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In This Issue

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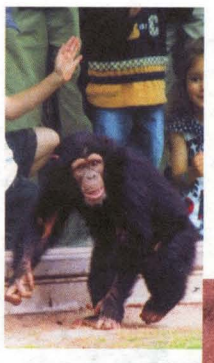

ON THE COVER
The focus is on the many faces and facets of the Institute as Caltech embarks on the most ambitious fund-raising effort in its history.

Also in this issue:
New frosh, new honors, new appointments, new findings on humans and chimps, a new neighbor for Pluto, and a new take on a familiar campus scene (on the back page poster).

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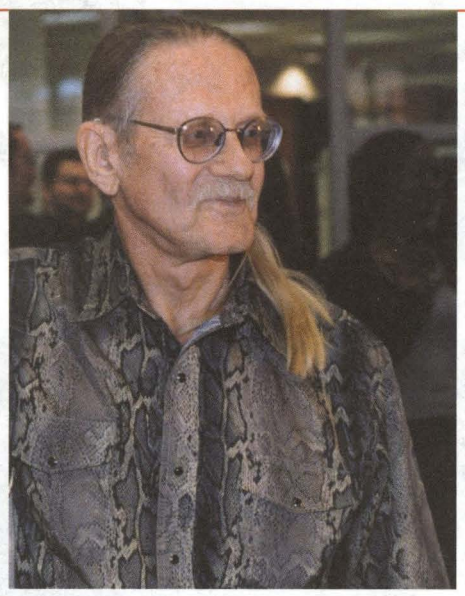
Up Front

Mr. Smith Goes to Stockholm



Vernon Smith '49 gets ready to meet the press at Virginia's George Mason University after learning that he is corecipient of the 2002 Nobel Prize in Economics.

No matter how exceptional you think you are, the proper response to the news that you've won a Nobel Prize is genuine surprise or at least a convincing approximation of it. On the morning of October 9, when Vernon Smith '49 got the call from Stockholm, and the official who relayed the news that he was a cowinner of the Nobel Memorial Prize in Economic Sciences asked him how he felt, Smith says that he replied, "I'm relieved."

Relieved? Not even Richard Feynman would have been so brazen. But if you're acquainted with the 76-year-old economist with the ponytail and Western twang in his voice, then you know that there wasn't a bit of hubris in his comment.

"I was relieved, because my friends have been predicting this for years and they were finally right," explains Smith, speaking by phone from his home in Tucson, where he was preparing the speech he would give at the Nobel Prize ceremonies in Stockholm in December. "When you hear these things from friends and people who have nominated you in the past, all it expresses is their hopes. When I didn't get it, I'd feel as though I'd let them down, even though there was nothing I could do about it."

Smith, a professor of economics and law at George Mason University, shares the prize with Daniel Kahneman, a professor of psychology at Princeton. He now becomes Caltech's 29th Nobel laureate, and the winner of the Institute's 30th Nobel Prize, counting the two won by Linus Pauling, PhD '25, who taught Smith chemistry in the 1940s.

According to the Royal Swedish Academy of Sciences, Smith won the Nobel "for having established laboratory experiments as a tool in empirical economic analysis, especially in the study of alternative market mechanisms." Over a nearly 50-year career, Smith founded and promoted the field of experimental economics, changing economics from a science of observation to one where theories could be tested and confirmed or refuted through controlled experiments. While the trend toward experimentation has met resistance from some economic theorists, numerous institutions, including Caltech, have established experimental economics programs. In a few cases, the discipline has changed the way business and government are practiced.

Smith's first introduction to economics came at Caltech. The son of socially conscious parents with eighth-grade educations, Smith grew up in Wichita, Kansas. Smith says he was an average student. He first heard about Caltech as a high-school senior when he went to the local library to gather information on universities. He picked up a book that pronounced Caltech the best institution of higher learning in the country. "So, I said to myself, 'Why not just go there?'" says Smith. After taking a year of science and math courses at a local college, he passed the Caltech entrance exam and went off to Pasadena in 1945.

"I just worked for four straight years at Caltech, including weekends," he recalls. "I didn't have a social life. I worked very hard and never regretted it."

Smith's father, a machinist, had instilled in him a desire to understand how things work. Taking his first economics course his senior year, Smith recalls, "I guess I realized that economics was not that different from physics." But unlike physics, "economics didn't have a foundation in empirical work. It was not clear that the way it was taught was how things actually worked." Theories were just accepted without proof. Smith would eventually challenge that notion.

After Caltech, Smith went to the

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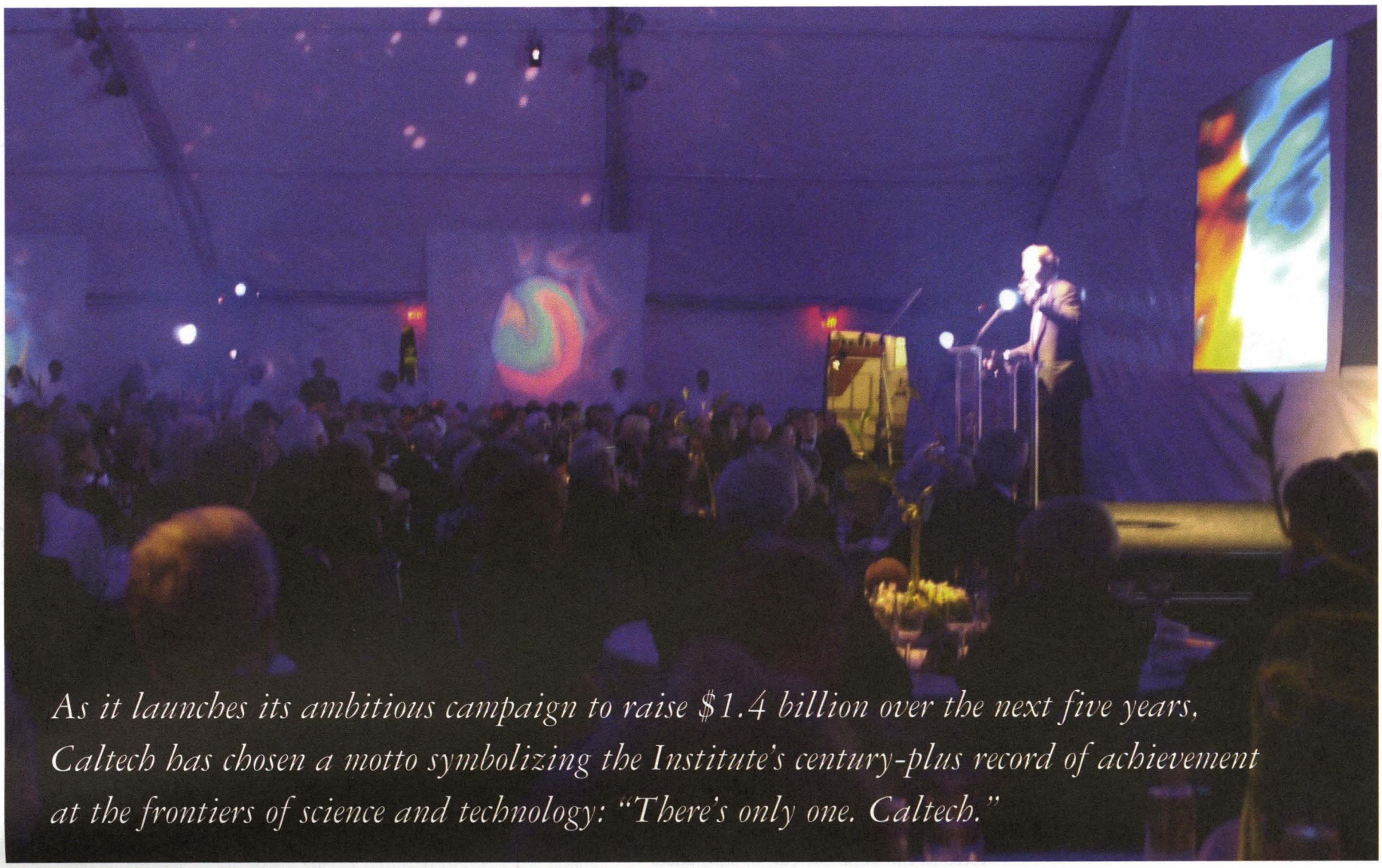


As it launches its ambitious campaign to raise $1.4 billion over the next five years, Caltech has chosen a motto symbolizing the Institute's century-plus record of achievement at the frontiers of science and technology: "There's only one. Caltech."

At an October 25 kickoff celebration marking the start of the campaign's public phase, David Baltimore explained the significance of those simple-yet-evocative words. "The phrase tells it all. There is no other place like this one," Caltech's president told some 400 Institute friends, donors, and supporters who filled a voluminous party tent pitched on the campus athletic field.

Charlie Rose, the Emmy award–winning public-television interviewer and the evening's master of ceremonies, put it this way: "What is the most influential thing that will have the most impact in the new century? Clearly, science and technology is the answer. What Einstein did in the 20th century is probably what someone from Caltech will do in the 21st."

Rose, who hosts *The Charlie Rose Show* on PBS, also served as moderator for a series of panel discussions held the following day in Caltech's Beckman Auditorium. "A Celebration of Caltech Science" included faculty presentations and discussions of the latest Institute research into the brain, earth science, and the universe, and showcased the Institute's interdisciplinary strengths, which form a cornerstone of the campaign.

Scheduled to run until 2007, the campaign is chaired by Wally Weisman, the vice chair of the Caltech trustees, who will work closely with Gary Dicovitsky, Caltech's new vice president for development and alumni relations, and his campus development staff. (In an interview on page 14, Dicovitsky offers his perspective on the campaign.)

At the kickoff celebration, guests caught their first glimpse of some of the themes that will define the Caltech fund-raising drive as they watched a specially commissioned campaign video entitled *Infinite Possibilities*, which includes, among many other vignettes, Provost Steve Koonin's recipe for Institute success: "You take small, interdisciplinary, and bold, put them together, and magic happens."

That unique intellectual alchemy has been part of the Caltech scene for decades, said Ben Rosen '54. The chair of the Institute's board of trustees told the audience that the Caltech of today exudes a passion for knowledge and discovery that is as strong today as when he stepped on campus as a freshman 52 years ago.

Looking toward the Caltech of tomorrow, Baltimore characterized the $1.4 billion campaign figure as ambitious, yet realistic. The monetary goal reflects the aspirations and dreams of the faculty, he said, and also takes note of nuts-and-bolts needs, like replacing and upgrading campus infrastructure. Key components include funding to enrich student life, to support innovative research programs, and to construct new buildings. "Of course, for a school with fewer than 20,000 living alumni, it may seem like hubris to try to raise such a remarkable sum," Baltimore told the audience.

But he noted that the Institute had already been the beneficiary of a remarkable gift—$600 million from Trustee Chair Emeritus Gordon Moore, PhD '54, and his wife, Betty, and the Moore Foundation. Caltech showed its appreciation at the kickoff event, when JPL director Charles Elachi, PhD '71, announced the naming of an asteroid in Moore's honor and presented the couple with a commemorative plaque about "asteroid 8013 Gordonmoore" and a desktop model of the Mars Exploration Rover, which is slated to explore the Red Planet in 2004.

Along with the Moore gift—the largest commitment in the history of higher education—Caltech has raised approximately $200 million during the "quiet" period of the campaign, for a total of about $800 million.

With slightly less than half their monetary goal to go, Caltech leaders are banking on a successful campaign that will allow the Institute to carry out a wide range of groundbreaking research, from new investigations into the large-scale structure of the universe to the fabrication of revolutionary devices at the nanolevel of atoms and molecules. Said Baltimore, "We want to find the big new opportunities in the intellectual world, the great unknowns." All these endeavors will require state-of the-art facilities and equipment to ensure that Caltech can continue to attract and support the most outstanding scholars and students.

The campaign goals fall into three major areas: endowment, which encompasses funds for people and programs; buildings; and equipment. The $810 million earmarked for endowment will be used to support new professorships, faculty reinvention funds for professors wishing to change direction in their research, and faculty start-ups. This category also includes the visiting scholars program; graduate and postdoctoral fellowships; and Discovery Funds, which enable faculty to pursue promising, untried avenues of research without going through the usual bureaucratic funding hassles. This support will also be applied to undergraduate financial aid; the Summer Undergraduate Research Fellowships (SURF) program; and the President's Fund, which fosters enhanced JPL/campus interactions.

The Institute is seeking $400 million for buildings, more than half of which is designated for the renovation and expansion of existing structures. These include undergraduate and graduate student residences, Dabney Hall for the Humanities, the Robinson Laboratory of Astrophysics, biology laboratories, and the Caltech Children's Center. Funds in this category will also be applied to campus infrastructure renewal and an Athenaeum maintenance endowment.

As for new structures, Caltech has a wish list of facilities that will support world-class interdisciplinary research. The Institute is seeking funds for a new astrophysics laboratory that would unite campus astronomy and astrophysics under one roof; a multidisciplinary information sciences building; a chemistry teaching/research laboratory that

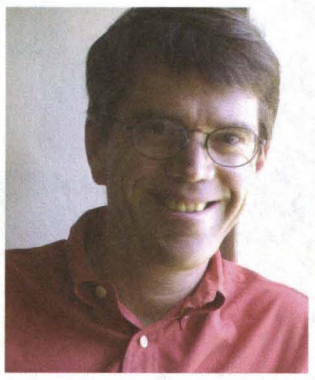
Continued on page 14

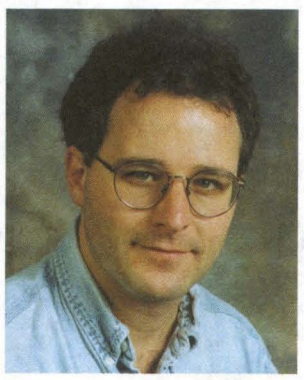
Bright lights, great expectations. At Caltech's campaign kickoff celebration, the evening's master of ceremonies, PBS interviewer Charlie Rose, addressed invited guests under a campus big top (top). Trustee vice chair and campaign chair Wally Weisman (above, center) and board of trustees chair Ben Rosen (above) also spoke at the event.

Campus

Update

Two Caltech faculty awarded MacArthurs





Astronomer Charles "Chuck" Steidel (left) and environmental scientist Paul Wennberg have joined the "genius" ranks, courtesy of the MacArthur Foundation.

Professor of Astronomy Charles Steidel, PhD '90, and Professor of Atmospheric Chemistry and Environmental Engineering Science Paul Wennberg have been named 2002 MacArthur Fellows, a prestigious honor bestowed each year on innovators in a variety of fields and popularly known as the "genius grant."

The two Caltech faculty were among 24 fellows announced by the John D. and Catherine T. MacArthur Foundation of Chicago. Each recipient will receive a five-year, $500,000 grant, no strings attached.

Steidel has made numerous contributions to the field of cosmology in the ongoing attempt to understand galaxy formation and evolution. In particular, he's known for developing a technique that effectively locates early galaxies at specific cosmic epochs, making it possible to survey large samples of galaxies in the early universe. By studying these samples, observed primarily with the Keck Telescopes on Mauna Kea, astronomers have been able to map the galaxies' distribution in space and make detailed observations of individual galaxies, providing insights into their formation.

Steidel says he hasn't yet decided what to do with the grant. "I'm giving it some thought, but I'm still in the disbelief phase—it took me completely by surprise!" he says. "The unique nature of the fellowship makes me feel like I should put a great deal of thought into coming up with a creative use for the money. It does feel a bit odd to be recognized for work that is by its nature collaborative and dependent on the hard work of many people, but at the same time I am very excited by the possibilities."

A graduate of Princeton and Caltech, Steidel was a faculty member at MIT before returning to the Institute. He has also received fellowships from the Sloan and Packard foundations, as well as the National Science Foundation's Young Investigator Award and the American Astronomical Society's Helen B. Warner Prize.

Paul Wennberg, who holds joint appointments as a professor of atmospheric chemistry and of environmental science and engineering, examines how natural and human processes affect the atmosphere. He is particularly interested in the impact a class of substances called radicals has on both the health of the ozone layer and the proliferation of greenhouse gases, and he has earned recognition for developing airborne sensors to study them. One early result from these measurements contradicted conventional thinking about how ozone is destroyed in the lower stratosphere and has led to new assessments of the environmental impacts of chlorofluorocarbons and stratospheric aircraft.

He was "blown over by the award" when he found out, Wennberg said, adding, "It is a wonderful recognition of the work that I have done in association with the atmospheric scientists working on NASA's U-2 aircraft chemistry program. I have been pondering how I might use the funds, but have no concrete plans at the moment. It will certainly enable me to do things I wouldn't have thought possible—perhaps even take up the bassoon again!"

A graduate of Oberlin College and Harvard, Wennberg was a research associate at Harvard before joining the Caltech faculty. In 1999, he received a Presidential Early Career Award in Science and Engineering.

New MOSH with Caltech roots looks to sow seeds of change

Caltech undergraduates attend "the hardest educational institution in the world," says Catherine Jurca, Caltech's new master of student houses. Her goals, then, are twofold: to improve the quality of undergraduate life and to improve communication among students, faculty, and administrators. And, if she can get students out of the lab to watch a little NFL football on Sundays, she says, "all the better."

Catherine Jurca

"I've always been drawn to the undergraduates here," says Jurca, an associate professor of literature and unabashed NFL football fan ("Always have been, don't ask me why," she says with a laugh). "Caltech students are quirky, sweet, and very smart. But too many students come here and feel isolated and overwhelmed. Many of them spend almost all their time studying, tend to socialize almost exclusively with other members of their house, and they can miss out on the breadth of experiences Caltech can offer."

