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C a l t e c h N e w s

In This Issue

Moore's Law Man

Cellular Nobelist

Interdisciplinary Director

and

Streetwise Techers



Caltech News



ON THE COVER

Nate Austin '02 strikes again. The senior in mechanical engineering designed two "Giant Fighting Robots" for a Blacker House party and later installed them on the Beckman Mall, where the taller of the two can be seen hovering over Beckman Auditorium. Readers may recall the three copper dolphins that Austin and his friends welded and suspended over Millikan Pond in 2000, and which were pictured on the cover of the second issue of Caltech News that year. Another of his creatures, a "Huge Mechanical Elephant," lumbered across campus during this year's Ditch Day festivities, as pictured on this issue's back-page poster (lower right corner). After graduation, Austin would like to "do design of some sort. Maybe I'll go into art," he says.

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New NAS members, new professorships, and a new scholarship fund; a burst of findings in gamma-ray-burst research; alums on the Street; and Ditch Day on parade (on the back-page poster).

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Executive Editor – Heidi Aspaturian
Associate Editor – Hillary Bhaskaran
Writer – Rhonda Hillbery
Contributors – Jill Perry, Michael Rogers, Robert Tindol, Mark Wheeler
Copy Editors – Emily Adelson, Michael Farquhar, Elena Rudnev
Circulation Manager – Susan Lee
Photographer – Robert Paz
Graphics Production – Doug Cummings

Ted Jenkins '65, MS '66
President of the Alumni Association
Robert L. O'Rourke
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U p F r o n t

AFGHANISTAN EXAMINED

The 1980s and 1990s were particularly cruel decades for Afghanistan. From buildings to bridges, pistachios to grape crops, what the Soviet occupation didn't destroy, tribal infighting and the Taliban later demolished. Most people have seen and heard about the wholesale devastation from afar, through a post-September 11 prism. Mohammad Qayoumi has seen it up close, and this spring he spoke to Caltech students about it.

Qayoumi, who returned to the streets of Kabul earlier this year in a visit to his former homeland, was a guest lecturer in a undergraduate class on Afghanistan. The spring course was developed and taught by Professor of History Robert Rosenstone and his wife, Nahid Massoud, a specialist on Afghan women and family relations.

A key aim of the class has been to

help students see recent events in light of the troubled history of a country that would-be conquerors have found a tempting target for thousands of years.

Rosenstone says, "If there's one theme, it's that Afghanistan has always been a crossroads country, invaded or pushed about by its neighbors. From ancient to modern times, it's always been a place that other countries have sought to conquer."

As Qayoumi put it, "Afghanistan is not in the nicest neighborhood in the world. How do you create and blossom democracy when you are surrounded by so many despotic nations, and they all think they have a stake in the future of Afghanistan?"

The guest speaker, who is vice president for administration and finance at Cal State Northridge, described his ongoing work advising Hamid Karzai, the head of the Afghan government, as the country attempts to rebuild itself in



Students listen as Afghan government adviser Mohammad Qayoumi describes the situation in his native land, in a spring course on Afghanistan developed and taught by Caltech historian Robert Rosenstone and his Afghan-born wife, Nahid Massoud.

the months since the Taliban government was driven out.

During his evening talk on campus, Qayoumi screened a short video that he shot from a moving car, depicting the bleak winter streets of Kabul. A few bicyclists and walkers moved ghostlike through sections of the city in which all

of the buildings appear to be destroyed, not unlike newsreel images of a devastated post-World War II Europe.

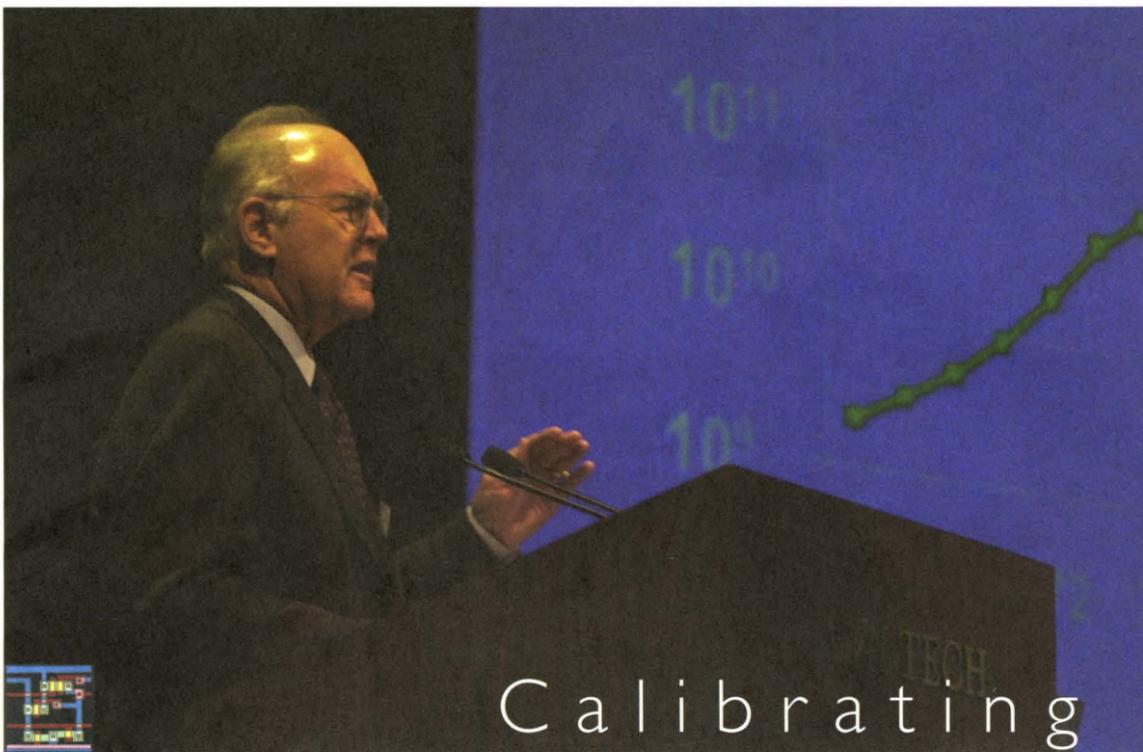
As bad as it looks, the reality is much worse, said Qayoumi, who described his work in Afghanistan as an advisory, unpaid effort to help rebuild the nation's shattered infrastructure. "The level of destruction seen is only physical. The challenges faced by the country are much deeper than that."

Somehow, an Afghan spirit remains. Qayoumi said that despite dueling regional warlords and two decades of war and instability, the Afghan people retain hope for a democratic future.

The development analyst was one of several experts recruited for the course, which Rosenstone and Massoud decided to design and teach in the aftermath of the September 11 attacks and the subsequent military operation in Afghanistan.

Within the humanities and social sciences division, where he teaches, Rosenstone quickly gained support for the course, which the couple developed through immersing themselves in

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Calibrating Gordon Moore

BY HILLARY BHASKARAN

Like many Techers, Gordon Moore puts a lot of stock in numbers. They can serve as the litmus test when he's viewing a presentation of someone's work. "I have a bad habit of picking out numerical errors on slides," he says, "and then not believing anything else."

And as with many Techers, Moore's attention to numbers has served him well. Phenomenally well.

He may not be a household name like Bill Gates, but the techie crowd will instantly recognize Gordon Moore as the man behind Moore's Law and Intel, probably in that order. The Caltech alumnus (PhD '54) is known for his leading role in the computer revolution, as well as for his rankings as a billionaire in *Fortune* magazine and his recent record-setting gifts to Caltech and Conservation International.

Of his accomplishments, Moore doesn't put his famed "law" at the top of the list and points out that it isn't a law at all. "It's only relatively recently that I was even able to utter the term," he says. Moore's Law was an observation and prediction that he made in 1965 for an article in *Electronics* magazine. He observed that computer power, as measured by the number of transistors that could be placed on a chip, was doubling every year. Extrapolating forward to account for potential improvements in technology, Moore predicted that this annual doubling would continue for the next 10 years. He was right. In 1975 he predicted that the rate, which was slowing, would change to a doubling every two years. The time span turned out to be closer to 18 months, the figure most often cited by the media when they refer to Moore's Law.

Business Week recently credited Moore's Law with capturing "the essence of semiconductor technology: relentless, geometric growth in chip power," noting that "the results eventually would make electronics the world's biggest industry and Moore's next

"In retrospect, I'm not a very good manager, but I did okay."

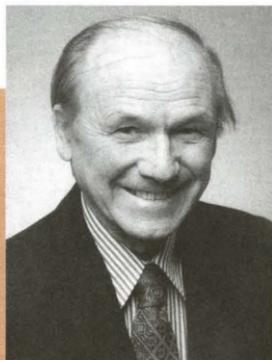
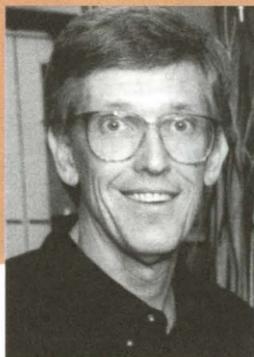
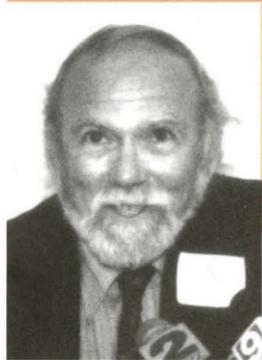


startup, Intel Corp., the world's richest chipmaker." Moore himself concedes that Moore's Law became the name given to everything that changes exponentially in the industry, and he once told a reporter, "I'm perfectly happy to take credit for all of it."

Moore's original prediction was an ironic mix of foresight and self-fulfilling prophecy. Once the potential pace was articulated, computer revolutionaries went to work developing the technologies needed to shrink transistors and thus double computer power at breakneck speed.

Gordon Moore, PhD '54, gives the keynote address at Seminar Day 2002 (top photo). Above, he and Robert Noyce (front right and left, respectively) lead Intel's first 106 employees into the computer revolution, in 1969. The inset shows a high-tech tile that graces fountains at Caltech's Gordon and Betty Moore Laboratory of Engineering.

Continued on page 10 . . .



From left, Caltech faculty Barry Barish, Jacqueline Barton, Jeff Kimble, and Anatol Roshko have been elected to the National Academy of Sciences.

CALTECH PROFESSORS, ALUMNI, ELECTED TO NAS

Four Caltech professors have been elected to the National Academy of Sciences, one of the highest honors that can be accorded an American scientist or engineer. The new Caltech members, among 72 electees whose names were announced by the Academy on April 30, are Barry Barish, Jacqueline Barton, Jeff Kimble, and Anatol Roshko, PhD '52.

Their election brings to 67 the number of living Caltech faculty and emeritus faculty who are NAS members. Established in 1863 by President Lincoln, the academy acts as an advisory body for the federal government on scientific matters.

Barry Barish, the Linde Professor of Physics and director of the Laser Interferometer Gravitational-Wave Observatory (LIGO), is an experimental high-energy physicist who has been involved with some of the highest-profile physics research in the United States and abroad. He led the development of one of the large detectors for the Superconducting Supercollider before the project was cancelled; searched for magnetic monopoles beneath the Gran Sasso in Italy; and is currently involved in the neutrino experiment inside the Soudan Underground Mine in Minnesota.

He was also responsible for the definitive Fermilab experiment that provided evidence of "weak neutral currents," the linchpin of the electroweak theory that won Glashow, Salam, and Weinberg the 1979 Nobel Prize. Barish joined the Caltech faculty in 1963.

Jacqueline Barton, Hanisch Memorial Professor and professor of chemistry, has pioneered the application of transition metal complexes as tools to probe recognition and reactions of double-helical DNA. These complexes have been useful in elucidating fundamental chemical principles that govern the recognition of nucleic acids, in

developing luminescent and photochemical reagents as new diagnostic tools, and in laying a foundation for the design of novel chemotherapeutics and biosensors.

With these transition metal probes, she has also carried out seminal studies to elucidate electron transfer chemistry mediated by the DNA double helix. This work provides a completely new approach to the study of DNA structure and dynamics and may be critical to understanding the chemical consequences of radical damage to DNA within the cell.

A recipient of the MacArthur Foundation "genius" fellowship (1991), Barton is a member of the American Academy of Arts and Sciences (1991) and a winner of the ACS Tolman Medal (1994) and the ACS Nichols Medal (1997), among other honors. Barton joined the Caltech faculty in 1989.

Jeff Kimble, Valentine Professor and professor of physics, is an expert in quantum optics and has made groundbreaking discoveries relating to quantum measurement and to the new science of quantum information. An ongoing theme of his research has been the generation and application of novel quantum states of the electromagnetic field, such as "squeezed" and "anti-bunched" light. In 1987 his group utilized such states to make the first measurement showing sensitivity beyond the standard quantum limit.

By further exploiting the basic techniques of light squeezing, Kimble and his Caltech colleagues were able to achieve the first demonstration of the original 1935 Einstein-Podolsky-Rosen "EPR" proposal involving the quantum correlations of spatially extended quantum systems. This work became the foundation for the attainment of unconditional quantum teleportation by Kimble's group in 1998. The team's

work has also been seminal in establishing the experimental foundations of quantum information science.

Kimble, who joined Caltech's faculty in 1989, is a winner of the Albert A. Michelson Medal of the Franklin Institute and the 1996 Max Born Award of the Optical Society of America, among other honors.

Anatol Roshko, the von Kármán Professor of Aeronautics, Emeritus, is known for his research in several areas of gas dynamics and fluid mechanics. He has made contributions to problems of separated flow, bluff-body aerodynamics, shock-wave boundary-layer interactions, shock-tube technology, and the structure of turbulent shear flows.

A native of Canada, Roshko earned his doctorate from Caltech and has spent his career at the Institute. He served as acting director of Caltech's Graduate Aeronautical Labs (GALCIT) from 1985 to 1987.

Already a member of the National Academy of Engineering, Roshko is also a fellow of the American Academy of Arts and Sciences and the American Physical Society, and an honorary member of the Indian Academy of Sciences, among other honors. He is a founding director of Wind Engineering Research, Inc.

Two Institute alumni were also named to the NAS this year. Tom Lubensky '64 is chair of the physics and astronomy department and the Mary Amanda Wood Professor at the University of Pennsylvania, where he conducts research in the field of "soft" condensed matter physics. Peter Shor '81 is a member and fellow of AT&T Research Laboratories in New Jersey. His work there focuses on algorithms, quantum computing, computational geometry, and combinatorics.

"UNCOMMON ANTHROPOLOGIST" NAMED TO CHAIR HUMANITIES AND SOCIAL SCIENCES

She has traveled alone in war-torn Africa and listened to lions pad around her tent at night, but now Caltech professor of anthropology Jean Ensminger has taken on a different challenge, as the new chair of the Division of the Humanities and Social Sciences.

In making the announcement, Caltech provost Steve Koonin '72 commented, "Jean brings a distinguished record of teaching and research, fine judgment, and demonstrated management skills to an important position of academic leadership within the Institute. We are very fortunate that someone of her talents is willing to take on this important responsibility."

Ensminger, who is the first woman to serve as a division chair at Caltech, started her new job June 15, succeeding John Ledyard, professor of economics and social sciences, who is returning, he says, to "the best position in the world: full professor at Caltech."

For her part, Ensminger is enthusiastic about the prospects for the division, and hopes to build on its successes over the last two decades. "The division has transformed the study of political science and political economy in ways now emulated and dominant in virtually every major university in America," she says, "and is currently incubating several areas of expertise that have the same potential for transforming disciplines as we know them today."

Specifically, she notes that the absence of disciplinary boundaries at Caltech is generating research that will "reshape the philosophy of mind, behavioral economics, and the frontier between neuroscience, psychology, and economics, while the division's uniquely seamless boundary between literature and history, together with proximity to the Huntington Library, affords us another opportunity to blossom in the humanities."

Ensminger is an uncommon anthropologist: her line of research is in experimental economics, a field that she notes the division has played a pivotal role in shaping. She is interested in how people make economic decisions, and her work involves running experiments—described to the participants as games—that use real money in order to learn something about real behavior. Unlike most experimental economists, however, Ensminger takes the method out of the university laboratory and into small-scale communities in Africa and elsewhere.

The simplest game she uses plays for fairly high stakes, usually a day's wages, whether the game is played in Hamil-



New humanities and social sciences chair Jean Ensminger is the first woman to head a division at the Institute.

RECOGNITION

Five Caltech faculty members have been elected to the American Academy of Arts and Sciences, joining the 177 Fellows and 30 Foreign Honorary Members in the academy's "class of 2002." They are **Richard Andersen**, Boswell Professor of Neuroscience; **David Anderson**, professor of biology, as well as an investigator with the Howard Hughes Medical Institute (HHMI); **Ronald Drever**, professor of physics; **Mary Kennedy**, Davis Professor of Biology; and **Mark Wise**, McCone Professor of High Energy Physics. Their election brings to 80 the number of Caltech faculty who are Fellows of the academy.

Founded in 1780, the AAAS is composed of leading scientists, scholars, artists, business people, and public leaders from around the world. Its goals include promoting the analysis of critical social and intellectual issues and the development of practical policy alternatives, and the fostering of public engagement and the exchange of ideas.

David Baltimore, Caltech's president, has been named an honorary member of Art Center College of Design's Board of Trustees. The honor reflects the importance of research collaborations between the two institutions, exploring the nature of creativity.

Barry Barish, Linde Professor of Physics and director of the Laser Interferometer Gravitational-Wave Observatory Laboratory (LIGO), has been selected by the awards committee of the American Association of Physics Teachers (AAPT) to receive the 2002 Klopsteg Award. He will give a major lecture at the summer meeting of the AAPT in Boise, Idaho, on a topic of current significance for nonspecialists.

Seymour Benzer, Boswell Professor of Neuroscience, Emeritus, has been chosen to receive this year's March of Dimes Developmental Biology Prize of \$250,000. He is being honored "for research that addressed many of the mysteries of human biology and contributed to the design of new treatments for birth defects and other disorders." The prize will be shared equally by Benzer and his corecipient, Sydney Brenner, Distinguished Professor at the Salk Institute.

Thomas Caughey, Hayman Professor of Mechanical Engineering, Emeritus, has been chosen by the Engineering Mechanics Division of the American Society of Civil Engineers as the recipient of the 2002 Theodore von Kármán Medal. Awarded in June at the Engineering Mechanics Division Conference in New York City, the medal is for Caughey's "pioneering developments and sustained leadership in developing tools for dealing with challenging problems in engineering science."

David Chan, assistant professor of biology and Bren Scholar, has been selected to receive a 2002 Beckman Young Investigator Award. Established by the Arnold and Mabel Beckman

Foundation in 1991, the Beckman Young Investigator program "provides research support to the most promising young faculty members in the early stages of their academic careers." The \$240,000 grant will be awarded over a three-year term, to support innovative scientific research.

William Deverell, associate professor of history, will serve as the 2002-03 Haynes Fellow beginning July 1. The oldest private foundation in the city of Los Angeles, the Haynes Foundation has been supporting social science research into regional policy issues since 1926. Deverell has also been elected chair of the California Council for the Humanities (CCH). In this position, he will be working to ensure the success of a new three-year program—"California Stories"—that the council is launching this June. The initiative is aimed at highlighting the story of California with the stories of today's citizens and at strengthening the sense of community across the state.

Michelle Effros, associate professor of electrical engineering, and **Stephen Quake**, associate professor of applied physics, have been named to the TR100, the world's top 100 young innovators according to *Technology Review* magazine, which is published by MIT. The theme for the 2002 selection, according to the magazine, has been the transformation of existing industries and the creation of new ones—the influence of technology "on the *real economy*, as opposed to the now moribund 'new economy,'" particularly in "hot spots" such as information technology, biotechnology and medicine, nanotechnology and materials, energy, and transportation.

Effros conducts research on information compression and communication, with applications to the World Wide Web, signal processing, wireless communications, Internet and wireless networks, data storage devices, and speech recognition. Quake uses biological molecules as model systems for studying physics, and his work in microfluidics has led to the development of "lab on a chip" devices that will enable advances in biology and medicine.

John Eiler, assistant professor of geochemistry, has been selected by the American Geophysical Union (AGU) to receive the 2002 James B. Macelwane Medal, in recognition of his scientific accomplishments. The medal, which honors significant contributions to the society by outstanding young scientists, will be presented at the AGU's spring or fall meeting.

