SURFers attended weekly seminars led by Caltech faculty and JPL researchers, got acquainted with public-speaking skills, learned techniques for delivering technical talks, and participated in workshops on topics related to science and engineering careers. On October 15, they presented oral reports at SURF Seminar Day, a one-day conference modeled on professional technical meetings.

Approximately 228 Caltech faculty members, JPL staff members, and off-campus researchers, companies, and entrepreneurs participated in the 2005 program.

Commenting on the outstanding success of SURF, now in its 27th year, Caltech president David Baltimore notes, "I am convinced that most students learn best when they can do science or engineering rather than just study it in the classroom, and the SURF program offers our students the extraordinary opportunity to engage in research with mentors who work at the frontiers of their fields. The students

Corinna Zygourakis '06 (the Heather and Paul Haaga SURF Fellow) studies samples that could help scientists determine which brain structures play a central role in the detection of social emotions, research with potential applications in the treatment of such disorders as autism. Her SURF advisors for her project, "The Role of the Frontoinsular Cortex in Social Cognition," were neuroscience professors John Allman and Ralph Adolphs.

experience the life of scientists and engineers while mentors and other members of the research group welcome them into the community of researchers and scholars."

Baltimore, who presented a SURF seminar this year on stem-cell research, adds that as an undergraduate at Swarthmore, he had the remarkable opportunity to do research one summer at Cold Spring Harbor Laboratory through an NSF-funded program. "That undergraduate research experience shaped my decision to become an experimental biologist."

Each SURF student receives a stipend of $5,000 to support them through their 10-week research project. The program is funded by close to 200 donors, including support from approximately 60 individual endowments, two corporations, three private foundations, JPL, NASA, and the National Science Foundation.

The Institute's "There's only one. Caltech" campaign seeks to raise $10 million for the SURF endowment. For further information, please contact Mark Reinecke at mreinecke@caltech.edu or at 626/395-3707.

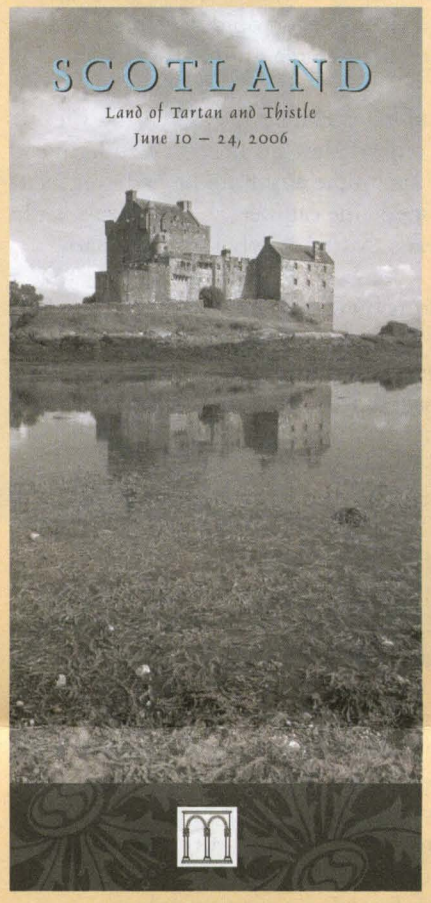
Associates Activities

All events will be held at the Athenaeum unless otherwise noted. Individual invitations for each event will be sent monthly. For more information about the Associates, contact Lori Brickner at 626/395-3919, or at associates@caltech.edu. Visit our website at http://giving.caltech.edu/CA/.

December 1, 2005, *Associates Luncheon and Program at the Caltech Athenaeum*—"Planets Past Pluto," with Michael Brown, professor of planetary astronomy.

January 2, 2006, *Associates Annual Rose Parade Event*—Packages include parking and continental breakfast at the Athenaeum, and parade seating on Colorado Boulevard.

The Caltech Associates are pleased to announce Cathleen Godzik as our new president for the 2005–2006 fiscal year! Cathleen, whose term began on October 1, is an orthopaedic hand-and-upper-extremity surgeon in Los Angeles and is the current president of the medical staff at Orthopaedic Hospital. She has traveled with the Associates several times, and has been an active Associates Board member. The Associates also welcome Ginger Caldwell, Julie Farr, John Gee, Elizabeth Tito, and Liz Wilson to the Board of Directors.



Experience Scotland through the eyes of Anneila Sargent, PhD '77, a Scotland native as well as OVRO/CARMA director and Caltech's Benjamin M. Rosen Professor of Astronomy. From June 10 to 24, 2006, we will travel through the country learning about its culture, history, architecture, and ecology. Our itinerary in the Scottish highlands will include a visit to historic Eilean Donan Castle, pictured above. Please call Christina Yen in the Associates office at 626/395-2926 for details.

Barely a year after site development began in the Inyo Mountains of California, high above the current Owens Valley Radio Observatory, the CARMA (Combined Array for Research in Millimeter-wave Astronomy) telescopes and buildings have all been duly transported to their new home at Cedar Flat. In mid-August, signals from three telescopes were successfully combined. "This is a major milestone—the first critical step in operational testing," said Anneila Sargent, PhD '77, OVRO/CARMA director and Benjamin M. Rosen Professor of Astronomy. "First observations with all fifteen telescopes are expected in December 2005."

Budget . . . from page 5

from consideration. Thus, subject to final approval by the Board of Trustees, the changes that can be expected will include increasing income from the utilization of our property at the former St. Luke Medical Center and from campus filming; increasing other sources of revenue; replacing some printed materials with electronic communication; restructuring, and in some cases reducing, administrative and divisional operations; modifying employee and student health insurance programs; and increasing tuition and fees for students in the upcoming years. The implementation of the new parking program is also part of the solution. (See related article, next column.)

"However, the news is not all bad. These actions will create a more efficient and resilient Caltech, enabling us to respond nimbly and effectively to inevitable changes in the world economy and government policies. The budget deficit will no longer be a recurring problem for this great institution. Our students will continue to receive a first-class education, while living in upgraded housing and receiving the most robust financial aid our assets allow. Employees will receive annual salary increases, both this year and in coming years. Most importantly, we will continue to be the unique and vibrant institution that Caltech has always been.

"The decisions made this past weekend will eliminate the general budget structural deficit by 2008, with the majority of the actions being put in place during the coming fiscal year. I want to stress that no one campus constituency—neither staff, faculty, nor students—will be asked to bear an unfair share of the budgetary reductions or the organizational changes. This problem affects the entire campus community and we will all share in the solution. Each of us can contribute on an individual basis by conserving the Institute's resources through such simple actions as turning off lights and equipment when they are not needed and judiciously using the supplies needed to perform our jobs.

"The deficit-reduction plan is still a work in progress, so I ask your understanding of the necessarily general nature of this letter. We also welcome any further suggestions you might have about how we might deal with the budgetary problem.

"From your daily interactions on campus, you know how special Caltech is, and how important it is that it continue (to quote our mission statement) 'to expand human knowledge and benefit society through research integrated with education.' Working together, I am convinced we will emerge a more adaptive institution that will face the future with undiminished vitality."

Campus Inaugurates Paid Parking Program

Caltech's new paid parking program went into effect in October for all faculty, staff, and visitors who park on campus. Students will be included beginning in January 2006. Visitors who wish to use campus parking facilities will be able to purchase single-use permits at automated kiosks; fees will range from $1 per hour to a maximum of $5 per day. The new parking regulations will be enforced Monday through Friday from 8 a.m. to 5 p.m. For more information, or to view a map showing the locations of parking kiosks, please go to www.parking.caltech.edu.

The Astronomer Who Found the Light

By Michael Rogers

As a young astronomer, Eugene Epstein '56 spent hours investigating what the far reaches of the universe might look like. With powerful radio telescopes, and the appropriate calculations, he could create reasonably good representations of the luminous wonders in space. Yet Epstein maintains that the first time he saw anything that really astounded him was at an art museum, where he eyed a strange item that resembled a cosmos in a box. His encounter with that object would develop into a lifelong passion that would enable a once-obscure artist to regain major museum recognition.

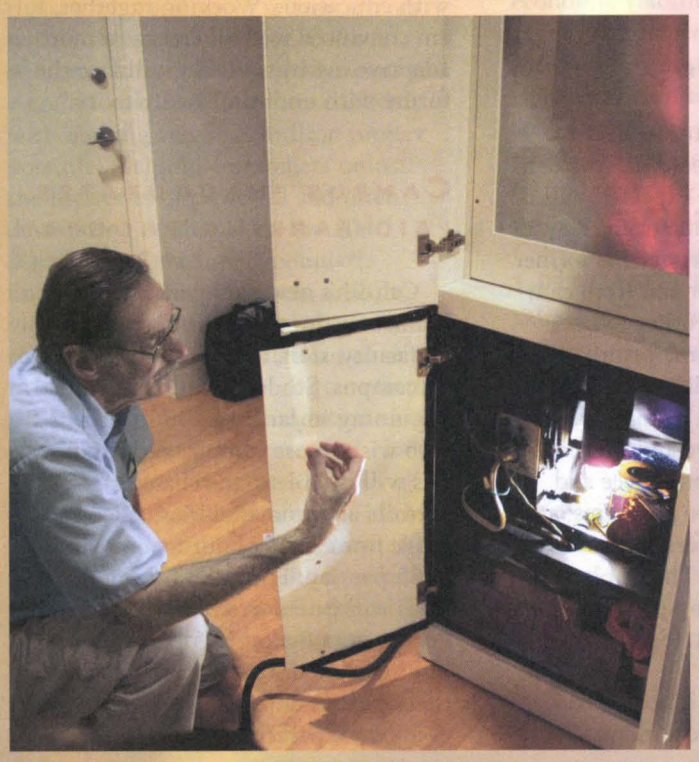
It was 1960, and Epstein, then a graduate student at Harvard, was visiting the Museum of Modern Art (MoMA) on a weekend trip to New York City. Wandering through the galleries, he stumbled on a work of art unlike anything he had ever seen before: an illuminated box, a bit smaller than a medicine cabinet, and set into a wall. Hazy wisps of colors resembling the aurora borealis drifted slowly down the dark screen like a hypnotic, abstract ballet.

"When I turned the corner and saw this work, it blew me away," says Epstein. "I thought, 'Wow! Where has this been all my life?' I watched so long that I ended up sitting on the floor. It was captivating." The work was called *Vertical Sequence II, Opus 137*, and its title plate listed the artist as Thomas Wilfred. Epstein had never heard of him, which was not surprising, since even among art experts of the day, Wilfred was largely unknown. The work itself could have been described as psychedelic, except that Wilfred had created it in 1941, long before the term was even coined. Epstein had to know more about the artist. A museum staff member told him that Wilfred ran a nonprofit organization called the Art Institute of Light, in West Nyack, up the Hudson River from Manhattan, and gave him the address. Back at Harvard, Epstein wrote to him and asked if he could buy one of his works. Wilfred wrote back offering to sell him one for about $3,000, which was beyond the means of a graduate student.

Epstein got his PhD in 1962, and then took a job in El Segundo, California, as a radio astronomer with the Aerospace Corporation. Fortified by a regular paycheck, he wrote again to Wilfred, but this time Wilfred responded that he had nothing available to sell. Nothing if not persistent, two years later Epstein wrote again. This time Wilfred offered to create for him one of his "lumia" compositions, although by now the price had jumped to $4,000. They struck a deal and in early 1965, Wilfred sent Epstein *Sequence in Space, Opus 159*—a small work featuring a range of colors and intensities.

For most people, that would have been the end of the story. For Epstein, it was just the beginning. Collecting ran in the family: his father, Louis, had channeled his lifelong interest in books into the establishment of the Pickwick Bookshop, a legendary Hollywood bookstore that had grown into a flourishing Southern California chain before Epstein Sr. sold it to B. Dalton in 1968.

Eugene was never interested in the book trade, but by the age of 12 he had become hooked on astronomy. While visiting the Griffith Observatory's planetarium with a friend, Epstein says that he was "bowled over by the whole subject. I knew almost immediately that this was what I wanted to study for the rest of my life. I went back month after month. As a teenager, I joined the L.A. Astronomical Society. I made my own telescopes. It became obvious that Caltech was the place to go for college. I applied and went in the fall of 1952. I think it was the only school I applied to."



Eugene Epstein shows off the nuts-and-bolts mechanism that's behind one of artist Thomas Wilfred's phantasmagoric lumia.

Epstein was one of only two astronomy majors in his class, and he found mentors in Caltech astronomer Jesse Greenstein and physicist Robert Leighton '41, PhD '47 (both now deceased). He was still a freshman when Leighton invited him to go on an observing run at Mount Wilson. "He was doing time-lapse photography using a 16-millimeter camera with the 60-inch telescope looking at Saturn and Mars. He let me do the guiding. For a kid 18 years old, that was a real treat."