Jurca knows whereof she speaks. She's been a Caltech faculty member since 1995 and comes from a long line of Techers—both her father—Joseph Jurca '59, MS, '64—and grandfather—George Merrill Berkley '33—are alums. (She broke tradition by doing her undergraduate work at Johns Hopkins.)

Like her predecessors in the MOSH job, Jurca plans to hold weekly dinners with faculty and students at Steele House, the traditional location for MOSH activities, and to host off-campus events such as trips to the theater and opera. In a break with tradition, however, she won't be inviting students to MOSH dinners on the basis of which residence they live in, but rather on the basis of their options. That way, undergraduates meeting one another for the first time will automatically have something in common with other students and faculty at the table.

Jurca's position also carries with it the new responsibility of acting as a liaison between students and administration, in an effort to bridge communication gaps that may occur between the two sides. "Part of the job is to meet on a more regular basis with student leaders and attend faculty board meetings, so I know the points of view on both sides of an issue," she says.

In consultation with students, Jurca intends to examine various Caltech policies to see if there are ways to make undergraduate life a bit easier. For example, "most of the students I've talked to are not happy with the core course curriculum that is mandated for the first two years of study," she says. "It makes it difficult for many to select an option at the end of their freshman year because, often, they've had no exposure to any classes in the fields they might be interested in."

She hopes the option dinners will improve this situation, since they will enable freshmen to meet faculty and upper-class students to discuss option prospects before making their choices.

At the same time Jurca doesn't necessarily see herself as an advocate for all student issues. "I like to think I'll be able to present their viewpoints fairly to the administration, even if I personally disagree with it," she says. "But even so, I've found that students' opinions are often extremely well thought out and articulate; you have to be on your toes with them."

The MOSH position is a five-year, half-time administrative appointment, and Jurca does not expect her new role to slow her research pace. Currently she is writing a book on post-World War II Hollywood, in which she puts forth the view that the propaganda aspects of World War II films gave way in the post-war period to a type of public relations endorsement of particular business enterprises and the business community in general. The films she considers include *Mildred Pierce, Mr. Blandings Builds His Dream House*, and *Miracle on 34th Street*.

As several Moshes have before her, Jurca will live in Steele House "rattling around," as she puts it, in the huge second-floor space that will be her personal quarters. The first floor and large backyard will be used for the weekly social gatherings.

And if she can twist the administration's arm for a big screen TV, what better way to spend a Sunday afternoon than with a group of students, watching NFL football?

Humans and chimps may be a little less closely related, new research shows

For the last two decades, genetic studies have estimated that humans and chimpanzees possess genomes that are about 98.5 percent similar. In other words, of the three billion base pairs along the DNA helix, nearly 99 of every 100 would be exactly identical.

Now, however, new work by one of the codevelopers of the method used to analyze genetic similarities between species says the figure should be revised downward to 95 percent.

Roy Britten, a Caltech biologist, reported in the October 2002 issue of *Proceedings of the National Academy of Sciences* that the large amount of sequencing that has been done in recent years on both the human and chimp genomes—and improvements in the techniques themselves—allow for the issue to be revisited. In the article, he describes the method he used, which involved writing a special computer program, to compare nearly 780,000 base pairs of the human genome with a similar number from the chimp genome.

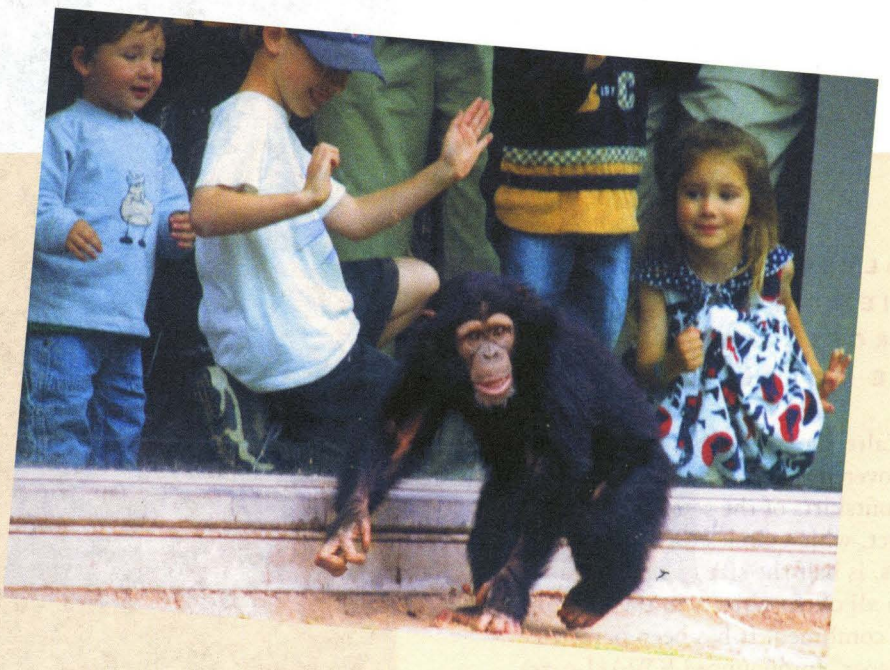
To describe exactly what Britten did, it is helpful to explain the old method as it was originally used to determine genetic similarities between two species. Called hybridization, the method involved collecting tiny snips of the DNA helix from the chromosomes of the two species to be studied, then breaking the ladder-like helixes apart into strands. Strands from one species would be radioactively labeled, and then the two strands recombined.

The helix at this point would contain one strand from each species, and from there it was a fairly straightforward matter to "melt" the strands to infer the number of good base pairs. The lower the melting temperature, the less compatibility between the two species because of the lower energy required to break the bonds.

In the case of chimps and humans, numerous studies through the years have shown that there is an incidence of 1.2 to 1.76 percent base substitutions. This means that these are areas along the helix where the bases (adenine, thymine, guanine, and cytosine) do not form a bond at that point.

The problem with the old studies is that the methods did not recognize differences due to events of insertion and deletion that result in parts of the DNA being absent from the strands of one or the other species. These are different from the aforementioned substitutions. Such differences, called "indels," are readily recognized by comparing sequences, if one looks beyond the missing regions for the next regions that do match.

To conduct the more complete survey, Britten wrote a Fortran program that did custom comparisons of strands of human and chimp DNA available from GenBank.



Were earlier estimates slightly skewed? Separated by a viewing window, and, according to recent Caltech research, by perhaps five percent of their DNA, human and chimp youngsters hanging out at the Los Angeles Zoo's Mahale Mountains chimpanzee habitat, still have plenty in common.

With nearly 780,000 suitable base pairs available to him, Britten was able to better infer where the mismatches would actually be seen if an extremely long strand could be studied. Thus, the computer technique allowed Britten to look at several long strands of DNA with 780,000 potential base pairings.

As expected, he found a base substitution rate of about 1.4 percent—well in keeping with earlier reported results—but also an incidence of 3.9 percent divergence attributable to the presence of indels. Thus, he came up with the revised figure of 5 percent.

As for the implications, Britten says these new findings should help future research into precisely how species branch off from each other, and why.

"The basic question you would like to answer is what makes the chimp different from humans—what were the basic changes in the genome that mattered. A large number of these 5 percent of variations are relatively unimportant. But what matters, according to everyone's idea, is regulation of the genes, which is controlled by the genes that are actually expressed. So to address this issue, you first have to know how different the genomes are, and second, where the differences are located.

Britten's article is available from PNAS by contacting Jill Locantore, the public information officer, at jlocantore@nas.edu.

Institute welcomes Afghan officials to campus

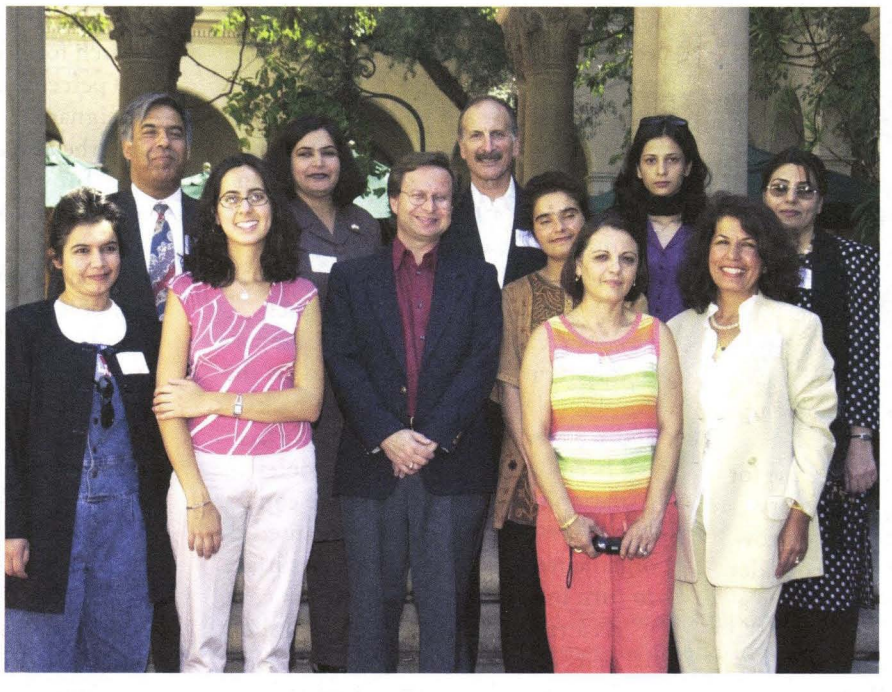
Caltech students and faculty welcomed a delegation of women from Afghanistan's new government to the Athenaeum in October for lunch and a discussion about their roles in rebuilding their war-ravaged nation.

The invitation grew out of a Caltech course on the history and culture of Afghanistan taught last spring by Professor Robert Rosenstone, now on sabbatical, and his wife, Nahid Massoud (see *Caltech News, No. 2, 2002)*.

The women were in Southern California to attend a specialized training program sponsored by the U.S. State Department. At Cal State Northridge, one of four American universities hosting them, they attended a two-week intensive program designed to improve their English and computer skills. The delegation focused on learning how to research and write grant proposals through the campus's College of Extended Learning.

The guests included Masooda Barekzaie and Breshna Sadat, who work in the Ministry of Foreign Affairs; Marzia Bazul, a judge; Jina Haidari, director of cooperatives; and Wilda Rustaie, from the Ministry of Women's Affairs. Also attending was Mohammad "Mo" Qayoumi, vice president of Cal State Northrige, who was a guest lecturer in the Afghanistan course. They were welcomed to campus by Provost Steve Koonin, Rosenstone, Massoud, and students, including senior Martha-Helene Stapleton.

Trying out fledgling English skills, each guest said a few words about her work and thanked the campus for its support and solidarity. As Bazul put it, "I think we would like such solidarity."



Afghan visitors and their campus hosts are, from left (back row) Mohammad Qayoumi; Marzia Bazul; Robert Rosenstone; Wilda Rustaie; Masooda Barekzaie. Front row, from left are Breshna Sadat; Martha-Helene Stapleton; Steve Koonin; Jina Haidari; the Afghan delegation's interpreter; and Nahid Massoud.

CALTECH PLANETARY SCIENTISTS FIND 10TH LARGEST OBJECT IN THE SOLAR SYSTEM

Caltech planetary scientists have discovered a sizable spherical body in the outskirts of the solar system. The object, which circles the sun every 288 years, is half the size of Pluto and larger than all of the objects in the asteroid belt combined. It has been named "Quaoar" (pronounced KWAH-o-ar) after the creation force of the Tongva tribe, who were the original inhabitants of the Los Angeles basin.

The discovery was made by Associate Professor of Planetary Astronomy Mike Brown and postdoctoral scholar Chad Trujillo. The duo detected Quaoar on a digital sky image taken on June 4 with Palomar Observatory's 48-inch Oschin Telescope.

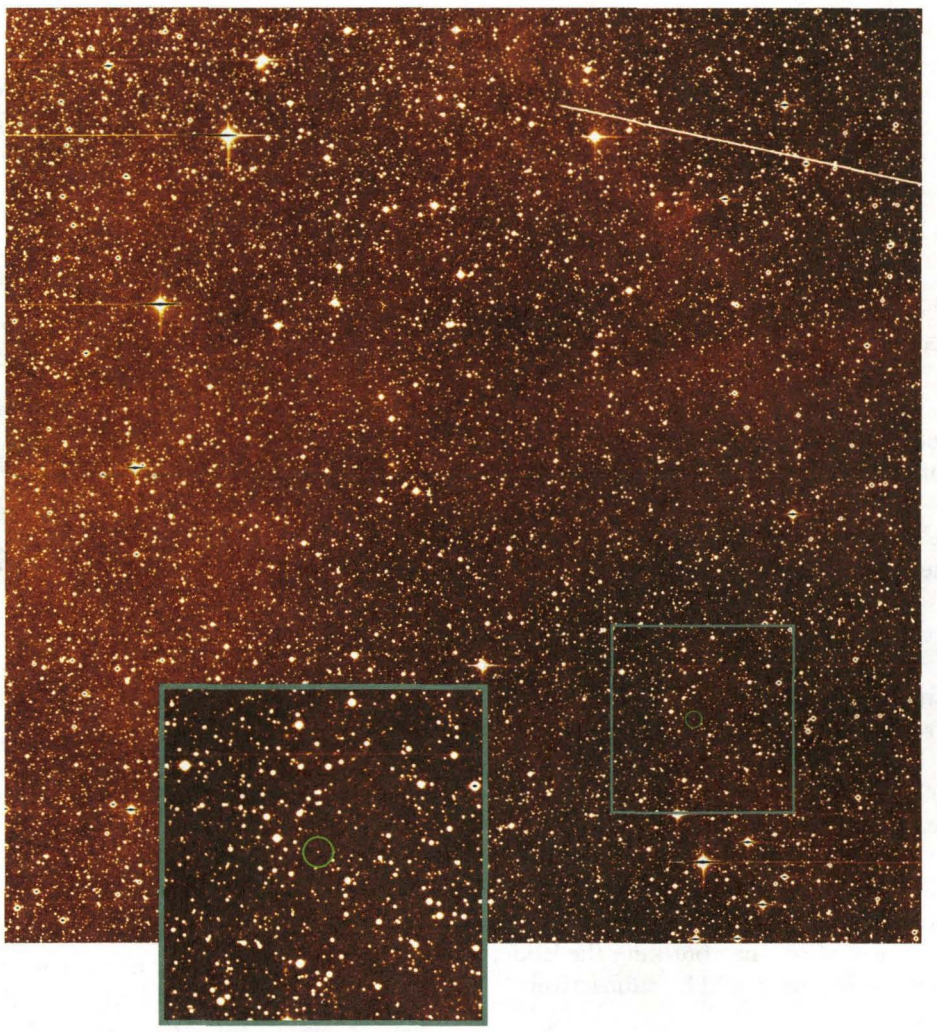
Quaoar is located about 4 billion miles from Earth in a region beyond the orbit of Pluto known as the Kuiper belt. This is the region where comets originate and also where planetary scientists have long expected to eventually find larger planet-shaped objects. Quaoar is by far the largest object found so far in that search.

Currently detectable a few degrees northwest of the constellation Scorpio, Quaoar demonstrates beyond a doubt that large bodies can indeed be found in the farthest reaches of the solar system. The discovery offers hope that more large bodies will be discovered there, some as large or even larger than Pluto. (*Caltech News* first wrote about Brown's Kuiper-belt research in 1999. Check out the article, "The Objects of His Affection," on the *Caltech News* Web site at http://pr.caltech.edu/periodicals/CaltechNews/articles/v33/n3.brown.html.)

More controversially, the discovery supports the emerging view that Pluto itself is best understood as a Kuiper belt object. A growing number of planetary scientists hold that Pluto was the first Kuiper belt object to be discovered, long before the age of enhanced digital techniques and light-detecting charge-coupled (CCD) devices, because it had been kicked into a Neptune-crossing elliptical orbit eons ago. Will the next generation of astronomy textbooks describe a solar system made up of *eight* planets?

"Quaoar definitely hurts the case for Pluto being a planet," says planetary scientist Brown. "If Pluto were discovered today, no one would even consider calling it a planet because it's clearly a Kuiper-belt object."

To confirm their June 4 finding of Quaoar, Brown and Trujillo looked through archived images of the same region of sky taken by a variety of instruments. They soon found images taken in the years 1983, 1996, 2000, and 2001 that not only allowed them to establish the distance and orbital inclination of Quaoar, but also to determine that the body is revolving around the sun in a remarkably stable, circular orbit.



It's a small world, after all. The image at left is one of three taken on June 4 with the 48-inch Oschin Telescope at Palomar Observatory, tracking the movements, over a 90-minute period, of the planetoid now known as Quaoar. The inset graphic provides a closer look at the region of sky in which Quaoar, which can be glimpsed as a speck inside the circle, was found. For more images and information on Quaoar, go to http://www.gps.caltech.edu/~chad/quaoar/.

"It's probably been in this same orbit for 4 billion years," Brown says.

In fact, Quaoar apparently was first photographed in 1982 by then-Caltech astronomer Charlie Kowal in a search for the postulated "Planet X," or the "tenth" planet. Kowal unfortunately never found the object on the plate—much less Planet X—but the image was left for posterity.