Jim Eisenstein, professor of physics, has been invited to give a series of Morris Loeb Lectures at Harvard next winter. These lectureships deal with research topics of special interest to the lecturers and usually involve talks for both specialized and less-specialized audiences.

Charles Elachi, PhD '71, Caltech vice president and director of JPL, has been elected a fellow of the American Institute of Aeronautics and Astronautics "for his leadership and contributions

CASE-ING CALTECH NEWS

In May, Caltech News received a gold medal—its second in three years—from CASE (the Council for the Advancement and Support of Education) in the 2002 Circle of Excellence Awards Program. The awards are presented annually for notable achievement in the area of college/university communications and alumni relations.

in the field of spaceborne imaging radars." He has also been named the 2002 Distinguished Alumnus of UCLA's department of earth and space science, where he earned an MS in geology. He has also received the Wernher Von Braun Award from the German Organization of Air and Space Travel, in recognition of the Shuttle Radar Topography Mission team.

Richard Ellis, Steele Family Professor of Astronomy and director of the Caltech Optical Observatories, has been awarded an honorary doctor of science degree by the University of Durham, England. The honor will be conferred at a special ceremony there in the fall. A postdoc and lecturer in Durham's physics department, and professor of astronomy there from 1983 to 1993, Ellis is credited by Durham with being "a key contributor to the development of the department, which is now recognized as one of the top physics departments in the world."

Robert Grubbs, Atkins Professor of Chemistry, has been selected by the American Chemical Society to receive the 2002 Arthur C. Cope Award, which is sponsored by the Arthur C. Cope Fund.

Alexander Kechris, professor of mathematics, has won a 2002 John Simon Guggenheim Memorial Foundation Fellowship; the award will support his work in "classification problems in mathematics, group actions, and equivalence relations." Guggenheim Fellows "are appointed on the basis of distinguished achievement in the past and exceptional promise for future accomplishment."

Steve Koonin '72, Caltech's provost, has been elected a member of the Council on Foreign Relations. The council "aims to enhance the quality of study and debate on world issues, develop new generations of thinkers and leaders, and help meet international challenges by generating concrete and workable ideas."

Shrinivas Kulkarni, MacArthur Professor of Astronomy and Planetary Science, has been selected to deliver the 2003 Salpeter Lecture at Cornell University. The lectureship series was established in 1998 to honor Professor Edwin Salpeter.

Andrew Lange, Goldberger Professor of Physics, has been chosen by the Manne Siegbahn Institute in Stock-

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ARE CALTECH STUDENTS OVERWORKED?

What do you think? Have things gotten tougher since you were in school, at Caltech or elsewhere? Send your perspectives to the editor at hja@caltech.edu for possible publication in the Tech Talk section of Caltech News.



The issue came up more than once in an April 29 student-faculty conference, and then two days later in a *Pasadena Star-News* article entitled "Caltech Students Overworked." While conference participants generally agreed that students are overworked, related questions remained open for debate. Namely, is this a new phenomenon? How bad is it? What are the causes and solutions?

A panel of Caltech alumni who are also faculty members offered their perspectives. They were asked what changes they would like to see at Caltech. Kip Thorne '62, the Feynman Professor of Theoretical Physics, called for an improved intellectual atmosphere, one that "fosters self-education and maintains the curiosity people had as freshmen." People need "time to think and to read *Scientific American*," said Thorne, "but they're not able to because of the rat race. I don't know how to change this, but I think the negative atmosphere is mutually fostered among students and faculty."

Is this new? "It troubled me as an undergraduate," said Thorne, "and I don't think we're where we ought to be yet." Still, when Thorne talked about Caltech's reputation as the Marine Corps of educational institutions, he was not entirely critical. "I wish it were softer," but there's nothing wrong with the Marine Corps image in terms of technical training, he said. He urged Techers to talk with their friends at MIT in order to draw comparisons between core curricula.

Provost Steve Koonin '72 suggested lightening the course load or the requirements so that students could "look around intellectually." Gary Lorden '62, the acting vice president for student affairs, said the undergraduate workload has increased and gave an example. It used to be that a course in, say, math would be taught by one professor for an entire year, he said. Now each quarter could be taught by two to three teachers, and each teacher might try to cover an entire area, such as statistics, in a short time period. He added



Clockwise beginning with top photo: Students Nick Knouf (left), Martha-Helene Stapleton, and Ted Jou take the stage at Caltech's first student-faculty conference in five years; Stapleton and Knouf prepare to serve as moderators as the crowd gathers in Ramo Auditorium; students grill panelists; and a picnic allows for informal interaction between students and faculty, including alumnus Kip Thorne (seated far left).

that the undergraduates of his day had harder problems but a lighter workload.

When the panelists noted changes that have occurred in student life, they may have indirectly pointed to some reasons for the increased workload and burnout experienced by today's students. Today, undergraduates seem to have a broader range of interests, said Richard Murray '85, chair of engineering and applied science. "They are all more serious than I was," said Koonin, to which Thorne countered, "speak for yourself." Finally, they have become more and more involved in research, said Thorne.

Does it all add up to too much work? "Actually," junior Ted Jou told the *Star-News*, "I don't mind the load so much as the lack of flexibility." Jou, president of ASCIT, the Associated

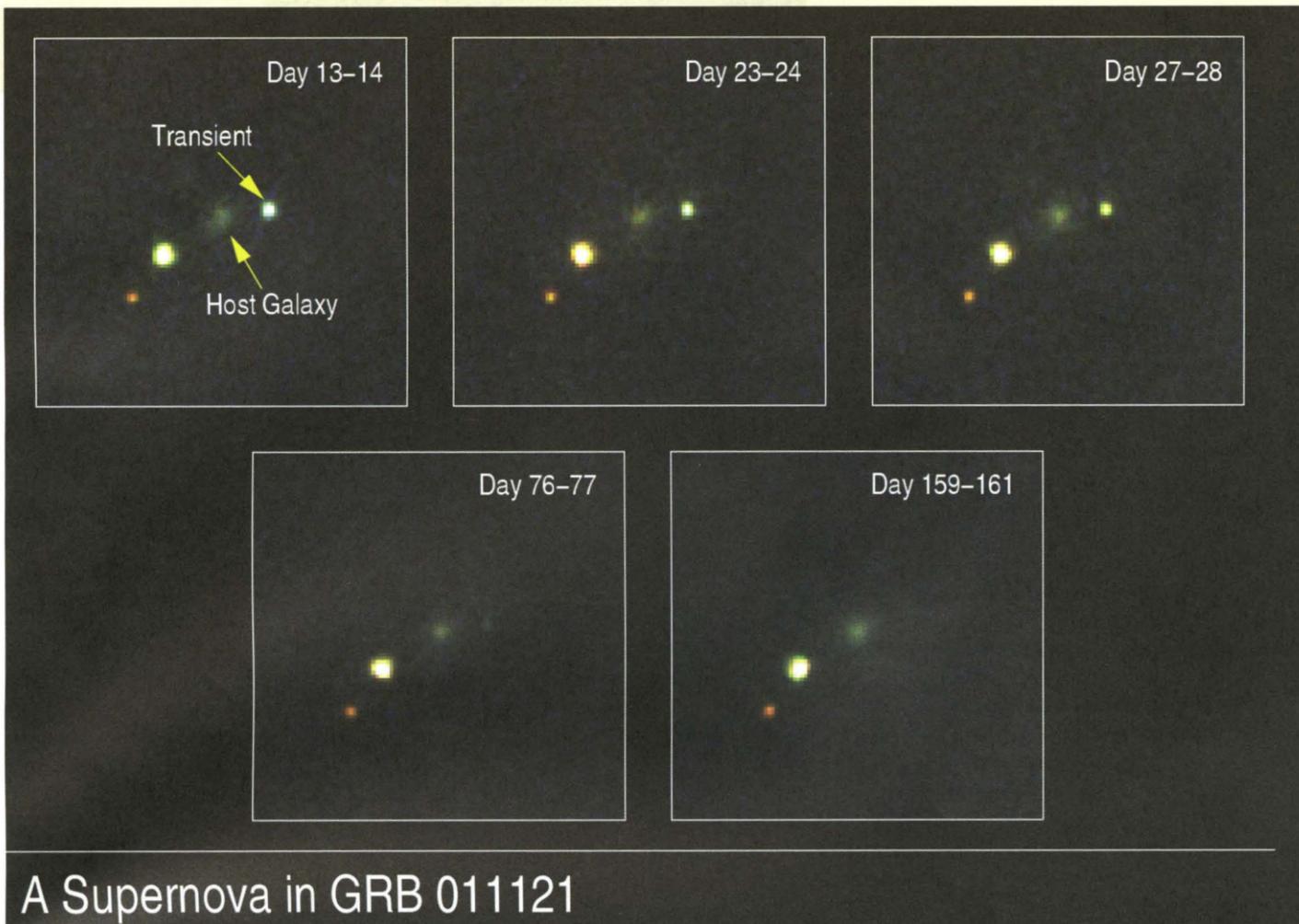
Students of Caltech, added that "there are sometimes so many requirements that we have very limited choices in what classes we can take when."

Since 1980, student-faculty conferences have been held every few years, with five years elapsing since the last conference was held. They are sponsored by ASCIT, Student Affairs, and the Dean's Office. This year's conference, brought to fruition by former ASCIT President Martha-Helene Stapleton '03 and senior Nick Knouf, included four 30-to-45-minute sessions: an administration panel; an alumni panel; a report by the quality of life committee that focused on the relationship between students and their advisers; and a report by a committee that looked at the role the Honor Code plays in the life of the Caltech community.

FUNDING FOR STUDENTS WILL COME OUT OF MOORE GIFT

At the start of the student-faculty conference, President David Baltimore announced that a fund is being established for the enrichment of student life at Caltech. The SLC Fund will draw upon \$3 million of the gift that was recently pledged to Caltech by Gordon and Betty Moore.

Lorden has since elaborated on the announcement, noting that the \$3 million gift's "annual return of about \$150,000–200,000 will be allocated by the president based on requests from student groups and the recommendations of a special committee composed of students and Student Affairs staff." Baltimore has asked Lorden to first convene a group of students, faculty, and staff to suggest guidelines for fund requests and allocations, by midsummer. Lorden noted that "the idea is to enrich student life by supplying types of funding that are not available through the usual channels like ASCIT, the Graduate Student Council, or Student Affairs. This could include programs, activities, equipment, visitors, and educational ideas that are outside the existing academic program."



This color composite image shows the fading supernova transient of the gamma-ray burst GRB 011121 as captured by the Hubble Space Telescope on five occasions between December and May. The supernova transient and its host galaxy are labeled. By precisely monitoring the changing brightness and color of the transient, Caltech astronomers were able to show the presence of a supernova. Since supernovae are known to be exploding stars, the implication is that this gamma-ray burst originated in the explosive death of a massive star. At the same time, the Caltech team was able to determine that the explosion site was surrounded by a cocoon of material from a stellar wind—similar to those seen around massive stars in our own Milky Way. The data were obtained from December 4, 2001 to May 5, 2002 using the Hubble Space Telescope WFPC2 instrument and its F555W, F702W, and F814W filters. More details and images can be found online at www.astro.caltech.edu/~derekfox/grb011121pr/

A Supernova in GRB 011121

EXPLODING STARS SHED LIGHT ON MYSTERY OF GAMMA-RAY BURSTS

In two papers appearing in the June 10 issue of the *Astrophysical Journal Letters*, an international team of astrophysicists led by Caltech astronomer Shri Kulkarni reports that new data show that supernovae are the source of gamma-ray bursts.

For the last few years astronomers have been chasing clues linking the mysterious gamma-ray bursts to their favored suspect: massive stars. Previous observations hinted at debris from an exploding star, but the observations were inconclusive.

The new information was obtained from a gamma-ray burst that was detected in November and studied by the Hubble Space Telescope, the Australia Telescope Compact Array, the Anglo-Australian Telescope, and optical telescopes in Chile.

Careful observations of gamma-ray burst GRB 011121 have uncovered remnants of the exploded star, whose signature was buried in the bright, fading embers. Now for the first time, two compelling telltale signatures of the massive star were observed.

As explained by Kulkarni, who is the McArthur Professor of Astronomy and Planetary Sciences at the Institute and the head of the international team that made this discovery, "With these observations we have tied this gamma-ray burst to an exploding star. I am absolutely delighted that nature provided us with such a clean answer."

At the core of the observations, the data show that a supernova accompanied the burst. Supernovae are a natural consequence of exploding stars and difficult to make by other means.

Joshua Bloom, PhD '02, lead author

on the supernova paper, said, "The unambiguous detection of a supernova component is very gratifying." He added, "The subject of my thesis was to uncover the progenitors of gamma-ray bursts and, by George, I think we've got it."

The astronomers were also able to deduce that the explosion took place in a cocoon of gas fed by a "wind" of matter emanating from the progenitor star. Paul Price, graduate student at the Australian National University and a lead author on the second paper, was "intensely excited. Once it became clear that we had not only seen the supernova but also the cocoon I was very happy; I couldn't sleep for days."

The gamma-ray burst in question was detected this past November, by the Italian-Dutch Satellite BeppoSAX in the southern-sky constellation of Chamaeleon. The position was quickly refined by a network of satellites. Astronomers from Poland and Chile, as well as another U.S. team from Harvard, used optical telescopes in Chile to rapidly identify the "afterglow," or glowing embers, of the gamma-ray burst and determined that the galaxy in which the burst was located was quite near—a "paltry" five billion light-years from Earth.

The sensitive optical and infrared observations were in part possible because of the relatively small distance to the burst. Given the proximity, the Caltech team decided to dedicate a large portion of their allocated Hubble Space Telescope time toward observing any possible supernova component.

Kulkarni says of the decision, "We

simply went for broke because of the potential payoff."

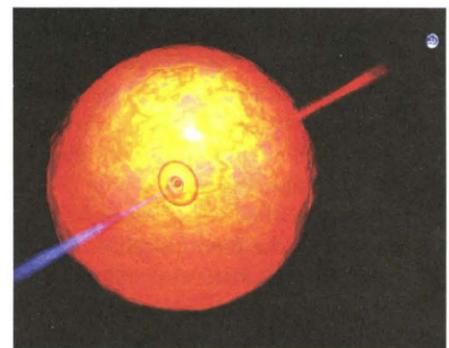
Kulkarni believes that this is just the beginning of a new era in our understanding of the death of massive stars. The stars die by collapsing, and the collapse both fuels the explosion and leaves a stellar residue of neutron stars and black holes. Indeed, theorists have long speculated that gamma-ray bursts are the birth-cries of spinning black holes. New facilities such as the Chandra X-Ray Observatory, and future facilities such as gravitational-wave observatories and neutrino telescopes, will allow astronomers to investigate the dramatic collapse process.

Kulkarni cautions, however, that all is still not known about gamma-ray bursts. It may be that other exotic phenomena, such as two colliding neutron stars, or a neutron star colliding with a black hole, produce some of the events that we see. "Despite extensive efforts, until now we have not seen clear signatures for a cocoon in dozens of other gamma-ray bursts, and there have been only hints of a supernova in a few other bursts," Bloom says.

Price adds, "It means there will be lots more to do in the future. I have a secure thesis now!"

In addition to Kulkarni, Bloom, and Price, members of the team reporting the results are Caltech professors S. George Djorgovski and Fiona Harrison and research fellows Daniel Reichart, Derek Fox, Titus Galama, and Re'em Sari. Edo Berger and Sara Yost are Caltech graduate students also on the team, as are Dale Frail from the

National Radio Astronomy Observatory, and many other international collaborators. Separately, P. M. Garnavich of the University of Notre Dame and his collaborators have reached similar conclusions with data taken from the Magellan telescope in Chile.



This illustration, created by Jonathan Williams, shows a gamma-ray burst in progress as the core region of a massive star collapses. The imploding core forms a rapidly spinning black hole (small central dot) that is surrounded by a ring of dense material. The interaction of this ring with the black hole powers two narrow, extremely energetic jets of radiation that shoot out of the star and beam first gamma rays, and later X-rays, visible light, and radio waves toward Earth (which is shown—albeit not to scale—at upper right). In a process that was first elucidated by MacFadyen and Woosley in 1999, these shooting jets blow the star apart, producing a supernova at the same time as the gamma-ray burst.

Hartwell Rising

Nobel Prize-winning yeast researcher finds new challenges leading a cancer research center

BY RHONDA HILLBERY

As a boy growing up in Glendale, California, where wildlife spills out of the Verdugo Mountains that envelop the foothill neighborhoods, Leland Hartwell '61, without any particular encouragement, collected butterflies. Then he headed to the library to read up on them.

"None of my friends was doing that," says the cowinner of the 2001 Nobel Prize in physiology or medicine, which he received for basic discoveries about the universal mechanisms controlling cell division in organisms. "I really didn't understand that I was sort of an inborn scientist. I didn't realize I was weird."

Hartwell met kindred spirits at Caltech, where opportunity serendipitously led him. During his freshman year at Glendale Community College, a guidance counselor hooked him up with a Caltech recruiter, who rightly gambled that the intellectually curious Hartwell would soak up the Institute's coursework like a dry sponge.

At Caltech, Hartwell considered physics as a major before tumbling headlong into biology. Plant physiologist James Bonner, PhD '35, was one of his role models.

"He made biology sound just terribly exciting," says Hartwell. Around the same time, a bacteriophage genetics course captivated him, showing that biology could be quantitative, as well as exciting. "I think I immediately changed my major."

He adds, "Caltech is a very special place, because as an undergraduate you can participate in research. I did research the entire time I was there. I really learned what science was about and it was very seductive."

After completing his PhD at MIT, Hartwell spent more than 30 years as a bench scientist in the lonely study of yeast cells. "I was sort of alone in the woods because it wasn't at all clear to me that yeast cells were related to human cells," says Hartwell, who chose yeast mostly because it could be studied at a level then impossible with human cells.

The biologist (who shares the prize with Timothy Hunt and Paul Nurse, both of the Imperial Cancer Research Fund in London) carried out most of his groundbreaking work as a faculty member at the University of Washington. His research has revealed that humans have a lot more in common with the backbone of bread and beer than had been previously imagined, and that the process of cell division is fundamentally the same in all organisms.

"We are essentially all made out of the same Erector set," Hartwell sums up colloquially.

Just a few years before being awarded the Nobel Prize, Hartwell became head of the Fred Hutchinson Cancer Research Center in Seattle. The "Hutch," where his earlier research is now being used to help develop anticancer drugs, is internationally known for pioneering bone-marrow transplantation. Also known for its cancer-prevention research, the Fred Hutchinson program is among the world's largest. Transplantation is now recognized as one of the leading life-saving therapies for cancer, blood disorders, genetic diseases, and autoimmune disorders.

Hartwell maintains a laboratory on the Hutch campus, but admits that the demands of his administrative job leave him little time for work there.

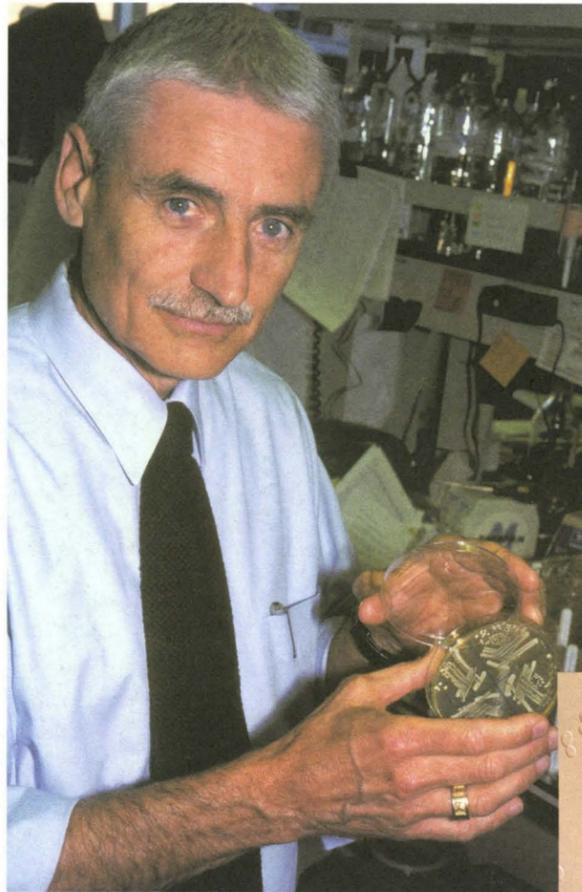
His job also keeps him from traveling widely, even though becoming a Nobel laureate confers a blizzard of invitations to speak and write from all over the world. Suddenly, everyone wants to know what you are thinking.