After Caltech, Epstein spent six years at Harvard. After he arrived, the university's radio telescope was equipped with a new device called a maser, which amplified radio waves and helped astronomers study emissions from objects that would otherwise have been too faint to detect. Using this instrumentation, Epstein became one of the first astronomers to measure the atomic hydrogen content of distant galaxies. Then he went to work for the Aerospace Corporation, formed in 1960 to oversee space and missile programs for the U.S. Air Force. The company decided to do radio astronomy research because it felt that the investment in basic research would help drive its development of computer-controlled antennas, high-frequency microwave equipment, and sensitive electronic receivers. "Naturally," says Epstein, "they realized that they needed a radio astronomer, too."

It's uncertain how many lumia the artist made, but most of them would probably have ended up in dumpsters if it hadn't been for Epstein.

Epstein spent his entire career at Aerospace, helping run the company's radio telescope and conducting his own research, which included measuring the thermal emission from the surface of Mercury and the rings of Saturn and studying the variability of the radio emission from quasars. He also helped build the company's spectral line receiver, used by many outside astronomers, including Anneila Sargent, PhD '77 (currently Caltech's Benjamin M. Rosen Professor of Astronomy and director of the Owens Valley Radio Observatory and the Combined Array for Research in Millimeter-wave Astronomy), who used the receiver to study star-forming regions in the Milky Way galaxy. But by the 1980s, Aerospace was no longer emphasizing radio astronomy, so for a few years he managed a "photon bucket" project and then worked on "Star Wars"-related projects. In 1989, when he was 55, he took early retirement. At an age at which many people start second careers, Epstein returned to his fascination with Wilfred.

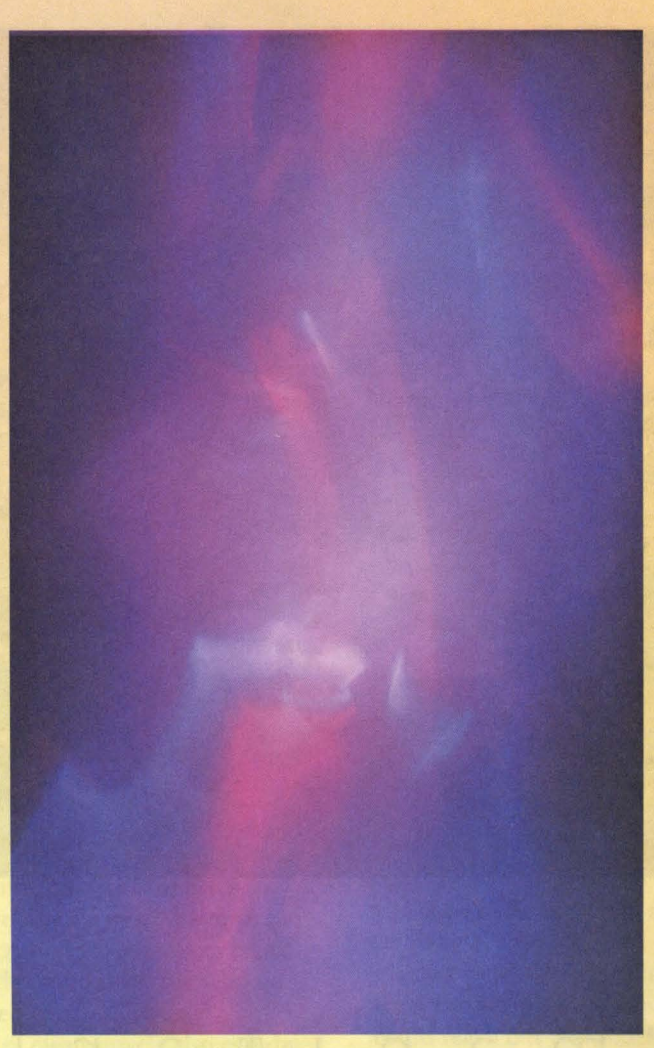
Tripping the Light Fantastic

The aesthetic pull that Wilfred's work exerted on Epstein seems to support the old adage that opposites attract. Epstein is articulate to the point of garrulousness and exudes nervous energy. Wilfred, by all accounts, fit the Ingmar Bergman-esque stereotype of the withdrawn, stoic, even sullen Scandinavian.

Born in Denmark in 1889, Thomas Wilfred studied art and, in 1905, while supporting himself as a concert-hall singer and lute musician, began tinkering with crude devices that would project light through colored glass. He eventually moved to New York, and by 1921 he finished building a rather large apparatus that triggered an array of colored lights projected on a screen. Wilfred called the apparatus a "clavilux" and coined the term "lumia" to describe the compositions in light he created with it.

Around 1930, he made his first small, self-contained lumia instrument. It plugged into the wall and continuously showed one of his lumia. Others followed, each featuring different colors and patterns. Despite the intricate displays, the lumia instruments were made from fairly mundane, even primitive, parts—a standard unfrosted light bulb; a set of lenses; a disk of glass that Wilfred had painted in various colors revolving above the light bulb; a simple motor that caused the disc and lens wheel to turn; another motor that slowly moved the bulb; and carefully shaped aluminum surfaces that reflected the light onto a screen. These inner workings were locked in wooden boxes, usually hidden behind a wall, so that viewers saw only the light show, projected on the screen.

In a 1947 essay published in *The Journal of Aesthetics & Art Criticism*, Wilfred wrote that his aim had been to create an entirely new art form "in which the artist's sole medium of expression is light." With more than a bit of bombast, he added, "The lumia artist conceives his idea as a three-dimensional drama unfolding in infinite space." A handful of museums, including MoMA and the Metropolitan Museum of Art, bought one or two of the phantasmagoric lumia for their collections. Other artists, either influenced by Wilfred or acting independently, experimented with light art in various incarnations, creating an extremely specialized niche within modern art. But art experts generally acclaim Wilfred as the maestro of the medium. It's uncertain exactly how many lumia he made, but many of them probably would have ended up in dumpsters if it hadn't been for Epstein and another one of his chance encounters.



This aurora borealis–like sequence tracks a single Wilfred lumia through a series of shape changes. Each lumia cycle can last for more than a year before repeating itself.

Wilfred Goes to Washington

In 1964, Donna Stein, a graduate student from New York University's Institute of Fine Arts, came out to Los Angeles for the summer. She met Epstein, and the two dated for a while. "I was trying to figure out what to do for my master's thesis, and Eugene told me about Wilfred," says Stein, now an art historian and independent curator living in Pasadena. When she returned to New York she checked out the Wilfred piece at MoMA and, like Epstein, was fascinated. Her adviser arranged for her to meet one of MoMA's curators at the museum, who, upon hearing that Stein was interested in Wilfred, told her, "He's downstairs. Let me introduce you." It turned out that Wilfred was at the museum checking up on his art work.

"By the time I met Wilfred, he was embittered," says Stein. He believed that the art cognoscenti had largely dismissed his work as frivolous. "From the 1940s to the 1960s, Wilfred labored in obscurity," a situation not helped by what Stein calls his "astringent personality. He was very quiet and shared very little with me."

Stein's thesis would eventually evolve into the first and only retrospective ever held of Wilfred's work, but the artist was no longer alive by the time the show opened, in the spring of 1971, at the Corcoran Gallery of Art in Washington, D.C., traveling later that year to MoMA. He had died in 1968. Through extensive detective work, Stein tracked down 19 lumia for the exhibition. "I'm not sure that any others exist," she says. "Some were lost."

By now Stein had become a Wilfred resource for Epstein, providing him with the names of the owners of all the existing lumia. "After the Corcoran show, Eugene started buying them up, keeping after collectors or museums that no longer wanted them, either because they had forgotten what they were, or because they had become too difficult to maintain," Stein says. Over the next 30 years, Epstein acquired eight Wilfred lumia and became the world's leading collector of this unique art form.

He'd keep in touch with other lumia owners, and when they were ready to sell, he was there to buy. "One thing led to another and it became kind of a mission," he says. It seems natural to ask why the technically oriented Epstein didn't just build some of his own light boxes, since they look easy to assemble. He's heard that question before, he says, and, as always, he bristles at the idea.

"I can hit the keys of a piano, but I can't play the piano," he says. "I'm not an artist. It never occurred to me to try my hand at creating a lumia composition even though I have a mechanical bent and have built things like telescopes. How many people have looked at a Jackson Pollock painting and thought of buying some cans of paint and trying to paint one themselves? I have no interest in trying to top a master."

In 1993, Epstein and his wife, Carol, decided that their traditional-looking home in West Los Angeles didn't fit their growing interest in contemporary art. So they razed it to build a concrete and glass Modernist-style house whose white interior walls display works that the couple has collected over the years by such famous contemporary artists as James Rosenquist and David Hockney. It was Carol's idea to give the Wilfreds a special place in the home's lower-level den, where they occupy an entire wall and can be switched on and off by a remote-control device that Epstein adapted for the purpose.

No two lumia are alike. Some look like burning fires, while others, darker in texture and hue, almost resemble murky liquids. Because the disks and lights revolve at different rates, more than a year can elapse before each light show repeats itself exactly. (Epstein says that Wilfred calculated these durations using a simple formula that involves multiplying the reciprocals of the time periods of the revolving parts.) Although just a few minutes of viewing are enough to discern general patterns in each lumia, during an interview for this article Epstein sat transfixed, watching a display as if he were seeing it for the first time.

Keeper of the Flame

Once Epstein became a major Wilfred collector, his life took on an added dimension. In 2003, he launched a website on Wilfred (http://www.wilfred-lumia.org), providing information on the artist and images of the lumia. In recent years, this has become a more important role, as Wilfred's work has gradually been rediscovered by museums. While Epstein was not responsible for this development, he has eagerly shared his Wilfreds and his knowledge of the work with art institutions. The Wilfred revival began in 1999, when a museum in Wilfred's native Denmark put

Continued on page 15 . . .

A lumia from one of Wilfred's early machines, which he called a clavilux.

Top: Evacuees from New Orleans fill the floor of the Houston Astrodome, where alumna Stephanie Charles was stationed for two of the 11 days that she spent as a Red Cross volunteer, helping Hurricane Katrina victims. Above: Charles in the vest that marked her out as a Red Cross volunteer during the relief effort.

Humanitarian in Houston

By Michael Rogers

On Sunday, August 28, with Hurricane Katrina bearing down on New Orleans and the Gulf Coast, Stephanie Charles '73 got a call at her Mountain View, California, home from the Red Cross. But the humanitarian organization wasn't asking for money. It was calling for her to physically lend a hand. Within 48 hours, Charles was on her way to a sea of hurricane victims.

Charles, who served last year as president of the Alumni Association, has been a volunteer with the Red Cross for the past five years. During that time, she's been on call for disaster duty, in which volunteers are asked if they can give three weeks of their time to relief efforts in emergencies. But during previous disasters, such as the 2003 Southern California wildfires, she'd been unable to get away from her job as a telecommunications consultant.

This time, though, Charles had a rare block of free time in her schedule. And it became easier to offer help when the Red Cross lowered its time commitment to seven days to attract as many volunteers as possible to cope with what was shaping up to be a full-blown catastrophe.

Told to fly to the Red Cross staging area in Houston, Charles said good-bye to her longtime partner, Norm Berube, Tuesday morning and got to Houston that evening, after the levees had been breached in New Orleans. At a Red Cross meeting the next morning, volunteers were told that they'd be going to Baton Rouge, and many headed out for the five-hour journey. Charles was part of a group of 70 volunteers who were still waiting for their assignments when word came that they would remain in Texas. With New Orleans now mostly under water and a major evacuation under way, Houston had offered the Astrodome as a shelter. Charles and her fellow volunteers were told to head there to handle the flood of evacuees who were expected to start arriving in a few hours.

Their job was to provide food, cots, and other humanitarian aid and answer questions. Basically, they'd be running a facility that was about to become the world's largest homeless shelter. It didn't take a Caltech graduate to figure out that the numbers did not favor the volunteers. Says Charles, "Seventy Red Cross volunteers was minuscule compared to what we needed." Luckily, hundreds of Houston residents started arriving at the Astrodome to help out.

"It was surreal. It was like being in a Third World country."

The volunteers were divided into 10 teams, each working about a 12-hour shift, to care for men, women, families, the elderly, and those with special needs. They were told to prepare for 23,000 people. "For someone like me, it was a bit frustrating, because I knew that mathematically they could never fit 23,000 onto the floor of the Astrodome," Charles says. "I estimated a maximum of perhaps 10,000." Eventually, 12,000 of the arrivals were squeezed in the Astrodome, while the rest were sent to adjacent facilities.

On Thursday, Charles reported for work at the Astrodome at 6 a.m., and soon thousands of evacuees were streaming in. Wearing her Red Cross vest, Charles was stationed on the ramp into the stadium, whose floor had been stripped to its concrete foundation. Buses dropped people off outside the facility on the street level, and the exhausted arrivals had to walk down four levels past Charles to get to the Astrodome floor.