Because the precise location of Quaoar on the old plates is highly predictable, its orbit is thought to be quite circular for a solar system body, and far more circular than that of Pluto. In fact, Pluto is relatively easy to spot—at least if one knows where to look. This is because Pluto comes so close to the sun for several years in its 248-year eccentric orbit that the volatile substances in its atmosphere are periodically heated, which increases its reflectance, or albedo, to such a degree that it is bright enough to be seen even in small telescopes.

Quaoar, by contrast, never approaches the sun in its circular orbit, which means that its volatile gases never are excited enough to kick up a highly reflective atmosphere. As is the case for other bodies of similar rock-and-ice composition, Quaoar's surface has been bathed by faint ultraviolet radiation from the sun over the eons, and this radiation has slowly caused the organic materials on the body's surface to turn into a dark tarlike substance.

As a result, Quaoar's albedo is about 10 percent, just a bit higher than that of the moon. By contrast, Pluto's albedo is 60 percent.

Regarding spin rate, the scientists know that Quaoar is rotating because of its slight variations in reflectance during the six weeks they've observed it. But they're still collecting data to determine the precise spin rate. They will also probably be able to figure out whether the spin axis is tilted relative to the ecliptical plane.

The Kuiper belt can be thought of as a band extending around the sky, superimposed on the path of the sun. Brown and Trujillo's research method, in effect, is to take repeated exposures of a several-degree swath of this band and then use digital equipment to check and see if any tiny point of light has moved relative to the stellar background.

Brown and Trujillo are currently using about 10 to 20 percent of the available time on the 48-inch Oschin Telescope, which was used to obtain both the Palomar Sky Survey and the more recent Palomar Digital Sky Survey. The latter was completed just last year, freeing up the Oschin Telescope to be refitted by JPL for a new mission to search for near-Earth asteroids. About 80 percent of the telescope time is now designated for the asteroid survey, leaving the remainder for scientific studies like Brown and Trujillo's.

Since Quaoar's discovery, the scientists have used other telescopes to study and characterize it, including the Hubble Space Telescope and the Keck Observatory on Mauna Kea. Information derived from these studies will provide new insights into the precise composition of Quaoar and may answer questions about whether the body has a tenuous atmosphere.

There's good news here too for the serious amateur astronomer: he or she doesn't necessarily need a space telescope or 10-meter reflector to get a faint image of Quaoar. Armed with precise coordinates and a 16-inch telescope fitted with a CCD—the kind advertised in magazines such as *Sky and Telescope* and *Astronomy*—it should be possible to obtain images on successive nights that will show Quaoar as a faint dot of light in slightly different positions.

As for Brown and Trujillo, the two are continuing their search for other large Kuiper belt bodies. Some may be larger than Quaoar. "Right now, I'd say they get as big as Pluto," says Brown.

RECOGNITION

Yaser Abu-Mostafa, PhD '83, professor of electrical engineering and computer science, and **Oscar Bruno**, professor of applied and computational mathematics, are recipients of the 2002 Graduate Student Council Teaching Awards.

Frances Arnold, Dickinson Professor of Chemical Engineering and Biochemistry, has been selected by the Delaware Section of the American Chemical Society to receive the 2003 Carothers Award, for her "outstanding contributions and advances in industrial applications of chemistry."

James Arvo, associate professor of computer science, **Vladimir Baranovsky**, Taussky-Todd Instructor in Mathematics, **Niles Pierce**, assistant professor of applied and computational mathematics, **John Preskill**, MacArthur Professor of Theoretical Physics, **John Sutherland**, visiting professor of literature, and **Darryl Yong**, von Kármán Instructor in Applied and Computational Mathematics, are recipients of the 2002 ASCIT (Associated Students of Caltech) Teaching Awards. At the same time, **Michael Shumate**, Eng '64, lecturer in applied physics, has been honored with the 2002 ASCIT Lifetime Achievement Award.

Jacqueline Barton, Hanisch Memorial Professor and professor of chemistry, has been chosen by the American Chemical Society to be the 2003 recipient of the Ronald Breslow Award for Achievement in Biomimetic Chemistry. Sponsored by the Breslow Endowment, the award recognizes "outstanding contributions to the field of biomimetic chemistry" and consists of $5,000 and a certificate.

Pamela Bjorkman, professor of biology at Caltech and investigator of the Howard Hughes Medical Institute (HHMI), has been elected a member of the American Philosophical Society in recognition of her work with molecules needed for cell-surface recognition, and their role in the immune system. Founded by Benjamin Franklin in 1743, the society is the oldest learned society

Continued on page 9 . . .

Nobel Prize . . . from page 2

University of Kansas and got a master's degree in economics in 1952, and then went to Harvard, where he got his PhD in economics in 1955. At Harvard, he was influenced by a professor who provided classroom demonstrations to show that the prevailing theories of competition among small groups of individuals were unrealistic.

When Smith left Harvard for his first teaching job at Purdue University, he began to set up experiments using students to simulate different market situations. Challenging classical economic theory of supply and demand, Smith showed that markets could work efficiently even if buyers and sellers had incomplete information about each other's strategies and preferences.

"The more you know about the circumstances of other people, the more you should be able to use that to your advantage," he says. "But what you know may be inaccurate. So having more information may not be better."

Smith left Purdue in 1967, was at Brown University briefly, and then went to the University of Massachusetts. In 1973, he returned to Caltech as a Sherman Fairchild Distinguished Scholar and, along with Charles Plott (today Caltech's Harkness Professor of Economics and Political Science), taught a course in experimental economics in which faculty members sitting in the class outnumbered the students by a margin of two to one. Plott had introduced experimental economics to Caltech the previous year and, when Smith returned, they conducted experiments that advanced the discipline and helped make Caltech the nation's leading center of experimental economics.

"Vernon is the prime evangelist for the whole field of experimental economics," says Ross Miller '75, one of the students who took the Plott/Smith class. Miller's book about Smith and the field he established, *Paving Wall Street: Experimental Economics & the Quest for the Perfect Market*, was published in 2002. "He's wonderful in all dimensions; a great teacher and researcher who has influenced hundreds of students over time," said Miller, a financial consultant.

"When he returned to Caltech as a Fairchild Scholar, Vernon brought with him a wealth of knowledge of techniques that he had learned in the '60s," says Plott. "He had stopped doing experimental economics for several years, and this brought him back to experimentation. He was the first person to observe the law of supply and demand working in its quantitative form and, if nothing else, he deserved the Nobel Prize for that."

Plott, who had been an associate professor of economics at Purdue before coming to Caltech, had been Smith's fishing buddy in Indiana, and the two spent countless hours driving to lakes and rivers to fish for bass during the two years that Smith was teaching at Caltech.

"We just talked economics the whole time," Smith says. It was the middle of the Arab oil embargo and the energy crisis, when gas stations' supplies were limited by the government, based on quotas that were linked to the stations' previous year's sales. Smith recalls that while the gas stations in Pasadena were running low on gas, he and Plott would pass station after station in the desert that were overflowing with supply that they couldn't sell because urban residents were passing up road trips for fear that there would be no gas available to get them home. "You could see the economics of controls working so badly," Smith says.

The market effects of government regulations would figure in Smith's experiments and in the applications of his research. After leaving Caltech, he went to the University of Arizona, where he established a research group in experimental economics in 1975.

Expanding his research into so-called irrational markets, Smith saw that government regulations, which purport to create fairness by establishing a level playing field with a free flow of information, often create unfair situations. In the case of auctions for oil drilling rights, for example, Smith says that the government not only publishes successful bids but also the names of the bidders, which he says makes it easier for collusion to take place.

Over the past few years, Smith has focused on the creation of private markets for trading electricity, a sore subject for many U.S. consumers, who watched their utility bills skyrocket in 2001 thanks to the artificially inflated prices orchestrated by rogue companies like Enron.

His research has had a positive influence in Australia and New Zealand, where he has helped those countries develop a spot market for electrical power. Due to increased competition among utilities and a proliferation of technologies that allow consumers to automatically limit their electricity usage during peak periods, prices have dropped.

Smith and his experimental economics group left Arizona in 2001 and moved to George Mason University in Virginia. Caltech's newest Nobelist says that he will give his half of the approximately $1.07 million Nobel award to the International Foundation for Research in Experimental Economics, the foundation he established in 1997 to support his group's research.

And Smith definitely won't let his newfound fame keep him away from his own active role in that research. "The Nobel Prize is only the beginning for experimental economics," he says. "There is still much to do."

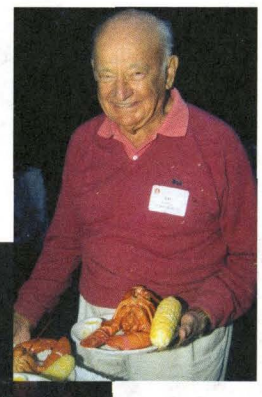
MIKE ROGERS

OVERSEAS OVERTURES

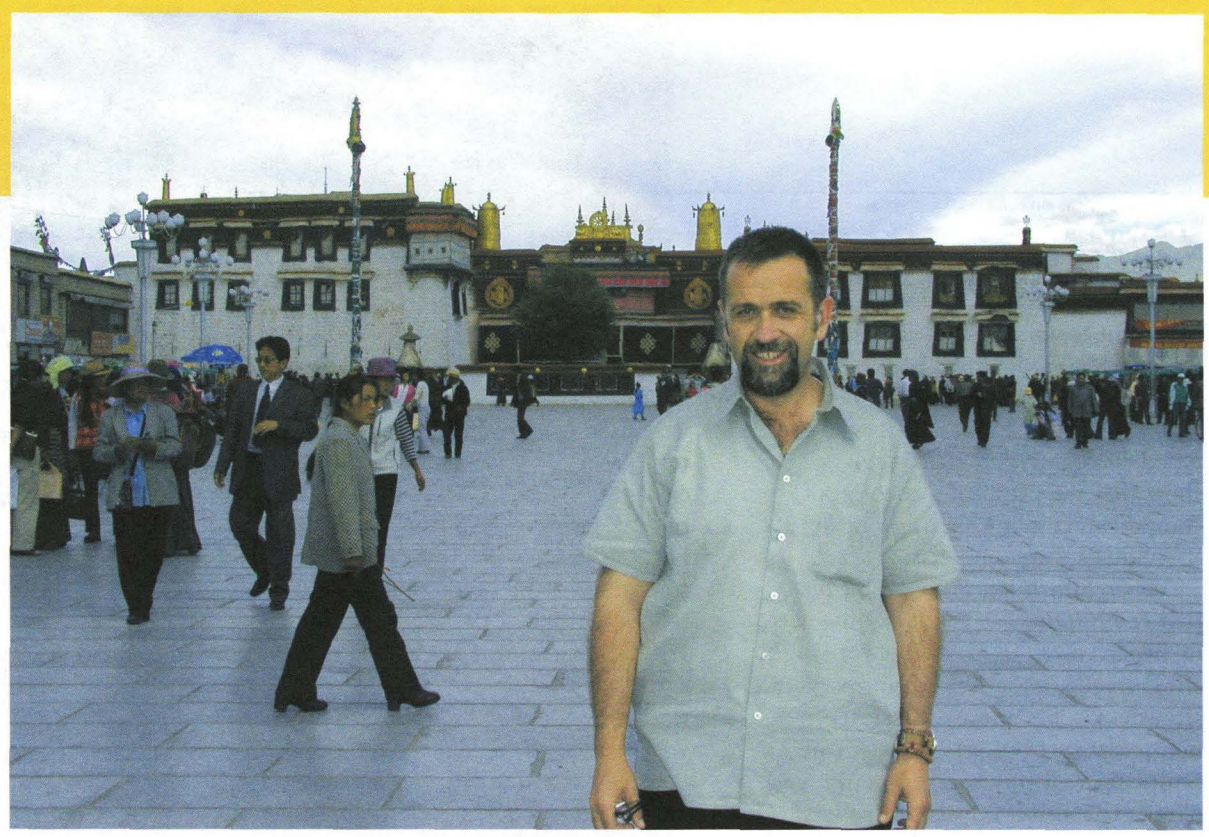
In the last year, Caltech "ambassadors"—faculty, administrators, and staff traveling abroad—have made time to meet with almost 100 alumni in nine countries. These encounters have included an October gathering in Paris, where President David Baltimore and his wife, Faculty Associate in Biology Alice Huang, were guests at a dinner with Parisian alumni, hosted by Gerard Emile Bloch, MS '67, and his wife, Brigitte Bloch-Le Chatelier. Pictured in the top photo (from left) are Christian Dambrine, MS '54, Michel Bloch, PhD '58, and host Bloch. Previously, the Baltimores had traveled to Singapore and Hong Kong, where President Baltimore spoke on the future of the Institute to an audience that included James S. W. Wong, PhD '65 (pictured with Baltimore) and (bottom photo, left to right) York Liao '67 (seated), Brandon Ming Fai Lee '90, and Joel Disini '84 (who flew to Hong Kong from the Philippines for the occasion).

For more information about international alumni activities, visit the Alumni Association website at http://www.its.caltech.edu/~alumni and follow the "International Alumni" link. News and information about Caltech alumni overseas may be submitted to alumni@caltech.edu.

AND CAPE COD CONNECTIONS



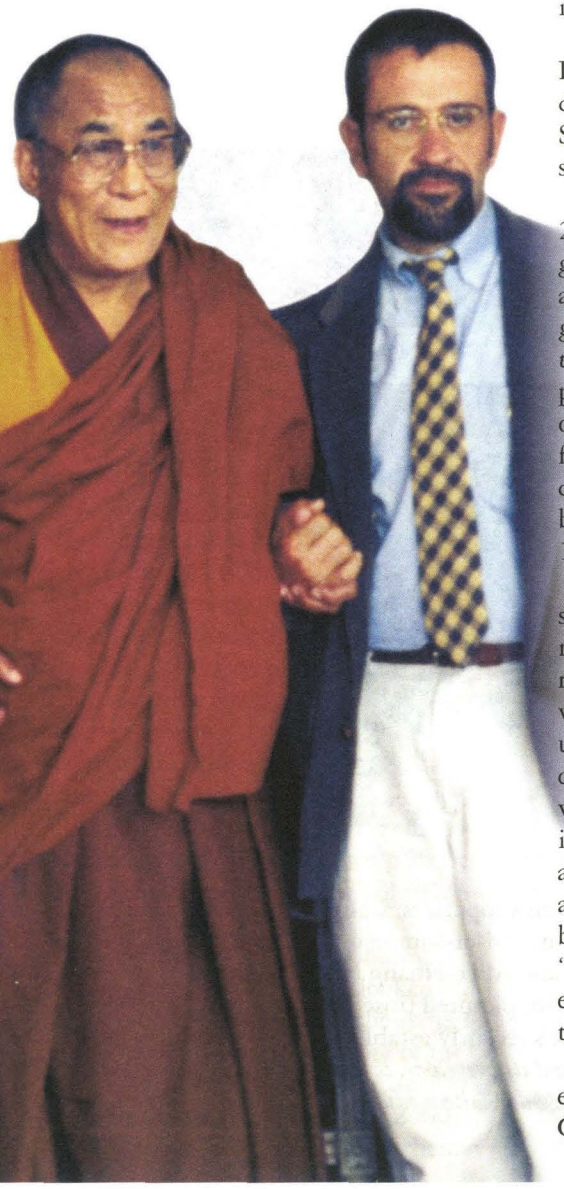
A bit closer to home, about 120 alumni supporters, Caltech Associates, and other friends of the Institute got together for an end-of-summer clam bake at the Cape Cod summer home of David Baltimore and Alice Huang (above). Guests included Joseph Charyk, MS '43, PhD '46, pictured (inset) at the lobster bar. The gathering was organized by the Institute's recently established East Coast Regional Office. *For more information on the office and its programs, contact Krissy Sudano, associate director, at 212/899-5472 or eastcoastoffice@dar.caltech.edu.*



"Both physics and Buddhism are interested in going beyond our intuitive understandings of the world so as to access a reality that is more fundamental."

José Cabezón's Unexpected Discovery

BY RHONDA HILLBERY



José Ignacio Cabezón '78 was a budding scientist when a chance purchase at the Caltech Bookstore foretold his true calling. The physics major would subsequently go on a spiritual journey—living for years with Tibetan refugees in India, traveling and translating for the Dalai Lama, and becoming a Buddhist monk.

Now he is serving as the first XIV Dalai Lama Professor in Tibetan Buddhism and Cultural Studies at UC Santa Barbara, a major center for the study of world religions.

Cabezón was recruited by UCSB in 2001 to develop undergraduate and graduate programs in Tibetan religion and culture, including Tibetan language studies. His appointment, which the university calls the only endowed program and professorship of its kind on the West Coast, is supported by funds raised from various donors over a decade. The endowment was inspired by the Dalai Lama's campus visit in 1991.

Cabezón's early years didn't foreshadow a life of world travel, Eastern religion, or academia. His family moved from Cuba to the United States when he was four years old. Growing up in a hard-working Boston blue-collar family, a university education was not a given, he says. Today, sitting in his UCSB office, where the wall is adorned with a Tibetan prayer cloth and the windows overlook campus bluffs that lead to the beach, he recalls, "I had to make the case with my parents for the importance of the intellectual life."

At a young age, he became interested in science, which brought him to Caltech.

"In a way, what drew me to physics was the same thing that later drew me to Buddhism. Both physics and Buddhism are interested in going beyond our intuitive, often naive, understandings of the world so as to access a reality that is more fundamental." A good example of this, he says, is the way students of physics make the early realization that our seemingly solid world is actually composed entirely of minute atomic and subatomic particles.

