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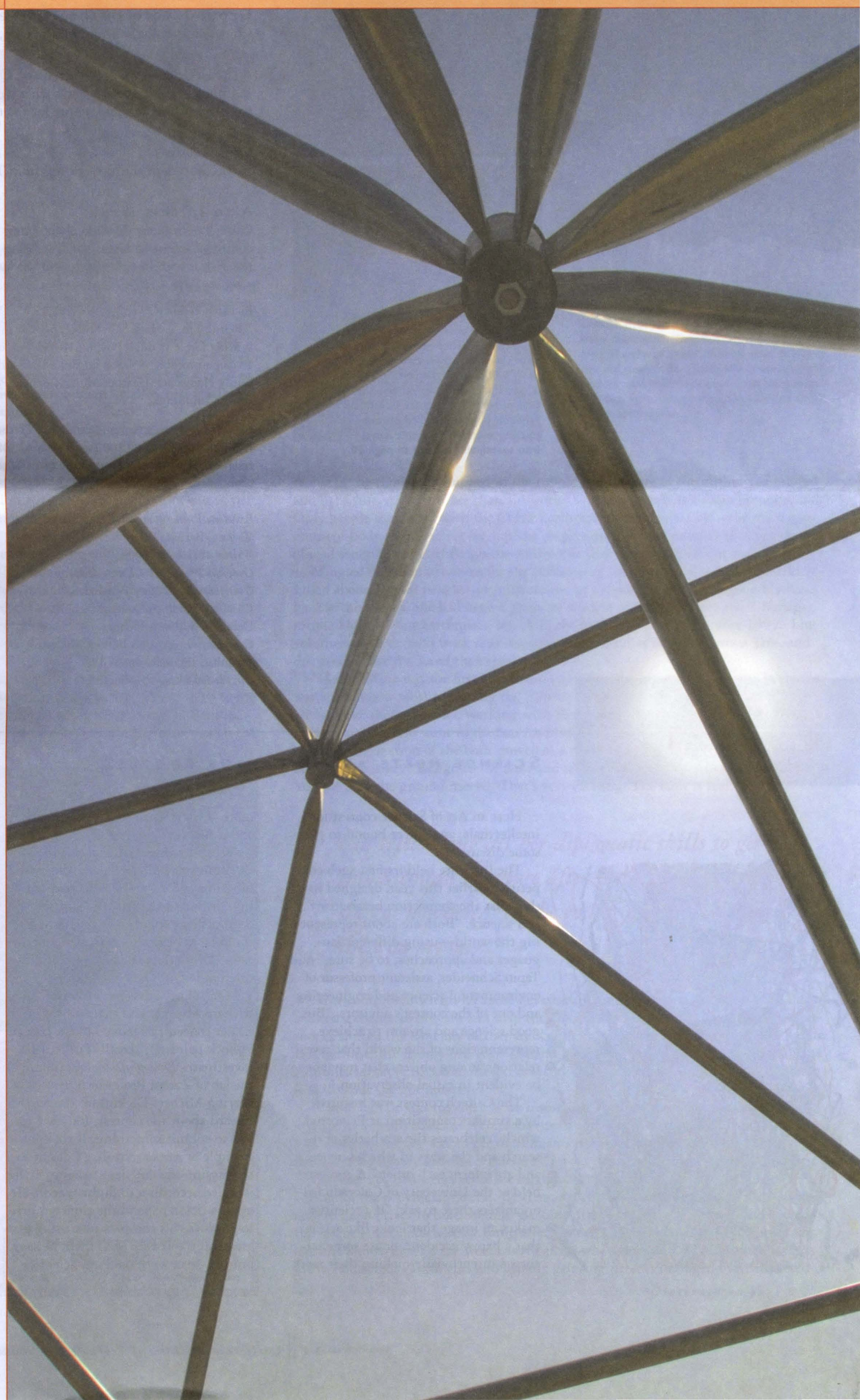

In This Issue

California Institute
of Technology

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ON THE COVER
Let the sun shine in. Soaring above the Holliston parking structure, this starlike lattice awaits its date with the solar panels that once in place will provide the Institute with a renewable energy resource—the first of several such solar facilities scheduled to be installed on campus. For more on Caltech's forays into sustainability, turn to page 10.