"It was surreal," she says. "It was like being in a Third World country. The sounds, the odors, the sights were overwhelming. Many people were barefoot. People had open sores on their legs, probably from making their way through polluted floodwaters.

"We were worried that after all that they had been through, the people would turn into a mob," Charles says. "But they were glad to be there. I can't tell you how many people said, 'God saved my life. I'm missing someone from my family, but I'm sure that God will make them safe.' I don't think that I could go through what they did and be so upbeat.

"The endless rows of cots were overwhelming when I stood back and looked at them," she says. "It was unlike anything I'd ever seen or expected to see. But it struck me that it was rather orderly, which meant that people's needs were being met and that they were almost able to settle down

into something of a routine as they worked on finding lost family members and making longer-term plans."

Late that day, she helped gather personal information from people for a computer registry. "At that point, people were telling us their stories. We had been too busy to watch the news, so it was very depressing to hear what had happened. Still, everyone there was optimistic. And polite. I haven't heard so many 'thank you ma'am's' in my life. The faith, optimism, and simple courtesy on the part of almost all the shelter residents were striking. They were good people.

"There were a tremendous number of children there. Quite a number of elderly. Not a whole lot of men under 50. An awful lot of single mothers. These were the people who had no means to evacuate earlier. For the most part, they were poor, inner-city folks. I would guess at least 95 percent of them were African Americans. I was astonished that there was no anger over what they had been through. I think they were just exhausted. People were so grateful to get something to eat and then lie down and go to sleep."

After 15 hours on her feet, Charles got to her hotel room at 10 p.m. and collapsed in bed. On Friday, she was transferred to Houston's Reliant Arena, which is sometimes used for livestock shows, and now housed some of the Katrina victims. "Here, I experienced one of the saddest things," Charles says. "People were hungry and tried to hoard food because they hadn't eaten in days," but Red Cross officials wouldn't let them bring food from the food dispensary to the sleeping areas because it could create unsanitary conditions. Charles had the unhappy task of guarding the door and letting people know they had to leave their food behind. "I told people to set their food against a wall and come back for it after they had claimed a cot, but there was incredible food waste. One woman had baby formula for her child and broke into tears when she was told that she couldn't take it with her to her cot. I told her I'd hold it for her. She came back later and I gave her the bottle."

On Sunday, a week after she answered the Red Cross call, Charles contracted a stomach bug that put her out of commission for 48 hours. "It was the sickest I've ever been in my whole life," she says. She spent 24 hours in a temporary satellite hospital set up in the arena by Houston doctors and nurses, and was treated with antibiotics and five bags of intravenous fluids after antinausea medications didn't work. After another 24 hours in bed at her hotel, she went back to work in the arena, but she had a series of volunteer commitments coming up in the Bay Area, so on Friday, September 9, she flew home.

As a Caltech-trained engineer, it's not surprising that Charles turned her finely honed analytical skills to resolving a few of the logistical and other problems that surfaced during the hastily organized relief effort. She kept notes on her observations in Houston, and intervened when she thought she could improve things. She quickly noticed that many of the infirm who were brought to the Astrodome floor in wheelchairs were kept in them once they got there, leaving no wheelchairs outside to transport new arrivals, who remained stuck on buses.

"I ended up running a wheelchair brigade," she says. "I went down to the floor and recruited volunteers to bring back wheelchairs from people who no longer needed them."

The lack of clean towels also caught her eye. Once showers were set up, people were given towels to last their entire stay, and after one use, they got dirty and wet and stayed that way. It would have been better, Charles says, to hand out towels before individuals showered, collect them afterward, and then send them to be laundered so there would always be a fresh supply. She plans to forward these and other suggestions for improving future relief efforts to the appropriate Red Cross officials.

Constantly busy, "solving six problems at once, and multitasking like I had never done before," Charles regrets that she had few opportunities to learn much about any of the thousands of people she helped. An exception was a woman who arrived with a family of 10, including her mother, who had recently undergone heart surgery. After volunteers at the registration desk refused to let her in because she had stayed in a motel for a couple of days until her money ran out, "I talked to her at length and got the shelter manager to allow me to break the rules and let her in," Charles says. "We got medical attention for her mother. Later on I heard her call out, 'Miss Stephanie!' She came running up to me, hugged me, and thanked me. She said, 'You were a lifesaver.'

"Overall, I have mixed feelings about the time I was there. The Red Cross did a tremendous job, but now that we've had the experience, there are lessons that we can learn from about how to handle a future crisis better. But it was very rewarding."

Epstein . . . from page 13

together a show of light artists and included two of Epstein's Wilfreds. Other shows exhibiting his Wilfreds followed, including one co-organized by the Hirshhorn Museum in Washington, D.C., and the Museum of Contemporary Art in Los Angeles, another at the Pompidou Center in Paris, and yet another at the Liverpool branch of London's Tate Museum, which was suitably entitled *Summer of Love, Art of the Psychedelic Era*. Later this year, Epstein will send lumia to exhibits in Karlsruhe, Frankfurt, and Vienna. Wherever the lumia go, Epstein goes too: his arrangements with the art institutions provide for him to fly out to unpack the works and inspect them for transit damage. He is also available to make any necessary repairs; and, as Epstein says, "We stay for the opening parties."

Epstein has also come in for his share of credit for advancing the artist's reputation, not least, according to two recent pieces in the *Los Angeles Times*, for his ability to keep the increasingly antique lumia in working order. Hirshhorn curator emerita Judith Zilczer singles him out for playing "a crucial role in preserving Wilfred's major works and in promoting wider understanding of his art."

Epstein says that, most importantly, he is gratified to see that the recent shows have brought Wilfred the critical acclaim that largely escaped him during his lifetime. In a review of the Hirshhorn show in the *Wall Street Journal*, art critic Matthew Gurewitsch wrote, "In the long-forgotten . . . Thomas Wilfred (1889–1968), the curators have resurrected a true visionary. The 'sculpted light' . . . rivals the Northern lights in fascination and surpasses them in variety and intensity of colors, evoking rainbow X-rays of living creatures, the dissolution of drops of jewel-toned inks in a glass of water, the spiraling of nebulae through the cosmos. Maybe even stranger, the light can seem to liquefy or turn to dust, then to congeal into substances you feel you could reach out and touch."

Why the sudden surge of interest in Wilfred? "A lot of younger artists are working in kinetic media and when you look at a Wilfred, you see where they started from," Stein says. "The beauty of his work has been consistent. It has elegant, refined imagery and sophisticated use of color with the simplest of means. What comes out in front rises above the technical aspects."

Although Epstein met Wilfred only a couple of times and never felt that he got to know him, they did correspond and speak occasionally. "He knew that I was an astronomer and he respected me as a scientist," Epstein says. "In one letter Wilfred wrote about one of his works, 'I'm trying to imagine what a space traveler might see while journeying between the stars.'"

Could Epstein's early attraction to light shows in space account for his affinity for Wilfred's work? "At some gut level," he says, "there's got to be some connection. As an astronomer, I was visually oriented. I have said that some of the lumia images look like a solar prominence or a cloud of gas and dust in a star-forming region. Some of the shapes resemble images obtained by the Hubble Space Telescope."

Still, Epstein prefers a simpler explanation, saying, "It's a visceral experience. Would any astronomer be more interested in this? I don't know." He recalls inviting over to his house the late planetary scientist and brilliant science popularizer Carl Sagan. He led Sagan, a longtime friend, into his den, dimmed the lights, and turned on a lumia, anticipating a suitable expression of aesthetic appreciation. "After five minutes," recalls Epstein, the creator of *Cosmos* said, "Okay, I give up. How does it work?" Says Epstein, "I was certainly surprised at that. I thought he would just go with the flow."

Epstein displays a collection of catalogs from recent museum shows that have exhibited one or more of his Wilfred lumia.

Alumni Association president Ponzy Lu '64, proudly wearing a Caltech prankster T-shirt whose flip side reads "Because Not Everyone Can Go to Caltech," joined the Institute's newest students at Freshman Camp in September. In Lu's case, the sartorial choice is particularly apt, since after Caltech, he did indeed go to MIT, where he earned his PhD. Along with his longtime involvement with the Association, Lu finds time to be professor of chemistry, chair of the college biochemistry program, and director of the Vagelos Scholars Program in Molecular Life Sciences, all at the University of Pennsylvania.

From the Association president—That old Caltech magnetism has me in its spell

Our editor started her instructions, diplomatically presented as "suggestions," for this piece by observing, "I note you are . . . across the country . . . a faculty member . . . at a peer university . . . " To my mind, the real question was, How come you lasted long enough on the CAA board to become president? In fact, any participation in an alumni organization is viewed by most of my colleagues as tantamount to being a telemarketer or spam generator. Admission of participation in alumni *leadership* is clearly a sign of presenile dementia (see note at the end of this letter).

My first reaction to the editor's instruction was: "peer university"? There is only ONE Caltech. My day job is at the University of Pennsylvania. Penn is part of the Ivy League, a group of universities that have sufficiently weak sports teams that we need to play each other to avoid embarrassment. On second thought, Caltech's football team was indeed sufficiently weak. As for "across the country," I discovered a while back that traveling in an airplane to a meeting or to give a seminar was a good way to work undisturbed. At my advancing age, it is also not a bad place to sleep in the daytime without shame. So, going to board meetings in Pasadena had its benefits.

About 15 years ago, Karen Carlson of the Alumni Association staff called to convince me to volunteer in the alumni admissions support program. It seemed more to my liking than calling classmates for money, and it is a lot more like part of what I do for a living. (My predecessor in this job, Stephanie Charles '73, described the experience of being a volunteer with the CAA and/or the Alumni Fund in her letter in the last *Caltech News*. For more information, visit http://alumni.caltech.edu/volunteering/.)

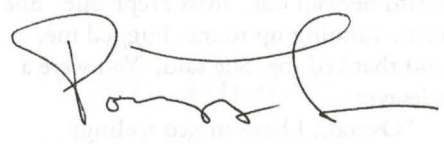
However, going to college fairs or visiting high schools and telling the typical high school senior that Caltech did not have athletic scholarships or cosmetology—it took the better part of a year for me to realize that the noun was not cosmology—seemed a waste of my limited time. I also had to compete with Caltech faculty, my ex-classmates, and even ex-TAs at the federal funding trough. So, I suggested improvements to the CAA. They said if you have good ideas, help us implement them . . . and here I am.

I am a molecular biologist and thus see replication as a biological imperative. Encouraging students to apply to Caltech is part of the replication process—making more alumni. More important, Caltech is unique and special, which will not come as news to you. Caltech clearly sees such replication as important as well. All of the applications for undergraduate admission are still read by faculty and students—our peer universities have outsourced that to professional admissions staff. As a professor at Penn, I am often asked if my recruitment activities for my alma mater do not constitute conflict of interest. This is not a problem—to quote a recent MIT T-shirt, "Not everyone can go to Caltech." (Check out said shirt at http://www.caltechvsmit.com.) The emphasis is on "can," as in "to be able."

"To be able"—this was a problem when I was a freshman. At that time, it was not obvious that I would be able to complete a BS degree. In the midst of those tough times, Frank Rhame '64 showed me an article from the September 1959 issue of *Fortune* magazine while we were both in our Chem 1 lab (the freshman chemistry laboratory was then in Gates, about where the DAR office is currently). The author was George Boehm, and it was entitled "Magnetic Caltech." This had been written the year before I enrolled at the Institute and before words like superstar and turbo-anything existed. It began, "The California Institute of Technology harbors what is probably America's richest concentration of talents in fundamental science." To drift or even sink in that harbor seemed okay to me.

By my senior year, with my GPA solidifying within a standard deviation of the mean, another article appeared, this time in the French magazine *Réalités*. In the November 1963 English-language edition, the journalist Danielle Hunebelle wrote: "Are you on a farm in Provence or in a monastery at Assisi? You might well think you were in either place during daylight, with olive trees growing in courtyards, the scent of jasmine, and the cypresses stretching into the bright sky. . . . It is possible only because students and professors are exceptionally gifted people. I feel if Socrates were to come back . . . and attend a university of his own choosing. . .Caltech. . . would be . . . where he might . . . feel at home." That from a French female!

Those quotes did not come from Caltech's development office. The opportunity to work with Caltech alumni on the Association Board, on campus, is firsthand evidence that the magnetism is still there.



*Note: *To clarify my role for my alumni colleagues, I am involved with the Caltech Alumni Association (CAA), a freestanding 501c3 organization. The Caltech Alumni Fund is an activity of the Institute's Development and Alumni Relations (DAR) office. CAA raises friends, and the Fund raises money. This is a distinction that I learned after I joined the CAA Board.*

Rise with the roses

Join fellow Caltech alumni and friends as we welcome 2006 with "It's Magical," the theme of the 117th Tournament of Roses Parade on January 2 (In accord with long-standing Pasadena tradition, the parade is held on the second day of the new year when New Year's Day falls on a Sunday). The Alumni Association's New Year's package includes reserved parade seating and lunch at the Athenaeum. An optional breakfast is available for an additional cost. The Association will send confirmation of your reservations and additional information, and your tickets will be held for pickup at the Athenaeum on the morning of January 2.