For Cabezón, the big-picture aspects of the science became more interesting than its equations and algorithms. "At some point, I realized that I was always interested more in the philosophical questions of physics. And, in retrospect, probably, I was less interested actually in the science itself than in those questions."

In a turn of events that some might consider fate, during Cabezón's junior year a friend offered to buy him a book as a birthday present. Perusing the shelves at the Caltech Bookstore, he chose one on Tibetan Buddhism. He is still not sure why.

"I don't think at that point I even would have said that I was interested in Buddhism. I think I developed an interest as a result of reading about it."

The book made a strong enough impression to convince him to completely change his academic universe just a few courses shy of a completed physics major. Since Buddhist studies aren't part of the standard Caltech curriculum, Cabezón informed the Institute that he wanted to enroll in the independent studies program. "To my surprise, I received a great deal of support, especially from the then head of the independent studies program, planetary-science professor Andy Ingersoll."

His search for a university program matching his newfound interests drew him to the Midwest. "I spent the first half of my senior year at the University of Wisconsin-Madison studying Tibetan language and Buddhist philosophy, and the second half in Dharamsala, India, studying at the Library of Tibetan Works and Archives. That's when I realized that this is what I really wanted to do."

During the period he was earning his PhD, Cabezón completed much of his doctoral work while living for six years with Tibetan refugees and studying at the Sera Je Monastic University in India.

In India he met the Dalai Lama, who later asked Cabezón to travel with him in Spain, Mexico, and Costa Rica to translate his teachings and texts. In addition to his expertise in Tibetan and Spanish, Cabezón also has some fluency in Sanskrit, Pali, Japanese, Hindi, Latin, French, and German.

Some of the professor's Dalai Lama–related work is available in U.S. bookstores, including *Answers: Discussions with Western Buddhists*. Cabezón compiled and edited the text, which is drawn from informal group discussions between the Dalai Lama and Western Buddhists that took place at a village in North India, where the Dalai Lama travels annually to give teachings.

"The Dalai Lama is a very impressive person who tries to live out the tradition of Buddhist values and to be an example for people all over the world," says Cabezón.

"He is one of those rare individuals who manages to live out day to day the values that he espouses."

Around the same time that Cabezón was rising at dawn to pray at Sera Je Monastery, American readers were

eagerly exploring the ties between science and mysticism. During the 1970s and 1980s, several books on the topic were best-sellers, including *The Dancing Wu-Li Masters* by Gary Zukav and *The Tao of Physics* by Fritjof Capra.

As a Caltech-trained physicist turned Buddhist scholar, Cabezón has his own views about the apparent parallels between quantum physics and Eastern religious beliefs. "When I first read about *The Tao of Physics*, I became quite excited because I thought it was a kind of bridge between science and Buddhism. I'm not so sanguine about this anymore. I think that those similarities tend to be only on the surface. They're superficial. What's interesting to me, and where my approach is quite different, is in exploring those differences.

"In the end, science is not a failure but it has limitations. And so I find Buddhism, because of its concern with both the outer and inner world, to be more pertinent to the human condition viewed holistically. I don't want to paint science in a negative light. But overall, the scientific world view has an uncompromisingly materialist stance that I think from a Buddhist point of view isn't entirely valid."

The Tibetan government went into exile following the Chinese invasion of Tibet in 1959. Since then, Buddhism has flourished internationally despite efforts to suppress it in Tibet, where, under the Chinese occupation, thousands of monasteries were destroyed and more than one million Tibetans were either killed or died of starvation.

Still, the visibility and popularity of the exiled Dalai Lama has only grown since he received the Nobel Peace Prize in 1989 for his nonviolent resistance to Chinese rule. And many of the spiritual leader's books, including *An Open Heart*, a compilation of lectures on the importance of compassion in everyday life, are best-sellers.

Cabezón is not surprised that many Westerners are drawn to Buddhism as an antidote to the modern world's frenetic pace. A core purpose of Buddhism is to help people empty their minds of distortions and constant thoughts of the future and the past that cloud perception and prevent human beings from living fully in the present.

"The purpose of Buddhism is to add a kind of cognitive corrective dimension to our experience," Cabezón says. "It's realizing that our ordinary tendency in life is to misperceive ourselves by superimposing thought and feelings on events. When we realize that we live much of our life through the distorted filter of our past habits and actions, then the possibility of living a more free and open life opens up for us."

Returning to the West in 1989, Cabezón spent 12 years as a professor at the Iliff School of Theology, in Colorado, teaching courses in world religions, Buddhist philosophy, and comparative philosophy. He was then recruited to Santa Barbara as the Dalai Lama Professor, and delivered his inaugural lecture in November 2001.

A university leader notes that Cabezón emerged early as a standout when it set out to appoint the chair. "After a rigorous, international search, Professor Cabezón was identified as one of the most outstanding scholars of Buddhism in the world today," says David Marshall, UCSB's dean of humanities and fine arts.

One of Cabezón's colleagues offers a similar assessment. "He is a first-rate scholar, and a prolific publisher; he has enormous linguistic skills," says Sheila Greeve Davaney, a professor of theology at Iliff. "When we hired him, one of his letters of recommendation said he was the premier linguist of his generation."

Cabezón's breadth of scholarship also sets him apart, taking him from ancient Buddhist texts to contemporary Buddhist issues including sexuality. Davaney adds that as a practicing Buddhist, Cabezón offered a different perspective to Iliff students, especially those training to be Christian ministers or leaders of other religious communities.

"I used to kid him that before he was a Buddhist he was a Catholic," Davaney says. "But he always insisted, 'No, before I was a Buddhist I was a scientist.'" The scientific grounding gained from his earlier studies appears in his rigorous approach to academia and Buddhism, she adds. "He is very opposed to anti-intellectual movements in the world. He was insistent that you bring all your intellectual powers to your practice," not merely accepting doctrine on blind faith.

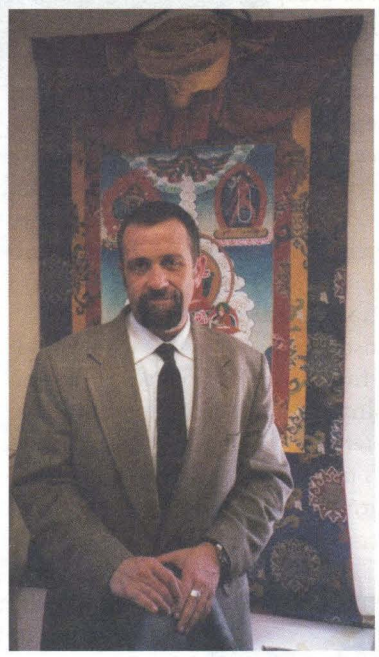
Cabezón's scholarship focuses broadly on Buddhist texts and Tibetan philosophy, religions, and cultures. His research interests include the intersection of Buddhism and popular culture and the ways in which the religion has been turned into a commodity through its growing popularity in the West. These are issues he will cover in an upcoming book, tentatively titled *Consuming Tibet.* He is also researching Buddhism and the ethics of sexuality, and is working on an annotated translation of a 15th-century Tibetan book on the theory of emptiness.

"This year has been tremendously busy but also tremendously exciting," Cabezón says of his first year's activities, which included organizing a national conference on Tibetan Studies at UCSB in May. To help fulfill a cultural outreach and cultural mission, Cabezón has led department-sponsored programs that include a film series, lectures on different aspects of Tibetan culture, and performances by troupes of monks.

Last summer, Cabezón traveled to Tibet and India to gather data for a history of Sera Je Monastery, which he calls "one of Tibet's great scholastic educational institutions."

When all is said and done, this Tibetan Buddhist scholar might be expected to offer an explanation, or at least an interpretation, of why the book he chose at the Caltech bookstore all those years ago set in motion such profoundly life-changing events. But true to his tenets, Cabezón refuses to tie life events into neat packages. The most he'll say is, "I don't think I have an answer to that. If there is an answer, it is beyond me."

Caltech News welcomes comments and thoughts from readers on how their lives and career paths were affected by their years at Caltech. Write to hja@caltech.edu.



Left: During the 1980s, José Ignacio Cabezón traveled with and translated for the Dalai Lama in India, Spain, Mexico, and Costa Rica. Above: The professor in his UC Santa Barbara office, whose wall is adorned by a Tibetan scroll painting. Above left: Cabezón at Jokhang temple in Tibet during a research trip last summer.

Recognition . . . from page 6

in the United States devoted to the advancement of scientific and scholarly inquiry.

Christopher Brennen, professor of mechanical engineering, has been selected to receive the Fluids Engineering Award, the highest award given by the Fluids Engineering Division of the Japan Society of Mechanical Engineers. In 1992 he received the equivalent U.S. prize, the Fluids Engineering Award of the American Society of Mechanical Engineers.

Noel Corngold, professor of applied physics, has been selected to receive the 2002 Wigner Award from the Honors and Awards Committee of the American Nuclear Society "in recognition of his outstanding achievements in the field of nuclear reactor physics."

Peter Dervan, Bren Professor of Chemistry, has been chosen by the Technion—Israel Institute of Technology as the recipient of the 2002 Harvey Prize in Science and Technology, for his "pioneering studies that have laid down the foundations for gene regulation by small molecules." In a separate honor, Dervan has also been elected to the American Philosophical Society.

JPL director and Caltech vice president **Charles Elachi** has received the 2002 Takeda Award for his work in developing spaceborne radar instruments to monitor the global environment. The award, given by the Takeda Foundation of Japan, honors individuals who demonstrate outstanding achievements in the creation and application of new engineering knowledge to benefit human needs. Elachi, who shares the prize with Japanese environmental researchers Nobu-yoshi Fugono and Ken'ichi Okamoto, was presented with the honor, which includes half of the monetary award of 100 million yen (approximately $833,000), at a November ceremony in Tokyo.

Richard Ellis, Steele Family Professor of Astronomy and director, Caltech Optical Observatories, has been elected a Fellow of the American Association for the Advancement of Science for his "seminal work in observational cosmology that has provided insight into the origin and evolution of galaxies and the distribution of the unidentified dark matter."

Michael Hoffmann, Irvine Professor of Environmental Science and dean of graduate studies, was honored as the Dodge Distinguished Lecturer in Chemical Engineering at Yale last April; the title of his lecture was "Kinetics, Mechanisms, and Reactor Design for Aqueous Phase Sonochemistry."

Bill Johnson, PhD '75, Mettler Professor of Engineering and Applied Science, has received several honors. He has been elected a Fellow of ASM International, the Materials Information Society, "in recognition of his distinguished contributions to the field of materials science and engineering," with

Continued on page 15 . . .

"Space Travel Is Utter Bilge"

So said British Astronomer Royal Sir Richard Wooley in 1956. Now, a JPL scientist pays tribute to the visionaries who, in the face of skepticism and gravity, opened the way to interplanetary flight

By Donald Yeomans

Until a few decades ago, interplanetary travel was the stuff of dreams and fantasy. But it was a fantasy in which the dreamers often turned out to be uncannily farsighted and correct, while the predictions of some eminent scientists proved to be far too conservative. Successful space travel would actually come about, in large part, through the efforts of engineers and scientists who were also dreamers. In the end, it would be a handful of these individuals, existing on the fringe of contemporary science, largely ignored and sometimes derided by the "experts" of their day, who carried forward the torch of interplanetary travel and manned spaceflight. For centuries, they predicted that an era would come when mankind would venture into space. That fortunate era is now.

The younger generation of rocket engineers is just beginning. They are of the new generation to which space travel is not going to be a dream of the future but an everyday job with everyday worries in which they will be engaged.
—Willy Ley, spaceflight pioneer and historian, 1951

While the conquest of the skies via heavier-than-air vehicles did not arrive until the Wright brothers' historic flights in 1903, earlier dreamers needed only to point to the birds to demonstrate that the air would one day support human flight. But travel beyond Earth's atmosphere was only conceivable through their flights of imagination.

Early in the 17th century the noted astronomer Johannes Kepler penned a treatise entitled "The Dream" (Somnium), in which the central character, Duracotus, takes a voyage to the moon. The story is based loosely upon Kepler's own life, and the lunar voyage is facilitated by Duracotus's mother. She is in league with lunar demons that can, on occasion, provide the necessary transportation to the moon. Once in space, Duracotus protects himself from the rarefied air by applying damp sponges to his nostrils, while noting that the pushing supplied by the lunar demons is no longer necessary once he has ascended beyond Earth's orb. Kepler, who would be remembered for his laws of planetary motion, did not dare publish the book during his lifetime. However it was read in manuscript form and was partially responsible for his mother's being tried as a witch. Fortunately, she was freed in October 1621 after spending 14 months in custody.


Johannes Kepler

The English bishop Francis Godwin published another lunar fantasy entitled *The Man in the Moone* in 1638. Its hero, a shipwrecked mariner named Domingo Gonsales, wishes only to escape the uninhabited island on which he is stranded. He trains a flock of wild swans to fly him back to civilization, but the birds' migration season has begun and their home turns out to be . . . on the moon. After a 12-day voyage, our hero arrives at the moon to find the inhabitants there to be much larger than those on Earth. The lunarians are an average of 28 feet tall. Despite his puny stature, Domingo is well-treated by the lunarians, and after enjoying their company he returns to Earth safely, although two of his swans have died and the rest "began to droop."

In 1827, in an early example of American science fiction, George Tucker, writing under the pen name Joseph Atterley, wrote *A Voyage to the Moon*. The spacecraft was a copper vessel loaded with scientific equipment and powered by lunarium, an antigravity metal with no more validity than moon-bound wild swans.

It was a Russian schoolteacher, Konstantin Tsiolkovsky, who would be the first to seriously consider realistic means for achieving spaceflight. Born on September 17, 1857, 100 years and 17 days before his countrymen launched Sputnik, Tsiolkovsky contracted scarlet fever as a child and became nearly deaf. Unable to attend the local schools, he began an intensive course of self-study into the natural sciences. In 1879, he passed his teaching examinations without having attended any of the lectures and began teaching outside Moscow in Kaluga province. What spare time he had was devoted to research into aeronautics.


Konstantin Tsiolkovsky

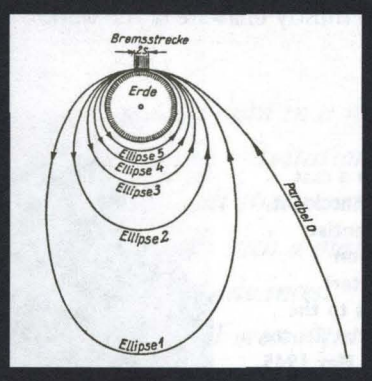
At age 26, he wrote a short treatise entitled "Free Space" and stated that the path to space was through rocket propulsion. Rockets were certainly not a new concept, having been invented by the Chinese by the 13th century, but Tsiolkovsky was the first to note that only rockets could serve the needs of space travel. He is also credited with a variety of forward-thinking ideas on spaceflight, including a theory of rocket travel that took into account the rocket's changing mass; the use of liquid hydrogen and oxygen for rocket fuel; multistage launch vehicles; the effects of atmospheric drag and solar light pressure on space vehicles; the nature of weightlessness in space; and geosynchronous orbits, whereby a satellite could always remain above a single location on Earth's surface.

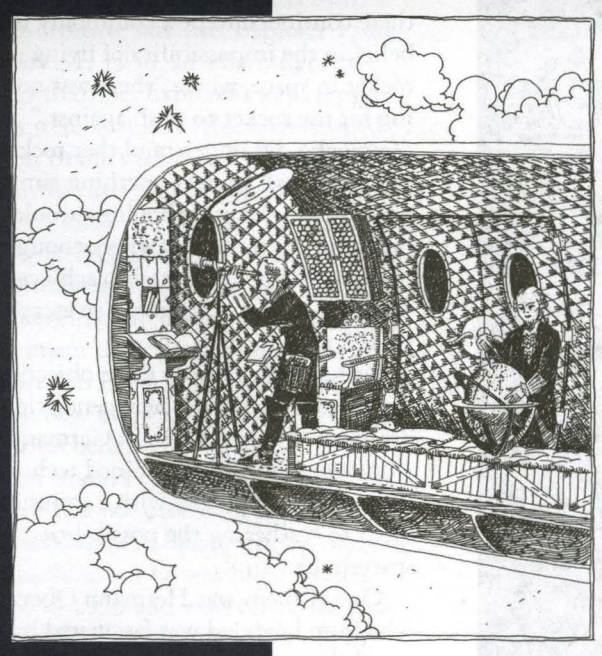
Did Tsiolkovsky's advanced ideas find easy acceptance or support? They did not. Up to the time of the Russian Revolution in 1917, he was either ignored or considered a crazy inventor and rootless dreamer by the recognized scientific community of tsarist Russia. However, his ideas for using technology to overcome gravity meshed with the Marxist philosophy that machines would be indispensable for the construction of a communist society. Thus, in 1919, the now-ruling Communist Party yanked Tsiolkovsky from obscurity and appointed him to the Socialist Academy, which later became the Soviet Academy of Sciences. In 1921, at the age of 64, he was given a personal pension, which allowed him to devote himself entirely to his scientific research. While he still worked alone, he now had government assistance for publishing his works and to republish some that had appeared earlier in very limited printings, published at his own expense. In the 1920s his work on spaceflight began to receive international recognition.

There are many similarities between Tsiolkovsky's life and that of the American rocket pioneer, Robert Hutchings Goddard. Goddard also worked in relative obscurity, and he did not receive the credit due him until after his death in 1945. Like Tsiolkovsky, Goddard taught school—he was a professor at Clark University in Massachusetts. But whereas Tsiolkovsky never attempted to actually build a rocket, Goddard developed and flew various rockets, as well as conceiving many new ideas in the theory of rocket flight.