Picture Credits: Cover,2,4,5,6,7,11,12,13,15-Bob Paz; 2-Sawyer Buckminster Fuller; 3,8-Jing Liu; 4-Herb Shoebridge; 6-BCA Films, Tom Ellis; 7-Julia Cody; 9-Formosat; 9-Ming Lu; 9,13-Moh Huang; 10-Ben Sexson, Alejandra Antonnuci; 11-George Cadena; 13-Superprotonic; 13-Bob Logan; 14-Liz Allen; 15-Hillary Bhaskaran; Back Page Poster-Emily Hamecher, Heather Murrey, Ashley Potts. Poster design by Hillary Bhaskaran and Doug Cummings.

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Up Front

SCIENCE MEETS ART IN CAMPUS CONTEST

Host an Art of Science contest for intellectuals, and you're bound to get some discussion.

The Institute held its first such competition earlier this year, designed to showcase the connection between art and science. "Both are about representing the world—using different languages and approaches, to be sure," said Tapio Schneider, assistant professor of environmental science and engineering and one of the contest's advisors. "But good science and art aim to achieve representations of the world that reveal relations among objects that may not be evident in casual observation."

The Caltech contest was inspired by a similar competition at Princeton, which "celebrates the aesthetics of research and the ways in which science and art inform each other." A contest held at the University of Colorado led organizers there to ask, "If a scientist makes an image that looks like art, is that a happy accident, or are some scientists intentionally making their work more 'artistic' than strictly necessary, and if so, why?"

When graduate student Sawyer Buckminster Fuller prepared the winning image for the Caltech competition, he found that the trajectories of fruit flies exploring a wind tunnel could be as beautiful as they are intricate. "Drosophila the Dripper" is pictured at left.

"One of my advisors, Professor Richard Murray, said that some of my earlier trajectories looked like a Jackson Pollock painting," recalls Fuller, who investigates *Drosophila* locomotion in the lab of Zarem Professor of Bioengineering Michael Dickinson. "So when I heard about the contest, I knew I had to submit something. It took me a couple of weeks to realize I ought to try varying the dot size so that each dot is scaled according to flight speed." He usually doesn't spend the time required to produce this complex plot using programming software MATLAB, he says, but the extra work paid off. Scientifically speaking, "it's a pretty useful tool for showing the flight velocities." And artistically speaking, "that touch is really what elevated it to being something you want to look at."

Dickinson's team uses wind tunnels and other tools to determine how the tiny brains of fruit flies can rapidly respond to the aerodynamic forces acting on their pint-sized bodies. Such knowledge helps the team model these *Drosophila* processes and build creations like Dickinson's signature "Robofly."

Fuller credits Dickinson Lab colleague Andrew Shaw for the flight-tracking apparatus used in his research and Pollock-esque knockoff, because, after all, art is not created in a vacuum, at least not wind-tunnel art. "This machine is Andrew's baby," says Fuller.

The contest itself was made possible by a grant from the Moore-Hufstedler Fund for Student Life—endowed by Gordon and Betty Moore and the

Continued on page 6 . . .

GROUND ZERO in the Middle Kingdom

By Michael Rogers

Earthquake geologist Jing Liu (at left) and several of her students spent one month in Sichuan Province tracking the entire rupture from the devastating Wenchuan quake. She took the photo above showing what is left of the old town of Beichuan, where seismic-wave shaking and landslides caused severe damage. The two maps below show the affected areas of the earthquake.

On May 12, earthquake geologist Jing Liu, PhD '03, was in an afternoon meeting at the Beijing headquarters of the Institute of Tibetan Plateau Research when the 7.9-magnitude Wenchuan earthquake in Sichuan Province shook much of China. Nearly 1,000 miles away from the epicenter, Liu felt nothing, although some of her colleagues on higher floors of the building felt a gentle swaying.