And there's no question that Hartwell has a lot on his mind.

"I'm interested in seeing public-health science move into genomic areas where it may be possible to identify people at risk for disease very early and manage disease risk before people become seriously ill," he says. "The whole area is very promising." Mapping of the genome is expected to lead to revolutionary discoveries about the relationship between genes and disease—insights that scientists expect will lead to new treatments for a wide range of diseases.

But as biomedicine's promise grows, says Hartwell, a growing threat looms over clinical research. As a scientist who heads one of the country's leading biomedical centers, Hartwell worries about public ignorance of science, and society's growing mistrust of clinical research trials.

"On the public-policy side, I think the most critical medical issue in our country right now is the increased oversight, regulation, and criticism of the



2001 Nobel laureate Leland Hartwell '61 displays a culture of yeast cells—his research subject for three decades at the University of Washington. His discoveries about how the genes that govern cell division in yeast function and malfunction have produced new insights into the nature of cancer and other diseases. At right, a magnified image taken in a lab at Seattle's Fred Hutchinson Cancer Research Center, which Hartwell now heads, shows yeast undergoing stages of cell division.



clinical trial process," he says. "There have been a lot of articles written about how clinical trials endanger people. There's a negative mood in the country now on clinical trials."

Most damaging may have been the 1999 death of Jesse Gelsinger, an 18-year-old whose volunteer participation in a gene-therapy trial at the University of Pennsylvania went fatally wrong. The lead researcher was found to have an interest in the company whose treatment substance was being tested. After looking into the case, the Food and Drug Administration temporarily shut down all human gene-therapy experiments at the university. And public scrutiny intensified with the recent highly publicized death of a healthy volunteer who died during an asthma-drug treatment experiment at Johns Hopkins Medical Center.

Fred Hutchinson itself has been on the receiving end of negative coverage. A 2001 series of articles in the *Seattle Times* alleged that patients weren't properly informed of the treatment risks and stated that Fred Hutchinson and some doctors held financial interests in the drugs being used.

Says Hartwell, who became the facility's director in 1997, "It was a very distorted and inaccurate series to begin with, about research trials carried out 20 years ago."

Dealing with the controversy has been time-consuming and not the type of leadership responsibility that Hartwell likely had in mind when he signed on for the job.

In letters to the editor of the *Seattle Times*, on the Hutch Web site at www.fhcrc.org, and through other avenues, the Hutchinson emphatically rebuts the articles' conclusions. Following publication, an internal investigation by the Hutch concluded that the central themes of the articles were "false and unsupported." Hartwell adds that the issues were investigated and put to rest nearly 10 years ago by the federal Office of Protection from Research Risks, part of the National Institutes of Health. And in an attempt to assure patients and the public that the Fred Hutchinson is taking a leadership role on this evolving issue, the center recently outlined an 11-point course of action intended to strengthen practices and policies in the conduct of clinical trials.

Among the changes, the Hutchinson has centralized its trial-monitoring procedures and now uses an outside contractor to monitor safety and ethical issues. The facility has hired a regulatory compliance officer, and tightened its conflict of interest policy governing clinical researchers.

Hartwell believes the measures will foster increased confidence among patients. "Those of us who conduct the medical research necessary to allevi-

“There have been a lot of articles written about how clinical trials endanger people. There’s a negative mood in the country now on clinical trials.”

ate disease and suffering recognize the importance of ensuring that the clinical trials system meets strict safety and ethical standards. We all need clinical research and clinical trials to improve the outcomes and quality of life of the critically ill because any one of us might at some time be a patient with a life-threatening disease.”

An often-overlooked larger issue, in Hartwell’s view, is a growing public ignorance of biology and science, which is fed by negative, often overblown media accounts. Fear of litigation and concerns over ever-increasing regulatory requirements are leading some researchers to leave the field altogether. He says the worsening environment for clinicians makes it harder to identify appropriate patients to enroll in tests and may ultimately make it harder to test new drugs that may save lives and cure disease.

“It’s very dangerous, because at a time when science has the ability to translate a lot of its findings to benefit people, that translation will be impossible if there is not a robust clinical-trial process.”

At best, he says, the new scrutiny will help the nation come to terms with the risks and benefits associated with clinical trials. “We need to educate the public, to take advantage of opportunities to speak and write.”

At a recent retreat representing 60 cancer advocacy organizations, he says, he reminded his audience, “When people are talking about patients’ rights, they are frequently meaning that we need more oversight. But they are forgetting that what patients really want is the right to the fruits of the research that, as taxpayers, they’ve been paying for over the past few decades.”

Although Hartwell often misses carrying out the research for which he was honored in Stockholm, he is philosophical about this new stage in his life.

“It takes a while to get used to a change, and it is no different when you become an administrator. I’ve been a bench scientist for a long time. I took this job because I really felt an enormous opportunity to apply basic research findings to medical science. It’s just doing science at another level.”

In its citation, the Nobel Committee recognized Hartwell for his discoveries of a specific class of genes that govern the cell cycle—the process by which cell division is initiated and regulated in organisms. At the heart of his research is learning when and how genetic errors can cause the cell cycle to go awry, often leading to the runaway, uncontrolled cell division that is characteristic of cancer.

“In an elegant series of experiments” in 1970–71, the committee noted, “he isolated yeast cells in which genes controlling the cell cycle were altered (mutated). By this approach he succeeded to identify more than one hundred genes specifically involved in cell cycle control,” which are known as cell division cycle genes. One of these genes, known in the trade as “start,” was found to have a central role in controlling the first step of each cell cycle. Hartwell also introduced the concept of “checkpoint” genes.

The discoveries by Hartwell, Hunt, and Nurse have led to new avenues of research that, as the Nobel citation said, “may in the long term open new possibilities for cancer treatment.”

Says Hartwell, “It turned out that the same genes we found in yeast were found in human cells and all other higher organisms. This common evolutionary heritage that has come out of so many simple organisms—yeast, and fruit flies, and nematodes—has resulted in a tremendous amount of information that is very fundamental to medical science. It really has confirmed that we all share one biology.”

When the former butterfly enthusiast looks at his beloved dog, Emma, he is reminded how seemingly little genetic material separates one species from another.

“I think I do have a sort of Buddhist feeling about the sacredness of life of any type—a sense that affinity rather than separateness characterizes all forms of life. It’s that unity that means a lot to me.”

Afghanistan . . . from page 2

articles, books, movies, and discussions about Afghanistan. “One of the beauties of Caltech is, if you have an idea for a course, they say, ‘Sure, sounds interesting. Go teach it.’”

Rosenstone doesn’t profess to be an Afghanistan expert, calling himself an “interested amateur,” but he is married to someone who is. Massoud, a psychiatric nurse at UCLA’s Neuropsychiatric Institute, helped teach the course and delivered one of its lectures.

During the nine-week class, students covered territory as wide ranging as Afghanistan’s rugged landscape. Topics included the ancient art of the region, the formation of modern Afghanistan, the Soviet invasion, the rise and fall of the Taliban, Afghan family and tribal structure, and the role of women, as well as political and economic prospects for the future.

Course materials included movies, a major research interest of Rosenstone’s.

“Film brings a sort of immediacy to students that books may not,” he said.

“Movies show them the look of the land, show them the way people look and sound and speak, how people dress and talk.” Students watched an Iranian love story dramatizing the plight of Afghan refugees, an Italian documentary showing life and conditions behind the lines of the Northern Alliance, and a feature film about life under the Taliban. They also saw a sequence from *Rambo III*, depicting the national sport of buzkashi, in which men on horseback knock around the carcass of a headless sheep. Polo it’s not, but it is a revealing pastime.

“This sequence is really brilliant; it’s almost like a metaphor for Afghanistan,” Rosenstone says, explaining that despite participation from two teams, each player seems to be competing for himself, making the sport a symbol of extreme individualism.

About 30 undergraduates and members of the Caltech community attended class regularly. “That to me shows a real interest in the topic,” the professor adds. He points out that while many Caltech students have a background in American and European history, few of them know much about the history of central Asia.

Other guest speakers included Khalil Hashemeyam, a former professor at Kabul University; Robert Brown, UCLA art history professor; and Galal Elkholy, a specialist in Islamic law.

Sina Yeganeh, a sophomore chemistry major, said he enjoyed the chance to survey a broad swath of Afghan history, “ranging from the early art of the region to the basis of Islamic law, which was so grossly misinterpreted by the Taliban. I realized that although I know some things about the current situation in Afghanistan, like many other people, I knew very little about what conditions led to the Taliban control of the country.”

When Jane Greenham learned about



Robert Rosenstone

the course, she jumped at the chance to enroll. The junior in planetary science grew up as a diplomat’s child in the predominantly Muslim country of Jordan. A few years ago, reading through a large stack of *National Geographic* magazines, she read several issues featuring Afghanistan.

“An issue from the 1970s showed an Afghanistan emerging into the modern world, and the pictures from a decade later showed complete destruction of that modernization,” said Greenham. “I wondered how the world could care so little—and how I could have known so little.” She was struck by how the country’s quality of life had foundered, and was especially moved by the plight of Afghan refugees.

“When the terrorist attacks on 11 September turned all eyes on Afghanistan, I hoped that all this attention would cause improvements in the lives of Afghan civilians, and my desire to learn more about Afghanistan increased even further.”

The students said that their exposure to Afghanistan’s history helps them better see the country’s contemporary problems, which seem monumental. Today, Afghanistan has the world’s highest concentration of refugees and land mines, as well as a dismal infant mortality rate. An estimated one in four children dies before age five, and adults have a life expectancy of just 44 years. To make matters worse, the country is in the grip of a years-long drought. “The war is the major problem, but the convergence of all these factors has increased the level of human suffering significantly,” Qayoumi said.

Throughout the term, classroom discussions often came back to the Taliban and its harsh treatment of women, symbolized by the burka, the head-to-toe garment that they were required to wear in public.

In the last class, Massoud briefly donned a burka, and allowed curious students to put it on as well. The garment is nothing she grew up wearing in Afghanistan, but for many observers it stands as a suffocating symbol of patriarchy run amok under the Taliban.

Massoud maintains that the real problem for Afghan women today is not the burka, which some women prefer out of tradition and female modesty, but whether they are able to fully participate in society. “Give Afghan women a decent education and economic opportunities, and they will soon feel free enough to shed their burkas,” she said.

RHONDA HILLBERY

Moore . . . from page 3

Intel, which Moore cofounded in 1968, quickly became the biggest contender in the race. Now the world's leading manufacturer of microprocessors, Intel is Moore's greatest pride. "It's unusual to have had the chance to participate in building such a company and to see it grow from a startup to a 30-billion-dollar company the year before last," he says. "Not last year."

Moore likes to keep track of things, such as the date when he and his wife, Betty, first saw the mountains of Pasadena emerge from the haze. (He says he can "calibrate" the September 17, 1950, occasion from his wedding date one week earlier.) But he can't pinpoint when his interest in numbers began. "I've always liked math," he says, noting that it ought to come easily to anyone considering a career in science and engineering.

It's not hard for Moore to quantify the time frame during which his proclivities found an outlet. When he was 10, his family moved from his native Pescadero, California, to nearby Redwood City. Shortly afterward, his new next-door neighbor received a chemistry set. "In those days you got really interesting chemicals, even minor explosive mixtures," he says. "Being able to follow the recipes in the book and seeing the results was fascinating." Moore devised his own experiments and built up a home lab, well stocked to make nitroglycerine. "A couple of



"I look at the world as it exists, and figure out the best way to proceed."

ounces of dynamite makes a marvelous firecracker," he beams.

From then on, he was sure he would study chemistry in college, even though he had practically no role model to follow in such an endeavor. His father had quit school in seventh grade after Moore's grandfather died. Only one relative, a cousin, had gone to college. Moore thinks she studied English to become a teacher. Despite his collegiate aspirations, Moore was a lazy

student in high school, he admits. "I could get by easily and still get pretty good grades. The last year I buckled down more."

His educational ascent was "gradual." He went to San Jose State for two years, commuting from home by train. Improved study habits and good grades allowed him to transfer to Berkeley and then to attend graduate school at Caltech. Along the way, he met Betty Whittaker, who would receive a 1949 BA in journalism from San Jose State, relocate near Moore in Berkeley, and then marry him the day before the couple made a beeline for Caltech.

Moore chose Caltech over a few other schools for its reputation in chemistry and its small size. Campus social life was not an issue for the "freshly married" Moore, who, in any case, spent most of his time in the sub-basement of Crellin—"not a high-traffic area," he points out. He and Betty socialized with colleagues, including Hector Rubalcava, PhD '56, and postdoc Roger Newman, and he learned a lot from professors Verner Schomaker, PhD '38, Norman Davidson, and Richard Badger '21, PhD '24, his thesis advisor. The latter "had some research ideas that got me off to a rapid start," says Moore, who appreciated the fact that Badger was "available when I wanted to see him but didn't bother me otherwise."

Linus Pauling made an impression on Moore. "I found him very intimidating. He could ask me my name in such a way that I didn't know the answer," he says. "I planned my final oral when he was away on a trip."

Moore submitted his thesis on the infrared spectra and structure of a few simple molecules, and he took off for a research position at Johns Hopkins University's Applied Physics Laboratory, expecting to remain in or closely connected to academia. Then came a turning point.

"I found myself calculating the cost per word of the articles I was publishing at APL and wondering if, at \$5 per word, the taxpayers were getting their money's worth," he says, adding that his basic research on infrared absorption lines and spectroscopic studies of flames was pretty abstract. "It was time to look for something more practical." Although he rejected an offer from Lawrence Livermore, among other places, his Livermore application happened to be picked up by William Shockley.

Shockley, whose role as coinventor of the transistor would win him a share of the 1956 Nobel Prize in physics, succeeded in luring a diverse group of accomplished scientists, including Moore, to the Shockley Semiconductor Laboratory, in Palo Alto, California. He then proceeded to antagonize and alienate enough of them to inspire an exodus.

Moore credits Shockley with causing two important changes in his life: "First

of all, he got me into semiconductors, and secondly, he unwittingly gave me the push to go off and found Fairchild. He made an entrepreneur out of me—an accidental one." When Moore and seven others, including Robert Noyce, left Shockley in 1957, the Nobelist dubbed them the Traitorous Eight. The eight defectors went on to secure enough support from Fairchild Camera and Instrument Corporation to start Fairchild Semiconductor Corporation, which would develop silicon transistors and commercialize the first integrated circuits, or microchips.

Eleven years later, unhappy with the parent company's management policies, Moore and Noyce left Fairchild and founded Intel. Their company's success and Moore's role as executive vice president (1968–75), president (1975–79), CEO (1975–87), chairman (1979–97), and chairman emeritus (1997–01) are well documented. But Moore's take on accidental entrepreneurship has received less attention.

The career twists and turns that resulted from working with and then leaving Shockley "got me into management at a much younger age than I would have otherwise," says Moore. He wasn't alone. "It was a very young industry," he says. "We were all learning together."

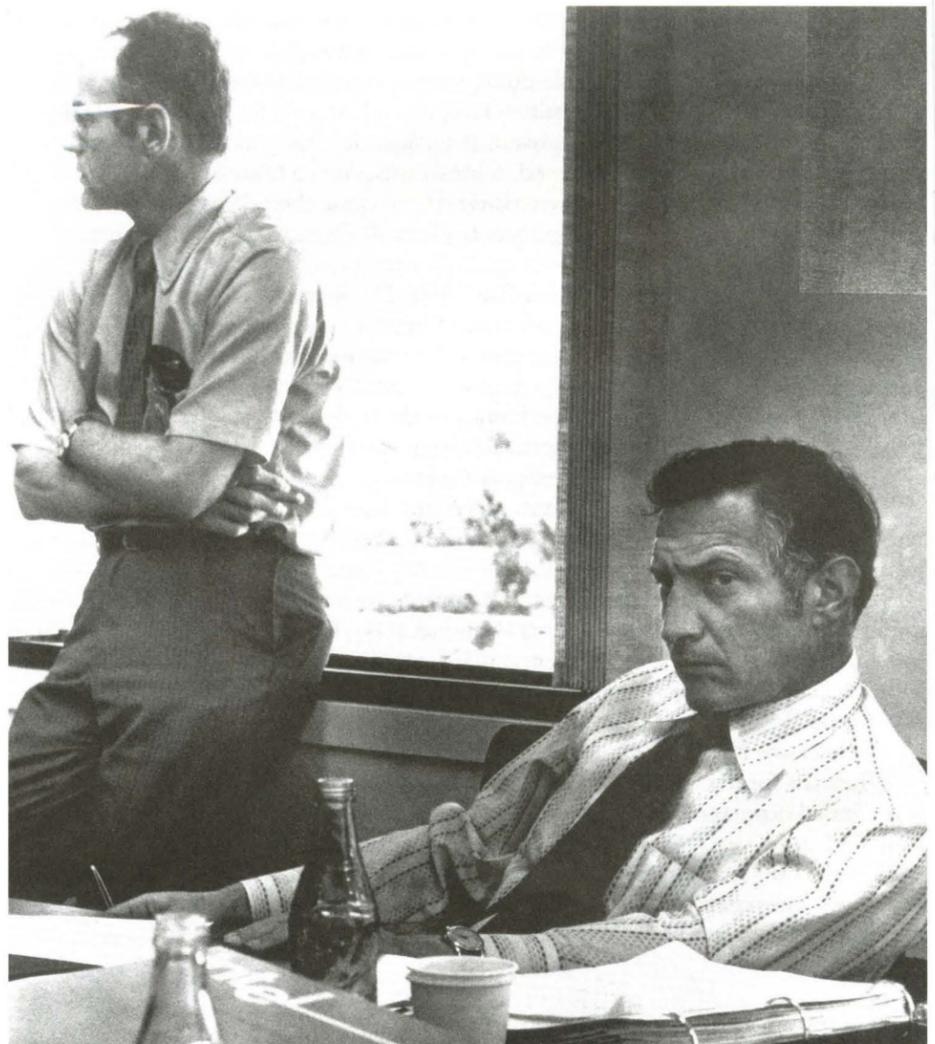
But to this day, he prefers delving into technical details to looking at the big picture. In management, "you don't get the joy of discovering the details. I liked doing science and engineering,

but somebody had to take the management job, and it fell on me."

As it turned out, he says, "I evolved in that direction fairly naturally." This would surely have surprised the psychologists at Dow Chemical (where he considered working in 1954) and Shockley Semiconductor Lab. The experts at both places had run Moore through personality tests to determine whether he had management potential. They all reached the same "amazingly grim conclusion," says Moore, "that I would never be a manager." He notes that Shockley's people reached the same conclusion about Noyce.

Moore admits, "in retrospect, I'm not a very good manager. And Noyce was probably less of a manager than I am, though he was a phenomenal leader." On what criteria does he base this evaluation? "Managers are people-focused," he says. "They set directions and review projects. I was never very systematic at doing those things. For one thing, I'm a natural-born procrastinator."

He learned some things the hard way, things that he might have learned less painfully in a management course or two, he says. For example, "when I'd meet to discuss work with subordinates, I thought I needed to know more than they did, and I was embarrassed when I didn't. Later, one of my colleagues developed a very good one-on-one system" where he'd turn the tables and let the employee do the talking. "A lot more gets accomplished." That colleague was Andy Grove, who suc-





In the early 1970s, Moore (at left in the bottom photo) endeavors to do the right thing as executive vice president of Intel. He is seen on the job with cofounder Robert Noyce. Back at Caltech in 1996, Moore joins his wife, Betty, and President Tom Everhart to do the honors at the dedication ceremony for the Gordon and Betty Moore Laboratory of Engineering. Steven, the younger of the Moores' two sons, sits far left in the front row.

ceeded Moore as CEO of Intel in 1987. "I claim he's one of those people who got over his PhD," Moore says of Grove, who "became very interested in how organizations work and less interested in technical details than I ever did."

"But even without the usual management skills, I did okay," says Moore. "In our industry, having technical understanding and vision is probably a lot more important than being able to run a project well."