Early visions of human spaceflight spanned centuries and continents. Clockwise, from far right: In American Joseph Atterley's *A Voyage to the Moon*, published in 1827, the spacecraft was loaded with scientific instruments and powered by "lunarium." In 1925, German civil engineer Walter Hohmann demonstrated how Earth's atmosphere could capture a spacecraft returning to Earth, a technique that was recently used to ease the Mars Odyssey spacecraft into orbit around the Red Planet. The book cover illustration is from Russian schoolteacher Konstantin Tsiolkovsky's *Dreams about Earth and Sky*, published in 1935. In 1929, Austrian army officer Hermann Noordung envisioned and designed a multicomponent Earth-orbiting space station. Its three parts consisted of a disk-shaped habitat with a large solar mirror, a dishlike machine room suspended some distance away, and a smaller can-shaped astronomical observatory.

Earth is the cradle of mankind, but man cannot live in the cradle forever.
—Konstantin Tsiolkovsky





Goddard published the first of two important monographs in the January 1920 *Smithsonian Miscellaneous Collections*. In a slim paper entitled "A Method of Reaching Extreme Altitudes," he discussed his theories and experiments concerning the efficiency of the ordinary rocket. He provided calculations for the minimum rocket mass needed to raise one pound to various altitudes in the atmosphere and calculations for the minimum mass required to raise one pound to escape Earth. In an effort to demonstrate that a rocket could escape Earth and reach the moon, Goddard had worked out how much flash powder would be needed for an observer on Earth to see the flare through a one-foot aperture telescope when the rocket crashed into a dark region of the lunar surface. But he was completely unprepared for the publicity that greeted this scenario. The press termed him the "moon man," and made him the butt of jokes. Never an outgoing person to begin with, Goddard responded by withdrawing further into professional and private seclusion, so that his work was generally not well known during his lifetime.

Goddard demonstrated the first flight of a liquid-fuel rocket in Auburn, Massachusetts, in March 1926. The rocket reached an altitude of 41 feet and covered a mostly horizontal distance of 184 feet, roughly comparable with the distance covered by the second flight of the Wright brothers' airplane in 1903. Like Tsiolkovsky before him, Goddard realized the liquid-fuel rockets were more efficient than those powered with dry, or solid, fuels. The 1926 rocket flight was documented 10 years later as part of Goddard's second significant publication, entitled "Liquid-Propellant Rocket Development."

Goddard's extraordinary achievements did not go entirely unnoticed. The aviator Charles Lindbergh and the secretary of the Smithsonian Institution, Charles Abbot, were influential in helping him secure a $50,000 grant from the Guggenheim Fund for the promotion of aeronautics. Using this substantial award, Goddard, his wife, and four assistants established a research area near Roswell, New Mexico. There in the desert, between 1930 and 1941, they undertook one of the most amazing lone-wolf efforts in the history of technology. In tests conducted at this site, Goddard's liquid-fuel rockets reached speeds of 700 mph and altitudes above 8,000 feet. His innovations included the use of fuel-injection systems, regenerative cooling of combustion chambers,

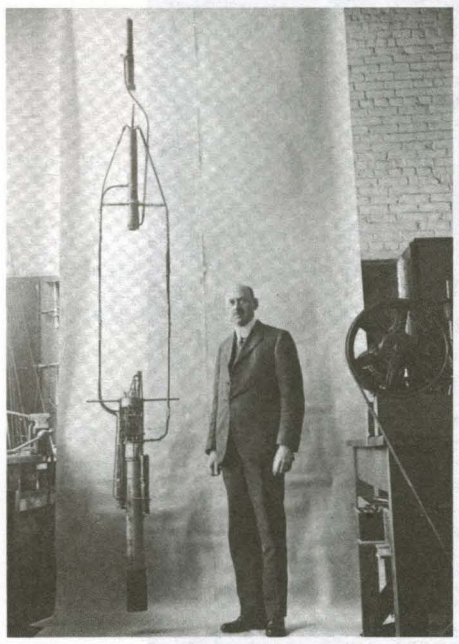
Continued on page 12 . . .

In spite of the opinions of certain narrow-minded people . . . we shall one day travel to the moon, the planets and the stars with the same facility, rapidity and certainty as we now make the ocean voyage from Liverpool to New York.
—Jules Verne, 1865

There is no hope for the fanciful idea of reaching the moon because of insurmountable barriers to escaping the earth's gravity.
—Dr. F. R. Moulton, University of Chicago astronomer, 1932

Professor Goddard with his "chair" in Clark College and countenancing of the Smithsonian Institution, does not know the relation of action to re-action, and of the need to have something better than a vacuum against which to react. . . . Of course, he only seems to lack the knowledge ladled out daily in high schools.
—New York Times editorial, January 13, 1920

(On July 17, 1969, the New York Times commented that "further investigation and experimentation have confirmed the findings of Isaac Newton in the 17th century, and it is now definitely established that a rocket can function in a vacuum as well as in an atmosphere. The Times regrets the error.")



American rocket pioneer Robert Goddard in 1915, standing beside one of his early liquid-fueled rockets.

Space Travel . . . from page 11

gyroscopic stabilization and control, instrumented payloads and recovery systems, guidance vanes in the exhaust plume, gimbaled and clustered engines, and aluminum fuel and oxidizer pumps.

By the early 20th century, the works of Tsiolkovsky and Goddard had clearly shown that spaceflight was theoretically possible. Assuming that a sufficiently powerful rocket-thruster could be developed, Isaac Newton's 17th-century formulation that for every action there is an equal and opposite reaction provided the basis for rocket flight. Nevertheless, there continued to be a commonly held belief in the impossibility of flying a rocket in space, where "there was nothing for the rocket to push against." Many who did understand that rockets need not push against anything simply denied that rocket technology would ever advance to a point where enough power could be generated to achieve the 11.2 km/s velocity required to escape Earth's gravity.

Fortunately, none of these objections was enough to deter a new generation of dreamers, many of them in Germany, who, like Goddard, combined technical training and expertise with a commitment to furthering the possibilities of spaceflight.

One of them was Hermann Oberth, who from boyhood was fascinated by the possibility of space travel. By 1920, he had derived the formulas for calculating the impulse necessary to achieve escape velocity. Born in Transylvania in 1894, Oberth produced a treatise on rockets and interplanetary travel as his doctoral dissertation at the University of Heidelberg. But since neither his advisor, the well-known astronomer Max Wolf, nor anyone else on the faculty would declare themselves competent in this subject, he was unable to submit it for a degree. His thesis was also rejected 20 times by various publishers before the firm of Oldenbourg agreed to issue it, with the proviso that Oberth pay for the printing costs himself. Today *The Rocket into Interplanetary Space* is recognized as a classic in the early theory of spaceflight. In it Oberth established that a rocket could operate in a void and could travel faster than the velocity of its own exhaust. He also discussed the merits of alcohol and hydrogen as rocket fuels and outlined a type of rocket that he felt could be used to explore the upper atmosphere.

In the only section that was relatively free of complex equations, Oberth dealt with the physiological and psychological problems of manned flight, including acceleration, weightlessness, loneliness, and claustrophobia. He also discussed the possibilities for satellites, space stations, and space mirrors that could beam sunlight to the dark side of Earth.

You have ignited the flame, and we shall not permit it to be extinguished.
—Hermann Oberth to Konstantin Tsiolkovsky, 1929

Like Tsiolkovsky and Goddard before him, Oberth had been inspired as a youth by the rich stories of Jules Verne, particularly by Verne's 1865 work *From the Earth to the Moon*. Unlike them, he worked hard to publicize rocketry in general and his own work in particular. In 1930, he became a technical advisor to the Fritz Lang movie *Girl in the Moon*. As a publicity stunt for the film, Oberth and his assistants were asked to design, build, and launch a rocket. For all his theoretical genius, Oberth was not a rocket engineer and, like the movie itself (a silent film in an era of talkies), the rocket was unsuccessful. It never left the ground.

In the 1920s, while the work of Oberth in Europe was being discussed within a small circle of followers, and the work of Goddard was closely followed by an even smaller group of American dreamers, the general public remained mostly unaware of the work being done to free the human race of Earth's grasp. In Germany, however, the spark of interplanetary travel continued to be fanned by two other dreamers—Walter Hohmann and Hermann Noordung.

Born in 1880, Hohmann became the city architect in Essen, near the German-Dutch border, in 1912. While his day job was that of a civil engineer, he spent all his free time investigating the possibilities of space travel. His *The Attainability of the Heavenly Bodies*, published in 1925, was prescient for the ideas it advanced, and many of them seem remarkably modern even today. Among them are the variable-pitch wing for dynamical control of the spacecraft during landing, the use of nose cones and parachutes for successful landings, the manufacture of rocket fuel from planetary resources to save weight, and the use of a surface lander that would detach from a planetary orbiter. However, Hohmann is best-remembered for what is known today as the Hohmann trajectory—the formulation that the optimal energy transfer orbit between planets is an ellipse that is just tangent to the orbits of both planets.

Hermann Oberth

Ironically, Hohmann, who did not participate in the intensive rocket development projects in Germany during World War II, was killed in an Allied bombing raid on Essen in 1945, just two months before the war ended.

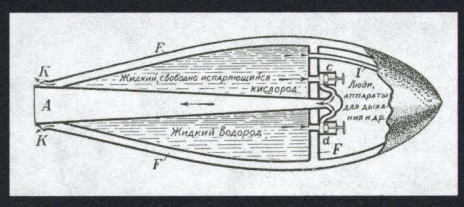
Hermann Noordung, whose real name was Herman Potocnik, was an Austrian army officer. Although his life was cut short by tuberculosis in 1929 (he was 36), the year of his death saw the publication of his classic *The Problem of Space Travel*. Though much of the book was based upon Oberth's 1923 work, Noordung proposed an impressive number of innovative ideas, particularly with regard to space stations. He suggested placing a space station in geosynchro-

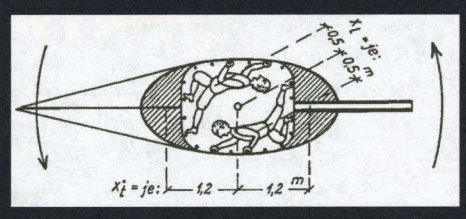
Readers are invited to share their perspectives on the development of space travel. Send letters to the editor c/o Caltech News 1-71, Pasadena, CA, 91125, or to hja@caltech.edu. We reserve the right to select and edit them.

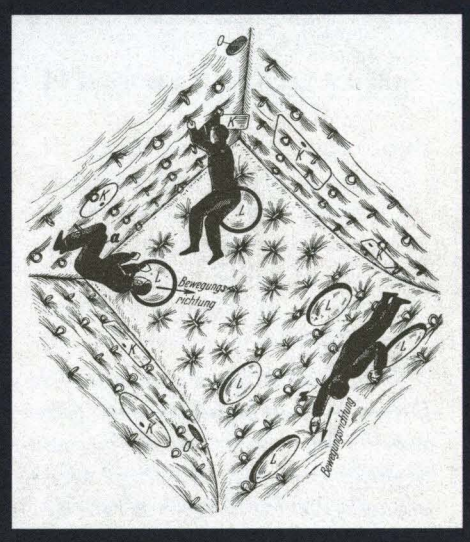
His arm in a cast from a car accident, rocket scientist Wernher von Braun(center) surrenders to the Americans at Reutte, Austria, in May 1945. At left are U.S. counterintelligence agent Charles Stewart and Peenemünde Chief of Staff Herbert Axter. At right are Magnus von Braun and Mittelwerk engineer Hans Lindenberg.

nous orbit and using air locks and space suits for walks in space. He also envisioned radio communication between Earth and space stations, and suggested that momentum wheels could be used to maintain control of a spacecraft's orientation in space. Finally, Noordung proposed several possible uses for a space station: as a site for doing physical and chemical experiments in the absence of gravity and heat; as an astronomical observatory above Earth's atmosphere; and as a platform for a parabolic space mirror for weather control and military advantage.

Original space technologies—Top, right: Konstantin Tsiolkovsky's design for a liquid-fuel rocket appeared in his *Dreams about Earth and Sky*, in 1935. Below: In his 1925 work, *The Attainability of Heavenly Bodies*, Walter Hohmann suggested that a manned spacecraft could be accelerated to the left by firing the attached cannon on the right. The spacecraft could be rotated by having the "inmates," as he called them, scamper along the spacecraft walls. Far right: Hermann Noordung considered the issue of weightlessness in space and thoughtfully provided his spacecraft with padded walls and handholds to aid the occupants' movements. He published this rendering in 1929 in *The Problem of Space Travel*.







In 1927, Oberth, Hohmann, Wernher von Braun, Willy Ley and other German space enthusiasts formed the Society for Space Travel (Verein für Raumschiffahrt, or VfR). Among the research efforts they discussed were those of Robert Goddard, and their goal was to work toward the day when their rocket technology could be used to send spacecraft to explore the solar system. However, this club of rocket enthusiasts was operating at the margins: their research was largely self-funded and their rocket experiments did not initially attract the kind of governmental support needed to get past the hobbyist stage.

Three years later, across the Atlantic, a group of journalists founded the American Interplanetary Society. Partly as a result of the ridicule aroused by the mention of interplanetary travel, the group soon changed its name to the American Rocket Society; it eventually evolved into today's Institute of Aeronautics and Astronautics. As with its German counterpart, funds were short, accidents in the course of experiments frequent, and for a time the group struggled to survive. The reclusive Professor Goddard was not even an active member.

While it would be nice to outline a scenario whereby the fledgling German and American rocket societies succeeded in convincing their governments to support research toward spaceflight, the reality was far different. The sponsor who ultimately stepped up to push and pay for the serious development of rocket flight was the German army. In 1932, the army hired a number of VfR members, including von Braun, and put them to work in the military's rocket artillery unit. Von Braun was soon put in charge of an expanding rocket-building program, and when Hitler and the Nazi Party took over the government in 1933, he was assigned the task of overseeing long-range missile development. Over the next dozen years, he would become the leading technical engineer for the Nazi rocket program at Peenemünde, Germany.

Back in the United States, as nervous observers watched these developments, Robert Goddard accepted some military contracts to continue his work on rocketry. It was within Germany, however, that the most rapid strides were taken to develop a long-range and reliable liquid fuel rocket, culminating in the V-2 (Vengeance) rockets that Hitler fired into England in the waning months of the war. It has been pointed out that the 25,000 slave laborers, forcibly transported to Germany from all over occupied Europe, who perished in hellish conditions while building the V-2s at the underground Mittelwerk factory and the Dora concentration camp were 10 times greater in number than the British civilians killed during the V-2 attacks. Von Braun's role in this program has been called into question on more than one occasion. A high-ranking Nazi party member, he also held the rank of major in the SS. Nevertheless, with an allied victory assured in May 1945, he and his brother Magnus surrendered to the American military with the expectation that their expertise would be considered extremely valuable to the Americans. And indeed, the United States made extraordinary efforts to ensure that the cream of the Nazi rocket scientists would remain in American rather than Soviet hands once the war was over. To many, the Cold War already seemed imminent, and the American military was counting on its captured German rocket scientists to develop the next generation of weapons delivery systems.

Whatever his principles, von Braun had unquestioned leadership abilities and an unparalleled grasp of the art of rocket building. The U.S. Army put him to work developing rocket-launch vehicles, but his dream of using rockets for spaceflight was to be shelved until the American public and Congress demanded a response to the Soviet Union's launch of Sputnik in October 1957. Working in relative obscurity, the Soviet chief rocket designer, Sergei Korolev, had helped develop an impressive missile program. He and his colleagues were also aided by some expert German engineers from Peenemünde.

The USSR would successfully put yet another satellite (this time carrying a dog named Laika) into Earth orbit in November 1957 before the United States successfully launched its own Earth-orbiting satellite, Explorer 1, on January 31, 1958. In a harbinger of things to come, Explorer's key components were a launch vehicle developed by von Braun's team and a satellite built under the direction of William Pickering '32, PhD '36, the director of Caltech's Jet Propulsion Laboratory. The satellite carried a charged-particle detector developed by James Van Allen. This instrument detected charged particles ensnared in Earth's magnetic field, a region now known as the Van Allen radiation belts.

Von Braun's contemporary Hermann Oberth had not played an active role in V-2 development during the Second World War, but he was hired by von Braun in 1955 and worked for the U.S. Army for a time, before returning to Germany in 1959. He died in 1979, having lived long enough to see his dream of space travel become a reality.

To place a man in a multi-stage rocket and project him into the controlling gravitational field of the moon {and return him} to Earth—all that constitutes a wild dream . . . . I am bold enough to say that such a man-made voyage will never occur regardless of all future advances.
—Lee De Forest, "father of radio," 1957

"Yuri Gagarin has been launched into utter bilge."
—The Times of London in April 1961, commenting on the world's first manned spaceflight, by Soviet cosmonaut Gagarin

The great rocket pioneer Robert Goddard had died four days before the end of World War II, but with the dawn of the space age, he was at last accorded the recognition he deserved. NASA's Goddard Space Flight Center was dedicated on May 1, 1959. The following year, the United States government awarded Goddard's widow, Esther, $1 million in settlement for the government's use of more than 200 of Goddard's patents for rocket hardware.