The cost for this year's program is $76 per person, and $70 for children under 12. The optional breakfast is an additional $11 per person.

The schedule for the Rose Parade event is as follows:

- 7:00–8:15 a.m.: Ticket distribution and optional breakfast
- 9:00 a.m. (time approximate): Parade. Seating on the south side of Colorado Boulevard, in front of Pasadena City College.
- 11:45 a.m.: Buffet lunch at the Athenaeum

For more information, please call 626/395-6592 or e-mail information@alumni.caltech.edu.

Update your profile!

Visit the Caltech Alumni Association website and update your profile. You can change your mailing address, update your career information, post a class note, describe your professional expertise, and even upload your photo. And you can search for fellow alumni to network or reconnect.

Go to http://alumni.caltech.edu/network to log in and access your profile. For help, e-mail information@alumni.caltech.edu or call 626/395-6592.

Save the Dates!

Thursday, May 18, 2006—*Reunions for the classes of '36, '41, '46, '51, and '56*

Friday, May 19, 2006—*Half Century Luncheon*

Friday, May 19, 2006—Reunions for the classes of '61, '66, '71, '76, '81, '86, '91, '96, and '01.

Saturday, May 20, 2006—*Alumni Association's 69th Annual Seminar Day*



Alumni event photos are online

Unable to attend a Caltech Alumni Association event? Visit the CAA online Photo Gallery and see what you missed! Photographs from campus and regional events are now online and regularly updated. View Photo Albums at http://alumni.caltech.edu/events/photos, then check the Events Calendar at http://alumni.caltech.edu/events for upcoming activities. Who knows? Maybe you'll be in the Photo Gallery next!

Caltech's Alumni House celebrates 25 years

The Caltech Alumni Association, recognizing a need to expand programs and services, first proposed building an alumni center in 1966. Various possibilities for a center were explored, and when Caltech granted the Association the use of a charming old house on Hill Avenue in 1979, the Association board voted to raise the money to refurbish the 3,900 square feet of interior space. In less than a year, the Alumni House had become a reality. The facility opened its doors in September 1980.

Twenty-five years later, 345 South Hill Avenue is still a home for Caltech Alumni. Located on the east side of Caltech's campus, Alumni House is a convenient place for alumni and friends to drop in on while visiting the Institute, and serves as a friendly roof over the offices of the Alumni Association. Members of the Association can use the Bascom Alumni Library downstairs for checking e-mail or making local phone calls, and the deck is a pleasant place to relax in a garden setting. The house is available for rental by Association members up to six months in advance for parties, receptions, meetings, and other events. When on campus, drop by Alumni House and visit your home on Hill Avenue.

Remembering Olaf Frodsham

On June 27, Olaf Frodsham, 89, the former director of the Caltech Men's Glee Club and other campus choral groups, died in Pasadena. A number of alumni who had performed with him during his nearly four decades at the Institute attended his service on July 8, and many sent remembrances to Francis Celii, PhD '86, one of those at the service. Below, Celii and Jeff Eriksen '76, PhD '84, recall the Olaf Era at Caltech.

Though not a student prankster or Nobel Prize–winning professor, Olaf Frodsham surely must be considered one of the "legends of Caltech." Starting in the 1950s, he spent nearly 40 years as director of both the Caltech Men's Glee Club and smaller vocal ensembles of both genders, and created many opportunities for students to take a break from their rigorous academic studies and come together to learn and perform vocal music.

Olaf Frodsham, in his element, during a Glee Club rehearsal.

Many undergraduate alumni probably remember the impromptu singing events that Olaf organized at Freshman Camp. His active recruitment there led to large student participation in the Men's Glee Club, often up to 50–70 singers. Not bad for an undergraduate student body of 700 with competing priorities.

Olaf maintained that anyone could learn to sing, and proved it by giving free voice lessons to anyone interested, including many who had virtually no previous singing experience. Some of

Continued on page 23. . .

Recognition. . . from page 4

at the Method of Archimedes," and "Figures Circumscribing Circles."

Marc Bockrath, assistant professor of applied physics, has been selected by the Office of Naval Research Young Investigator Program to receive a Young Investigator Award, which provides up to $100,000 per year for three years.

Emmanuel Candes, associate professor of applied and computational mathematics, received the James H. Wilkinson Prize in Numerical Analysis and Scientific Computing at the Society for Industrial and Applied Mathematics annual meeting; his prize lecture was titled "Uncertainty Principles and Signal Recovery from Incoherent and Incomplete Measurements." The honor, established in 1979 "to stimulate younger contributors and to help them in their careers," recognizes Candes's "outstanding theoretical and practical contributions to computational harmonic analysis and image processing."

Charles Elachi, PhD '71, vice president of Caltech and director of JPL, and professor of electrical engineering and planetary science, has received the American Astronautical Society (AAS) 2005 Space Flight Award, the highest honor that the AAS bestows on an individual who has contributed the most to the advancement of space flight and space exploration. Previous recipients include Wernher von Braun; William Pickering '32, PhD '36; Caltech's Morrisroe Professor of Physics Ed Stone (both former directors of JPL); former NASA director Dan Goldin; and astronauts Neil Armstrong, John Glenn, and Caltech trustee Sally Ride.

Hossein Jadvar, a visiting associate in bioengineering who has been working with Liepmann Professor of Aeronautics and Bioengineering Mory Gharib, PhD '83, has received a five-year, $3.3 million grant from the National Cancer Institute. Entitled "FDG PET-CT in Metastatic Prostate Cancer," it received a top priority percentile score of 1.2 percent.

Mark Konishi, Bing Professor of Behavioral Biology, and his former postdoctoral researcher Eric Knudsen, now chair of the neurobiology department at Stanford University, have been awarded this year's Peter Gruber Foundation Neuroscience Prize. They have been recognized for their work on the brain mechanisms of sound localization in barn owls, a focus of Konishi's research since the mid 1970s, and the pair will receive an unrestricted cash prize of $200,000, a gold medal, and a citation for their contributions to neuroscience.

Shri Kulkarni, MacArthur Professor of Astronomy and Planetary Science, was chosen as the Biermann Lecturer for 2005. The Biermann Lectureship is considered the highest visiting position of the Max Planck Institute for Astronomy, located near Munich, Germany. At the Max Planck, he presented three lectures: "Cosmic Explosions," "Astrometric Searches for Extra-Solar Planets," and "Recent Advances in Neutron Stars."

Jerrold Marsden, Braun Professor of Engineering and Control and Dynamical Systems, was selected to give this year's John von Neumann Lecture at the Society for Industrial and Applied Mathematics annual meeting, held July 11–15 in New Orleans. Established in 1959, the award provides an honorarium for an invited lecture. Marsden, chosen "in recognition of his fundamental contributions to geometric mechanics based on symmetry," gave a lecture entitled "Geometric and Computational Dynamics."

John Preskill, MacArthur Professor of Theoretical Physics, has been invited by Harvard University to be a Morris Loeb Lecturer this spring. He will give a series of lectures on quantum information science.

George Rossman, PhD '71, professor of mineralogy and divisional academic officer for geological and planetary sciences, has been chosen to receive the 2005 Friedrich Becke Medal of the Austrian Mineralogical Society. The first U.S. recipient of the award, Rossman is being recognized for his "outstanding contributions in the fields of mineralogy, petrology, and geochemistry."

Alexander Varshavsky, Smits Professor of Cell Biology, has been elected to the Academia Europaea. An academy of humanities, letters, and sciences, its membership is by invitation only.

Alumni Notes

1942
Harrison "Buzz" Price writes that during its most recent graduation ceremony "CalArts made a PhD out of me." He adds that "they are making me an honorary lifetime alumnus and I will be a lifetime alum at both CalArts and Caltech!" A renowned theme-park designer as well as a founding trustee of CalArts (officially the California Institute of the Arts), Price has served on the school's board continuously since 1962. He also, in collaboration with Walt Disney and Lulu May Von Hagen, completed several drafts of plans for CalArts. The many projects on which Price has consulted during his career have ranged from theme parks such as Disneyland to specialty attractions like the Rock and Roll Hall of Fame and such public attractions as seven World's Fairs.

1948
Paul MacCready, MS, PhD '52, has, just shy of his 80th birthday, received the San Gabriel Valley Economic Partnership's Technology Leadership Award. It is the organization's fifth time bestowing the annual award. "His life's work is remarkable. To point to him and say this is a product of a world-famous institution like Caltech is obviously something that we feel very proud of," according to Bill Carney, the partnership's chief executive. He added that it was almost a surprise MacCready hadn't been singled out before. As the chairman and founder of Monrovia-based AeroVironment Inc. and the creator of the Gossamer Condor and the Gossamer Albatross, both of which now hang in the National Air and Space Museum in Washington, D.C., MacCready has been called the "father of human-powered flight." He also created the prototype for the General Motors Corporation's EV-1 electric car.

Benoit B. Mandelbrot, Eng '49, Sterling Professor of Mathematical Sciences at Yale University, has been awarded the Orlicz Prize of the Adam Mickiewicz University in Poznan, and the Waclaw Sierpinski Prize of the University of Warsaw and the Polish Mathematical Society. Earlier he received a doctorate honoris causa from the Politecnico di Torino (Italy).

1949
James Harvey Crate, Eng, reports that a reproduction of a table lamp he designed in 1950 has recently been introduced. The original design was submitted to a lamp-design competition sponsored by New York's Museum of Modern Art, in which it won third prize (see photos, above). Only a few of the lamps were made at the time, and they were sold by competition cosponsor Heifetz Manufacturing Company. Some of these lately have appeared at "modernist auctions," selling for more than $20,000 to collectors of '50s-era furniture and accessories. "Collectors value the originals," says Crate, "because of their scarcity and for the whimsical use of the spun aluminum hyperbolic bulb housing, stainless steel legs (elements of the hyperboloid) and cork balls at the base and capital of the legs. In addition, as one auction house stated, 'the lamp is an icon of the era.'" During his career at General Electric Appearance Design, General Motors Styling, and Du Pont Plastics, Crate was on the design team of the first Corvette, was responsible for the first plastic BMX bicycle wheel (one of which is in the Smithsonian collection) and the first plastic wheelchair wheel, and pioneered the use of reinforced plastic materials in office-chair bases and other furniture components. He currently conducts artist's workshops at the Philadelphia Sketch Club, the oldest U.S. art club; volunteers at Bowman's Hill Wildflower Preserve in New Hope, Pennsylvania, doing plant propagation of native species; and is a design consultant to H Lighting Co, Inc. He received an honorary degree of Mechanical Engineer in 1987 from Stevens Tech, where he received his BS in 1947.

1950
Robert H. Korkegi, MS, PhD '54, writes: "I was invited to give the Culpepper Memorial Lecture at the 13th International Space Planes and Hypersonic Technology Conference held 16–20 May, 2005, in Capua, Italy (Italian Center for Aerospace Research just north of Naples). I spoke about 'Hypersonics—the Early Years,' covering the period of the 1940s and 1950s when research at very high flight speeds got a boost to support development of long-range missiles. In Germany during World War II it was motivated by the development of the V-2 and successors, and in the United States during the early years of the Cold War, by the development of the ICBM and IRBM."

1951
Peter V. Mason, MS '52, PhD '62, a visiting associate in physics at Caltech, has received the Cryogenic Engineering Conference's 50th Anniversary Award for "exemplary contributions to the CEC during the first 50 years." A retired member of JPL's technical staff, a former Caltech professor, and a member of the CEC's board of directors for a number of years, Mason has received numerous NASA awards and other honors related to cryogenics. He is a past president of the Caltech Alumni Association.

1957
Gerald Klaz reports that he has "finally retired, again," after 20-plus years in medicine as a general practitioner, followed by another 20 plus in property management and development. "I don't know where the time went." He is now living in Kona, Hawaii, "and loving every minute of it," adding that he plans "to be at our big '50' in 2007, so will see everyone then."

1960
Leroy Hood, PhD '68, president of the Institute for Systems Biology and a visiting associate in biology at Caltech, has received the 2005 Bio-IT World President's Award, which was presented at the annual Bio-IT World Best Practices dinner, held June 28 at the National Press Club, in Washington, D.C. He was unable to receive the award in person, having been called home earlier in the day to complete preparations for his daughter's upcoming wedding. In a written acceptance speech, Hood said, "I had the good fortune to be a participant in several paradigm changes in biology over the last 35 years," adding at the end of the speech: "The 21st century will be the Century of Biology!"