As venture capitalist Arthur Rock told *Fortune* magazine, "Gordon, more than anyone else, set his eyes on a goal and got everybody to go there." Rock provided financial support to start Intel, served as its first chairman, and serves with Moore on the Caltech board of trustees, which Moore chaired from 1994 through 2000.

Moore operates on some deeply held values. He says he believes in "treating people in a straightforward manner and running a very open organization. The more people know," he adds, "the more likely they are to make the right choices." It helps if they're smart, which is why Moore says he has always sought the very best people available, subscribing to the tenet "don't hire your assistant, hire your replacement." He adds, "I never felt uncomfortable having smarter people working for me."

If Moore has an overriding philosophy, it may be this: "I look at the world as it exists, and figure out the best way to proceed." In his fast-paced field, he has found that flexibility is key. "What works in one organization doesn't in another." Apparently, he figured out what worked at Intel, riding out booms and busts, valuing mistakes and successes.

"Along the way, we had to make some of the right decisions, to focus on the right products and the right technologies. This is a business where things change rapidly. If you zig when

the rest of the world zags, your company goes down the tubes. You have to zig at the right time."

Zigging at the right time seems to come naturally for Moore.

Take, for example, a recent cause. Gordon and Betty Moore, through their foundation (which they established in 2000) and through personal conviction, have become major supporters of Conservation International. CI is an environmentalist organization whose agenda centers on preserving Earth's so-called "hot spots" of biodiversity. These hot spots make up only 1.4 percent of Earth's land surface, but they are thought to contain some 60 percent of its terrestrial plant and animal species.

If enough of these hot spots can be "saved"—through preservation, eco-friendly land use, and the like—there may be hope for the future. If they can't, says Moore, we are likely looking at "the last generation that will have wild places on Earth. These regions are being wiped out, opened up, and developed. We are seeing the impact of a single species gone amuck in the world."

On a lighter note, he says that "resort hotels and golf courses are nice, but they shouldn't be everywhere." For those who haven't heard, Moore is not a golfer but a fishing enthusiast who will go as far as Vanuatu to get away from everything except family and exotic species. Over the years, in his quest for remote fishing locales, he realized that places such as Baja California were becoming increasingly developed. Since he counts his fish (and Betty's), he also noticed that, as development went up, the number of fish species went down. This served as Moore's indicator of a larger problem—the problem of exponential growth rather than the beauty of it, as encapsulated in Moore's Law.

But what has prompted Moore to

earmark some \$300 million for preserving biodiversity rather than, say, K-12 education, the state of which he has also lamented? And what has prompted him to put both money and time behind Conservation International, serving as a board member and hosting meetings in nonremote places like Pasadena and Santa Monica?

The answer may rest with the numbers. Moore points to a theory that holds that "world population will peak sometime during this century and then drift down," which would result in a decrease of pressure on resources some time after the population peak. "If you believe this," he adds, it follows that "we have a chance at saving something that might then last a very long time."

The chance to "preserve at least some of what's left" of these hyper-rich ecosystems is tangible enough to spur Moore to put his energies and support behind it. He believes that Conservation International is well-positioned to help lead the way. "The attraction of CI is that it tries to be science-based," he says. Its emphasis on hot spots is inspired by the work of biologists, including Oxford ecologist Norman Myers, who in 1988 developed the concept of focusing on these areas, which together total 524 million acres, a land mass three times the size of Texas. Moore has put \$35 million into CI's Center for Applied Biodiversity Science, which he says draws on "the natural inclination of scientists to measure resources." Researchers are developing an "early warning system," which pulls together data pointing them toward, say, economic conditions that lead to deforestation and which shows them satellite images of regions where deforestation is already in progress.

Looking beyond Conservation International's scientific strengths, Moore points out that the organization

has representatives on site in foreign countries, that it involves the local people in those countries, and that it has good relations with most of the governments. Still, Moore wants to see CI and other conservation organizations cooperate with each other, a task that does not always come naturally when egos and conflicting agendas come into play, he says, referring to the environmentalist arena as well as to other fields.

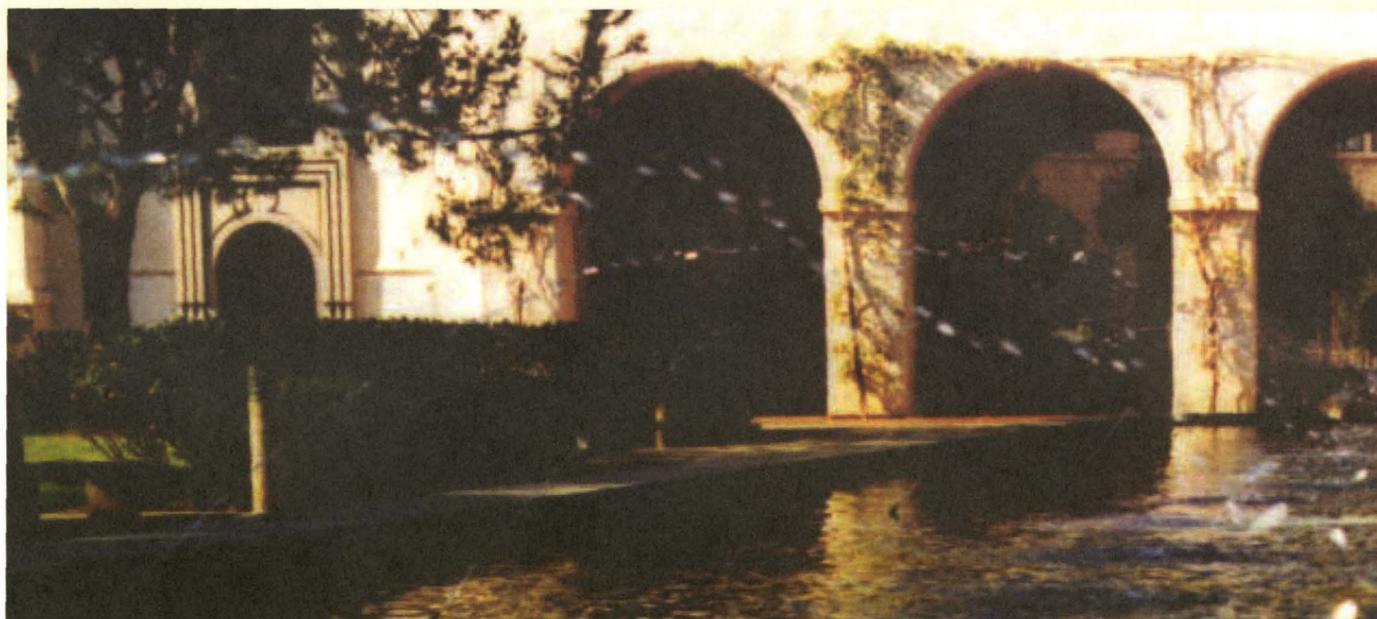
On the topic of scientific cooperation, he adds, "I was watching a *Nova* program recently about a paleontologist who hoarded a fossil for years before someone else finally got to study it. I can't imagine hoarding a scientific treasure."

In science and in management, Moore has high standards to which he holds people accountable, including the beneficiaries of his philanthropic efforts. When the Gordon and Betty Moore Foundation awards a grant, he says, the parties "negotiate measurable things that have to happen or be looked at in order to see how effective the grant was. This represents a new discipline for potential grantees."

A quantitative approach offers "a valuable way to look at a lot of things," says Moore. "If you can't measure something, you'll always wonder how well you understand it." Of course, he adds "it's hard to tie to a lot of emotional things."

While Gordon and Betty Moore remain private people, the personal side of the Moore equation has added up to 51 years of marriage, two married sons, and two grandsons. All reside in the Bay Area. Kenneth, born soon after Moore graduated from Caltech in 1954, received his BS in business administration from San Jose State and is working for the Moore Foundation after having spent nearly 20 years at Philips Electronics. Steven received his BS in business management from Santa Clara University and has been the executive director of the separate and smaller Moore Family Foundation since it was established in 1986. Parents and sons share an interest in philanthropy that

Continued on page 18 . . .



Barbara Wold: 30,000 Quest

BY HILLARY BHASKARAN

Years before she came to Caltech, Barbara Wold set out to learn how living things worked. How did genetic makeup determine an organism's structure and function? What were the key genetic similarities and differences between organisms?

Such questions led her from Arizona State University directly into the lab of Caltech cell biologist Eric Davidson. There she embarked upon five years of study into gene expression in the embryonic development of sea urchins, which would earn her a Caltech PhD in 1978.

She came right in the middle of what she calls "Caltech's genomic era number one." Norman Davidson's group was studying the *drosophila* genome. James Bonner's team focused on mammals: rats and mice. Eric Davidson and Roy Britten's specialized in sea urchins.

"They were all scoping out what was in the genomes in a global way—though at the time, no one had the technology to study a specific single gene or learn its sequence." Big questions, then and now, concerned the nature and control of RNA, the unstable middleman that links the expression of a gene to its cellular activity by serving as the template for making proteins—the real workhorses of the cell.

Sea urchins made great research subjects, says Wold. They produced vast quantities of embryos, from which she would extract RNA and simultaneously identify how many genes were "on," or active, during each stage of development. By understanding such fundamental processes, the scientists began to relate the structure of the genome to its output—how the information encoded in genes plays out to build a fully formed, "spectacularly complicated" organism, starting from just one cell. "It's wonderful to look back 25 years," says Wold, who joined the Caltech faculty in 1981 and is now professor of biology. "Now we're learning the detailed structure of *all* the genes it takes to make a sea urchin, a worm, a human.

"Now that we have the DNA se-

quences of multiple entire genomes, enormous power is coming from comparing them." For instance, when Wold looks at how an organism makes skeletal muscle—an ancient need of any animal that moves around on its own—comparing networks of genes and proteins across the animal kingdom gives her insights into "how this process was invented, how it was allowed to vary, and how it wasn't. It gives a remarkable view of evolution," she says.

If the 1970s ushered in the first era of what Wold calls global genomics, the 1980s saw its expansion. Wold describes it as a decade in which her lab and many others were "consumed" with focusing on the structure and function of specific genes, using molecular cloning technology and genetic assays to characterize one gene at a time.

The beginnings of the second era could be said to coincide with the opening of Caltech's Beckman Institute in 1989. There, Wold points out, Professor Lee Hood '60, PhD '68, "drove the possibility of the Human Genome Project by having the vision that large-scale, whole-genome DNA sequencing was the right thing to do, that it would be done, and that automation was the only way to go." Likewise, Mel Simon, now the Biaggini Professor of Biological Sciences, invented (in collaboration with Hiroaki Shizuya) "bacterial artificial chromosomes" that enabled scientists to use bacteria as micromachines to churn out large segments of DNA for what became the human genome sequencing assembly line. Both advances ushered in the current era of genomics and its near relative, proteomics—the comprehensive analysis and characterization of the structures, functions, and interactions of large sets of proteins.

"In a certain way," Wold says, seeing the progress "makes me feel a little old and a lot hopeful and excited about where we are going."

MOVING ON UP

Being older and hopeful should serve Wold well in her new position. In

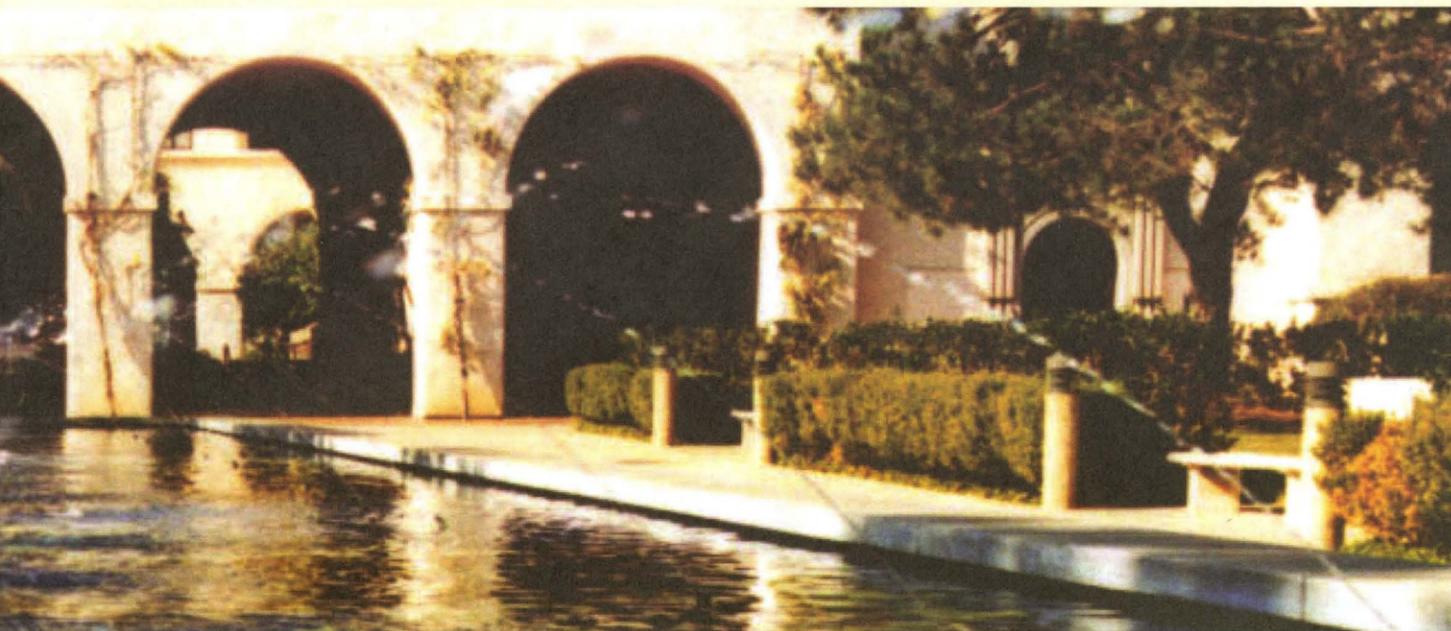
November, 2001, she was named director of the Beckman Institute, succeeding Harry Gray, Beckman Professor of Chemistry and leader of the institute's Laser Resource Center. The institute is charged with pursuing innovative research at the frontiers of biology, chemistry, and computational science.

Its successes are the successes of its scientists, of whom Hood, Simon, and Gray are "typical examples," says Wold. Its people, their research needs and aspirations, and the way their new technologies can, as she puts it, "supercharge" other labs at Caltech, are now her concern.

"Parts of biology and chemistry are getting to be big science," says Wold. Biology labs are still modest in scale compared to those of astronomy and physics, like the Keck and LIGO observatories, "but compared to how biology and biochemistry have been done throughout much of my career, we now need more and more infrastructure—robotics, computational resources, and the like—to solve major biological problems."

For example, says Wold, "we're seeing more and more need among scientists for high-tech imaging capabilities." One of the Beckman Institute's resource centers is designed to fill that need. The Biological Imaging Center, run by Scott Fraser, Rosen Professor of Biology, allows scientists to create three-dimensional movies of, say, a mouse embryo, as it develops. It joins eight other resource centers in the Beckman Institute complex in an effort to "develop novel, cutting-edge techniques" in anticipation of, and in response to, the needs of scientists throughout campus.

Bringing high-risk ideas and new technology to fruition can take years, Wold notes. But the Beckman Institute, with its human, financial, and physical resources, "can act as a catalyst to make this happen much faster than usual and often across interdisciplinary boundaries." Timely access to technologies while they are in development can shrink what otherwise might be a lengthy interlude between an idea and



Beckman Institute and its new director, above.

ons and Counting

its application down to an hour over coffee with a colleague at Caltech's Red Door. As a result, scientists can organize and carry out in a week experiments that they could not otherwise do in their own lab for years. Says Wold, "This is the sort of thing that makes science go."

What does it mean to direct this enterprise? "On a day to day basis, I'm finding out. But, in the larger scheme of things, my goal is very simple: Ensure that the BI is a dynamic, high-impact, catalytic agent for science at the interface of chemistry, biology, and, increasingly, computation and engineering," says Wold. "That has been the essence of the BI mission since its founding and will continue to be."

Meanwhile, in her Kerckhoff office, it's business as usual. Wold looks over a student's latest research findings, asking him a few quick questions in a rapid-fire lingo of letters and numbers, with a few English words thrown in for good measure. She sends him off with the decipherable message that more work needs to be done, and then explains that the project's goal is to use genomics to figure out how to better diagnose and treat childhood cancers that arise from muscle and bone.

Soon after, artist in residence David Kremers knocks on her door, wondering if he can show a visiting team from Universal Studios around the genetics labs. They're doing advance research for a movie version of "The Incredible Hulk."

GETTING THE WORD OUT

As if it weren't enough dealing with scientists, students, hulks, and other organisms, Wold has taken on a new challenge. She wants to help explain science, especially genomics, to the "person on the street."

She is acting as lead scientific advisor on an upcoming PBS series with the working title "The Age of Genes: The Science of Your Life in the New Genomic Era." Currently in the draft stage, the series is being developed by Peter Baker of Baker Associates, whose

prior PBS science shows include *The Astronomers* and *Intimate Strangers*, the latter being a multipart voyage through the world of microbes. Working on the nascent genome series, says Wold, is surprisingly similar to launching a research project in a lab. From the grant writing to the development of a concept from a general idea to a specific proposition, "the similarities have struck me since the early stages."

Funding is available from such agencies as the National Human Genome Institute and the Department of Energy, she says, thanks to the "wisdom" of founders of the Human Genome Project, who earmarked specific research support for the studies of ethical, legal, and social implications of the knowledge that would result from the project. Wold hopes that this foresight in funding "becomes paradigmatic for how science interacts with a society that pays its way."

The goal of the PBS project is to communicate the exciting science of the Human Genome Project and, as important, the impact it's likely to have on people's lives. "We're entering a period of promise as the sequencing of key genomes is completed, and we can get on with the business of using it," says Wold. But it's also an era of "letdown, if not disappointment in the eyes of the public"—a time in which people may hear that, although a gene has been identified and linked to a disease that they or friends or family may have, no immediate cure will be forthcoming. The time lag that ensues between scientific understanding and treatment is often long and convoluted, says Wold, and the public needs to be made aware of this.

Wold cites an example of early genome-based research that is beginning to fulfill its promise. The success story hits close to home since it involves research conducted some 20 years ago by Caltech's David Baltimore, along with UCLA's Owen Witte and others. But more to the point, says Wold, it shows a clear progression from fundamental to applied research, resulting in the production of the kind of "smart

drugs" that are envisioned by proponents of the Human Genome Project.

The drug—STI571, or Gleevec—is proving successful in targeting cancerous cells in patients with chronic myelogenous leukemia (CML). It was created because researchers now understand the basic mechanism by which CML occurs: a genetic anomaly triggered by the rearrangement of two chromosomes, forming what is called the Philadelphia chromosome. A molecular consequence of this anomalous chromosome is the fused *bcr-abl* gene, present in 95 percent of CML patients. In the mid-1980s, Baltimore and colleagues identified and characterized the cancer-causing properties of the altered form of the *abl* gene. They also showed that it could cause cancer in mice.

The notable presence of *bcr-abl* in CML patients inspired pharmaceutical researchers to develop a drug that would inhibit the *abl* kinase reaction. The resulting therapy, STI571, proved so effective in clinical trials that it was extended to other patients in the study and quickly approved by the Food and Drug Administration last May. Its developers, Alex Matter of Novartis, Nicholas Lydon of Novartis (and later Amgen), and Brian Druker of Oregon Health Sciences University, shared the 2001 Alpert Prize with Baltimore and Witte for their research.

Such success offers hope that cancer, because it has a genetic basis, can one day become a manageable disease, says Wold. But for every different cancer, the path to a cure will likely be different, and some treatments could still take many years, depending on the specific nature of the tumor. "As a scientist, I have to say, some genetic disorders may never have a facile treatment. And unfortunately, scientists can't always predict which ones will be the real stinkers."

So Wold sees the need to get this critical word out to the public: "The promise of the Human Genome Project is very real, but it's a little more complicated than it seems in a typical three-minute television story." The PBS special will be a four-part, four-hour series.

"Timely access to technologies while they are in development is the sort of thing that makes science go."

She hopes the series will help people think about difficult questions before they are faced with them, say, in a doctor's office. Would they want to know about their genetic predisposition for a certain disease, even if there were no known cure? Would they want family members, employers, or insurance companies to have access to their personal genetic profiles? Their feelings may—and probably should—affect the way they vote, she points out, as public policy enters the era of the genome.