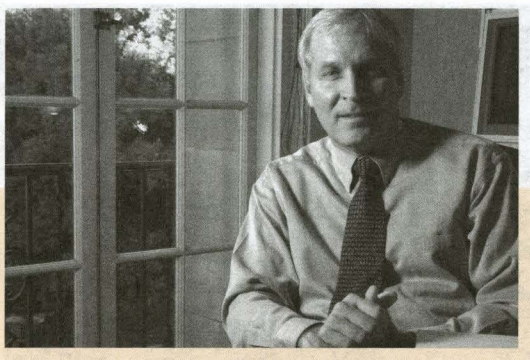
The race to outer space was on. In 1961, President Kennedy committed the United States to landing a man on the moon "and returning him safely to Earth" by the end of the decade. The successful Apollo program was the result, an effort initiated primarily for political posturing but nevertheless achieving superb scientific goals.

With the close of the 20th century, our generation has been privileged to witness several lunar landings and the continued opening of the solar system frontiers, with the exploration of eight of the nine planets and dozens of natural satellites, comets, and asteroids.

"Centuries hence," planetary scientist and science writer Carl Sagan said, "when current social and political problems may seem as remote as the problems of the Thirty Years War are to us, our age may be remembered chiefly for one fact: It was the time when the inhabitants of the earth first made contact with the vast cosmos in which their small planet is embedded."

Indeed, we are living in that privileged era that Tsiolkovsky, Oberth, Hohmann, Noordung, Goddard, and other visionaries hoped would one day come.

Donald Yeomans is a JPL senior research scientist and supervisor of the Lab's Solar Systems Dynamics Group. He's also manager of NASA's Near-Earth Object Program Office, and, as such, his is often the voice that the public hears reassuring them (thus far) that the latest Earth-crossing asteroid to be spotted is not *on a collision course with our planet. A writer and rare-book collector as well as a scientist, he combined these roles in his 1991 book* Comets: A Chronological History of Observation, Science, Myth, and Folklore, *and he has written and lectured frequently about the history of space science.*



A TALK WITH GARY DICOVITSKY

Fresh from directing a successful five-year capital campaign at Pomona College, Gary Dicovitsky finds himself the point person in Caltech's mission to raise $1.4 billion over five years. The Institute's new vice president for development and alumni relations was recruited in October from Pomona College, some 25 miles east of Caltech in Claremont. The liberal arts college set out in 1997 to raise $150 million and under Dicovitsky's watch closed its books in 2002 having raised $206 million. Prior to joining Pomona in 1995, Dicovitsky served as director of planned giving at Princeton and held senior positions at the University of Virginia and Dartmouth. Dicovitsky took time out during his first days on campus to talk to Caltech News *writer Rhonda Hillbery about his plans and his impressions of the Institute.*

How do you calibrate priorities while simultaneously starting a new job and kicking off a major campaign?

The campaign is central to everything at the Institute. The campaign is the most important thing we'll be doing for the next five years. Every major decision will be affected by its success, or lack of success. Everything that is going on in Development right now will be guided by the campaign needs. If I had had a choice, I would have loved to have had more time to understand Caltech's culture before I jumped into this endeavor. At the same time, no matter when you choose to kick off a campaign, there is always going to be something that you think could have been better. In our case, in my mind, that something is the economy. We're not going to control that, no matter what we do. But a lot of thought went into why our specific campaign needs emerged above so many others at the Institute. It is clear to me even after my short time on the job that Caltech's needs are real and immediate, and that fulfilling them can really make a huge impact on what our faculty and students want and aspire to do here. So I think that perspective will be our guiding light when we run into things we can't control, such as the economy. People will see and understand that this is not a frivolous undertaking.

How do you plan to surmount the challenges of the economy in your appeals to potential donors?

This is not simply a capital campaign—that is, one aimed exclusively at raising funds that can be applied toward capital projects. It is a comprehensive campaign that really aims to increase the Caltech endowment. The schools with which we compare ourselves and that compare themselves to us are better endowed, and I think we can make an excellent case there. We also have to raise current-use funds that can be applied immediately to programmatic needs and equipment needs, and to a number of other projects that are priorities.

If you look at specific sources of support, it's true that foundations might not give to endowment, but they might help us both on capital projects and programmatic needs. We need to go to the corporate sector more than we have in the past. Every appeal we make should broadly acknowledge that we here have some of the greatest faculty in the world, and that they need to be supported with resources and equipment so that they can go on do to things that in some cases may even change the world. Overall, we are very well-positioned on many fronts for our challenges. People understand that Caltech can and is doing things that no other institution in the world can do. And that fact will get people's attention.

Will you talk a bit about the strategy that you and your staff will use regarding fund-raising?

This is not going to be a campaign that you do by writing letters. We need to be out in the field, getting to know our constituencies more personally. We're going to have to be out there hearing what people are interested in and matching up interests to needs, and that is going to require a very personal approach. That also takes time.

No matter what has been done at the Institute in the past, we will need to ratchet up our activity level. Fund-raising basically works the same way in all institutions, whether they're corporate, charitable, or nonprofit. It's about building and sustaining relationships. So we need to get to know the Caltech faculty better as a group so that we can communicate their needs and aspirations effectively. We also must focus on five or six priority campaign projects at a time, instead of simultaneously trying to raise funds for the 30 or so identified needs. This will limit the potential for spreading our resources too thinly and will allow us to more intelligently approach our finite number of support constituents.

How will you spend the next weeks and months?

There are no shortcuts. I believe the most important thing to do initially is to meet with people and to learn about the real culture of a place. It is something that you can't pick up from reading. Getting out and listening is really how I'd sum it up. Before I can start making decisions, I would like to solicit a fair amount of input, and I'd like that input to be as broad as possible.

Campaign . . . from page 3

would meet both present and future needs for undergraduate and graduate chemistry instruction; and a new campus-center building.

The $190 million earmarked for equipment will support the design and acquisition of an array of state-of-the-art instrumentation. This includes a design proposal to construct a new telescope three times the size and with nine times the light-gathering power of the two Keck Telescopes on Mauna Kea. Funds will also be used to relocate the Owens Valley Radio Observatory and to support the creation of a Combined Array for Research in Millimeter-Wave Astronomy (CARMA). The Institute also envisions creating a first-of-its-kind center that will bring seismology, space geodetic techniques, and field geology to bear on the global study of tectonic plate movement.

Moving from the extremely large scale to the extremely small, instrumentation needs also include a cryoelectron microscope, imaging magnets, nanofabrication facilities, and a synchrotron beamline that will be used to probe and study the structures of proteins. Funds in the equipment category will also help pay for instrumentation and distributed and central computation in all divisions.

Reflecting on Caltech's unique character, Baltimore talked at the campaign kickoff about streams of visitors to campus who ask him how to replicate the Institute. "I wish them well, but they are doomed to failure because you can't create a place like this overnight." Thanks to George Ellery Hale's foresight and Robert Millikan's devotion, Caltech found its enduring ideology, he said. The financial backing of the local community, coupled with contributions from America's first great philanthropists, brought that philosophy to life. "The secret of Caltech is that it was born from the vision of a few great people who believed that a new type of institution could be built in Southern California and who then made it happen."

Of course, it will take more than imagination and vision to help Caltech achieve its current goal and fulfill its aspirations for the future. Baltimore emphasized that the Institute will be asking for the help of a great many people, from individual donors to corporate and foundation sources.

"Research and education are expensive today, and particularly expensive when you are pushing the frontiers," Baltimore said. "We will need the help of every person here, as well as every person who knows and believes in the vision of Caltech. We can make unique contributions to America and the world but we can only do it with the commitment of those who believe as we do that a society which builds on knowledge and adapts technology to enrich life is a society in which each individual can fulfill his or her greatest dreams and loftiest goals."

More information on the campaign can be found at http://one.caltech.edu.

President David Baltimore (left) joins the applause, as JPL Director Charles Elachi announces that an asteroid has been named for Gordon Moore and presents Gordon and Betty Moore with a commemorative plaque.

Alumni
Update

Association president finds class of '06 "an impressive and interesting group"

I have had the good fortune this year to spend time with the new freshman class—both at Freshman Camp in the mountains of Idyllwild and at the annual freshman pizza party at Alumni House. Since I sent my own first-born east to his first year of college this fall, this had a special significance for me.

While Freshman Camp was a lot more fun than my own Caltech orientation (which was held that one year on campus), it reaffirmed that many of the factors that defined the Institute for me and my class continue to be the same today. The new Techers heard David Baltimore tell them that the Honor System is more than just a set of standards for academic integrity—it is a way of life. They came to know Jean-Paul Revel as a comedian and as a resource when things get tough, and soon they will come to know him as the pioneering biologist he is. They learned about exciting research that they might be a part of during their undergraduate years. They heard that homework problems are assigned with the expectation that no student can finish them working on his or her own, and that they will need to form study groups and work collaboratively if they are to succeed. They had the opportunity to get to know one another—before being separated by house rivalries and academic demands.

The new freshman class is an impressive and interesting group. Its members come from 36 states and 12 foreign countries. For 56 out of the class of 253, English is not their first language. The majority believes that they will major in physics, engineering and applied science, or biology, and two have stated a preference for economics. Eighty-one percent went to public schools; four students were home-schooled.

Eleven of the new freshmen had parents who attended Caltech—and two of them are the offspring of two parents who attended Caltech. Interestingly, 13 freshmen are the first in their families to attend college.

As expected, this group of entering students has stellar academic credentials. Forty percent were class valedictorians, and an additional 8 percent were salutatorians. They also demonstrate proficiency in a wide range of other areas: 10 have or are pursuing a ham radio license, two have pilots' licenses, two are currently taking flying lessons, and one is learning to fly a helicopter! Thirty-five play piano, 16 play violin, 10 play the trumpet, and another 32 play other instruments, including one who plays the zither. Twenty-six play competitive chess. Others were writers and editors on yearbooks, literary magazines, and school newspapers; there are also thespians and debaters among the entering class. And, not surprisingly, more than half were on math teams or in math clubs.

The number who participated in high-school athletics is certainly much different than it was when I arrived at Caltech. Twenty-seven played interscholastic tennis, 25 were on cross-country teams, and 16 were on track and field teams. Eighteen played soccer, six played basketball, and five played football. Entering students also played water polo, pursued martial arts, rowed, figure-skated, fenced, golfed, and played lacrosse and numerous other sports.

They were not focused only on self-achievement, but also displayed a deep commitment to community. One hundred sixty-one of them volunteered their time and talents to help others. They worked as volunteer tutors, and also in nursing homes, libraries, zoos, nature centers, and museums. They built houses for Habitat for Humanity, worked with autistic children and the deaf, and participated in numerous other community-service activities.

On a personal level, I have been pleased by the enthusiastic reception that the freshmen have given the traditions and values of Caltech. They are excited about the challenge of the coursework, even as they are somewhat apprehensive about it. They are enraptured by the Caltech legends. We were blessed with the presence of Tom Apostol at the freshman pizza party. Although he no longer teaches, his book is used for freshman calculus. When they realized who he was, many freshmen ran back to their Houses to get their math books for him to autograph. The freshmen I have spoken with are fascinated by the Honor System and its possibilities. After talking with them and watching their adjustment to Caltech, I have confidence that these young men and women are well-equipped to thoughtfully continue the Caltech traditions as well as to establish some of their own, and that they will continue to advance science at an ever-increasing pace as they take their places in the road of time.

Debbie Hall

Caltech made them an offer they couldn't refuse? Top Photo: Members of the new freshman class settle in to hear about campus life and lore, and, above, one of those Institute moments that may or may not make it into the record: As an Alley Upperclass Committeeman in Ruddock House in the '70s, future Association president Debbie Dison Hall (center) dons Godfather gear to issue an Alley Challenge to fellow Ruddock residents, flanked by molls and mobsters (from left) Kelly Beatty '73, Marie Beall '75 (with violin case), Jean Claire "Jinkle" Seagrave '76, and Doug Jones '77.

Alumni Activities

February 21, *Chicago Reception, with Caltech president David Baltimore.* Ritz Carlton, 5:30–7:30 p.m.

March 22, *Mini Alumni College*, on the topic of Information Science and Technology, New York. For more information, contact the Alumni Association at 626/395-6592.

May 15, *Reunions for the classes of '38, '43, '48, '53.*

May 16, *Half Century Club Luncheon.*

May 16, *Reunions for the classes of '58, '63, '68, '73, '78, '83, '88, '93, '98, '02.*

May 17, *Alumni Association's 66th Annual Seminar Day.*

Nominate an alum

The Alumni Association is now accepting nominations for the 2004 Distinguished Alumni Awards. Alumni interested in submitting a nomination can request a nomination packet from the Association by calling 626/395-6592. The deadline for nominations is March 28, 2003.

The Distinguished Alumni Awards are given in recognition of extraordinary achievement by Caltech graduates. Alumni who have attained a Caltech degree (BS, MS, Engineer's Degree, or PhD) may be nominated. Graduates who are currently on the Institute's faculty or staff, on its board of trustees, or deceased, are not eligible.

Recognition . . . from page 9

his particularly being noted for the invention of bulk metallic-glass-forming alloys and for the development of bulk metallic glasses as structural materials. He has also been selected to receive the 2003 Fellow Award and the 2004 Robert Franklin Mehl Award, both from the Minerals, Metals and Materials Society (TMS) in recognition of his contributions to materials science. In addition, he has received a Highly Cited Researchers Certificate from the Institute for Scientific Information in honor of "his accomplishments as one of the most highly cited and influential researchers in his field."

Joe Kirschvink '75, MS '75, professor of geobiology, has been elected a 2001 Fellow of the American Association for the Advancement of Science for his "unique capabilities in producing innovative ideas for linking geologic events and biologic evolution through a study of rock and paleomagnetism and biomagnetism."

Wolfgang Knauss '58, PhD '63, von Kármán Professor of Aeronautics and Applied Mechanics, and **Anatol Roshko**, PhD '52, von Kármán Professor of Aeronautics, Emeritus, were recently honored with special symposia at the 14th U.S. National Congress of Theoretical and Applied Mechanics, held June 24–28. Knauss was recognized for his "leadership and many contributions to the mechanics of structures and materials," and Roshko for his "seminal contributions to our knowledge of separated flows and shear-layer turbulence."

James Knowles, Kenan Professor and Professor of Applied Mechanics, Emeritus, has received the Warner T. Koiter Medal from the American Society of Mechanical Engineers, which is honoring him for "seminal contributions in nonlinear solid mechanics."

Shri Kulkarni, MacArthur Professor of Astronomy and Planetary Science, has been chosen as the 2002 Jansky Lecturer. Established in 1966 by the trust-

Continued on page 16 . . .

Recognition . . . from page 15

ees of Associated Universities, Inc., the Karl G. Jansky Lectureship recognizes outstanding contributions to the advancement of astronomy. It is named in honor of the man who, in 1932, first detected radio waves from a cosmic source.

Carver Mead '56, PhD '60, Moore Professor of Engineering and Applied Science, Emeritus, is being inducted as a Fellow of the Computer History Museum in Mountain View, California, along with industry pioneers Charles Geschke, John Warnock, and the late John Cocke. The chairman and founder of Foveon, Inc., Mead is being recognized for his "many pioneering contributions in solid-state electronics."

Dianne Newman, Luce Assistant Professor of Geobiology and Environmental Engineering Science, is one of 20 young researchers nationwide to be named a recipient of the 2002 Packard Fellowship in Science and Engineering. Presented annually by the David and Lucile Packard Foundation, the award consists of a $625,000 grant over a five-year period. It supports scientific research by young faculty, with the goal of developing scientific leaders, encouraging networking, and helping to attract talented graduate students into university research. In her research, Newman takes an interdisciplinary approach to studying problems in environmental science, applying the tools of bacterial genetics, physiology, and biochemistry to understanding how microorganisms have shaped, and continue to shape, the chemistry of their environment.

Matthew Porteus, postdoctoral scholar in biology, has received a Burroughs Wellcome Fund Career Award in the Biomedical Sciences. The five-year, $500,000 grant consists of two parts, a two-year postdoctoral portion and a three-year faculty portion; the program is intended to develop biomedical researchers early in their careers as they make the transition to becoming independent investigators.

Alexander Varshavsky, Smits Professor of Cell Biology, and Avram Hershko of the Technion—Israel Institute of Technology, have been named corecipients of the E. B. Wilson Medal by the American Society for Cell Biology. Presented at the society's annual meeting in December, the medal conveys the society's "highest recognition for science, and is awarded each year for significant and far-reaching contributions to cell biology over the course of a career."

Theodore Yao-Tsu Wu, PhD '52, professor of engineering science, emeritus, has been elected a foreign member by the Chinese Academy of Sciences at its 11th Annual Meeting, concluded on June 1; he was recognized for his "distinguished contributions to fluid mechanics." A Fellow of the American Physical Society (APS) and a member of the National Academy of Engineering, he was the recipient of the APS's 1993 Fluid Dynamics Prize.

Class Notes

1966
Dave McCarroll
dmccarro@alumni.caltech.edu

Phil Coleman writes: "We moved to Philomath, Oregon, (near Corvallis) last April. My wife retired from the SDSU library, but by the grace of a DSL line and Southwest Airlines, I am still working. We have acres to play on, it's green everywhere, the freeway is 15 miles distant, the air is clear, the natives ARE friendly, and there is a lot going on since Corvallis is home to Oregon State University. Wineries are springing up all over the Willamette river valley, and we can recommend a great real estate agent. Pay us a visit sometime."