Jacob V. Maizel Jr., PhD, has been named by the Alfacell Corporation to its scientific advisory board. He will work closely with the board's chairman, David Sidransky, as well as the other members to optimize the potential of the company's proprietary ribonuclease (RNase) technology. From 1983 to 2005, Maizel served as chief of the Laboratory of Experimental and Computational Biology at the National Cancer Institute, where he oversaw the creation of a supercomputing facility known today as the Advanced Biomedical Computing Center. He previously was a professor in the department of

Back to the Future. James Harvey Crate, Eng '49, reports (see *Note*, left) that an award-winning lamp he designed in 1950 (above) is back in vogue—both as a pricey collector's item and as a recently issued reproduction (right).

cell biology of the Albert Einstein College of Medicine. In 1982 he received the U.S. Public Health Service Superior Award, and in 1993 a National Institutes of Health Merit Award.

1961
Terry L. Babineaux, MS, reports that he retired in 2002 and moved to Grants Pass, Oregon, in 2003 after 44 years in California. He spent 1959–1964 with JPL and 1964–1969 as a manufacturer's representative in the L.A. area. He worked for Optical Coating Laboratory Inc., in Santa Rosa, 1969–1985, rising to marketing manager, and then spent two years with Ramtek, in Napa. Following Ramtek he worked for a few years as a technical recruiter and, finally, as a private professional fiduciary.

1963
Gerald D. Chandler wrote in June: "I retired in 1999 as a software consultant and started traveling the world with my wife, Jan Bates. Since then we have seen a good part of Europe, China (including six months of consulting) and South East Asia, Mexico, and Central America. We are about to end three months in Paris and start a July–August stay in Moscow."

Albert Y. C. Yu has joined the board of directors of PDF Solutions, "the leading provider of process-design integration technologies for manufacturing integrated circuits." Yu, who worked with Intel Corporation for almost 30 years until his retirement in 2002, is currently active in private venture investing and serves on several high-technology company boards. At Intel, he held numerous technical and executive management positions, most recently as a senior vice president and a member of the Corporate Management Committee, with responsibilities for corporate strategy, microprocessors, chipsets, and software. He received his PhD in electrical engineering from Stanford University.

1964
Leon Thomsen, a senior advisor at BP in Houston and an expert on seismic anisotropy, has been elected president of the Society of Exploration Geophysicists (SEG) for the 2006–07 term of office. He will serve as president-elect on the 2005–06 SEG executive committee. After receiving his PhD in geophysics from Columbia University in 1969, Thomsen held a series of academic appointments in the 1970s before joining Amoco's Research Center in Tulsa in 1980. Since the BP-Amoco merger in 1999, he has been part of BP's Exploration and Production Technology Group in Houston. The recipient of numerous honors, he is the author of more than 60 peer-reviewed papers and 13 issued patents, and the "Thomsen anisotropic parameters," introduced in a *Geophysics* article in 1986, are now universally used in the technical literature in discussions of seismic anisotropy.

1966
David C. Gakenheimer, MS, PhD '69, of Rancho Palos Verdes, California, writes: "After receiving my PhD and spending four years at the Rand Corporation and 32 years at Northrop Grumman (and predecessor companies R&D Associates and Logicon), I have started my own company called GA Industries to develop and market software for the dental industry for analyzing digital radiographs to find tooth decay. My patented and FDA approved technology is on display at the National Museum of Dentistry, 31 South Greene St., Baltimore, MD 21201, for the next 12 months."

1968
Eric Garen has been appointed to the board of the Center Theatre Group, recognized as Los Angeles' leading not-for-profit theatrical company. Garen cofounded Learning Tree International in 1974 and served as its executive vice president through 1991 and president through 2003 and now serves as vice-chairman. Specializing in informational technology and management training, Learning Tree has subsidiaries in the United States, Canada, the United Kingdom, France, Sweden, and Japan, and has trained more than 1.5 million managers and IT professionals from 13,000 corporations in 30 countries worldwide. Garen also is founder and president of the nonprofit Bright Prospect Scholar Support program headquartered in Pomona, California. Bright Prospect helps outstanding high school students from poor families gain admission to top-tier colleges with full financial aid; it continues to counsel and provide financial support for these students through graduation. After graduating from Caltech, Garen received a master's degree in computer science from USC. He currently resides in Los Angeles with Nancy, his wife of 32 years.

1970
Jack Griffith, PhD, Kenan Distinguished Professor, Lineberger Comprehensive Cancer Center, University of North Carolina at Chapel Hill, has been elected to the American Academy of Arts and Sciences. A member of the university's medical faculty since 1977, he is the author of more than 150 professional publications. He is known for his melding of electron microscopy with the techniques of biochemistry, and "his 1999 discovery with Rockefeller University colleague Titia de Lange that the ends of chromosomes, telomeres, are tied in firmly knotted loops was heralded worldwide as important for gaining insights into cancer and aging," according to UNC's *University Gazette*.

Cornelius (Niall) O. Horgan, PhD, a professor in the University of Virginia's department of civil engineering, has been awarded the 2005 A. C. Eringen Medal by the Society of Engineering Science (SES). The prize is awarded by the SES in recognition of "sustained outstanding achievements in Engineering Science." The award certificate cites Horgan's "seminal contributions to applied mathematics and the theory of elasticity." The Eringen Medal was first awarded in 1976, and previous recipients represent a diverse group of outstanding engineers and scientists, including three Nobel laureates. The medal was presented in June at the

joint SES/ASME/ASCE Meeting on Mechanics and Materials, Baton Rouge, Louisiana, where Horgan presented the SES Annual Engineering Science Plenary Lecture, entitled "Continuum mechanics based hyperelastic strain-stiffening constitutive models for rubber-like materials."

Thales Papazoglou, MS, professor and director, Electric Power Systems Laboratory, Iraklion, Crete, writes: "Earlier this month, on September the 7th, I met again with my dear old friend Charles Elachi (PhD '71), in Ireland, after 35 years no-see! It was during an evening reception by Cork Mayor Councilor Deirdre Clune, B.E. This event was part of the annual Universities Power Engineering Conference: UPEC (7–9 September) 2005. I was very-very glad, of course. The two of us had a chance to reminisce our past years at Caltech and our common acquaintances and friends there." He adds that they also met on the following day at the University College of Cork, "the host of UPEC'05, where Charles had been invited as a keynote speaker to discuss the accomplishments, excitements and challenges of space exploration, and the JPL agenda for the next 15 years. His presentations were very well made and everybody in the audience appreciated that keynote. On September the 9th we both had to leave Cork, returning to our home bases: Pasadena for him and Iraklion for me—which was a good thing too, since it turned out that the weather changed to quite rainy on that day. One notable fact was that co-organizer for UPEC'05 was the Cork Institute of Technology, locally known as CIT! For my friends, of my years at Caltech, I give my e-mail address for contact: tmpapa@teicrete.gr."

1974

Willie W. Ng, MS, PhD '79, of Agoura Hills, California, was one of six individuals and 15 teams to be presented a 2004 Raytheon Excellence in Technology Award in a ceremony on April 12 at the Smithsonian National Air and Space Museum, in Washington, D.C. Currently principal research scientist and manager of the photonics department at HRL Laboratories, a Malibu, California, R&D lab jointly owned by Raytheon, Boeing, and General Motors, Ng was cited "for career achievements in photonics, and pioneering demonstrations of photonic approaches that enhance the performance of microwave phased array antennas."

1976

Joe Parker, PhD, has joined Glimmerglass as vice president of systems and will be responsible for all facets of new product development. Specializing in the field of automated fiber-optic management, the company offers intelligent optical switches that enable customers to automatically, remotely, and instantly monitor and manage fiber-optic connections in a wide range of applications. Parker's experience spans more than 20 years of research and development in high-performance networking and telecommunications, including a decade focusing on optical networking. Prior to joining Glimmerglass, Parker was founder and COO of Opthos, an optical networking company. Earlier, Parker directed research at ONI Systems into next-generation all-optical networks, in addition to collaborating with Bellcore and the Department of Defense on the MONET signaling protocol for all-optical networks.

1981

Arturo Cifuentes, MS, PhD '85, has joined R. W. Pressprich & Co., Inc., "a research-oriented broker/dealer whose principal focus is providing fixed income relative value and market-timing information to institutional clients, both domestic and international." Previously head of worldwide operations for CDO (collateralized debt obligation) research at Wachovia Securities in New York, Cifuentes will augment R.W. Pressprich's presence in the CDO market. Prior to Wachovia Securities, Cifuentes held a number of senior positions at Triton Partners, AMBAC, and Moody's Investors Service, where he is credited with developing an important part of the core methodology used by Moody's to rate CDOs.

1982

Ari Fuad has been named a principal of the firm Cutter Associates Inc. His 20 years of experience includes strategic business and technology planning, portfolio management and trading systems implementation, operational design and redesign, and compliance and risk management. Prior to joining Cutter, he was an associate partner with IBM Consulting Services and a director with PricewaterhouseCoopers. A CFA (chartered financial analyst), he is a member of the Twin Cities Society of Security Analysts. He earned his MBA in finance from the University of Minnesota.

Jack A. Kaye, PhD, director of the research and analysis program in the Earth-Sun System Division of NASA's Science Mission Directorate, writes that late in 2004 he was selected as a recipient of a Presidential Rank Meritorious Executive Award for his service at NASA. When not working, he's busy with his wife, Dawn, and their three daughters (Rebecca, age 17; Hannah, age 14; and Allison, age 11). They are still living in Annandale, Virginia, just outside of Washington, D.C.

1984

Moses Mares has joined Acacia Research Corporation's Acacia Technologies Group—which specializes in technology licensing—as vice president for business development. Most recently senior corporate counsel with Siebel Systems, where he managed a wide variety of intellectual property matters, he previously held positions with Baker & McKenzie, in both the Intellectual Property and Corporate Groups, and with Knobbe, Martens, Olson & Bear in their patent prosecution and intellectual property licensing practice. Earlier in his career, he served as program manager with Intel Corporation and an R&D engineer with IBM Corporation. A registered patent attorney, Mares received an MS in chemical engineering from the University of Texas at Austin, an MS in electrical and computer engineering from UC San Diego, and a JD from Santa Clara University.

1986

Adam Kolawa, PhD, is cofounder and chairman/CEO of Monrovia-based Parasoft Corporation, whose software product Jtest has received the Software and Information Industry Association's 2005 Codie Award in the category of best software-testing product or service. The award goes to the best product or service developed to test the functionality of a software product or service, as determined by a panel of industry experts, technology writers, and representatives from the trade press. Jtest analyzes and tests for errors in programs that are written in Java code.

Michael Varney, PhD, has joined Genentech Inc. as vice president for small molecule drug discovery. He will be responsible for directing the small molecule drug discovery efforts at Genentech and will oversee the departments of medicinal chemistry, small molecule assays and screening, drug metabolism and pharmacokinetics, and early stage formulation. He comes to Genentech from Pfizer Global Research and Development, where he was vice president for drug discovery, and he began his career at Agouron Pharmaceuticals in San Diego in 1987, where he built and led the chemistry teams and infrastructure necessary for the development of small molecule therapeutics and became vice president and head of research. A member of two scientific editorial advisory boards, Varney is the author of numerous scientific articles.

1988

John '89 and **Linda Schlueter Cordes** '88 welcomed Anna Marie to the world on April 6, 2005. "Anna joins big sister Kari Elin (8/02) and folks in Tucson, AZ, where we are all enjoying the desert. Would love to hear from friends (jvcordes@yahoo.com or lschluet@yahoo.com)."

Michael Goedecke recently received his PhD in biomathematics from North Carolina State University. A mathematical modeler with Research Triangle Institute, he lives with his wife, Maria, in Wake Forest, North Carolina.

Richard Mgrdechian reports that, after 15 years working as an engineer, an investment banker, and a high-tech entrepreneur, he has released his first novel, *3000 years*. "In a nutshell, *3000 years* is a thrilling and remarkably thought-provoking look at the future of American society as a physicist travels through time to save the woman he loves," he writes. "In addition to exploring numerous social and political aspects of these future societies, *3000 years* also contains a host of scientific and technological elements—such as the abuse of nanotechnology by anarchists known as nanohackers—which help create a story which is absolutely unique on every level. Overall, the future societies of *3000 years* will be carefully constructed, highly plausible worlds based on the logical, linear and cumulative extrapolation of current political, cultural, social, scientific, and technological trends. They will be both intriguing and controversial. In particular, the scientific and technological elements should be especially appealing to other Caltech alumni." The book is available through both bookstores and online catalogs, as well as through his website, www.3000years.org.