"I think policymakers and others get detached from how smart the person on the street is," says Wold. "People need the facts. But if these are shrouded in technical jargon, people become mildly disenchanted with what science is bringing them." Wold's lifelong interests in art and literature, as well as science, may come into play as she attempts to communicate science to the citizen.

She also wants to communicate the intellectual excitement inherent in the Human Genome Project. "Imagine," she says, "unlocking the bases for complex human behavior, understanding how the brain works, or that old problem I have loved from the beginning—how do you build a whole organism based on genome instructions?"

Wold likes to paraphrase David Baltimore's comment about the genome project: "I don't think of the genome as 30,000 answers. I think of it as 30,000 questions."

And looking beyond those questions, Wold says, "the field is really aiming to understand a problem of dynamic combinatorics—how myriad combinations of proteins (each coded by a different gene) work together to specify the form and behavior of an entire creature. When we do find 30,000 first-order answers, the challenge will not be over."

**KAVLI FOUNDATION
ENDOWS PROFESSORSHIP**

The Kavli Foundation has established the Fred Kavli Professorship at Caltech. The new endowed chair will support a faculty member working in one of two research areas—understanding the universe or understanding the brain and the human condition, with a preference for the former.

The Kavli Institute has made a separate gift to upgrade Caltech's Cosmic Background Imager, an astronomical instrument that is studying the structure and evolution of the very early universe, and which is located at the Llano de Chajnantor Observatory in the Chilean Andes.

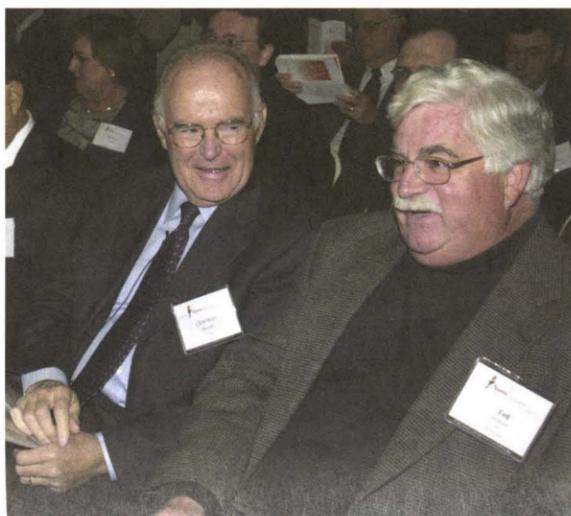
"We are delighted to have the Fred Kavli Professorship at Caltech," said David Baltimore, Caltech president. "Fred's gifts will help Caltech do what it does best—to explore and understand the universe. We are very pleased that Caltech is a beneficiary of his philanthropy."

Kavli received his education in physics at the Norwegian Institute of Technology, financing his studies with proceeds from a business venture he and his brother ran as teenagers during World War II—making wood briquettes for automotive fuel. He came to the United States in 1956 to launch a business and founded the Kavlico Corporation, in Moorpark, California, two years later. Under his leadership, Kavlico became one of the world's largest suppliers of sensors for aeronautic, automotive, and industrial applications. The company received many awards, and Kavli was awarded numerous patents. He remained the company's CEO and sole shareholder until he divested his interest to C-MAC Corporation in 2000.

Since then, he has established the Kavli Foundation and the Kavli Institute to support scientific research aimed at improving the quality of life for people around the world. The Foundation will establish chairs at leading universities worldwide and give prizes to promote and recognize excellence in research focusing on specific areas. These include expanding our knowledge and understanding of the cosmos; life and the human being, including the aging process and expanding human life spans; the technology field, with emphasis on nano-quantum-bio-technology; and methods of making education more effective worldwide. The work of the Foundation is enhanced by research and educational seminars conducted at the Kavli Institute.

**NEW JENKINS PROFESSORSHIP WILL SUPPORT
RESEARCH AT FOREFRONT OF INFORMATION SCIENCE**

Throughout his career with Intel, Ted Jenkins '65, MS '66, helped make computers so powerful, fast, and inexpensive that they became as ubiquitous in offices and homes as the telephone. Now, Jenkins is supporting the next



At Caltech's 65th Seminar Day, Ted Jenkins (right), presiding over the event as Alumni Association president, is joined by longtime colleague and the day's keynote speaker, Gordon Moore, PhD '54.

revolution in computing, in which Caltech is playing a leading role.

Jenkins, president of the Caltech Alumni Association for 2001–02, and his wife, Ginger, have established the Ted and Ginger Jenkins Professorship in Information Science and Technology at the Institute. Kerry Vahala '80, PhD '85, will be the first occupant of the new chair and will also retain his current title of professor of applied physics. Vahala, who spent a year as a Caltech research fellow before joining the faculty as assistant professor in 1986, conducts research on the physics of photonic devices and nanoscale material systems and their application to ultrafast communication and signal processing.

"We're extremely pleased that Ted and Ginger decided to create this chair, particularly in information science and technology," said Richard Murray '85, chair of the Division of Engineering and Applied Science and professor of mechanical engineering. "IST is an extremely important research thrust for Caltech. And with Ted's background in the computer industry, this gift is a natural fit."

IST has emerged as a major intellectual focus for Caltech over the past two years, spanning numerous disciplines in engineering and the sciences. The primary areas of investigation are novel computational substrates, networked information systems, and mathematical foundations.

Novel computational substrates include disciplines such as DNA computing, in which biochemical mechanisms will be used to do computations in biological systems, and computing with light, in which computers will be created to operate completely optically rather than electronically.

"These are completely different ways of thinking about computations," said Murray. In networked information systems, which is the other potential area of focus for the Jenkins Professor, investigators are attempting to take complex systems such as power-distribution or air-traffic control and to design computer networks to make them more reliable, efficient, and robust. The mathematical foundations component of IST will help support investigations in computational substrates and networked information systems by providing insights into computational complexity, information theory, and systems theory.

To build up the IST program, Murray said that Caltech plans to hire new faculty over the next few years and also hopes to construct a building to bring together IST investigators who are now spread out across campus. The gift from Ted and Ginger Jenkins is the biggest contribution so far to the IST program.

"Information science and technology is one of the country's most vital areas and is the largest industry in the United States," said Jenkins, who, in 1966, was recruited from Caltech by Gordon Moore, PhD '54, chair emeritus of Caltech's Board of Trustees, to work for Fairchild Semiconductor, a company cofounded by Moore. After two years there, he followed Moore to Intel, also cofounded by Moore, and was the new company's 22nd employee. Jenkins held a variety of positions at Intel, including manager of microprocessor/peripheral manufacturing and vice president and general manager of the Memory Components Division. He retired in 1999 as vice president and director of corporate licensing.

"Advancing the state of the art in computers and networks is very exciting," Jenkins said. "The commercial and human impact can be huge. Engineering is all about applying basic science for people and business solutions, and that's what we hope this gift will promote."

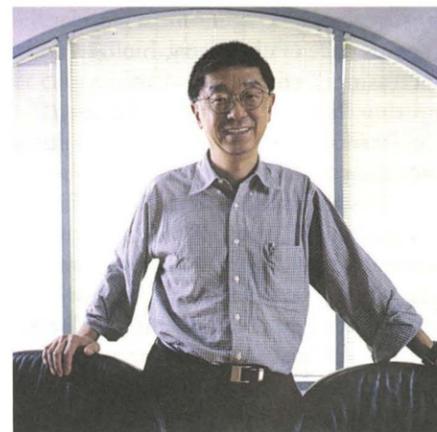
**GEMSTAR FOUNDER
NAMED TRUSTEE**

Henry Yuen, PhD '73, has been named to Caltech's board of trustees. The chairman and CEO of Pasadena-based Gemstar-TV Guide International, Inc., Yuen developed the comprehensive on-screen television program guides in use on most cable and satellite television systems.

Yuen cofounded his current firm's predecessor, Gemstar International Group, Ltd., in 1989, after wrestling with a dilemma most of us have faced—programming a VCR.

In 1988, Yuen tried to tape a game of the Boston Red Sox—his favorite team. When he subsequently found that he had recorded a screenful of snow, the Caltech PhD and lawyer (he holds a JD from Loyola University Law School) invented a new technology called VCR Plus+. Still in use today, it allows viewers to record shows by punching in a program (found in most television guides) that corresponds to the show they want to watch.

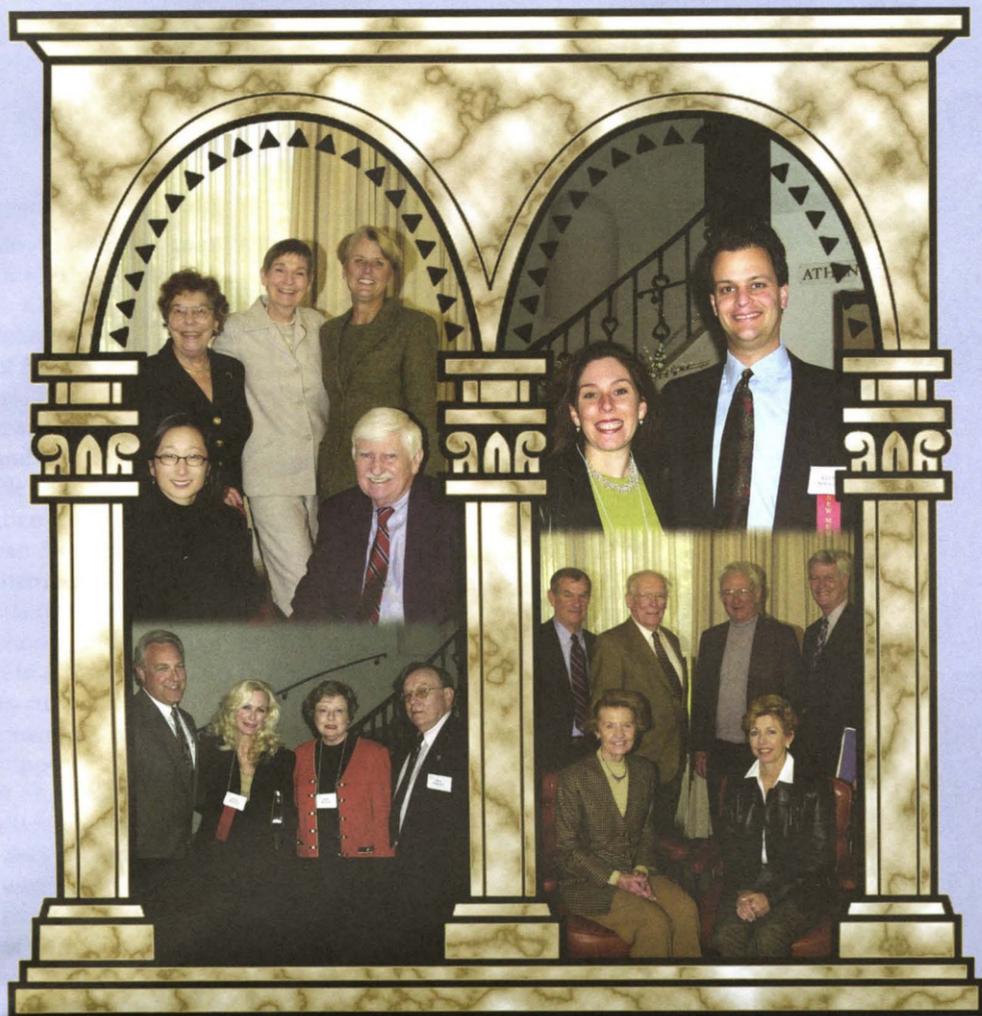
Prior to Gemstar, Yuen was a



Henry Yuen is a new Caltech trustee.

research scientist and technical fellow at TRW, Inc., held faculty positions at Caltech and New York University, and practiced law in California for over ten years.

Yuen has maintained his ties to Caltech, which honored him with a Distinguished Alumni Award in 1999. He sponsors the annual Program for Law and Technology, a joint academic venture between Caltech and Loyola Law School of Los Angeles. The program brings scientists and lawyers together to explore new developments on issues of mutual importance, especially as they relate to emerging technologies. It also brings prominent speakers from industry and government to both campuses for workshops and lectures. Past speakers have included former Senator Gary Hart and Judge Richard A. Posner of the United States Seventh Circuit Court of Appeals.



Pillars of the Institute since 1926, the Caltech Associates (whose arched logo is modeled on Caltech's Spanish-style architecture) welcomed new members and new governing members into the fold earlier this year. At top left, the Institute support group's new board members for 2002 are (clockwise from left) Rita Palmer, Alyce Williamson, Judith Wheatley, Ray Destabelle '52, MS '53, and Janice Ohta. (Not Pictured: Pierce O'Donnell.) Top right: Colleen Jaurrette and Geoff Shrager were among the guests at the New Members' Dinner this past spring. Bottom right: the Associates' 2002 executive committee is made up of (left to right) Tom Tyson '54, PhD '67, past president; Gordon McClure '47, president; Roland Smoot '50, vice president; Peter Cross '68, treasurer; (seated in front) Margaret Richards, vice president; and Janet Rogers, secretary. Bottom left (left to right), new Associates Jeffrey Throop (a distant cousin of Amos Throop, founder of Throop Institute, the forerunner of Caltech) and his wife, Angel Throop, are joined by sponsoring members Elizabeth Evans Wright and William Wright. Associates membership is open to all alumni and all interested friends of Caltech. For more information, please contact the Associates Office, 105-40, Pasadena, CA 91125; Phone: 626/395-3919; E-mail: young@dar.caltech.edu

Gifts by will

The John and Ellamae Fehrer Endowed Biomedical Discovery Fund was recently endowed through a generous gift of \$500,000 from the estate of John Fehrer. The purpose of the Fehrer Discovery Fund is to provide the Division of Biology with funds for research in the field of biomedicine.

The Institute received \$2 million from the estate of Jane Mohr, a member of the Associates. The bequest was added to the recently established Milton and Jane Mohr Endowed Student Aid Fund.

Lois Sherman Chope benefited Caltech through an unrestricted, pecuniary bequest of \$100,000.

J. Richard Love '49 has directed Caltech to receive 20 percent of the remainder of his estate in support of the Caltech Alumni Fund.

Henry and Lois Pratt have provided for Caltech through a residual interest in their living trust. Their gift is in part an expression of their appreciation for the fine, problem-solving education that their son, Richard H. Pratt '56 received at Caltech. It is also an endorsement by Mr. and Mrs. Pratt of the broader educational and scientific mission of Caltech as a whole.

These are just a few of the many individuals who have contributed to Caltech over the years. For more information regarding bequests, please contact the Office of Gift and Estate Planning, Mail Code 105-40, Pasadena, CA 91125; 626/395-2927; planned_gifts@dar.caltech.edu; www.gep.caltech.edu.

Recognition . . . from page 5

holm, Sweden, to deliver its annual Manne Siegbahn Memorial Lecture.

David MacMillan, associate professor of chemistry, was selected as a recipient of the 2001 AstraZeneca Excellence in Chemistry Award. This award recognizes the accomplishments and potential of young academics in the areas of organic, bioorganic, and medicinal chemistry. In addition, he was chosen by the Pfizer Global Research and Development Academic and Industrial Relations Committee as a recipient of the 2001 Pfizer Award for Creativity in Organic Chemistry. He has also been selected to receive a Sloan Research Fellowship. Fellows are chosen by the Alfred P. Sloan Foundation "from among hundreds of highly qualified scientists in the early stages of their careers on the basis of their exceptional promise to contribute to the advancement of knowledge."

Carver Mead '56, PhD '60, Moore Professor of Engineering and Applied Science, Emeritus, was awarded Carnegie Mellon University's Dickson Prize in Science at a ceremony on March 19 at Carnegie Mellon, which included his delivering a lecture, "The Coming Revolution in Photography," as well as receiving the \$47,000 prize. The Dickson Prize in Science is awarded annually and honors the individual judged by Carnegie Mellon as having made outstanding contributions to science.

Dianne Newman, Luce Assistant Professor of Geobiology and Environ-

mental Engineering Science, has been selected by the Department of the Navy as a recipient of the Office of Naval Research Young Investigator Award. The program "is designed to attract young scientists and engineers who show exceptional promise for outstanding research and teaching careers."

Michael Ortiz, professor of aeronautics and mechanical engineering, has been selected to receive a Humboldt Research Award for Senior U.S. Scientists. The Alexander von Humboldt Foundation of Germany "grants up to 150 Humboldt Research Awards annually to foreign scholars with internationally recognized academic qualifications. The award is intended as a lifelong tribute to the past academic accomplishments of award winners." Ortiz's award is in the amount of 65,000 euros.

Jonas Peters, assistant professor of chemistry, has received a 2002 Camille Dreyfus Teacher-Scholar Award from the Camille and Henry Dreyfus Foundation. Only 15 Teacher-Scholars were chosen. The program "is designed to provide external support to young faculty members at early stages of their academic careers. It is the foundation's expectation that this award will assist these outstanding scientists to continue the high level of accomplishment in education and research that they have demonstrated thus far." The award to Peters is for \$60,000.

Michael Roukes, professor of physics, presented one of the 2002 Lillian M. Gilbreth Lectures from Frontiers in

Engineering, at the National Academy of Engineering's national meeting at the Beckman Center of the National Academies, in Irvine, California. His talk was entitled "Nanomechanical Systems: Progress, Challenges, Applications, and Ultimate Limits."

Robert Rosenstone, professor of history, has been selected by the Getty Research Institute of the J. Paul Getty Trust as one of eleven Getty Scholars to be in residence beginning this fall. Each year, the Getty Research Institute brings together scholars and artists from around the world to work on projects related to a theme central to the concerns of art history. The theme for 2002-03 is biography, and Rosenstone's research will focus on biography on film.

Re'em Sari, Sherman Fairchild Senior Research Fellow in Astrophysics and lecturer in planetary science, has been awarded Case Western Reserve University's 2002 Michelson Postdoctoral Prize Lectureship, which includes an honorarium and the presentation of lectures and a colloquium by the awardee.

John Seinfeld, Nohl Professor and professor of chemical engineering, will receive an honorary doctor of science and technology degree from Carnegie Mellon University.

Barry Simon, IBM Professor of Mathematics and Theoretical Physics and executive officer for mathematics, has been a Distinguished Visitor this spring at UC Irvine, where he gave three

Continued on page 17 . . .

CALTECH CONNECTS ON WALL STREET

They may be far from their old student houses, but about 65 Caltech alumni from the New York area have “reunited” over the past several years at the midtown law firm of Shearman & Sterling to share common interests. These members of the “Wall Street Group” are linked not only by their Caltech degrees, but by their vocations, since they primarily work in the finance industry or in other occupations that are largely unrelated to science and engineering.

The meetings, which occur about three times a year, have attracted approximately 25 Institute alumni for each event. Attendees—who range from recent graduates to those who graduated in the 1940s—first met in 1995, according to Andrew Weigel '73, a computer programmer who has worked for numerous Wall Street firms.

Weigel, a former president of the Caltech Alumni Association's New York chapter, said that in the early 1990s the Association had considered forming a New York subchapter made up of people who worked in the finance industry. But it took a study by Caltech to highlight the need and make it happen.

In the mid-1990s, the Institute established an Alumni Relations Task Force, consisting of alumni, trustees, and other Institute friends, to evaluate how Caltech alums felt about the Institute. Among its findings, the task force determined that many alumni who had gone to work in fields unrelated to science and engineering—such as business and finance—wanted to forge a closer connection to Caltech, even though they had chosen what were then considered “nontraditional” career paths.

“The Institute made an effort to reach out to these alums,” said Roger Goodspeed '72, a member of the task force. A managing director in corporate finance at Lehman Brothers in Manhattan, Goodspeed helped Elaine Fleming (who was then working on campus and is now director of the Caltech East Coast Regional Office) to compile a list of New York-area alumni who had chosen careers outside science and engineering. These individuals were then invited to an inaugural meeting in 1995, at which time the group was known as the “Corporate Group.” Now known as the Wall Street Group, it has held about 15 meetings since that initial gathering in 1995.