Richard Silver writes: "I currently live in Santa Fe, New Mexico, with my wife, Leda, who is a writer and lawyer. We are very proud of our four children, three of whom have finished college and are self-supporting. I am also Group Leader for Electronics and Electrochemistry in the Materials Science and Technology Division at the Los Alamos National Laboratory. In this role, I supervise about 60 scientists, engineers, and technicians working on acoustic and chemical sensors, fuel cells, fuel reforming, and novel electronic materials for DOE and DOD energy and counterterrorism programs."

Bill Colglazier, who is executive officer of the National Academy of Sciences and the National Research Council, writes that he "would be happy to give a tour of the Academy's new building at 500 Fifth Street, NW, or its old building at 2101 Constitution Ave., NW, whenever classmates are in Washington, D.C." He can be reached at bcolglaz@nas.edu.

Alan Harris writes: "My latest news is that I have retired from JPL as of October 1. I am still working as much as ever, doing research on asteroids, particularly of the 'killer' variety (the Near-Earth Objects kind that can go bump in the night, kill dinosaurs, etc.). I am working out of my home in California with a small company in Boulder, Colorado, that manages my NASA grant and pays me a part-time salary. I had intended to keep it part-time, but I was immediately glutted with consulting offers too good to refuse, so I'm busier than before retirement."

David McCarroll writes: "Judy and I still live in our first house in Hacienda Heights, California, about 25 miles from Caltech. I completed 30 years with IBM as a senior programmer and now do consulting work for IBM from home. First son Mike graduated from MIT; second son Chuck from Cal Poly San Luis Obispo. We are considering following Phil Coleman up to Oregon."

Jerry Yudelson is sustainability lead and marketing director for Interface Engineering, Inc., Portland, Oregon, where he's been since late last year. Interface is one of the larger West Coast mechanical electrical engineering firms that serves the commercial building market. Jerry recently ended two years on the Board of the U.S. Green Building Council, a national nonprofit with 2000 industry members. He recently gave an invited paper at the European Green Building Challenge conference in Oslo, Norway, and is giving a similar paper at the U. S. Green Building Council's annual conference in Austin, Texas. Jerry's article, "Post Modern Engineering," was just published in the national trade magazine *Consulting-Specifying Engineer*. He can be reached at yudelson@ieice.com. Jerry and his wife, Jessica, are living well in Portland, along with a two-year-old Scottish terrier named Madhu.

1972
Roger Lighty
ral@alumni.caltech.edu

Coming off the 30-year class reunion, we are still getting a trickle of updates. **Robert Lewis**, having returned to college and received a PhD (1995, UCSB, EE and computer engineering), has moved into consulting in MEMS (Micro-ElectroMechanical) and optical networks. Recently he has added film and video production to the skill list.

1986
Scott Karlin
karlin@alumni.caltech.edu

As class agent, I have waited a long time to finally be able to pass on the news that I completed my PhD in computer science from Princeton in October. I am currently continuing my research there as I look for a full-time position that I can start next summer. As these notes go to press, my wife, Rosie, daughter Molly (9), and I are rehearsing for a local community theatre production of the musical, *Annie*. I'll be playing the part of (bald) Oliver Warbucks. My hope is that by the time you read this, we will have had a great run and that my hair will have already grown back. Based on the recent batch of class notes, it seems that everyone in the class of 1986 has been as busy as ever.

Robin Wilson writes, "To my surprise, I have found contentment as a medical intern at Johns Hopkins Bayview in Baltimore." She is preparing to start her three-year neurology residency at Johns Hopkins in July 2003, having graduated from the University of Pittsburgh medical school in May 2002. "My husband, Eric (a biologist), daughter, Alexandra (6), and I live in Mt. Airy, Maryland. In my spare time (when I'm not staying up all night at the hospital), I play Celtic and classical music on my flute and concertina." She adds that she can be reached at robinkindahl@hotmail.com and would love to hear from old friends.

Richard Doherty reports, "After finishing up the start-up company I did with Dave Johannsen and Carver Mead in 1997 (which finished fairly well), I graduated from the USC Film School in 2000." His thesis film, *My Chorus*, has been in over 40 festivals and has won 11 festival awards so far. "I even got a paid trip to the Cannes Film Festival as an 'extreme filmmaker,' where I had to complete a short film in nine days." Currently, Richard is working for yet another start-up, making a new video editing product in San Diego. "My daughters, Ember (5) and Aria (3), are still as fabulous as ever. And Carolyn, the wife of eight years, is still outstanding as well."

Paul Gillespie received his PhD in the history of science and technology from Lehigh University in June 2002. Before returning to teach at the Air Force Academy in Colorado Springs, he has been assigned as chief of deployed communications at Air Mobility Command near East St. Louis, Illinois.

"I have been living in Italy with my wife, Beatrice, and my dog Pepsi for just over eight years now," writes **Mario Montessori**. "Life here is very good, but of course I miss the friends I left in the Los Angeles basin, especially the Techers. EMBO to all you who are 'modeless.'"

Both **Steve Hsu** and his wife are professors at the University of Oregon in Eugene. He is a physics professor currently doing research in theoretical physics; she is a literature professor. Steve and his security and encryption company, SafeWeb, were the subject of a feature article about a year ago in *Caltech News* (issue no. 1 2002).

Felice Borisy Rudin and her husband, Nathan Rudin, are pleased to announce the birth of their third child, Deborah Aletha. "After an early start out the gate, baby, big brother Isaac, and big sister Shoshana are all doing well," says Felice. She is currently busy enjoying the many rewards of motherhood; a new home in Madison, Wisconsin; and teaching Sunday School on the side. She'd be happy to hear from classmates at frudin@chorus.net.

Hans Hermans reports that he has been coaching his son Hansy's school soccer team.

CLASS NOTES CUTOUT COUPON

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Personals

"Although it is 60 percent 6th graders, there are also a few 7th and 8th graders. With two games and one tournament to go, it looks like we'll finish with a 500 season. Not surprisingly, I find that running around in the afternoon with a bunch of kids is quite enjoyable and agrees with me."

Dan Loeb writes that he is still living in the Philadelphia area, doing programmed trading for Susquehanna Investment Group. Helen and the kids are doing well. Gabby's bat mitzvah is coming up in April. Jonathan (8) is an aspiring geologist. Benjamin (3) is practicing the violin.

"I am just in the midst of moving back to the States (Philadelphia) from Geneva, where I have been working on international health issues," writes **Yvette Madrid**. "I am not quite sure what I will be doing in Philadelphia, but I plan to take a break to catch my breath and enjoy my family." Yvette has two daughters, Alessandra (4) and Paola (2), and a husband, Simone, who all manage to keep her extremely busy. She would especially welcome news from anyone else who might be in the Philly area.

In August 2002, **Ken Poppleton** was awarded his second patent, "Method and Apparatus for Multi-Level Image Alignment (6,433,840)."

After a grueling but wonderful four-year stint with nVidia, **Charles Flaig** and his wife, Heather, are happily retired in the Sonoma wine country. While their three-year-old daughter (Trier) and five-month-old son (Talyson) keep him plenty busy, especially since Talyson is not yet sleeping through the night, he reports that "it is nice to be able to have time to read books and work on hobbies again. I am becoming more active in my congregation, and hope to become a full-time minister at some point."

Hsiu-Tung Alex Yu has been selected as a Kauffman Fellow, a fellowship in the venture capital industry. Since May 2002, he has been working at Gabriel Venture Partners, an early stage VC firm in the San Francisco Bay Area. "This firm has perhaps the highest concentration of Caltech EEs '86 of any VC firm because **Scott Chou** is a general partner here," he writes. "I am having a very fun time here and learning a ton."

Finally, we learn that **Myles Sussman** has returned to Pasadena after 16 years and was pleased to discover that they'll still give him a discount at Burger Continental. He's working for Luxtera, Inc., a startup company partly based on technology developed at Caltech. Luxtera is developing breakthrough nanophotonics products, "which is a funny thing for me to be working on, considering my degree is in aeronautics. When I'm not at work I can be found hanging out with my girlfriend, Tina, who is a fifth-grade schoolteacher in Oxnard."

1927

John E. Marsland, of Easton, Maryland, writes, "Today is September 9, 2002, 1593 days till my 100th birthday."

1934

J. Robert Schreck, of Los Altos, California, reports that he turned 90 on October 25. "Would like to hear from other classmates—if any."

Al Switzer, of Los Osos, California, writes, "Well, I'm still getting up in the morning, although I'm a little slow. But there is no one but me to hear the creaking joints. The doctor says 'your blood pressure is great, but stop eating so much and sit down when you're putting on your pants.' Medicare and AARP cover my medical bills, and prescription drug bills aren't very high. I'm still doing battle with the Coastal Commission, the EPA and the County, what with Banded Dune Snails, Pygmy Oaks, open space, growth control and dead Indians. I still belong to the NRA and the Pacific Legal Foundation. I haven't bought a computer, because if I did I would have to learn how to use it and at 91 my learning capability is pretty low, although I'm pretty good at pushing the buttons on my microwave."

1939

James C. Ritchey, of Mission Viejo, California, writes that "as always, we really enjoyed the alumni luncheon and reception at the Athenaeum in May." The class of '39, he adds, was just one table. "Our retirement has worked out well," he says, "with plenty of volunteer activities and recreation."

J. Eugene Stones, of Houston, Texas, reports that he retired from Monsanto in August 1981 as an exploration geophysicist and was president of Seis-Wise Enterprises and did consulting work until 1988. "My wife, Esther Taylor Stones, died 5-3-97 (drowned on white water rafting trip) on Guadalupe River after $56^{1}/_{2}$ years of marriage."

1940

Robert O. Cox, of Fort Lauderdale, Florida, asks, "Where have I gone wrong? When I read the personals everybody from my class of '40 and indeed for many years thereafter is either retired or dead or some combination of both of those which retirement often is." He says that he still owns Lauderdale Marina, which is now 54 years old, but that a son is president and a grandson is working toward general manager. "I am what is euphemistically called their 'consultant.' However, to keep the pot boiling as I reach my 85th birthday this month, I have started a new fiberglass boat company for which I am doing the engineering." His friends think he should call the first one *Senility II*, but actually the product is a modernized copy of a 90-year-old fast-launch hull.

1948

Vincent Honnold, of Manhattan Beach, California, enjoys getting together with 11 grandchildren. He's also been busy keeping up with the state of the art in computers; he has built all of his current machines and is now into digital imaging.

1959

Joseph M. Colucci, MS, was elected to the National Academy of Engineering last February; the induction ceremony was held in Washington, D.C., on October 6. According to the NAE, this is "one of the highest distinctions that can be accorded an engineer," and Colucci's citation was "for leadership at the 'fuel/vehicle system' interface leading to improved automotive fuel and vehicle quality and reduced emissions." Colucci retired in 1995 as executive director, materials research, after 36 years with the General Motors Research and Development Center (formerly the General Motors Research Laboratories). He is currently president of Automotive Fuels Consulting, Inc., and he and his wife, Sue, live on a lake in Clarkston, Michigan. They have three grown children and eight grandchildren, and their hobby is traveling.

1959

William L. Ko, MS, PhD '63, has been selected to receive a 2002 Dryden Peer Award, which comprises a plaque and a cash honorarium; he has been cited for "excellence in the category of Best NASA Series Report for 2001." He is currently working at the NASA Dryden Flight Research Center, Edwards, California, where he is conducting research on various thermo-structural problems associated with future hypersonic flight vehicles. An accomplished watercolorist, he is preparing to publish a book entitled *Railroad Short Stories and Railroad Fine Art*, which will feature 32 of his own paintings.

1965

Virginia Trimble, MS, PhD '68, delivered the 32nd annual J. Robert Oppenheimer Memorial Lecture in Los Alamos, New Mexico, in July. Earlier in the year she was the Shaw Memorial Lecturer at Southern Illinois University, Edwardsville.

1966

Thomas B. McCord, MS, PhD '68, has retired as professor of planetary sciences at the University of Hawaii and has been professor emeritus since January 1, 2002. "This, perhaps premature, act is directed at forcing new experiences and providing positions for younger faculty at the University of Hawaii." He adds that he continues his career, working "with full vigor" as a scientist in the field of solar system exploration, focusing on determining and interpreting the surface composition of the planets, satellites, asteroids, and comets. He currently works out of his research center near his home in Winthrop, Washington, as well as from the University of Hawaii, and remains active as a science investigator on five deep-space missions: Galileo, Cassini, Mars Express, Rosetta, and DAWN. Last summer he completed a four-month residency at the University of Nantes, France, as a distinguished visiting professor under the sponsorship of the French Space Agency, CNES. He and his wife, Carol, also continue their long-term efforts at starting and developing small businesses.

1972

Nelson E. Brestoff, MS, of Calabasas, California, writes, "I'm happy to report a significant victory. I was the plaintiff's lead trial lawyer in a federal court case against a Fortune 500 company. The 10-person jury returned fraud and unfair competition verdicts in favor of my client and awarded $9.8 million in damages."

1982

Cathryn (Allen) Manduca, MS, PhD '88, a geoscientist at Carleton College and director of its Science Education Resource Center, was invited to present research on three topics at the 114th annual meeting of the Geological Society of America, October 17–30, in Denver. The first, "Living with Karst in Oldmsted County: Lasting Partnerships Bring Science into Decision Making," dealt with effective partnerships between geoscientists, the public, and policy makers, particularly in regard to water-quality issues in Olmsted County, Minnesota. The second, "A Role for Digital Libraries in Facilitating K–16 Research," explored geoscience research partnerships as a strategy for engaging K–16 students and teachers in inquiry-based learning. The third, "Digital Libraries: Helping Geoscientists Think about Issues in Teaching," examined the issue of digital libraries as vehicles for systemic educational change.

1990

Aaron Earley, MS, of Atlanta, Georgia, writes that he is currently a senior member of the technical staff at BellSouth Telecommunications.

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Obituaries

1933
George H. Pickett, MS '34, of Pasadena, California, on October 17, 2001; he was 90. He worked 41 years for the Southern California Gas Company, retiring as assistant to the president in 1976. Predeceased by his son, Roderick, he is survived by Frances, his wife of 68 years; his daughters, Nancy Gibson, Sharon Cavallo, and Georgia McGrew; and nine grandchildren and five great-grandchildren.

1934
Milford C. Childers, MS '35, MS '36, of Laguna Niguel, California, on December 1, 2001; he was 88. A distinguished aeronautical engineer, he worked for Lockheed Aircraft from 1937 until 1974 on such aircraft as the P-38 Lightning, the Constellation, and the C-130 Hercules. He also worked on advanced research projects and consulted for TRW on the Atlas rocket, and for Lockheed Georgia on the graphite composite wing for the B-1 bomber. A lecturer at UCLA between 1964 and 1969, he wrote numerous technical papers on the materials, structures, and design of aircraft and spacecraft. He was awarded the Wright Brothers Medal in 1959 for a paper presented to the Society of Automotive Engineers, and in 1961 he was named San Fernando Valley Engineer of the Year by the California Professional Engineers. He appeared twice in *Who's Who in California*. An elder and a member of the board of directors of the First Presbyterian Church of Hollywood and actively involved with his son in Burbank's Boy Scout Troop 4, he enjoyed travel, photography, woodworking, and lapidary work, as well as astronomy and the sea, and loved sailing. Predeceased by his first wife, Helen, in 1987, Childers is survived by his second wife, Jean; a daughter, Kathy Bressler; a son, Bill; and six grandchildren and one great-grandchild.

Ralph A. Naylor, of Flemington, New Jersey, on July 25, 2001. He worked for American Cyanamid for 42 years as a research chemist and developed many chemicals derived from rubber. He is survived by Nancy, his wife of 55 years; a daughter, Carol Donnelly; and two sons, Ralph Jr. and Robert.

Donald R. Rooke, of Fair Oaks, California, on October 18, 2000. He is survived by his wife, Barbara, and by a sister, Judith Schomaker.

1935
William F. Keyes Jr., of Albuquerque, New Mexico, on March 15, 2001; he was 88. After graduating from Caltech he received his master's degree in chemistry in 1938 from the University of Illinois, Urbana-Champaign. He worked for the Johns Manville Corporation at their Lompoc, California, diatomite mine and processing plant for 33 years, retiring in 1978. At the time of his death he was a charter member of Sandia Presbyterian Church in Albuquerque and an emeritus member of the American Chemical Society and the American Institute of Chemical Engineers. He is survived by Luella, his wife of 41 years; a son, David; and a granddaughter, Julianna.

1936
Eugene Bollay, MS, of Santa Barbara, California, on November 28, 2001; he was 89. One of the first weather forecasters on Los Angeles television in the late 1940s and throughout the 1950s, he made meteorology the focus of his life. He taught at the U.S. Naval Academy and retired from the Navy with the rank of commander in 1950. In the late '50s and early '60s he started several businesses in the Pasadena and Santa Barbara areas, including North American Weather Consultants, North American Instruments, and E. Bollay Associates. In 1971 he was appointed program director for the National Oceanographic and Atmospheric Administration, and in 1979 he was asked to join the UN's World Meteorological Society, where he was director of its precipitation and enhancement project. A past president of the American Meteorological society and a fellow of the American Geophysical Union, his other affiliations included Sigma Xi, the American Society of Civil Engineers, and the American Association for the Advancement of Science. He wrote numerous reports on weather modification and coauthored and edited the *Handbook of Meteorology*. Predeceased by his wife, Virginia; a son, Eugene; and his eldest brother, William, he is survived by his special friend and companion, Lisa; three daughters, Barbara Metcalf, Suzanne Kiesz, and Kathy Ricarte; a son, Robert; and ten grandchildren and eight great-grandchildren. His younger brother, Ronald, died the following day.