1991

Peter Hofstee, MS, PhD '95, was selected by Global Technology Conferences Inc. to lead a session on the IBM Cell Processor as part of the Multi-Core Processor Tutorial at GSPx 2005, the October pervasive signal processing event at the Santa Clara Convention Center in California. The IBM Systems and Technology Group's cell chief scientist and cell synergistic processor chief architect, Hofstee joined the IBM Austin Research Laboratory in 1996, where he worked on the world's first 1GHz CMOS integer microprocessor. In 2001, he was one of the founding

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NEWS_____

members of the joint Sony-Toshiba-IBM design center in Austin, established to develop the next generation of microprocessors for the broadband era.

1995

Tim Nelson has been named vice president for sales consulting byTenFold Corporation, provider of the EnterpriseTenFold platform for building and implementing enterprise applications. He recently completed his eighth year at TenFold and is considered one of the company's fastest and most creative applications developers. After graduating from Caltech, Nelson spent two years as a chemist before changing careers and joining TenFold. He has both developed TenFoldTools technology and served as a company guru, providing expert advice on using TenFold technology to build applications for multiple applications-development projects. He became director of TenFold's gurus in 2001.

Shuyun Wu, MS, PhD '00, has been appointed director of device development by RedShift Systems Corporation, which has pioneered low-cost, high-performance thermal-imaging solutions for mass markets. He will be responsible for the design, fabrication, and packaging of the Thermal Light Valve, a technology that translates thermal images into visible images. With more than 15 years' experience in microsystems product development, Wu comes to RedShift from Continuum Photonics in Billerica, Massachusetts, where he was director of engineering.

1998

Mike Herrera reports that he is now married. "The unlucky lady is Kaycee Otis (well, now Kaycee Herrera)," he writes. "We've known each other for about 10 years and have been together for 7 of them. Wow, it's amazing how time flies. In case you're wondering how we met, Kaycee's sister is Stevie Otis ['99] (a fellow Darb)."

Mason A. Porter writes: "I am renting my soul to Caltech once again, but this time they're paying me for the privilege. (The admissions people always say they never make a mistake when they admit Techers, but they've managed to repeat their mistake 3 times in my case. I'm happy about it, but somebody somewhere must be wondering what happened . . .) My research is on applied mathematics and nonlinear dynamics. Just google me or stop by room 130 in the Sloan trailer park (I mean Annex) for more info." He adds that last March he helped organize a special session at the 2005 American Physical Society meeting in Los Angeles, in honor of the 50th anniversary of the publication of the Fermi-Pasta-Ulam problem. "Every speaker in the session except for me was a bigshot. (I was sandwiched directly between the co-inventor of the mathematical formulation of solitons and the co-inventor of the Fluctuation-Dissipation theorem.) This session basically became one of those 'which of these doesn't belong' contests, although my associated self-deprecating humor fell a bit flat on that day." He continues: "I am still hard at work with Autumn Looijen '99 on the new *Legends of Caltech* book. Following the pattern we established as undergrads, we have previously missed several deadlines, but the text has now been submitted and the wheels are in motion. (As Douglas Adams said, 'I love deadlines—especially that whooshing noise they make as they go by.') The book will only be 1 year late, which I've heard is pretty good by EE 52 standards."

2000

Eleanor Park married Bruce Pattie July 23, 2004. "We backpacked and camped in Wyoming for 3 weeks. Since we are both public school teachers in the Chicago area, we spent our one-year anniversary SCUBA diving in the Philippines for 6 weeks and hob-nobbing around Tokyo. Hope to hear from the rest of you!"

2004

Joseph Jewell, currently attending the University of Oxford as a Rhodes Scholar, is proprietor of the start-up company PrepMe.com (www.prepme.com), along with Avichal Garg, a graduate student in management science and engineering at Stanford, and Karan Goel, who is attending the University of Chicago Graduate School of Business, and now the three entrepreneurs are corecipients of the ninth annual Edward L. Kaplan New Venture Challenge, which is awarded by the Polsky Center for Entrepreneurship at the University of Chicago Graduate School of Business. The honor includes a $20,000 cash prize as well as access to facilities such as office space and a conference room, plus phone lines and computers. The trio's business plan was picked by 20 judges—representing a spectrum of business interests, including venture funds, consulting companies, lawyers, and entrepreneurs—over 58 other business-plan entries as the top entrepreneurial idea. Designed to help high-school students prepare for the SATs, PrepMe.com also made it to the final round of the Stanford Technology Challenge and won a challenge round at the Rice Business Plan Competition. The company has drawn the interest of several Silicon Valley investors.

Grubbs . . . from page 2

Although his stay in New Zealand was scheduled to last another week, Grubbs cut it short to return to the Institute, where colleagues, students, and postdocs were already celebrating. "I taught my classes there on Thursday and Friday and went for a walk on Saturday and then flew home on Sunday." On Monday, the chemistry division and hundreds of well-wishers threw him a party in the Iris Garden, next to Crellin Lab, where he has carried out most of his work. The next day Grubbs was back to the business of being a Caltech scientist and professor.

The term metathesis literally means "change places," and Grubbs credits the Swedish Academy for coming up with an analogy that compares metathesis to dance couples swapping partners. "My colleagues and I just came up with the molecules. We didn't think about ways of explaining it."

Caltech licenses the Grubbs metathesis technology through Materia Inc., an Institute spin-off that Grubbs founded in 1997 (he's now the company's scientific advisor). In his Crellin office, the mild-mannered scientist brandishes a baseball bat as he explains one technology application.

"This is made from a piece of wood that's not very good, and there's a shortage of really good wood for making baseball bats." By inserting a polymer into the tiny spaces between

An accomplished outdoorsman, Grubbs, shown here at Eaton Canyon, enjoys rock and mountain climbing.

the wood fibers, "the polymer strengthens the wood so now you can hit the ball 400 or 500 times without the bat breaking. Without the treatment, maybe it would break the first time you hit with it." The bat is certified for use through Class A in baseball's minor leagues, he adds.

Materia also sells its technology to agribusiness firms such as Cargill, which convert bioseed oils from crops such as corn and soybeans into industrial chemicals, livestock feed, and consumer products. Several companies use metathesis to produce insect pheromones to control a pest in peach production, reducing or eliminating the need for toxic pesticides. It works by interfering with the male peach twig borer's sense of smell. "The concentrations they use are so small, it takes only a few grams to cover an acre," says Grubbs. "Since it's everywhere, the males can't find the females, so there's no mating and no destruction of fruit stock. Instead of spreading kilograms of pesticides everywhere and killing everything, you can use a few grams of this material."

Meanwhile, the materials industry uses metathesis to produce pipes that are resistant to caustic corrosives. And pharmaceutical companies are utilizing it to develop drugs—not yet on the market—that treat osteoporosis and hepatitis C. "This process enables the drugs to be made much more quickly, and in some cases, it's the only way to make them," says Grubbs. "I think the excitement about it has to do with the fact that you go all the way from making stuff like this baseball bat to making pharmaceuticals, based on this one platform technology that is the catalyst."

Helping make it all possible, he says, are the 22 grad students and postdocs who work in his synthetic chemistry group. "Graduate students work in the lab, make observations, and make many of the decisions that move projects forward," he says.

In the Nobel citation, Grubbs and his fellow laureates were credited with each providing a piece of the metathesis puzzle. Yves Chauvin, now retired from the French Petroleum Institute, explained in the early 1970s how the reaction worked, and provided the "recipe." Richard Schrock, a chemistry professor at MIT, is credited with being first to produce an efficient metal-compound metathesis catalyst in 1992.

"I've been a good friend and competitor with Dick for years," Grubbs says. He recalls that his own biggest breakthrough came in 1992, when he developed the first in a series of improved catalysts that became commercially viable in 1994. Produced with ruthenium, it is stable in air, can be used in alcohols and water, and is more selective in directing reactions.

Grubbs maintains that he did not originally foresee green chemistry growing out of his basic research, but calls that outcome a welcome benefit. "There are some cases where an industrial process would take seven or eight steps, with lots of solvents. Using this catalyst, you compress it down to one step with no solvents. In terms of waste and processing, it's a good savings."

Grubbs grew up in Kentucky, where he did plenty of the same square dancing moves that the Nobel committee used as an analogy for the chemical reactions in metathesis. After earning his BS and MS degrees at the University of Florida and his PhD in chemistry at Columbia, he spent a year at Stanford as a postdoc and nine years on the faculty of Michigan State University before joining Caltech as a professor in 1978. Elected to the National Academy of Sciences in 1989, he was named the Atkins Professor of Chemistry in 1990.

Grubbs's Nobel Prize brings to 32 the number of Nobels won by faculty and alumni. The new laureate says he is looking forward to traveling to Stockholm in December with his family to receive the medal.

"I just got the travel plans for the Nobel celebration and it sounds like a pretty wild week. Apparently there are great parties. It will be great fun to go to them with my kids."

Obituaries

1926
Glenn Graham, on July 1, 1986.

1931
Oscar McMullan Newby, of San Diego, on August 2, 2004; he was 95. After graduating from Caltech he received a divinity degree from Yale University and was ordained by the United Methodist California Pacific Conference in 1935. He served many churches in the western United States and in Japan and worked to improve the health, housing, and working conditions of low-income people. Following his retirement in 1974, he volunteered for San Diego's Interfaith Housing Foundation. He is survived by his children, Ken Newby, Mary Ramsey, and Beth Robinson; his stepchildren, Beverly Fellows, R. Bruce Johnson, and Wendell Johnson; 14 grandchildren and nine great-grandchildren; a brother, Frank; and a sister, Betsy Eberhardt.

1932
Robert Edwin Foss, of Rancho Santa Fe, California, on September 19, 2004; he was 94. A former president of Sun Oil Company, he was a member of the Rancho Santa Fe Association Board and the Caltech Alumni Association. He is survived by his wife, Lorene; two sons, David and Dixon; and five grandchildren.

1933
David F. Bender, MS '34, PhD '37, of Rancho San Diego, California, on September 20, 2004; he was 91. As a JPL astrophysicist he analyzed orbital mechanics and developed trajectories for spacecraft, plus he had an asteroid named in his honor. Following his retirement in 1987 he continued to present technical papers into his 80s. After graduating from Caltech, he taught physics at Louisiana State University and at Fisk University in Nashville, Tennessee. In 1946 he joined the faculty of Whittier College, where he established a tradition of traveling to Death Valley with his wife and former and current students during spring break and spending a week doing astronomy and launching miniature rockets. He also worked part-time as a consultant for North American Rockwell. An ardent pacifist and environmentalist, he belonged to the San Diego Zoological Society, the Sierra Club, and the Nature Conservancy and was an advocate for solar power and energy conservation. Predeceased by his wife, Elizabeth, in 1990, he is survived by his daughter, Susan Rodrigues; his son, Robert; and three grandchildren.

William A. Mersman, MS '34, PhD '36, of Los Altos, California, on September 8, 2004; he was 90. Winning the Caltech Travel Prize, he sailed to Europe by steamer through the Panama Canal in 1933. After earning his PhD in mathematics, he went into teaching, first at Deep Springs, an elite two-year Sierra Nevada men's college where students worked as ranch hands while preparing to transfer to Cornell, and then at California Agricultural College (now UC Davis) from 1939 to 1945. He also worked in the field of radar development during World War II. After the war, in 1947, he went to work as a research scientist at Ames Research Center, where he remained until his retirement in 1947. His work brought him international recognition, and he presented papers on orbital theory and celestial mechanics in Amsterdam, Rio de Janeiro, and São Paolo. After his retirement, he and his wife enjoyed hiking, both in the Bay Area and in Europe. He is survived by Evelyn, his wife of 64 years; his daughters, Patricia Mersman and Megan Black; and two grandsons.

Selby M. Skinner, PhD, of Kirtland, Ohio, on April 29, 2002; he was 96. He served in World War II as an antiaircraft battalion commander and a member of the Barrage Balloons Board, and then for 21 years in the reserves. A member of both the American Physics Society and the American Chemical Society, among other organizations, he served on the Atomic Energy Commission and with the Air Research and Development Command, U.S. Air Force. He directed programs, consulted, and did research in a number of fields, including solid-state electronics, lubrication and adhesion, the properties of polymers and elastomers, electrostatic printing, printed circuits, and instrumentation, including night-vision capabilities for aircraft during the Vietnam War. He held numerous patents and was the author of 40 publications. Predeceased by his wife, Charlotte, he is survived by his sons, Dunston and Reid; two grandchildren; and a brother, Carlton.

Alvin J. Smith, MS '34, on July 11, 2004.

1936
Edmund Borys, MS, on May 25, 2001.

William Dowd Humason, on July 24, 2004. He worked for Procter & Gamble in chemical engineering and manufacturing management.

Robert L. Jerauld, of Rancho Santa Margarita, California, on August 21, 2004. A real-estate agent and then an insurance agent until his retirement, he was active in the Lakewood and Long Beach communities, serving as president of the Lakewood Lyons and as golf commissioner of Long Beach. He was also a member of the Bellflower Elks Lodge and was involved with the LLBC Football Booster Association and the Sky Links Golf Course community. He enjoyed bowling, golf, raising cymbidiums, travel, and spending time with his family. Predeceased in 1987 by his first wife, Dorothy, he is survived by his second wife, Marie; a son, Jim; two daughters, Betty Wagner and Bobbi Dean; and eight grandchildren and seven great-grandchildren.