“In New York, you're a long way from Pasadena, and if you're not in-

“When I was at Caltech and talked about going to business school, some of the faculty looked at me as if I had two heads.”

involved in science or engineering, you're not going to have as much contact with the Institute as you would otherwise,” said Dale Collins '73, MS '74, a partner at the New York law firm Shearman & Sterling, who specializes in the anti-trust aspects of corporate mergers and acquisitions. “For me, these meetings are a way to revive a link to an institution that was very important to my professional development. The meetings make me feel connected again to the Institute and that I am part of something ongoing at Caltech. That's important to me.”

Group meetings typically feature speakers who are from Caltech or are connected to it in some way. President David Baltimore has addressed the group twice, and other faculty speakers have included John Ledyard, professor of economics and social sciences and former chair of the Division of the Humanities and Social Sciences; Peter Bossaerts, professor of finance; Yaser Abu-Mostafa, professor of electrical engineering and computer science; and Colin Camerer, the Axline Professor of Business Economics. Caltech trustee speakers have included Ben Rosen '54, chairman of the board of trustees and chairman emeritus of Compaq Computer Corporation; Phil Neches '73, PhD '83, founder of Teradata Corporation; and Stephen Ross '65, cochairman of Roll and Ross Asset Management Corporation and the Modigliani Professor of Finance and Economics at the MIT Sloan School of Management.

Nearly all of the speakers have discussed topics in economics and finance, reflecting the interests of the group members, but members of the group say that they also enjoy catching up on the latest news from the Institute. “We're all a long way from California, so it's nice to find out what's going on at Caltech,” said Kenneth Garbade '68, a vice president at the Federal Reserve Bank of New York, where he does research on capital markets. “It's interesting to see how things have turned out,” said Garbade, who credits Caltech with instilling in him an “intellectual honesty and rigor.”

Group members have also found



Top photo, left to right: At a recent meeting of Caltech's “Wall Street Group,” Caltech trustee Phil Neches '73, PhD '83, is joined by Dale Collins '73, MS '74, and John Krowas '93. Collins hosted the event at Shearman & Sterling's Manhattan offices, where he is an attorney and a partner; Krowas is a financial engineer with ITG, Inc. Below: The evening's guest speaker, Caltech president David Baltimore, talks with Jan Dash '63, director of quantitative analysis at Smith Barney.

that their Caltech experiences were similar. For example, many said that while their interest in pursuing careers in business was not encouraged by their professors at Caltech, the education they received was an asset in helping them become successful.

“A lot of things that today Caltech provides, I had to figure out on my own,” said Neches. Now based in New Jersey, he interrupted his studies at Caltech in 1979 to start a computer systems company called Teradata, and later became senior vice president and chief scientist of NCR Corporation. “Technology transfer, as now practiced at Caltech, was not even a distant dream back when I was there. But I could not have done what I did in my life if it wasn't for the education, experience, and contacts I got at Caltech.”

Recalled Goodspeed, “When I was at Caltech and talked about going to business school, some of the faculty looked at me as if I had two heads. When I left Caltech, I had never heard of investment banking. I got interested in finance because of the quantitative side of it. For a Caltech grad, the math of finance bordered on the trivial at the

time. It has gotten much more sophisticated since then."

Of Caltech's 20,000 alumni, slightly more than 700 live in the tri-state area of New York, New Jersey, and Connecticut. "People are surprised that so many Caltech alumni work in finance and law in New York City," said Fleming. "But it isn't surprising, as there are few boundaries to what one can do with a Caltech education. The members of the group obviously enjoy the contacts that they make with fellow alumni and the opportunity to maintain a connection with the Institute. In turn, Caltech appreciates their enthusiasm, commitment, and ongoing support."

According to Ledyard—who has served as the group's faculty advisor since its inception—group members were surprised to hear about the curriculum changes that have taken place at Caltech since they graduated, as well as about the Institute's new programs preparing students for careers in business and finance.

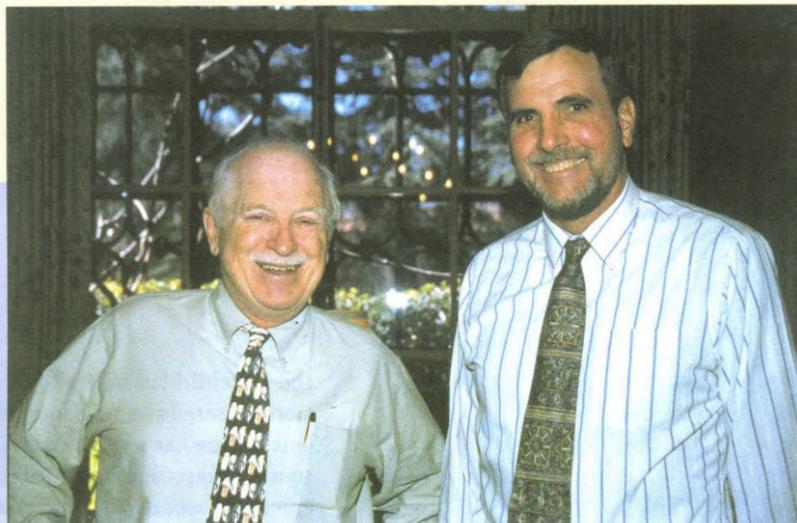
"One of the things I noticed when I gave my talk to the group was how surprised the alums were that the current faculty were undertaking path-breaking research and teaching serious courses in finance and business," Ledyard said. "That had not been true when they were here."

The group has already found ways to be of concrete assistance to Caltech. Many members have joined the Caltech Associates and are now helping to build that program on the East Coast. And according to Ledyard, members of the group have helped Caltech students get interviews for jobs on Wall Street.

"I am really pleased with the help we have gotten in placing our students in jobs on Wall Street," he said. "Because of the programs we are building in finance and the help of our alumni in New York, our undergraduates are now competitive with the business-oriented students from all of the best schools. Working together with the Wall Street Group, we can provide educational and employment opportunities in an area that had previously not been traditional for Caltech graduates."

For more information, contact Elaine Fleming at the East Coast Regional Office at efleming@dar.caltech.edu or 212/899-5465.

MIKE ROGERS



Gordon Treweek (right), PhD '75, has established an environmental science scholarship fund named for his thesis adviser and mentor, Professor Jim Morgan (left).

SCHOLARSHIP HONORS MENTOR WHO STANDS OUT ON AND OFF THE COURT

When Gordon Treweek, PhD '75, wanted to honor a longtime Caltech friend and thesis adviser, he sought a tribute that would prove as lasting as his memories of the fiercely competitive Friday-afternoon basketball workouts they shared.

Treweek found a permanent way to thank his mentor by establishing the James J. Morgan Scholarship Fund to support environmental science and engineering undergraduates and graduate students.

Morgan, the Goldberger Professor of Environmental Engineering Science, Emeritus, couldn't be happier. "I am certainly pleased he chose to make this gift to the institution. It will make a difference by providing financial aid in scholarships to future generations of students in this field."

As for Treweek himself, Morgan adds, "I always think of him among the handful of students I came to know best, through a most enjoyable collaboration as student and mentor."

The scholarship is funded through a gift from Treweek and his wife, Carol, of a partial interest in a Pasadena apartment building, which was subsequently sold. Staff in Caltech's Gift and Estate Planning Office assisted the Treweeks in completing this complex gift of real estate, which benefited the

Institute and at the same time provided significant tax benefits for them.

For Treweek, who earned his BS at West Point, discovering engineering science at Caltech helped him realize that he wasn't cut out to be a mathematician. "I was in my first year, and it wasn't going well," Treweek says of his math coursework. He used to run off his frustrations at the Caltech track, and eventually joined up with a group of basketball players who were playing in the Graduate Student Council League. One of the most avid players was Professor Jim Morgan.

At the same time, Treweek couldn't help but notice, as he gasped for breath from time to time on the court, that the air pollution around Pasadena was "horrendous." Treweek recalls, "I said to myself: You know, maybe I would be better as an engineer trying to do something about this than as a mathematician."

Morgan became his thesis adviser, and Treweek focused on the study of treatment processes and aquatic chemistry.

And they took time to have fun. "Jim Morgan—there was no way you could keep him on the bench," Treweek recalls. "Every Friday afternoon we would play basketball and

then go to the Athenaeum to 'replace the electrolytes.'" This was code, of course, for sharing a few well-deserved pitchers of beer.

After graduation, Treweek went to work for the consulting engineering firm MWH, and later joined the Pasadena company TetraTech, serving as vice president and manager for both firms and supervising projects related to hazardous waste management, water reuse planning, and remedial design for hazardous waste treatment and disposal facilities. In 1998, he became principal consultant with Pasadena-based Environmental Defense Sciences.

Over the years, Treweek and Morgan have stayed in close contact, through frequent visits, phone calls, and even the occasional ski trip. Morgan also credits his former student with frequently attending campus events and making himself available to new generations of students.

For his part, Morgan has received numerous awards for his work in water chemistry, environmental chemistry, and water purification engineering, including the 1999 Clarke Prize from the National Water Research Institute. That same year, he was named the corecipient, with Werner Stumm, of the Stockholm Water Prize.

Recognition . . . from page 15

lectures—one for graduate students in mathematics, and the other two for a more general mathematical audience.

John Todd, professor of mathematics, emeritus, and his late wife, Olga Taussky Todd, also professor of mathematics, emeritus, have been selected to have their pictures displayed in the Portrait Gallery of Distinguished NBS/NIST Alumni. The gallery honors staff members and research associates of the National Bureau of Standards—now the National Institute of Standards and Technology—from 1901 to the present. Only 178 alumni have at this time been

selected for the gallery. Todd and Taussky Todd were nominated by their former colleagues at NBS/NIST, endorsed by the Standards Alumni Association's Portrait Committee, and approved by the current NIST director.

P. P. Vaidyanathan, professor of electrical engineering, was selected by the Institute of Electrical and Electronics Engineers Signal Processing Society to receive the 2001 Technical Achievement Award. This award honors a person who, over a period of years, has made outstanding technical contributions to theory and/or practice in technical areas within the scope of the society.

Ahmed Zewail, Nobel laureate and Pauling Professor of Chemical Physics and professor of physics, has been selected to join the Welch Foundation's scientific advisory board. The Welch Foundation is one of the oldest and largest sources of private funding for basic research in chemistry, and its scientific advisory board counsels the foundation's board of directors on scientific issues. Zewail has also received the Distinguished Alumni Award from the University of Pennsylvania, where he earned his PhD in 1974 and been honored with the G. M. Kosolapoff Award from the University of Auburn.

Moore . . . from page 11

began during kitchen-table discussions and now plays out in meetings of the two Moore foundations.

In his role as philanthropist, Moore says his fortune constitutes both a luxury and a responsibility. "I've been fortunate enough to be at the right place at the right time and get more resources than I need. It's nice to pursue things that I'm interested in and where I think I can have an impact." He says it's his responsibility to efficiently allocate the money. After all, he points out, "either I do it or the government will."

"I'm egotistical enough to think that I can do better than the government," at least in certain areas, he says. Those areas, as specified by the Moore Foundation, include scientific research, higher education, the environment, and Bay Area projects.

"If I knew how to improve primary education," says Moore, "I'd do it. But so many people are throwing money at it, I don't see what I could do differently that would have an impact." On this note, he once told *Technology Review* that the challenge is "kind of like solving world hunger, the way I look at it."

In some ways, Moore is picking up where the government leaves off. He has told the press that "the way research is funded in the U.S., with peer review and government projects, does a very good job on the mainstream. [But] it's a lot harder for unusual, possibly hairbrained ideas to get funded."

Which brings us to SETI. The controversial Search for Extraterrestrial Intelligence was dumped from the U.S. space program "because it was ridiculed by a couple of senators," according to Moore. He "got involved in rescuing it, thinking it would work its way back into NASA funding." Now, "six or seven years later, I'm disappointed that there

doesn't seem to be any movement in that direction. I'm not inclined to keep it going, not that I ever did," he says, referring to his limited role in this effort.

Still, "it's a legitimate part of NASA," says Moore, refuting the notion that this is a hairbrained idea or even a dreamer's indulgence. "Looking for life in other places is very interesting and gets the imagination of a lot of people. Should it be intelligent life, it would be a spectacular find. If you're going to run a large space-exploration program, it fits in perfectly.

"If you look at the risk versus reward," he adds, "though I'm not sure I did that very consciously, there's a potentially huge payoff. If we discover signals, it could change the course of human history.

"It's like trying to understand what consciousness is. It's a mind-boggling concept. I'm not sure if it's open to science or philosophy or what the eventual applications will be. But the fact that we do experiments in that direction is exciting, and the tools for understanding are coming along pretty rapidly. Imagine what the next hundred years will do," says Moore of these and other endeavors. He cites the exponential progress in genomics and the promise that it "will lead to personalized medicine down the road." If you look at the progress, you could establish another Moore's Law curve," he adds. "What you can do tomorrow depends on what you have done today."

But the outcome of any line of research is anyone's guess, he says. When

the Fairchild lab under Moore's direction invented the first integrated circuit with what were thought to be small, cheap transistors at 60 cents apiece, Moore says that everyone thought, "Okay, we're done, what's next? We didn't realize that we had turned over the first stone in a rock pile. We had just opened the book. The economics would change completely, to the point where transistors would cost only one-millionth of a dollar or less per piece. We were just starting to understand what we were onto when Moore's Law came about. Every once in a while something like this happens, but it's not easily predictable. It's very hard to look into the future and be correct."

Moore, incidentally, says he'd rather be able to change the future than predict it. "I might predict a lot of problems, but if things didn't change, that would be discouraging." To him, Moore's Law represents a good mix of the two because of its role as a self-fulfilling prophecy.

If it's up to Moore, no worthy stone will go unturned. As chairman emeritus of Caltech's board of trustees, he has gotten a preview of the projects that faculty members would like to pursue, if only they had the resources. Moore trusts that his gift of \$600 million will help them realize their goals. "The faculty have two sets of wish lists: one to do the exciting work they're already doing, and the other to undertake a new set of programs that reach far beyond what they're doing now. I can't take

Not known as a seeker of luxuries, Moore now finds himself with one: giving away his fortune.

care of everything on both lists, but I can hopefully stimulate other people and take a big step in that direction."

Moore is betting on Caltech because, he says, "it really is a unique institution. It's very, very good and small," which results in extraordinary interdisciplinary work. Engineers and physicists "literally sit down at the same table for lunch. When Carver Mead would meet on Thursdays with Feynman, and you had those minds turned to microelectronics problems, imagine the cross-fertilization." He points out how Mead, Caltech's Moore Professor of Engineering and Applied Science, Emeritus, brought electronics to bear on the way that biological systems work, which helped lay the groundwork for the field of neural network computing.

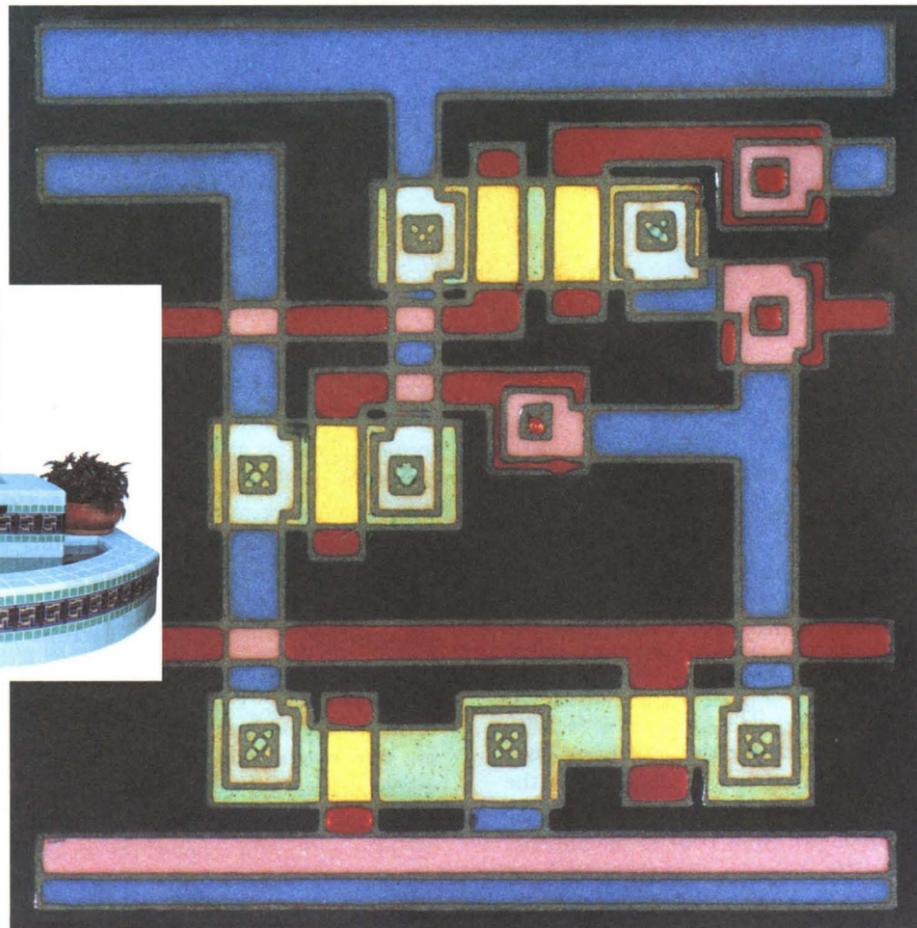
Moore sees Caltech not only as a hotbed of science but also as a business. "For Caltech to still be unique," he says, "it has to do an especially good job of matching significant resources with the advantages that come from its small size and outstanding group of people. It needs a lot of resources to support science and engineering. Since government research projects don't pay for themselves, the more successful Caltech is at getting contracts, the further in the hole it goes. I saw the chance to help in a way that will hopefully preserve Caltech's position."

Moore, who refers to himself as a "fairly quiet" person, was sparsely quoted in the press when news of his and Betty's unprecedented gift to Caltech broke last fall. The couple's personal gift of \$300 million, combined with their foundation's pledge of a like amount, represents the largest private donation ever to an institution of higher education.

Despite the staggering numbers, Moore remains a model of understatement. When he gave the press a few reasons for his gift, he mentioned his gratitude toward Caltech. As Moore put it, "the education I received there has served me well."



In the courtyard of the Gordon and Betty Moore Laboratory of Engineering, a fountain owes its intricate tile patterns to circuitry developed in Carver Mead's lab.



Alumni Update

ASSOCIATION PRESIDENT SALUTES ALUMNI STAFF

As I began my final article, I found myself in a bit of a quandary. It's tempting to recount our achievements of the last year, but this seems a bit self-serving. We've had a good year, but it's over. One thing that I have learned since I've been on the Alumni Association board is that we are pretty good at designing and overseeing ongoing programs. We will continue our stream of educational travel, events, programs, and service to Caltech and its alumni. The reasons for this are manifold:

- We have had and will have a good progression of officers.
- The board generally agrees on priorities, even if we quibble over the details.
- Most important, perhaps, we have an outstanding staff.

In the Association bylaws, the vice president automatically becomes the president. For the past several years the board has been promoting the treasurer to vice president. This means that our presidents have occupied every office and have been board members for at least five years. As a consequence, our officers are well-experienced. The officer lineup for the 2002–03 term is

- President—Debbie Dison-Hall '74
- Vice president—Tom Tisch '61
- Treasurer—Stephanie Charles '73
- Secretary—Ponzy Lu '64

But although the composition of the board changes somewhat with each new term of service, the staff continues to carry on the real work of the Association. Arlana Silver, deputy director, is responsible for travel/study, the Alumni College, the Distinguished Alumni Awards, and regional programs. Arlana or Andy Shaindlin, our executive director, staff or attend all events and travel programs. A couple of years ago, Arlana proposed that we begin trying a variety of formats for our program meetings. Our tradition had been to build events around Caltech faculty, which we still like to do, but in line with her suggestion we have also introduced a more flexible roster of events and programs that can, for instance, be more easily tailored to families or conducted in areas that have smaller alumni populations. Consequently we've held many more events and, we think this is working well.

Karen Carlson, perhaps best-known to the largest number of alumni outside Pasadena, supports our undergraduate admissions volunteer network (more than 400 strong) and the student/faculty/alumni relations committee. Karen handles the logistics of the Signature Award—the book award for

outstanding juniors in math and science in high school. She also organizes the on-campus training for volunteers, supports the pre-frosh weekend on campus, and organizes and staffs local programs involving students, faculty, and alumni. These range from the freshman pizza party to the senior class barbecue to career events for undergrads, grad students, and postdocs.