Frank W. Davis, of La Jolla, California, on July 15, 2001; he was 86. A naval aviator and Marine Corps officer, he started flying while still in school. In 1940 he joined a predecessor company of General Dynamics as an engineering test pilot, and he was the first pilot to fly a turboprop as well as the first jet pilot for General Dynamics. For his work at that time he was elected an honorary fellow of the Society of Experimental Test Pilots. In 1947 he joined Convair in San Diego as chief design engineer and assistant to the vice president for engineering. For his work during the early years of delta-wing aircraft such as the XP-92, F-102, and F-106, he as well as two associates received the Aircraft Design Medal from the American Institute of Aeronautics and Astronautics. In 1954 he moved to the Fort Worth Division of General Dynamics as chief engineer during the design stage of the B-58, the first supersonic bomber. He subsequently became president of the division, and in 1970 was assigned the added responsibility of running the Convair Division in San Diego. He retired in 1974. Elected to the National Academy of Engineering in 1967, he received Caltech's Alumni Distinguished Service Award in 1968 and an honorary doctor of science degree from West Virginia University in 1960 and from National University in 1984, plus he was a Navy League Citation Honoree. He was a registered professional engineer in Texas and California. Captain of the Caltech football team as an undergraduate, he was named to *Sports Illustrated*'s Silver Anniversary All-American Football Team. After retiring, he served on the boards of several companies and the board of overseers of UC San Diego, and he enjoyed restoring antique watches, which led him to membership in the American Watchmakers Institute and the National Association of Watch and Clock Collectors. Predeceased by his first wife, Frances, and his two brothers, Sidney and M. T. III, he is survived by his wife, Jean; his daughter, Caroline DeLaigle; two sons, Frank Jr. and William; a stepson, James Swanson; and 11 grandchildren and three great-grandchildren.

Bruce L. Hicks, MS '37, PhD '39, of State College, Pennsylvania, on December 26, 2001; he was 86. He taught for many years at the University of Illinois and other American and Canadian universities and did research there and in the laboratories of the National Advisory Committee for Aeronautics and in the Ballistic Research Laboratory in Aberdeen, Maryland. His research was in several fields of engineering and applied science and in applications of computers in instruction and in community networks. He particularly enjoyed working with artists in developing their tools for computer art. He is survived by a son, James.

1939
Josiah E. Smith, MS '40, Eng '48, of Ashburn, Virginia, on April 24, 2001; he was 84. He received dual BSs in mechanical and aeronautical engineering. During the 1940s and 1950s he was associate director of the Southern California Cooperative Wind Tunnel, and later, at Ramo-Wooldridge Corporation and the Space Technology Lab, he managed several projects, including the Reconnaissance Satellite Project Office, which oversaw the Discoverer, Samos, and Midas systems. At North American Aviation in the early 1960s he developed designs for the B-1 bomber and vertical-takeoff-and-landing aircraft. In 1967 he moved to the Washington, D.C., area, where he worked as an analyst and designer for the Institute for Defense Analysis and the Navy Department. He retired in the 1980s, after which he took up running, establishing records in his 75–80 age group for the long jump and the 400-meter race in the 1993 Northern Virginia Senior Olympics, and placing fourth at the age of 80 in the 800-meter race during the 1997 National Senior Olympics. He is survived by a son, Michael; a daughter, Judith Asbury; a stepdaughter, Ruth Lewis; and a stepson, Robert Lewis.

1940
Ralph G. Paul, of Santa Rosa, California, on October 3, 2001. He is survived by his wife, Doris.

1942
Forest M. Clingan, of Dunlap, California, on February 3, 2001. He was a captain in the U.S. Navy and a member of the Half Century Club. He is survived by his wife, Helen.

Charles W. Pearson, of Green Valley, Arizona, on March 5, 2001; he was 79. He is survived by his wife, Melissa.

Charles W. Seekins, PhD, of Carpinteria, California, on May 6, 2001. He is survived by his wife, Marilynn.

1943
Clarence E. Erickson, MS, of Tucson, Arizona, on March 11, 2001; he was 85. A captain in the U.S. Army Air Corps during World War II, he went on to serve as a meteorologist in the Department of the Army, which decorated him for meritorious service upon his retirement in 1970. He was for many years chief of the Atmospheric Sciences and Research Division at Fort Huachuca, Arizona. A 32nd-degree Mason, he was a member of the Sabaar Shrine Temple, the Sabaar Temple Band, Grace St. Paul's Episcopal Church, and BPOE Lodge 305. He is survived by Jeanne, his wife of 55 years; two sons, Paul and Eric; six grandchildren; and his sisters, Ruth Erickson and Dorothy Anderson.

1944
Keith S. Ditman, MS, of Beverly Hills, California, on July 19, 2001; he was 80. He was a graduate of the USC School of Medicine and then a professor of psychology at UCLA, after which he went into private practice. He is survived by a daughter, Cynthia; a son, Bryan; and two grandchildren.

1945
Elton L. Knapp, MS, Eng, of Indianapolis, Indiana, on September 13, 2001. He is survived by his wife, Vera.

1947
David Regnery, PhD, of Portola Valley, California, on May 9, 2001; he was 82. A professor emeritus in Stanford's department of biological sciences, he joined the faculty there after receiving his PhD. For more than 20 years he taught many of the introductory courses, as well as upper-division courses in eukaryotic genetics and the ecology of disease. "He is remembered for his genuine commitment to excellence in teaching and for the number of students that he inspired." His research interests, besides transplantation immunology-genetics in fish and population genetics of animal communities, included the genetics of disease resistance and the natural history of viral disease in native small animals, which often involved taking blood samples from wild populations at Stanford's Jasper Ridge Biological Preserve and on the Farallon Islands off San Francisco. Predeceased in 1990 by Dorothy, his wife of 44 years, he is survived by a daughter, Roberta; two sons, Richard and Russell; two grandchildren; a sister, Ruth Paine; and a brother, Rolland.

1948
Thomas H. Stix, of Princeton, New Jersey, on April 16, 2001; he was 76. Professor emeritus of astrophysical sciences at Princeton, he was a leading thinker in the field of plasma physics. After receiving his PhD from Princeton in 1953, he joined Project Matterhorn, whose goal was to develop fusion energy for peaceful uses. By 1961, Stix headed the project's experimental division, and its name was changed to the Princeton Plasma Physics Laboratory. Credited with revolutionary research in plasma physics showing how waves could heat plasma, he published his classic text, *The Theory of Plasma Waves*, in 1962, the same year Princeton appointed him professor of astrophysical sciences. He was also noted for his development of the Stix coil and for his contributions to the theory of stochastic and chaotic behavior of particles and magnetic fields in plasmas. His numerous awards included the James Clerk Maxwell Prize (1980), the highest award given by the American Physical Society (APS) in the field of plasma physics; and Princeton's University Award for Distinguished Teaching (1991). He was elected chair of APS's division of plasma physics in 1962 and served for many years as director of Princeton's Program in Plasma Physics. He was active in many Jewish charities and organizations, and he worked on behalf of human rights and the political freedom of scientists worldwide. An avid traveler, wind-surfer, swimmer, snorkeler, and skier well into his 70s, he had learned as recently as 2000 to scooter with his two grandsons around Central Park. He is survived by Hazel, his wife of 50 years; a daughter, Susan Fisher; a son, Michael; four grandchildren; and two brothers, Ernest and John.

1949
Paul B. Harris, MS '50, of Tulsa, Oklahoma, on January 13, 2001. He is survived by his wife, Marie.

Leigh Sheriffs, of Los Angeles, in July 2001; he was 74. He established Sheriffs Engineering, a mechanical-engineering and consulting company, in 1950, and he served on the California State Building Standards Commission during the 1980s. He is survived by his wife, Edna; a daughter, Mary Lynn Swanson; a son, Richard; and two grandsons.

1951
Woldemar F. von Jaskowsky, MS, of Medford, New Jersey, on January 31, 2001; he was 85. A physicist and a retired senior research engineer and lecturer in Princeton's department of mechanical and aerospace engineering, he was born in St. Petersburg, Russia. He emigrated with his family to Berlin during the Russian Revolution, and studied at several German Universities. He received his first patent at the age of 21 and served with the German army during World War II, losing the lower portion of his left leg in a mine explosion on the Russian front in 1942. Fluent in Russian, French, German, and English, he worked as an interpreter and investigator for the U.S. Occupation Forces' provost marshal's office after the war. Receiving a scholarship to Caltech, he earned his master's degree in physics, then served as a physicist with a number of California companies. He became a U.S. citizen in 1959. After a two-year fellowship at the Institute for Plasma Physics in Munich, he was appointed a lecturer and research engineer at Princeton in 1962. Author of or collaborator on dozens of articles, as well as a popular guest lecturer with professional groups, he particularly enjoyed teaching and working with students. He was a member of the American Physical Society and the American Institute of Aeronautics and Astronautics and a technical editor for *Astronautica Acta*. Following his retirement, he worked for Princeton as a consultant until 1995. Despite his amputation, he remained fit, swimming a mile a day, and he enjoyed art, making silver and turquoise jewelry, drawing in pen and ink and in charcoal, and painting watercolors. Predeceased in 1981 by his wife, Lore, he leaves no survivors.

1953
David E. Knapp, on September 11, 2001. He is survived by a daughter, Amy.

Donald K. Norris, PhD, of Kelowna, British Columbia, on May 7, 2001; he was 76. The recipient of dual PhDs, in geology and structural geology, he served as a research scientist with the Geological Survey of Canada for 35 years, working throughout the country from Newfoundland to the Northern Yukon, and continuing to write about and consult on geology after his retirement. He is survived by his wife, Marianne; a daughter, Susan; a son, Alan; and three grandchildren.

1954
John C. Ruckmick, MS, PhD '57, of Laguna Niguel, California, on March 19; he was 75. His PhD research on the geology of the Union Bay ultramafic complex in Alaska demonstrated for the first time that Alaska-type ultramafic bodies were injected as low-viscosity liquid melts. He was resident associate of Blacker House while at Caltech. After spending five years in Venezuela as chief geologist of the Orinoco Mining Company (U.S. Steel), he became a partner of the Noble & Ruckmick consulting group in Pasadena. He managed exploration for major firms in Western Australia, Tucson, and Denver, and he also worked as an independent consultant in the United States, Mexico, Argentina, and the Caribbean before retiring in 1998. He was responsible for the discovery of iron ore in Venezuela, nickel-copper ore in Western Australia, and sulfur in Texas. His wide range of interests and skills included literature, history, art, and aviation, and his wry and humorous cartoons were featured in posters and publications of Caltech's geological and planetary sciences division. He is survived by his wife, Jane; a son, Stephen; a daughter, Melissa; and three grandchildren.

1956
Bernard L. Mitchell, MS, of Middletown, New Jersey, on August 11, 2001. He is survived by his wife, Elizabeth.

1959
Dewitt Landis Jr., of Los Angeles, on February 13, 2001. He is survived by his wife, Elisabeth, and his son, Frank.

1960
David Arthur Evensen, MS, PhD '64, in Capistrano Beach, California, on June 30; he was 64. A retired aeronautical engineer and longtime engineering consultant, he served as a captain in the U.S. Army Signal Corps (1964–67), during which time he was stationed at NASA's Langley Research Center and was awarded the National Defense Service Medal. He then worked at TRW (1967–75), J. H. Wiggins Company (1975–79), and Hughes Aircraft Company (1979–85). A member of the American Society of Mechanical Engineers and an associate fellow of the American Institute of Aeronautics and Astronautics, he was also a registered mechanical engineer and a registered civil engineer in California. He was a member of the Tau Beta Pi, Sigma Xi, and Pi Tau Sigma honor societies. From 1985 to 1987 he served as professor and chairman of aerospace and mechanical engineering at Northrop University, and he founded Evensen Engineers, his own consulting firm, in 1982. He also taught various engineering courses at UCLA, USC, and Cal State L.A. and published over 50 research papers, including pioneering work in the area of nonlinear vibrations of cylindrical shells. He is survived by his wife, three children, and five grandchildren.

E. Philip Koltos, MS, of Burke, Virginia, on October 21, 2001; he was 64. A 1963 graduate of University of Virginia Law School, he had been a patent attorney in Washington, D.C., with the Department of the Interior for the past 15 years. Prior to that he had worked with Allied Chemical in New York State and with General Electric. A member of the Patent Bar Association, of St. Mary's Orthodox Church in Falls Church, Virginia, and of the Epiphany of Our Lord Men's Club in Annandale, Virginia, he worked with the homeless in the D.C. area and volunteered his time and energy to many different causes. He was also an avid skier, sailor, and world traveler. He is survived by Barbara, his wife of 31 years, and by his daughters, Antoinette, Melissa, Penelope, and Cynthia.

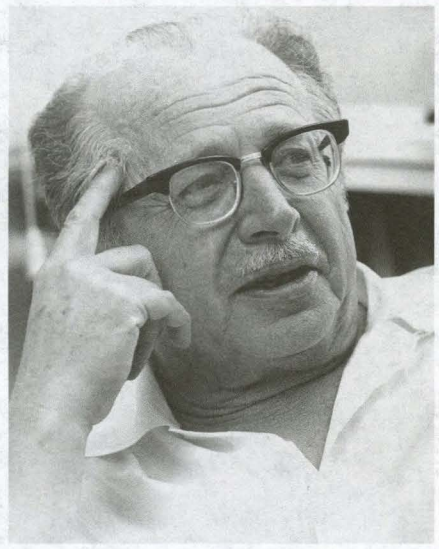
1964
Spicer V. Conant, of Hedgesville, West Virginia, on April 24, 2001; he was 59. He worked in the area of finance for small businesses and was active in the Alumni Association, serving as class agent for the class of 1964. He is survived by his wife and by three sons.

POND REFLECTIONS

The impressionistic scene on the back-page poster was captured in the waters of Throop Site, in the center of the Caltech campus.

JESSE GREENSTEIN, 1909–2002

Jesse Greenstein, an astrophysicist whose many accomplishments included pioneering work on the nature of stars and quasars, died October 21, 2002, three days after falling and breaking his hip. He was 93.



A native of New York City, Greenstein grew up in a family that actively encouraged his scientific interests. At the age of eight he received a brass telescope from his grandfather—not an unusual gift for an American child, but Greenstein soon was experimenting in earnest with his own prism spectroscope, an arc, a rotary spark, a rectifier, and a radio transmitter. With the spectroscope he began his lifelong interest in identifying the composition of materials, a passion that would lead to his becoming a worldwide authority on the evolution and composition of stars.

Greenstein entered the Horace Mann School for Boys at the age of 11, and by 16 he was a student at Harvard. After earning his bachelor's degree in 1929 and his master's in 1930, he decided that it would be prudent, in the depths of the Great Depression, to join the family's real estate and finance business in New York. But by 1934 he was back at Harvard, earning his PhD in 1937.

After winning a National Research Council Fellowship in 1937, Greenstein spent the next two years at the University of Chicago's Yerkes Observatory. In 1939 he joined the university's astrophysics faculty, and during the war years did military research in optical design at Yerkes. He also spent time at McDonald Observatory, then jointly operated by the University of Chicago and the University of Texas, before accepting an offer from Caltech to organize a new graduate program in optical astronomy in conjunction with the new 200-inch Hale Telescope at Palomar Observatory.

The Caltech astronomy program quickly became a premier academic undertaking, with Greenstein serving as executive officer from 1948 to 1972. During the 24-year period, he spent more than 1,000 nights observing at Palomar and other major observatories, and also took up radio astronomy in 1955. He was a staff member at Mount Wilson and Palomar Observatories until 1980, when he retired from the Caltech faculty. He stopped observing in 1983, but continued to do research on white dwarfs, M dwarfs, and the molecular composition of stars.

Greenstein's research interests largely centered on the physics of cosmic objects. He studied stellar composition and the related topic of nucleosynthesis in stellar interiors, as well as the physical processes and radio-emitting sources. In 1963, working with his Caltech colleague Maarten Schmidt on the high redshift of quasars, he demonstrated that quasars are quite compact objects. In later years, he studied the magnetic fields of white dwarf stars, established their luminosities, and did ultraviolet spectroscopy with data obtained from the International Ultraviolet Explorer (IUE) satellite.

A common thread of his research efforts, Greenstein once wrote, "was that they were pioneering thrusts, attempts to provide first tests of a variety of physical laws under extreme conditions in the inaccessible but convenient experimental laboratories of the stars."

Greenstein was active in the establishment of the National Radio Astronomy Observatory (NRAO) and served as chair of the board of the Association of University Research in Astronomy. He played a pivotal role in organizing various national astronomical facilities, serving as chair of the 1970 decadal review of astronomy for the National Research Council and served on the National Academy of Sciences' committee on science engineering and public policy.

Elected to the National Academy of Sciences in 1957, Greenstein was named California Scientist of the Year in 1964, awarded the NASA Distinguished Public Service Medal in 1974, and the Gold Medal of the Royal Astronomical Society in 1975. He received the Centennial Medal from Harvard, and was named to the American Academy of Achievement in 1982.

He is survived by two sons, Peter, of Oakland, California, and George, of Amherst, Massachusetts. Naomi Kitay Greenstein, his wife of 68 years, whom he met as a 16-year-old Harvard undergraduate, died earlier this year. The Greensteins were often commended for the warmth and hospitality they extended to astronomers from throughout the world.

A memorial service is planned for February 11 in Dabney Lounge at 3:30 p.m. For more information, call Gina Armás at 626/395-4671.

Caltech News