Glen Peterson, MS, on January 26, 1998.

Dale H. Van Riper, on December 4, 2002.

1937
Paul Frederick Jones, MS, of Dover, Delaware, on September 7, 2004; he was 91. An electrical engineer with the Rural Electrification Administration in the Department of Agriculture, he had retired in 1973. His interests included history, and in his retirement years he enjoyed genealogy research. He was a member of the Barcroft Bible Church in Fairfax, Virginia, and was also a member of the John Howland Society. Predeceased in 1978 by his wife, Hattie, he is survived by two sons, Paul and Philip; two daughters, Nancy Barr and Cynthia Carlson; and 14 grandchildren and 20 great-grandchildren.

John Allan Legge Jr., in Sun City West, Arizona, on May 30, 1999.

H. Dean Parry, MS, in Arlington, Virginia, on August 13, 2003; he was 94. He is survived by his wife, Virginia; two daughters, Judith Naillon and Vinette Bowman; three grandchildren and eight great-grandchildren; and a brother, Robert.

1938
James M. Orr, MS, of Portland, Oregon, on September 8, 2004; he was 93. He owned several businesses, including Orr Engineering and Chemical Company, and he taught geology and engineering at a junior college in Oakland, California. He is survived by Elisabeth, his wife of 64 years; a daughter, Heather; two sons, Jamie and Norman; and four grandchildren and two great-grandchildren.

1939
Charles Frederick Carstarphen, MS '40, of San Diego, California, on August 4, 2004; he was 86. After serving as an officer in the Navy during World War II, he returned to Procter & Gamble, where he had started working before the war. He remained with P&G for 37 years, retiring as head of the Paper Division, and during his tenure he was responsible for starting up the first Pampers lines and for overseeing the construction of six paper plants in the United States and one in Germany. Predeceased by his wife, Susan, he is survived by two daughters, Cindy Gordon and Gale Bunnell; a son, "Rick" Carstarphen; and four grandchildren.

1942
Othniel "Niel" Horne, of El Centro, California, on October 8, 2004; he was 84. Commissioned as a lieutenant in the U.S. Army Air Forces in 1942, he returned to El Centro four years later. In 1949, he married Ann Mitchell and opened Horne's Frozen Food Locker, which he operated until 1954, when he entered the real-estate business. In 1956, he opened his own brokerage—Niel Horne Real Estate—in which he remained active until shortly before his death. Elected president of the Imperial Valley Board of Realtors on two occasions, Horne was a member of the McCabe school board and an honorary member of the El Centro Rotary Club, where he was a Paul Harris fellow. He also served on the El Centro Public Library board, worked with the county Air Pollution Control District board, taught Sunday school, and sang in the choir of the First Presbyterian Church of El Centro. He married Joan Delongchamp Williams, a librarian at the El Centro Public Library, in 1989. Both she and his first wife survive him. Other survivors include his sons, Robert, Andre, Thomas, and Lawrence; a daughter, Elizabeth Ann "Betsy" Lane; a stepdaughter, Mary Nelson Williams; a stepson, Fred Williams; and 15 grandchildren and a great-grandson.

1943
Leon Blitzer, PhD, of Tucson, Arizona, died October 18, 2004; he was 88. A University of Arizona physics professor for more than 40 years, he was noted for his research in such fields as spectroscopy, astrophysics, and celestial mechanics. He also worked for NASA's Jet Propulsion Laboratory and the Navy, and he was a member of the faculty senate. Because he had lived through five decades of UA history by 1984, he wrote a booklet about his experiences at the school beginning in 1936, along with a history of the physics department. Titled "Skeletons Out of the Closet: An Anecdotal History of the UA Physics Department," Blitzer's booklet discusses the early years of the department, which opened its doors to students in 1892 with a one-man faculty and a single course. The booklet includes interesting details such as how, during World War II, the physics department was composed of only three professors, and had a single telephone in the hallway and a secretary who worked only two to three hours a week. Although he retired in 1986, Blitzer remained active in the department for years, attending faculty meetings, advising undergraduates, and mentoring university physics teachers. He was also a philanthropist and one of the founders of the Southern Arizona Chapter of the Cystic Fibrosis Foundation, and was involved with cerebral palsy research and Congregation Anshei Israel as well. He is survived by his wife of 62 years, Pauline; a son, Charles; a daughter, Miriam; and four grandchildren.

Leon Katz, PhD, on March 1, 2004.

Paul G. Thiene, PhD '52, of Sonoma, California, on July 19, 2004. He worked for Philco-Ford's research and development office in Newport Beach, California, and when he retired in 1988 he moved to Carmel and then, in 1999, to the Sea Ranch in Sonoma. He is survived by Sonja, his wife of 58 years; three daughters, Pamela Thiene, Kristin Thiene, and Maya Redwitz; and two grandchildren.

1944
Marvin S. Cohen, CAVU, of Cherry Hill, New Jersey, on May 19, 2004. He was one of a group of students during World War II who received certification after completing an accelerated training program in meteorology, and who referred to themselves as Ceiling and Visibility Unlimited. He worked for RCA, where he became engineering manager in research and development for the company's Astro-Electronics Division. He is survived by his wife, Shirley; three daughters, Marjorie, Ellen, and Beth Ann; and five granddaughters.

C. Billy Sharp, CAVU, of Arlington, Texas, on August 2, 2004; he was 79. One of a group of students who in 1944 received certification after completing an accelerated training program in meteorology, and who referred to themselves as Ceiling and Visibility Unlimited, he was retroactively awarded a master's degree in meteorology. He spent 20 years in the Air Force, retiring with the rank of lieutenant colonel, and 35 years with Bell Helicopter, retiring in 1989. He is survived by Johnie, his wife of 59 years; two daughters, Sue Williams and Sherri Skains; a son, Bill; and eight grandchildren and 12 great-grandchildren.

1946
Clyde C. Andrews, Eng '47, of Sun City West, Arizona, on September 13, 2004; he was 85. A retired rear admiral, he had joined the Navy in 1941 and become a naval aviator. After flight training, he was assigned to the aircraft carrier USS *Ranger*, and his fighter squadron participated in the invasion of North Africa in 1942. He was awarded an Air Medal after taking part in Operation Leader in Norway. In 1944, he was assigned to Tactical Test at the Naval Air Test Center at Patuxent as a test pilot, and one of his greatest thrills was checking out Colonel Charles Lindbergh in a Japanese Zero. In 1953 he was the Navy's nominee for the Octave Chanute Award, given annually to the U.S. test pilot making the greatest contribution in the field of aerial flight test. He had tours in the space program, at the Pentagon and the Navy

Department, and at the Naval Air Systems Command, where he was awarded the Legion of Merit. He was promoted to rear admiral in 1972 and awarded his second Legion of Merit. He finished his active duty as assistant commander of Naval Systems Command for Research and Development in 1976. He was later a partner of Aviation Information Services. After moving to Sun City West, he and his wife became active in Christian Science and Habitat for Humanity. Andrews is survived by Jean, his wife of 62 years; a daughter, Sheryl Batty; a son, Tommy Lee; and eight grandchildren and five great-grandchildren.

Allan B. Elliott, MS, of Miamisburg, Ohio, on September 25, 2004; he was 84. He had retired from Top Value Enterprises after 16 years of service and was a World War II veteran of the U.S. Army Air Forces and a member of the Central Christian Church of Kettering. Predeceased by a granddaughter, Caroline Althen, he is survived by Mary Ellen, his wife of 61 years; three daughters, Carol Bucher, Susan Garten, and Jane Althen; seven grandchildren and a great-granddaughter; and a sister, Barbara Neely.

Fremont Easton Reichwein, of Fort Washington, Maryland, on March 8, 2004. After graduating from Caltech as part of the Navy's V-12 Program, he served aboard several ships before beginning his advanced training and teaching responsibilities at the U.S. Naval Postgraduate School in Monterey, California. Along the way to earning his MS in physics, he served as operations officer aboard the destroyer USS *Agerholm* and executive officer aboard the destroyer USS Rogers. He was next appointed weapons officer aboard the aircraft carrier USS *Kitty Hawk*, and then was assigned to command the destroyer USS *Fletcher*. This was followed by appointment to the staff of the Commander in Chief Pacific Fleet and then command of the USS *Norton Sound*. His final duty station was at the office of the Secretary of Defense, in Washington, D.C. A recipient of the Legion of Merit, he was also a member of Sigma Xi. Upon retiring with the rank of captain in 1973, Reichwein entered the private sector, working as a consultant for several corporations. He enjoyed painting, calligraphy, swimming, tennis, and maintaining his Fort Washington home. A member of St. Mary's Catholic Church in Piscataway, Maryland, he was an avid participant in the church choir. He is survived by Irmingard, his wife of 51 years; two sons, Manfred and Louis Jerome; two daughters, Monica Ellen Gaylord and Marie Kristina Webb; four granddaughters; and two brothers, Jay Ormond and Charles Arthur.

Jay William Stuart, MS '48, Eng '51, on October 22, 2004. A longtime resident of Southern California and a 55-year member of the AIAA, he was involved in almost every facet of the aerospace industry and in recent years had contributed his expertise to the Wright Flyer Project. The recipient of numerous honors, he was included in *Who's Who in American Aviation* and *Who's Who in America*. He served as a class representative for the Caltech Alumni Fund, and for several years mentored high-school students at the Academy of Math and Science, at Dominguez Hills State University. He was a lifetime badminton player; he frequently assisted in the Manhattan Beach Junior Badminton program. He is survived by Nancy, his wife of 53 years; a daughter, Tani Robertson; a son, Joel; and four grandchildren and a great-granddaughter.

1947
Robert M. Kendall, on July 11, 2004.

Robert M. Stewart, on July 23, 2004; he was 78. A physicist, lifelong musician, and Southern California resident, he later in his career developed an interest in mathematics-based design and design theory. He did graduate study at George Washington University, and he was a member of the early Jet Propulsion Laboratory, where he contributed to rocket-guidance systems and was named in some of its patents. He went on to found Space Electronics with Frank Lehan and James Fletcher, who later headed NASA, and, when the firm was bought by Aerojet General, Stewart became head of research for its Space General subsidiary and acquired a dozen space-technology patents. He also became involved with electrochemical brain research, receiving an honorary doctorate of neurology from USC, where he had his lab, and associating with figures as disparate as the Maharishi Mahesh Yogi and Norbert Weiner, the "father of cybernetics." He was also part of the jazz scene, having played trumpet professionally through his school years, and he counted a number of jazz notables among his friends. His own "Art West"—read Stewart—big jazz band, for which he wrote and arranged music, was made up of top Hollywood studio musicians of the '60s and '70s. He also returned in later years to an early love, choral music. He became involved in moviemaking as well, with his copyrighted 3-D mathematical model "Tetralinks" being featured in the 1977 film *Demon Seed*, which starred Julie Christie. His last year he was still busy, submitting art designs for public spaces at Caltech and continuing to teach and tutor young people in California. He is survived by his daughter, Lynn Stewart-Ruiz; his son, James; his sister, Dorothy Ghose; and his former wife, Mei-Lin Ma.

1948
Nelson Jarmie, of Los Alamos, New Mexico, on May 14, 2004.

John T. Slusher, of Sherman, Texas, on August 24, 2002; he was 84. He is survived by his daughters, Alysson Ellen Blake and Jan Katherine Morris, and by two grandchildren and two great-grandchildren.

Sylvan D. Wanlass, on April 21, 2003.

1949
Charles C. Alsworth, MS, of Phoenix, Arizona, on August 30, 2004; he was 84. A World War II veteran who served with the 34th Infantry Division in North Africa and Italy, attaining the rank of captain, he dedicated many postretirement hours to volunteer work with the Malta Center. Predeceased by his wife and his oldest son, Charles Jr., he is survived by two daughters, Anne Marie and Mary Susan; two sons, James Stephen and Joseph Craig; three grandchildren; and a sister, Mary Weinzel.

George B. Guthrie Jr., PhD, of Bartlesville, Oklahoma, on September 20, 2004; he was 88. During World War II he worked at Caltech from 1942 to 1943 in the area of chemical warfare, and from 1943 to 1945 at MIT in the area of radar development. After receiving his doctorate he joined the Bureau of Mines, working from 1949 to 1969 in the thermodynamics section, developing an enthusiasm for computers that he shared with middle-school students in Bartlesville and with many in his family. After retiring, Guthrie taught at Oklahoma State University and Fort Lewis College, in Colorado. He served as a volunteer stagehand at the Bartlesville Civic Center and was active in the Bartlesville Little Theater Guild and Bartlesville Civic Ballet in set design and construction and lighting design, receiving an Outstanding Service Award with his wife in 1980 from the Bartlesville Arts and Humanities Council. Predeceased by Jeanne, his wife of 40 years, he is survived by four sons, Gordon, James, Carl, and John; two daughters, Allison Moore and Lindsey Hartman; and nine grandchildren and ten great-grandchildren.