Patsy Gougeon is responsible for Seminar Day and reunions, and for bookkeeping and financial matters. By the time you read this, she should be basking in the glow of yet another successful Seminar Day (the Association's 65th) and the related reunion events. Seminar Day is perhaps our largest and most demanding event, and to bring it off each year, Patsy and a dedicated committee of alumni volunteers work together to provide the organization and framework for our faculty speakers, as well as all the other ancillary events.

Tracy Davis is our Web-site guru. The Alumni Association has had electronic communications as a priority since the Internet began to take off. Over time we have increased our capabilities to include an electronic directory and online membership and event registration, as well as an events calendar, links, and updates about other facets of the Caltech community. Tracy also manages our e-mail newsletter to alumni. We still have a long way to go, but the responses have been positive, and this medium is perfect for our flung, high-tech membership.

Andy Shaindlin, our executive director, with support from the Association's administrative aides, Molly Nercessian, Tim Reid, and Kim Goodfriend, keeps the whole thing on track on a day-to-day basis. While we on the board enjoy our volunteer responsibilities, we all know that the staff could probably keep the Alumni Association going without our help.

It has been a real pleasure for me to work closely with this dedicated and special group of people as Association president, and I look forward to continuing to do so as past president and as an Association member in the years ahead.



Debbie Dison Hall '74 will take over this column in the next issue of Caltech News.



President David Baltimore (center) joins the 2002 Distinguished Alumni on Seminar Day. From left, Milton Chang, Baldomero Olivera, David Evans, Baltimore, Gary Felsenfeld, and Kiyo Tomiyasu.

CALTECH CONFERS HIGHEST HONOR ON SIX ALUMNI

President Baltimore presented six Caltech graduates with the Institute's 2002 Distinguished Alumni Award at the Alumni Association's 65th annual Seminar Day.

A key player in the fiber-optics industry, **Milton Chang, PhD '69**, is managing director of Incubic LLC, chairman of Arcturus Engineers and OEpic, and sits on the boards of Lightwave Electronics, OpVista, Rockwell Scientific, and YesVideo.

He is cofounder of New Focus, serving as chairman of the board, and has incubated more than a dozen other successful companies. He is currently the president of the IEEE Laser Electro-Optical Society, a fellow of the Optical Society of America, and he writes monthly business columns for *Laser Focus World* and *Photonics Spectra*.

David Evans, PhD '68, went straight from Caltech to a faculty position at UCLA, rising to the rank of professor in 1973. He then returned to Caltech as professor of chemistry until moving to Harvard in 1983. Named Abbott and James Lawrence Professor of Chemistry in 1990, he completed a three-year term as chair of Harvard's department of chemistry and chemical biology in 1998.

Elected to the National Academy of Sciences (NAS), the American Academy of Arts and Sciences, and the Royal Society of Chemistry, Evans is noted for fundamental advances in the design of stereoselective reactions, and their applications to natural-products synthesis. His techniques are widely used in industrial and academic labs throughout the world, and his research group has synthesized more than 40 complex natural products.

Chief since 1997 of the Laboratory of Molecular Biology, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, **Gary Felsenfeld, PhD '55**, is a noted investigator in fields ranging from physical chemistry to genetics. Before joining the laboratory in 1961 as chief of its section on physical chemistry, he served as assistant and then senior assistant scientist with the U.S. Public Health Service, Laboratory of Neurochemistry, National Institute of Mental Health, and then as assistant professor of biophysics at the University of Pittsburgh. He has also been a visiting professor of chemistry at Harvard and Cornell Universities.

A member of the NAS, a fellow of the American Academy of Arts and Sciences, and the American Association for the Advancement of Science, Felsenfeld has published nearly 200 papers, patented a DNA sequence, and served on numerous editorial boards and a variety of advisory boards and committees.

Baldomero Olivera, PhD '66, is Distinguished Professor of Biology at the University of Utah, and an adjunct professor at the Salk Institute in La Jolla, California. He joined the University of Utah as an associate professor of biology, rose to full professor in 1973, and was appointed Distinguished Professor in 1992. He served as director of the University of Utah's interdepartmental neuroscience program, 1994–95. At Utah, his laboratory has initiated the identification and characterization of biologically active peptides found in the venoms of predatory cone snails. Characterizing them has led to a broad involvement with molecular neuroscience and has raised wide-ranging biological questions. Several substances discovered in Olivera's lab are being developed as therapeutic drugs; one is awaiting final FDA approval.

Winner of the 1991 Utah Medal for Science, Olivera has been a Fulbright Scholar and has received the Ely Lilly Unrestricted Research Award, the American Cancer Society Faculty Research Award, the Alexander Von Humboldt Foundation Senior U.S. Scientist Award, and the University of the Philippines Chemical Society Outstanding Alumnus Award.

After graduating from Caltech, **Kiyo Tomiyasu '40**, went on to receive an MS from Columbia in 1941 and a PhD from Harvard in 1948. He then joined the Sperry Gyroscope Company before moving in 1955 to the General Electric Microwave Laboratory, in Palo Alto, California, and five years later transferred to the General Electric Research and Development Center, in Schenectady, New York, where he worked on lasers and microwave projects. In 1969 he joined the General Electric Valley Forge Space Center, in Philadelphia. For several years he has been involved with microwave remote sensing of the earth, using satellite-borne radiometers, scatterometers, and synthetic-aperture radars. As a result of corporate mergers in 1995, he is now with Lockheed Martin Corporation, in Philadelphia, and is a management and data systems fellow of the company.

President of the Institute of Electrical and Electronics Engineers (IEEE) Microwave Theory and Techniques (MTT) Society during 1960–61, Tomiyasu received an IEEE Centennial Medal in 1984 and an IEEE Third Millennium Medal in 2000.

READERS SHARE THEIR
THOUGHTS ON TSIEN

Thank you for the update on Dr. Tsien [*Caltech News* No.1, 2002]. I have often wondered what happened to him after deportation. But except for brief mentions in reports on Chinese missile development, there has been nothing in the press I read.

The article focuses on his experience in China for understandable reasons. However, younger readers may wonder why such a fuss is being made. Perhaps his former students and colleagues will write you and provide material for a follow-up that will show how much was lost by government stupidity. Unfortunately, during my time at Caltech, I had only limited exposure to his genius, but I can testify to his single-mindedness and dedication. He would come in and start his lecture on the left panel of the blackboard and proceed relentlessly to the opposite wall. If needed, he would return to the original panel and erase it. We learned to take careful notes!

One criticism. Please do not use red ink on a green background. It really strains the eyes.

—Robert Staley '42, MS '43

Dr. Frank Marble's account of his and his wife, Ora Lee's, recent trip to China to honor Dr. Tsien on his 90th birthday and present him with the 1979 Caltech Distinguished Alumni Award, was fascinating. It was fitting that Ora Lee and Frank Marble were chosen for this pilgrimage and mission. They are the most recent examples of the warm, caring, compassionate Caltech family, in the mold of the late Lester Lees, professor of aeronautics, and his wife, Connie, who also gave much of themselves to improve the lot of others.

Dr. Marble's report was both heartening and sad. Heartening to learn that Dr. Tsien, this great man and scientist, is still alive; and sad to be told that he "is now permanently confined to bed."

When Dr. Tsien taught and worked at Caltech, he was tireless, never seemed to be ill, worked 24/7.

It was also good to know that Dr. Ch'ien Wei-Zhang too is alive and apparently doing well. He is also a fascinating fellow. When Dr. Ch'ien was at Caltech, in general the Chinese students were quiet, reserved, sober; Dr. Ch'ien was ebullient, outgoing, enjoyed a drink. . . . He didn't hide the fact that he was an unabashed liberal (nor that in his native China, he was a Communist), although other Chinese rarely if ever discussed American or Chinese politics.

In 1995, Basic Books published a well-researched biography of Dr. Tsien, titled *Thread of the Silkworm*, by Iris Chang. About half of this book is devoted to Dr. Tsien's tenure at Caltech. Dr. Marble's name figures prominently in those chapters.

—Bernard Rasof, PhD '50

I approached with great interest the article on Tsien in the latest issue of *Caltech News*, because Tsien Hsue-Shen is a well-known and very controversial figure in modern Chinese history. The article left me disappointed and sad. I fully appreciate the context was the sentimental reminiscences of a good friend, and was not meant to be a true "revisiting" of Tsien. If it were, there are many Chinese (including scientists) who should be remembered and whose fates were sealed in part by the actions of Tsien (however unwittingly).

Tsien's travails in the U.S. during the McCarthy era are well known, and there is little doubt that he was the victim . . . in a political drama where the stage was nothing less than the Cold War during its most intense period. Perhaps it is [true] that he suffered unfairly in the U.S., but, whatever the reason, it is well documented that Tsien returned to China not only to be a leading scientist, but also a fervent and vocal supporter of the Communist Party and some of its worst purge campaigns.

During Chairman Mao's first major purge, the Anti-rightist Movement in 1957, many scientists and intellectuals refused to join the Party and to participate in its criticism meetings, which would [then] lead to purges. Tsien published his criticisms of his colleagues . . . and wrote articles promoting the Communist Party to the scientific community. His articles did not go unnoticed, and he was lavished with promotions, privileges, and prizes by the state.

Most devastating of all, he wrote highly complimentary articles in 1958 promoting Chairman Mao's Great Leap Forward movement to make China agriculturally self-sufficient. Tsien authored a very famous paper stating that agricultural yield was only limited by the amount of light and energy available. He claimed it was theoretically possible for China's existing fields to enhance crop yields by over 20-fold. Though this sounds innocent enough, Tsien was one of China's leading scientists, and his voice gave validation to the schemes of the Party. Accordingly, grain quotas were set that year that were entirely impossible to reach. When grain collection fell short, purges began to root out the "slackers." Whole regions submitted all the grain they had available, including their own rations, in an attempt to meet the quotas.

The idea that the yield quotas them-

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"I can testify to his single-mindedness and dedication. He would come in and start his lecture on the left panel of the blackboard and proceed relentlessly to the opposite wall."

selves were erroneous did not dawn initially because scientists of such stature as Tsien endorsed it. No less than millions died of starvation in the Great Leap Forward.

Even in later purges, Tsien and his wife, Ying, skated through with only minor inconveniences compared to the legions who voiced their consciences or who resisted the madness of the period. Tsien enjoyed great relative comfort and protection . . . including servants, chauffeurs, and education abroad for his children. His reputation as a political and self-protecting bureaucrat at the Academy of Sciences is well known and, unfortunately, almost entirely different in manner than the man Frank Marble describes.

It is even interesting that Marble recounts Tsien telling old Kármán jokes. On the occasion of Kármán's 75th birthday, Tsien sent a letter that basically suggested that Kármán sold out his scientific talent to further military ends. As recalled by Joseph Charyk, who had studied with both men, Kármán was shaken and deeply upset by the letter.

Of course, it is impossible for us to know the pressures that Tsien faced when he returned to a China that was controlled by a totalitarian and brutal Party regime, and it is entirely unfair to judge in hindsight. Certainly Tsien is not even remotely to blame for the madness of the movements, but that he was so vocal in his support . . . is truly tragic.

Faced with the same circumstances, hundreds of thousands of political leaders and intellectuals did resist . . . though, sadly, many died for their efforts. Hopefully, no person should ever be faced with the terrible circumstances that Tsien faced in both the U.S. and China. But in the event, one also hopes that reason and "doing the right thing" would prevail. . . .

(I received a 1985–1986 Watson Fellowship for Study Abroad, which I spent in Beijing, China, and I continued to live and work there until 1991. A short story on my Watson year appears in the anthology *Cultural Curiosity*, editor J. Khu, UC Press, 2001. My grandmother, uncle, and two cousins died of starvation in the Great Leap Forward in Anhui Province in 1959. My aunt, a journalist, died in a hard labor camp in Jiangxi Province in 1968.)

—Lily Wu '85

1939

Tyler R. Matthew, of Seattle, writes that in May–June 2001 he and his friend Mary cruised the Mediterranean. The plan for 2002 is to cruise the Intracoastal Waterway on the U.S. East Coast, and then the Mississippi, in April–May, and to tour San Diego, Los Angeles, and San Francisco by air in October.

Charles E. Pettingall, of Tucson, Arizona, writes, "Haven't heard from my old buddies: Ralph Ruggiero, Harold Hance and Spencer Oakley for years. What gives? I'm still happy here in the desert, hiking and biking every day. The articles in your Alumni News are getting harder and harder to understand. Maybe I should have gone to Stanford or MIT!"

1940

Dwight H. Bennett, of San Diego, writes that he retired in 1983 as program manager representing McDonnell Douglas at Northrop for the F/A-18. Due to heart problems, he also retired in 1985 from his flight-instruction activities, which included instrument flying, single- and multi-engine aircraft, and landings. "When I go flying with friends who are still active pilots," he adds, "I find I can still take off and land without scaring my friends too badly. My activities now consist mostly of visits to many doctors, and playing as much bridge as my remaining time allows."

1943

Edward I. Brown, of San Diego, reports that he has been retired for 22 years in the "garden spot of the universe—Rancho Bernardo." His last job was that of group vice president at Aerojet, where he was in charge of liquid rockets, general valves, and Johnson pumps. "We lost Bob Bashor" from Rancho Bernardo, he writes. Bashor was also class of '43.

1946

William Bongardt writes that he and Loraine are still in Clovis, California: "Nomads we are not! I make several fishing trips each year—locally and beyond. I ski frequently at Badger Pass in nearby Yosemite. We ancient ones ski free during the week. This year I won a silver medal in the NASTAR races. Of course it helped a lot to have a large handicap because of my age."

William A. Ross reports that he is retired and living in Laguna Woods, Leisure World, California.

1947

William R. Bellows, of Playa Del Rey, California, writes that he is "keeping busy."

Joseph Ernest Veale, MS, has moved to northern Virginia to be near his son and grandchildren. He is living in Fairfax Station.

Edward B. Winters, of Santa Rosa, California, writes that he is "still alive and complaining!"

1948

Kurt Barnett, MS, of Lengnau, Switzerland, retired in 1985, but continued working in Switzerland and in Montreal for SNEMO Ltd.

Kenneth Hedberg, PhD, of Corvallis, Oregon, retired from Oregon State University in 1987 as a professor of chemistry. He reports that he still has an active research program at OSU and works every day.

C. Gordon Murphy, of New York, writes, "Last year we went down the Amazon from Iquitos to Manaus, north to Prudhoe Bay and Point Hope, Alaska, and Maui for Thanksgiving. On 9/11 I was at the Mayo Clinic to have my heart's mitral valve reconstructed—a great success." He adds that he feels 20 years younger.

1952
William T. Wolf, MS, of Valley Park, Missouri, has retired and is living at Cape Albion, a senior retirement center.

1961
J. David Bowman, PhD '68, a scientist at the Los Alamos National Laboratory, has been awarded the Tom W. Bonner Prize in nuclear physics. "Granted annually by the American Physical Society, the Bonner Prize is the top American nuclear physics award." Bowman has been recognized "for his studies of parity nonconservation in compound nuclei—a property of physical systems related to the forces that act between nucleons (neutrons and protons)." A Los Alamos staff member since 1974, Bowman currently leads a team in the lab's neutron science and technology group.

1963
Alan Q. Lippert, MS, of Seattle, reports that he is coaching MATHCOUNTS math teams at the middle school where he teaches. "I have a couple of students who are national contenders."

John M. Rosen, MS, of Monroe, Connecticut, writes, "I have joined the faculty, in the Engineering Technologies Division, of Naugatuck Valley Community College. I am continuing my consulting practice as Solutions Associates."

1967
Peter N. Cross, of Boston, continues working on public-health issues in South Africa's poorest province, where nearly 25 percent of the adult population is estimated to be HIV positive. "I'm very pleased that my niece by marriage is a freshman at Caltech and also a member of Ricketts House! For those who may recognize my name on the Track and Field record board (English measurements), I continue to run—best recent performance: the Comrades Marathon 89.7 km in 8:35:55."

1969
Lawrence Shirley, of Towson, Maryland, served for several years as vice chair and acting chair of the mathematics department at Towson University, near Baltimore. He is now the associate dean of the College of Graduate Education and Research and is midway through a four-year term as president of the North American chapter of the International Study Group in Ethnomathematics.

1971
David A. Dixon, of Pacific Northwest National Laboratory (PNNL), has been named a Fellow of the American Physical Society "for his development and use of high level computational chemistry techniques to solve complex industrial and environmental problems." Dixon joined PNNL in 1995 as associate director for theory, modeling and simulation in the Department of Energy's William R. Wiley Environmental Molecular Sciences Laboratory, which is managed by PNNL; he leads one of the largest groups of computational chemists in the world and is responsible for the Molecular Sciences Computing Facility.

Chris G. Whipple, MS, PhD '74, of Moraga, California, was elected to the National Academy of Engineering in 2001. Election to the acad-

emy "is among the highest professional distinctions accorded an engineer. Membership honors those who have made 'important contributions to engineering theory and practice, including significant contributions to the literature of engineering theory and practice,' and those who have demonstrated 'unusual accomplishment in the pioneering of new and developing fields of technology.'"

1979
Paul Linares, MS, of Palo Alto, California, is working in the Voice-over-IP marketplace. His company is NetCentrex, whose U.S. headquarters is located in San Jose.

France A. Córdova, PhD, has been named chancellor of the UC Riverside campus by the UC Board of Regents, effective July 1; she has been serving as professor of physics and vice chancellor for research at UC Santa Barbara, and she was chief scientist at NASA before moving to Santa Barbara in 1996. Prior to that she headed the department of astronomy and astrophysics at Pennsylvania State University and served as deputy group leader of the space astronomy and astrophysics group at Los Alamos National Laboratory. Noted for initiating a program to encourage and fund research across disciplines at UC Santa Barbara, she also led a campuswide effort to increase research opportunities for students. At NASA, she was primary scientific advisor to the NASA administrator and the principal liaison between NASA headquarters and the wider scientific community. A winner of the Distinguished Service Medal, NASA's highest honor, her scientific contributions have been primarily in the areas of observational and experimental astrophysics, multispectral research on X-ray and gamma-ray sources, and spaceborne instrumentation.

1983
Liyuan Liang, MS, PhD '88, moved in 2001 from Oak Ridge National Laboratory in Tennessee to the engineering school of the University of Cardiff, in Wales.

1984
Norbert Arndt, MS, PhD '88, moved to England about a year and a half ago and is working for Rolls-Royce plc as vice president of engineering in International Aero Engines. "Just after moving, my wife, Michelle, and I had our first child, Matthias."

Gregorio Beitman, MS, is working for ELTec in Mexico City. "I would like to attend a class reunion if you organize one."

Marcus Chown, MS, writes that his new book, *The Universe Next Door: The Making of Tomorrow's Science*, was published by Oxford University Press, New York, in March 2002. He reports that, according to *Astronomy* magazine, his previous book, *The Magic Furnace*, "reads like a Sherlock Holmes novel."

1990
Volnei A. Pedroni, MS, PhD '95, is professor of electrical engineering at the Federal Center of Technological Education of Paraná (CEFET-PR), in Brazil. He is also coordinator of CEFET-PR's microelectronics lab and a consultant to several Brazilian companies.

1991
Howie Choset, MS, PhD '96, has been named to the TR100, the world's top 100 young innovators according to *Technology Review* magazine, which is published by MIT. The theme for the 2002 selection is the transformation of existing industries and the creation of new ones—the influence of technology "on the *real economy*, as opposed to the now moribund 'new economy,'" particularly in "hot spots" such as information technology, biotechnology and medicine, nanotechnology and materials, energy, and transportation. A specialist in "snakebots"—autonomous, multijointed robots that are being designed and engineered for a variety of technological and biomedical uses—Choset has devised motion-planning algorithms that enable these devices not only to sense and respond to objects they encounter, but also to actively explore their

environment. Now on the faculty of Carnegie Mellon, he is building bots that can search for buried explosive mines.

1993
Kelvin Lee, MS, PhD '95, has been named to the TR100 (see previous personal). Lee, now an assistant professor at Cornell, was doing research at Caltech when he discovered a marker protein for identifying Creutzfeldt-Jakob disease (CJD) in humans and, later, for "mad cow disease" in cattle. He is currently looking for indicators for variant CJD and for Alzheimer's disease.

1998
Suzie Hwang Pun, MS, PhD '01, has been named to the TR100 (see previous personal). Pun is exploring the use of polymers to carry injected genes through the bloodstream to precise locations, which, in addition to gene-therapy applications, opens up the possibility of accurate drug delivery; the Pasadena company Insert Therapeutics was founded primarily to exploit her work.

Classes Notes

1944
Paul Winter
paulwinter@caltech.edu

Thomas Hudson writes again that he is still traveling. Trips last year included Hungary, Mexico, Thailand, and the western United States. This year he is planning to visit China, Bali, and Mexico again, and expects to keep it up until his legs give out.

Ray Palmer has retired from Boeing/McDonnell Douglas/Douglas Aircraft after 47 years of service. He is now enjoying life in his Newport Beach home and is doing some traveling.

1950
Dwight Schroeder
dwightcsch@aol.com

Dick Wright advises from Akron, Ohio, that he has been spending time on the development of super-high-strength wrenches and fasteners for critical applications. Information and published articles are available at www.wrighttool.com.

Dirck Hartmann writes that failing eyesight is preventing him from driving and is severely limiting his reading. He lives in Huntington Beach, California.

1994
Bryce Elliot
bryce_elliott@hotmail.com

I haven't received much in the way of unsolicited updates on people's lives, but it's been a while since I've put forth a column, so I'm going to press with what I have on the people I've crossed paths with.

For my part, since my last installment, I've changed jobs twice, one of which included a career change. I was a control systems engineer, and now I'm a database administrator at Core Laboratories (we do reservoir optimization). I'm still working on my master's degree in chemical engineering part-time at the University of Houston; my expected graduation is May '04.

Continued on page 22 . . .

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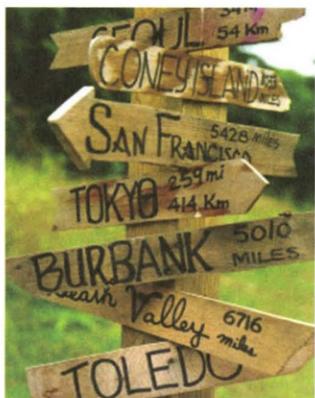
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Craig Smith over a time or two since he joined the mechanical engineering faculty at Texas A&M. Again, you have an opportunity to get educated via the Web at www.mengr.tamu.edu/GeneralScripts/facultyinfo.asp?LastName=Smith.

In July 2001, Mike and I took a trip to the Bay Area to attend the wedding of Nhat Nguyen. He's now Dr. Crazy Bug, having earned his PhD in computer science from Stanford. Nhat and his wife, Ha, have since moved somewhere near Tuscon. While we were in town for the wedding, we took the opportunity to meet up with several more Techers, including: Steve Harkness ('92); Eric Stout ('92) and his wife, Lisa; Fru ('93), who, like Madonna or Prince, needs only one name; Rich Chiu ('93); John Parks and his wife, Celia; Brett Warneke; Chinley Chang; Won Bang (One Big Bang!); Remy Hathaway ('95) and his wife, whose name escapes me, even though she was dating Remy when we were all at Tech; Tim Nelson ('95), Eddy Vataru ('95), and Josh Moats ('97).

John and Won both work at Applied Materials. Chinley is working on a bachelor of fine arts at San Jose State. Brett is still, to my knowledge, in hot pursuit of his PhD from UC Berkeley. I have to take this opportunity to note that it took me several seconds to recognize Brett with a completely shaved head.

I've traded e-mail with George Papa, who appeared to have fallen off the face of the planet. No, indeed; George recently moved to Chicago, and while Chicago may be nearer the edge of the planet, it is far enough away that one can consider the risk of falling off negligible. George is married and has a little girl about a year and a half old. Last I checked, George was a bigwig at an outfit called bigfoot.com.

Please note that while I have one Scurv, one Flem, and one Lloydie thrown in, the vast majority of folks published are Pageboys, because those are the folks I keep in touch with. More specifically, if you lived in Page, you might get published without lifting a finger; if you didn't, odds are stacked against you unless you do something proactive. Also note that the one with the most ink is Sacha, who sent me an e-mail. For the others, I put down what facts I had in memory.

So here's the deal: send me e-mail updates about your lives, and I'll publish them, typically almost verbatim, though I tend to change first person to third person. I have several e-mail addresses. They include: belliott@corelab.com; belliott3@houston.rr.com; bryce_elliott@hotmail.com. My hotmail address is the most permanent, but you can take your pick.

Class Notes . . . from page 21

I continue to enjoy being a dad, and for those of you to whom the idea of my being a father is a scary thought, imagine how mortifying it is for me.

Congratulations to Sacha Malin, who not only has been the lone member of our class to send in an update since my last publication, but has also received her PhD (hence the update). She successfully defended her thesis in neuroscience at Washington University in St. Louis in June 2001. Her dissertation title is "Molecular Identities and Functional Roles of Voltage-gated K Channels in Mammalian Neurons." She also noted that she was taking a bit of time off to decompress and do a little traveling for the summer.

I hook up with Michael Wong every couple of months since Mike moved to Houston. He is on the chemical engineering faculty at Rice University. Learn more at www.ruf.rice.edu/~che/faculty/wong/wong.html. I've also had

1926

Vladimir (William) Porush, of Los Angeles, on May 16, 2001; he was 100. He completed his first year of college at the University of Odessa in the Soviet Union, in 1921. He and his wife, Reva, then escaped from the USSR, and he arrived at Caltech as a sophomore in the fall of 1923. After graduating, he worked as a structural engineer for several organizations, including Bechtel, McCone and Parsons, Southern California Edison, and, during World War II, the Los Angeles department of building and safety. He started his own company in 1946, continuing as a principal until 1988. He also taught preparatory classes for the California Board of Registration's examination for licensing structural engineers, and for the structural portion of the licensing exam for architects, with perhaps 3,000 students passing through his classes between 1943 and 1988. Predeceased in 1980 by his wife, he is survived by two sons, Allan '59, MS '60, and Ted (who graduated from MIT in 1951), both of whom were also structural engineers; and by six grandchildren and nine great-grandchildren.

1931

Byron B. Johnson, of Santa Barbara, California, on October 21, 2001. He had retired in 1969 as director of design, Midwest Naval Facilities Engineering Command. He began his service with the Navy in 1941, working for a contractor improving facilities in the Hawaiian Islands; this included restoring water service—initially under fire—to Ford Island on December 7. Commissioned in May 1942 as a reserve lieutenant (jg) in the Navy's Civil Engineer Corps, he remained at Pearl Harbor for three years, with responsibility for the base water system. Later assignments included that of public-works officer at bases in California and Washington State, and he spent two years in Japan and Korea. He ultimately retired with the rank of lieutenant commander. As a civilian in civil service, he was assigned to Saigon, Vietnam, for six months. He is survived by his wife, Dorothy; two sons, Byron Jr. '56 and Charles; a daughter, Mary; a brother, Hyde; and eight grandchildren and three great-grandchildren.

1932

John L. Cox, of Ridgecrest, California, on August 5, 2000; he was 90. After graduating from Caltech, he worked for the Los Angeles County flood-control district, then went to the Panama Canal Zone in 1938 as a design engineer for the Navy. In 1941 he came to Los Angeles to design dams and channels for the Corps of Engineers, and in 1945 went to work for the Naval Ordnance Test Station in Pasadena, doing facility-design work. In 1952 he transferred to China Lake, where he worked for 15 years in weapons development, in the areas of production and quality engineering. He was then designated associate head, Engineering Division, Public Works Department, where he remained until his retirement in 1977, after which he continued to work as a consulting civil engineer for another 10 years. He was known for his involvement in community affairs. He is survived by Dee Dee, his wife of 48 years; a son, John; two daughters, Margaret Cox and Barbara Miras; and a brother, Robert.

1935

Lyman G. Bonner, PhD, of Pasadena, California, on March 22; he was 89. After receiving his doctorate from Caltech, he went to Princeton as a National Research Council fellow. In 1937 he moved to Duke University, where he served first as an instructor and then as an assistant

professor. An expert in rocket-propellant design and development, interior ballistics, spectroscopy, and molecular structure, he was employed by Hercules Inc. from 1945 to 1955 as technical director of the Allegany Ballistics Laboratory, and from 1955 to 1965 as director of development in the company's explosives and chemical-propulsion department. In 1953 he was awarded the Navy's highest civilian honor, the Distinguished Public Service Award. In 1965, interested in moving away from industry and government, he undertook the new position of director of foundation relations at Caltech, where his brother James was a professor of biology. In 1967 he was appointed assistant to the president—then Lee DuBridge—for facilities planning, and he was also named an associate in chemistry, though he taught recitation sections of freshman and sophomore physics for many years. In late 1968 Bonner became director of student relations, just in time to preside over the admission of female undergraduates. He enjoyed dealing with the students and remained director of student relations until 1980, when his title was changed to administrator for student affairs, a post he held until 1984. Principally responsible for establishing the Student Health Center as it exists today, he was also registrar from 1977 to 1989, when he retired. He is survived by his wife, Jackie; a daughter, Lynn; two sons, Allen and Philip; and five grandchildren and four great-grandchildren.

1938

John C. Lilly, in Los Angeles, on September 30, 2001; he was 86. After graduating from Caltech, he attended Dartmouth Medical School and the University of Pennsylvania School of Medicine, receiving his MD in 1942. From 1942 to 1956 he served in the department of biophysics and medical physics (Eldridge Reeves Johnson Foundation), University of Pennsylvania School of Medicine, first as a fellow, then as an associate, and finally as an associate professor (of medical physics and of experimental neurology). In 1949 he undertook psychoanalytic training, and in 1953 he joined the U.S. Public Health Service Commissioned Officers Corps with the rank of senior surgeon, and served until 1958 as section chief for cortical integration in the National Institute of Neurological Diseases and Blindness and in the National Institute of Mental Health. In 1959 he founded the Communications Research Institute on St. Thomas in the Virgin Islands, and in Miami, Florida, serving as director until 1968, after which he did research at a variety of institutions. He authored several books, including *Man and Dolphin* and *Center of the Cyclone*, and from 1973 until his death served as treasurer of Human Software, Inc., in Malibu, California. He belonged to a number of professional organizations, including the IEEE, Sigma Xi, the New York Academy of Science, and the Order of the Dolphin, and he was a life member of the Caltech Alumni Association. His awards included the University of Pennsylvania School of Medicine's Clark Research Medal and the National Institute of Mental Health's Career Award.

Daniel Chapin Pease, MS, on May 11, 2001; he was 86. After graduating from Caltech he went on to receive a PhD in cell physiology from Princeton. In the early 1940s he worked at Stanford, Columbia, and Princeton, and in 1946 he joined USC's anatomy department. When UCLA was in the process of founding its medical school, Pease moved to its anatomy department, where he served for the remainder of his career, teaching anatomy and doing

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research. A pioneer in the field of histological techniques for the electron microscope, he chaired the department for many years. Predeceased by Phyllis, his wife of 49 years, he is survived by two daughters, Katherine and Karen, and by two grandsons and one great-grandson.

1939

Frederick C. Hoff, of Vacaville, California, on September 20, 2000; he was 82. After graduating from Caltech, he joined the civil service at the Savanna Ordnance Depot, in Savanna, Illinois, and during World War II he served as an officer in the Navy. Returning to civilian life, he worked in the petroleum refinery equipment business, then was recalled to active duty during the Korean War. After the war he received his MBA from Harvard Business School, and from 1955 until his retirement in 1982 he was chief engineer for Basic Vegetable Company, in Vacaville. He is survived by Eleanor (Hettie), his wife of 58 years; two sons, David and Douglas; a daughter, Laura; and one grandchild.

1941

John K. Arnold Jr., MS, of Tallahassee, Florida, on January 3, 2002. He served in the Air Weather Service for 13 years. The forerunner of the Hurricane Hunters, his group was the first to fly into the eyes of hurricanes for research purposes, in 1944, and also the first to name storms. During the Korean War the B-29 on which he was senior officer was shot down, and he was held as a POW in Beijing from 1953 to 1955; a colonel, he was the highest-ranking Air Force officer captured. He later served as vice president for student affairs at Florida State University and worked for the state of Florida in various capacities. In retirement since 1979, he was active in volunteer service. He is survived by a daughter, Sally Roberts.

John Graydon Partlow, of Moon Township, Pennsylvania, on August 24, 2001; he was 82. A member of the scholastic honorary society Tau Beta Pi, he was employed for 39 years by Westinghouse Electric Corporation as an electrical-design engineer. He loved to travel and to present travelogues, and over a 20-year period he presented about 500 one-hour slide shows at retirement and nursing homes, senior-citizen centers, and libraries. He is survived by Imogene, his wife of 55 years; a daughter, Marilyn Penberthy; a son, William; and two grandchildren and one great-grandson.

1942

Erwin R. Larson, of South Pasadena, California, on March 6, 2001; he was 79. Immediately after graduating from Caltech he volunteered for the Navy's Civil Engineer Corps as an ensign. Assigned to the 40th Naval Construction Battalion (Seabees), he engaged in the construction of airfields and other facilities in the South Pacific. There, he contracted a serious tropical disease that required him to spend several years in Navy hospitals and the Mayo Clinic; he never totally overcame the effects of this illness and was partially disabled for the remainder of his life. After the war, he and his wife, Liz, settled in South Pasadena, where he took over his father's construction business, which he ran until the mid-'60s. He subsequently returned to school to become a computer programmer, working in this field until he retired in 1986. After retiring, he spent the spring and summer months boating and fishing on the lakes of Wisconsin, where he and Liz had purchased a house near her hometown of Neenah. He is survived by Liz, his wife of 49 years; three sons, Thomas, Daniel, and John; and four grandchildren.

Peter Luke Nichols, of St. George, Utah, on July 2, 2001; he was 83. He served as a senior research engineer at JPL from 1950 to 1954, and then worked at Stanford Research Institute, Aerojet General, Johns Hopkins University, and Thiokol, developing propellants for rockets ranging from Titan missiles to Space Shuttle boosters. He is survived by his wife, Phyllis; his first wife, Elberta; two daughters, Janice Parsons and Ellin Powers; and three grandchildren and two great-grandchildren.

1943

Walter A. Schroeder, PhD, of San Gabriel, California, on November 17, 2001. A senior research associate in chemistry, emeritus, at Caltech, he began his career at the Institute in 1943 as a research fellow, being promoted to senior research fellow in 1946, research associate in 1956, and senior research associate in 1981, retiring to emeritus status in 1986. He is survived by his wife, Ruth, and by two daughters, Glenna Lein and Rhonda Schroeder.

William Edward Sweeney, MS, Eng '43, of Camarillo, California, on February 25, 2002; he was 88. He entered the U.S. Naval Academy at the age of 16, and his Navy career extended from 1930 to 1967. While his career included duty on the USS *Idaho* and the USS *Arizona*, his real love was aviation, and he undertook flight training at Naval Air Station Pensacola. Besides his Caltech degrees, he earned master's degrees from George Washington University and Harvard Business School. He was stationed in many locations, including Washington, D.C., where he was involved in aircraft design at the Bureau of Aeronautics; Point Mugu, where he served as deputy commander of the Pacific Missile Test Range; at Naval Air Station Norfolk during the Cuban missile crisis; and in Paris, France, where he commanded NATO defense forces. His final duty was as program manager for the F-111 fighter-bomber, at Wright-Patterson Air Force Base, in Ohio. He left the Navy with the rank of admiral, retiring to Camarillo. A traveler and a golfer, he was a member of the Las Posas Country Club, and in 1995 he cofounded the Sweeney Youth Homes, a nonprofit organization that serves emotionally disturbed teenagers in residential treatment. Predeceased by his first wife, Dorothy, and his sisters, Bettie Adams and Ilda Deming, he is survived by Jeanne Maulhardt-Sweeney, his wife of 12 years; a son, Bill; a daughter, Sharon; and 14 grandchildren.

1944

Leonard S. Abrams, of Woodland Hills, California, on December 28, 2001; he was 77. He is survived by his wife, Diana; a daughter, Bernice Barnett; and a son, Howard.

1949

Satish Dhawan, Eng, PhD 51, of Bangalore, India, on January 3, 2002; he was 81. A founder of the Indian space program who held a remarkable combination of academic degrees—in mathematics and physics, in English literature, and in mechanical and aeronautical engineering—he also made multi-dimensional contributions to scientific education, to research, and to policy formulation and implementation. As chairman of the Space Commission and the Indian Space Research Organisation, he directed the Indian space program through a period marked by major satellite and launch-vehicle projects and pioneering experiments in remote sensing and satellite communications, all on a “shoe-string” budget. “With his death the country lost one of its most distinguished sons.” He is survived by his wife and three children.

RICHARD MCKELVEY 1944–2002

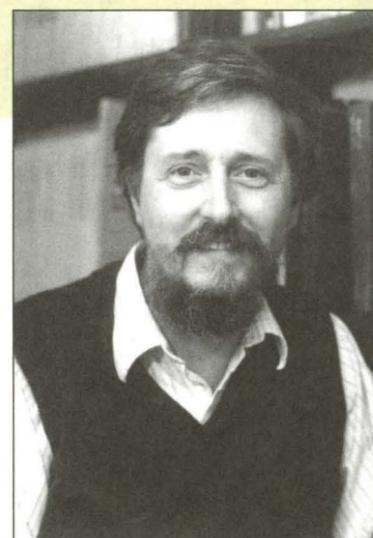
Caltech political scientist Richard McKelvey died at his home in Altadena, California, on April 22, of cancer. He was 57. The Edie and Lew Wasserman Professor of Political Science, McKelvey was best known for his leading role in the development of mathematical theories of voting. The first Caltech social scientist to be elected to the National Academy of Sciences (NAS), McKelvey was also director of the Institute's William D. Hacker Social Science Experimental Laboratory.

McKelvey made fundamental contributions to game theory, social-choice theory, experimental political science, and computational economics. Besides contributing research articles to the leading academic journals, he served on the editorial boards of many journals over the course of his career.

In one well-known paper, McKelvey showed that decisions made under the one-person/one-vote, majority-rule system of legitimate democracies do not necessarily cluster around “middle-ground” policy outcomes, as had generally been assumed. Rather, such decisions are very sensitive to such details of process as agenda control. As a consequence, nearly any outcome, even very unpopular ones, can result from manipulations.

In addition to his election to the NAS in 1993, McKelvey was elected to the American Academy of Arts and Sciences in 1992. He spent a year at Caltech as a Sherman Fairchild Distinguished Scholar before joining the Institute's faculty in 1979. He was named the Wasserman Professor in 1998.

McKelvey was a pioneer in the use of laboratory experiments to test theories of voting and other group behavior, and in the application of computational techniques to understanding strategic behavior. Some of his experimental



work, done in collaboration with Caltech colleagues, investigated the effects of different voting rules on the accuracy of jury verdicts, the effect of polls on election outcomes, and impasses in negotiations and bargaining.

In the last few years, he was developing a general statistical theory of games, called quantal response equilibrium. He was designing experiments to test its predictions about behavior, and had published widely on this topic. His work on computation in game theory began with his celebrated computer program Gambit, which finds numerical approximations of solutions to games.

The Caltech professor is remembered by his colleagues and students not only as an innovative and creative scholar but also as a fine educator and devoted teacher. He was highly sought after as a PhD advisor, and spent countless hours working with his students, many of whom now hold professorships at leading universities, where they carry on his approach to social scientific inquiry.

McKelvey received his bachelor's degree in mathematics from Oberlin College and earned his MA in the same field from Washington University in St. Louis, before going on to receive both a 1970 MA and 1972 PhD in political science from the University of Rochester.

He is survived by his wife, Stephenie Frederick, and three children, Kirk, Christopher, and Holly.



Move over Puff, it's Smaug the Ditch-Day Dragon. Handcrafted by students especially for the occasion, the fantastical resident of Middle Earth, looking for all the world like a gigantic Beanie Baby, appeared on campus May 22 for the Institute's annual day of brain-teasing pranks. As always, Caltech seniors bolted the campus, leaving undergraduates to solve the “stacks” they had left behind. Movie themes and plots were prominently represented this year, with students working their way through stacks based on Star Wars, Ocean's Eleven, Full Metal Jacket, and The Gauntlet. And not one but two Tolkien sagas came into play: The Hobbit and Lord of the Rings. For a sampler of Ditch Day activities, check out the back-page poster.