Jarvin R. Heiman, of Los Angeles, on October 9, 2004. An associate professor at UCLA, he practiced psychiatry in West Los Angeles for more than 30 years, and later in his career explored alternative medicine, transpersonal psychology, and Buddhist thought. After graduating from Caltech, he went on to earn additional degrees from the University of Chicago and UCLA. "Although we all wish he could have lived longer, Jarvin could not have lived better. We are grateful for the time we had with him, and for the difference he made in all of our lives." He is survived by his wife, Gibson; two daughters, Barbara Heiman and Elizabeth Ngo; a son, Robert; a stepdaughter, Nancy Marquino; three grandchildren; and a sister, Ethel Miller.

1950
Leon Joseph Bass, MS '51, of Woodland Hills, California, on November 5, 2004; he was 78. A decorated World War II Navy veteran, he worked in the aerospace industry for nearly 40 years and was particularly proud of his contribution to the Mars Viking Lander Mission. In addition, he received special recognition from UCLA Extension for over 20 years of teaching electronic engineering technologies. An avid bicyclist, he also enjoyed camping, traveling, Jewish traditions, classical music, and watching *JAG*. He is survived by Elaine, his wife of 57 years; three sons, Bill, Richard, and Robert; four grandchildren and two great-grandchildren; three brothers, Manuel, Hyman, and Isaac; and a sister, Madeline.

Roy Craig, MS, of Ignacio, Colorado, on March 18, 2004; he was 79. An investigator who worked on the largest, most systematic U.S. investigation of unidentified flying objects, he was chosen by Edward Condon to serve as chief field investigator for the Colorado Project, the official government search for evidence that "flying saucers" actually existed. He coauthored the three-volume Condon report, which debunked UFOs. Craig remained interested, however, feeling that the mere possibility opened people to the idea that humanity might not be the center of the universe. Years later he wrote *UFOs: An Insider's View of the Official Quest for Evidence* (University of North Texas Press). In addition, he donated nine boxes of his papers and research findings to the Science Fiction and Fantasy Research Collection at Texas A&M University's Cushing Memorial Library. Craig also worked for Rocky Flats in Boulder, taught physical science at the University of Colorado, and helped set up the Four Corners Research Institute. A World War II Army veteran, he turned to protesting the Vietnam War. A believer in deterrence, he had been making nuclear weapons, feeling that if America made them, America wouldn't have to use them. Then one night he heard an Army general during a speech say that there was no reason not to use tactical nuclear weapons against bridges in Vietnam. Not long after, Craig quit his job and started teaching. He also raised llamas on his ranch, pastured buffalo for a neighbor, and kept two peacocks. The beauty of the peacock's feather, he maintained, was his proof that God exists. He enjoyed chess and traveling. He is survived by his sisters, Carolyn Shryock and Dorothy Voss McCormick.

Donald A. Dooley, MS, PhD '56, on August 23, 2004.

1951
Robert E. Bible, on September 7, 2004.

1952
Robert D. Waldron, PhD, of Canoga Park, California, on July 6, 2005; he was 79. A NASA scientist who helped analyze the moon rocks brought to Earth by the Apollo astronauts, Waldron in the 1970s worked with University of Houston scientist David Criswell to examine rocks and other materials collected on the lunar surface. Waldron concluded that lunar raw materials would not be useful on Earth, but that materials such as iron, aluminum, magnesium, titanium, oxygen, silicon, and glass could be extracted and refined on the moon and used for assembling vehicles in space for missions beyond the moon. Waldron held several patents in optics, power transmission, and chemistry, and his contributions in the field of lunar science, according to David Criswell, are "considered by many to be the bible on using the moon." He is survived by Margaret, his wife of 50 years; two daughters, Karen and Nancy; two sons, Mark and Rick; two grandchildren; and a brother, John.

1953
Levi A. Brown, MS, of McLean, Virginia, on September 3, 2004; he was 79. He was a retired U.S. Army colonel. Predeceased by his wife, Barbara, he is survived by three daughters, Patricia Brown, Elizabeth Brown, and Maureen Petracca; two sons, Byron and Michael; eight grandchildren; a brother, Jules; and three sisters, Emily McCaffrey, Jane Brown, and Zoe Brown.

Coy Richard "Dick" Cantrell Jr., MS '54, of Chatsworth, California, on August 28, 2004; he was 80. A renowned aircraft designer, he was hired by Lockheed Aircraft Corporation in Burbank, California, immediately after he graduated from Caltech, and he was soon asked to join the company's top secret Advanced Development Projects (ADP) group, informally known as the "Skunk Works." Over the course of his career, Cantrell participated in the design and development of some of the world's most advanced aircraft, including the SR-71 Blackbird, the F-117A Nighthawk stealth fighter, and the YF-22 Advanced Tactical Fighter. In 1990, he was corecipient of an American Institute of Aeronautics and Astronautics award for his leadership role in the development of the F-117A, "the world's first operational stealth aircraft." He retired from Lockheed in 1991 as director of engineering and programs for ADP but continued to serve the company as a consultant. Predeceased by his daughter, Lee Anne, in 2003, he is survived by his wife, Emma Lou; a son, Tom; and a brother, Jim.

Frodsham . . . from page 17

the payoff came in the series of live concerts that Caltech chorus groups performed throughout the academic year. The spring concert was timed to coincide with Seminar Day, maintaining a strong bond among past and present Glee Club alumni, who could return to the stage and sing the Alma Mater (arranged by Frodsham), as well as other Club standards. Olaf was also a composer and arranger. His previous position at the Kamehameha School in Hawaii allowed him to pass on Hawaii's rich vocal music heritage (as well as the hula!) to most of the Men's Glee Club groups over the years.

Olaf was most certainly a showman, which contributed to the appeal and popularity of the concerts. His signature performance piece was the Festival of Light holiday concert, which combined Jewish and Christian vocal music with staged tableaus of Biblical stories exemplifying the theme of light. The show always sold out for multiple performances, and was a highlight of the campus and glee clubs' holiday season.

Glee Club tours were eagerly anticipated and provided wonderful memories for all involved. The group regularly toured California and the local southwest, and occasionally traveled to other parts of the continental United States, as well as to Hawaii and Europe. During these trips, Olaf encouraged club members to present science talks at local schools, a practice that was in keeping with his lifelong commitment to education. He also enjoyed demonstrating to audiences that one could be a science or technology "nerd" and still respect and enjoy the arts.

Eriksen adds, on a more personal note, "I sang with Olaf for 8 seasons, from 1971 through 1979—my 5 years as an undergraduate, 2 years post-grad, and my first year of graduate studies. Although I had sung in school vocal ensembles for years, I had never before experienced the wonderful 'male sound' of a large male chorus, or much of the rich repertoire that Olaf included in our concerts. I was raised Roman Catholic, but none of my church experience had included vocal music, and I am forever grateful for the introduction to Gregorian chants and the *Mass for Three Voices* of William Byrd.

"Olaf exemplified many positive qualities, which he managed to partially instill in some of us when we were receptive. They included leadership, discipline, cooperation, and dedication. I was most impressed by his seemingly boundless energy and enthusiasm—if we could only have bottled and sold it! He could also be demanding and sarcastic, but only if he knew the recipient could 'take it.' He went to great pains to make sure he knew every member of the Club personally, and would often assist students with personal problems. He knew that the academic demands at Caltech were strenuous and had a great respect for the students' time.

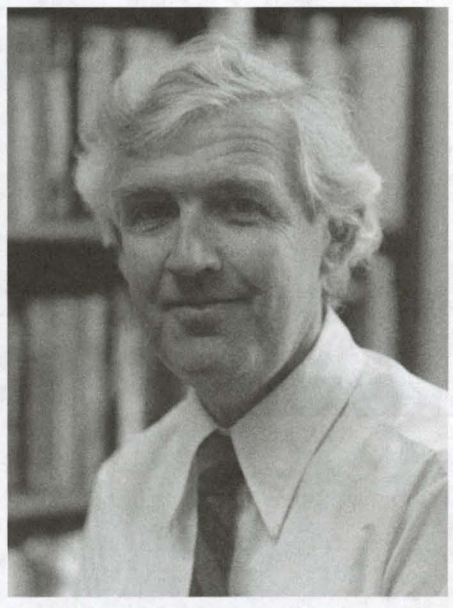
"Though many of us dismissed the idea at the time, Olaf was in many ways a 'father figure' by virtue of his position, viewpoint, and personality. Many Caltech students were a fair distance from home and thus cut off from parents. Olaf filled a certain gap for some of us, even if we fought it. Besides my parents, he was certainly the most influential person I experienced in my time at Caltech, and perhaps in my entire life so far."

Frodsham is survived by his wife, Elaine, and a son, Lance.

Francis Celii has posted photos of the Frodsham Service at www.Celii.PhotoReflect.com. For an e-mail compilation of alumni tributes to Frodsham, contact Celii at celii@ti.com.

Just before a concert performance in the late 1970s, Frodsham (at far right) joined his singers on the Beckman Auditorium stairway for this commemorative photo.

RONALD SCOTT 1929–2005



Ronald Scott, a soil engineer who designed the ingenious lunar scoop that first sampled extraterrestrial material, died August 16 at his home in Altadena, after a long battle with cancer. He was 76.

Scott was a professor of civil engineering at Caltech when he worked out a way to test the soil on the moon in anticipation of the Apollo landings. His design was incorporated into the unmanned Surveyor 3 mission, which landed below the rim of a small crater at Oceanus Procellarum in April 1967. The second soft landing on the moon by a U.S. spacecraft (Surveyor 2 having failed), Surveyor 3 provided crucial details about the strength, texture, and structure of the ground on which astronauts would walk two years later.

According to Caltech provost Paul Jennings, PhD '63, a longtime colleague, Scott was known in the technical community for numerous other advances in addition to his lunar soil studies. "Ron was an acknowledged intellectual leader in the field of soil mechanics and led the introduction in this country of the use of centrifuges to study problems in the mechanics of soils, particularly during earthquakes.

"He was an exceptional researcher who approached his subject with the motivation of an engineer and the tools of a scientist," Jennings said. "He was also a noted expert on the cause and mechanics of landslides and other soil failures. He was a consultant on the Baldwin Hills Dam failure in 1963 and the Laguna Hills Bluebird Canyon slide in 1978."

A native of Scotland, Scott had lived in the United States since arriving at MIT in the early 1950s for graduate study. After graduation he spent two additional years at MIT as a researcher, and then worked as a soil engineer with the U.S. Army Corps of Engineers and with Racey, McCallum and Associates in Canada.

He joined the Caltech faculty in 1958 as an assistant professor and rose through the ranks to become the Hayman Professor of Engineering. He retired as the Hayman Professor Emeritus in 1998.

During his Caltech career, Scott also worked on other NASA missions, including the Apollo manned missions as a member of the soil mechanics team, and the Viking spacecraft that landed on Mars in 1976. He also was a consultant to private industry, local government, and U.S. government agencies on a wide variety of soil engineering problems.

His research interests included the mechanics of deformation and yielding in soils, soil behavior in earthquakes, the physical chemistry and mechanics of ocean-bottom soil, and freezing and thawing processes in soils. He taught a variety of undergraduate and graduate classes in soil mechanics and foundation engineering at Caltech.

Elected to the National Academy of Engineering in 1974, Scott was a winner of the American Society of Civil Engineers' Walter L. Huber Civil Engineering Research Prize in 1969, the Norman Medal in 1972, the Thomas A. Middlebrooks Award in 1982, and the American Association for the Advancement of Science's Newcomb Cleveland Prize in 1976.

He is survived by his wife, Pam, and three sons, Grant, Rod, and Craig.

LET THERE BE LIGHT

What are the links between art and science? Between art and nature? Among all three? While the images on the back cover certainly won't answer these questions, they may offer some illumination. The larger picture, which is a still frame from a kinetic art form called a lumia, was created with remarkably mundane materials by artist Thomas Wilfred between 1965 and 1966. Spaceflight had only recently become a reality, and Wilfred acknowledged in a letter that he had visions of traveling between the stars when he created at least one of his lumia. In light of this, it is interesting that Wilfred's work bears more than a casual resemblance to the astronomical image at the upper left: a nebula of newborn stars called "DR 6," found in the constellation Cygnus. The infrared image was taken in November 2003 by the final observatory to be launched in NASA's Great Observatories Program—the Spitzer Space Telescope, which is managed by the Jet Propulsion Laboratory. A story on the Caltech-trained astronomer who has championed Wilfred's art begins on page 12. As for JPL, an interview with lab director Charles Elachi starts on page 3.

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