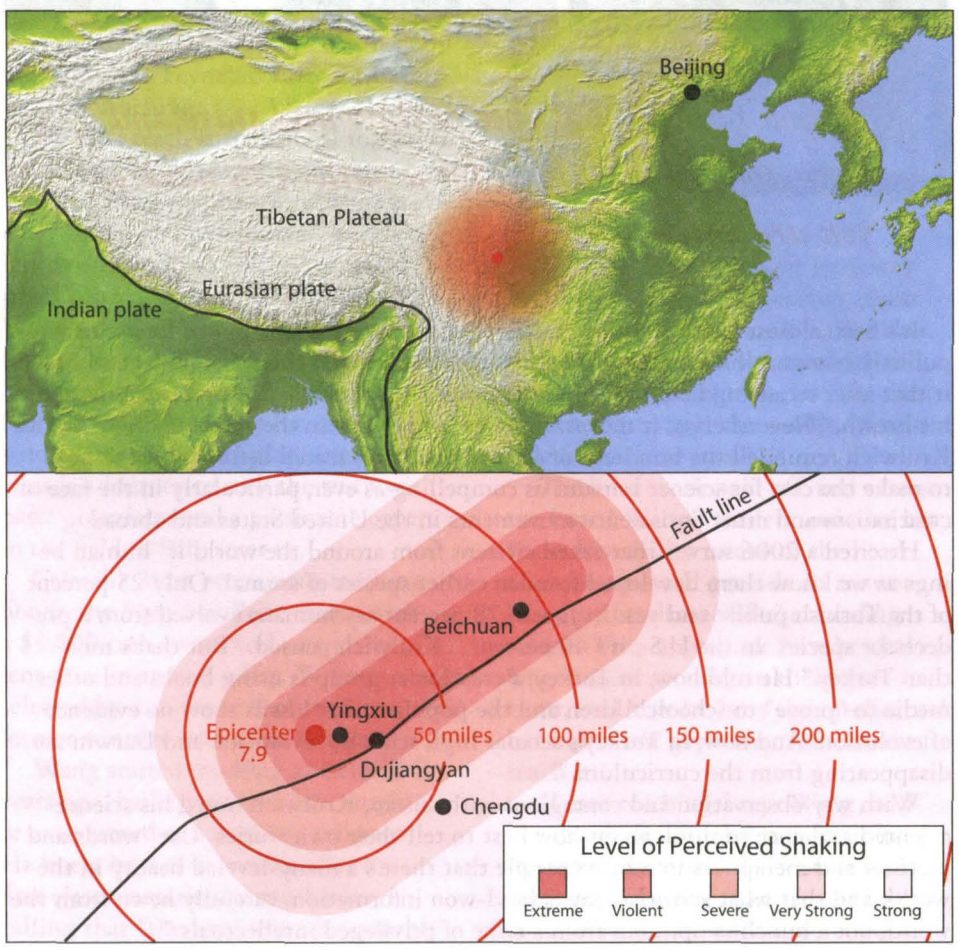
At first, Liu says, no one at the institute, where she is a professor, knew whether they had just experienced a mild local quake or a major temblor far away. She had a sense that it was the latter, but it wasn't until the late evening, when news started to filter in and she was able to check the U.S. Geological Survey website, that she began to appreciate the enormity of what had happened.

The Wenchuan quake—China's worst natural disaster in 30 years—took place on the eastern fringe of the Tibetan plateau, and along the Longmen Shan range (Longmen in Chinese means Dragon's Gate, and Shan means mountain), a highly active earthquake region that is the focus of most of Liu's research. Although Liu had no friends or family in the area, the news and images that eventually came out of the densely populated mountain region were so upsetting that she could no longer concentrate on her work.

She began e-mailing some of her colleagues around the world, asking them to share what they knew about the earthquake. She was troubled to learn that the Chinese army—which the Beijing government had mobilized to lead rescue efforts—was focusing most of its attention on the area directly around the epicenter (where the earthquake had originated 12 miles below the ground) instead of on cities like Beichuan, more than 60 miles away, where catastrophic damage had occurred.

"The epicenter wasn't the hardest-hit area," Liu says. "The place where the fault breaks the surface is where there is the most damage." As more images appeared on television and over the Internet in the days after the quake, she felt she had to go to the region to analyze the fault, but administrative officials advised her to stay in Beijing.

It would be difficult getting in, they said, because the immediate focus was on the rescue of the thousands trapped in the rubble and the care of the millions of injured and homeless. Anyone other than aid workers might be seen as a drain on resources. Only people associated with the China Earthquake Administration—the main government body that oversees earthquake preparedness—were permitted to get the official sanction to get through the roadblocks that now sealed off the area.



Mingled with Liu's concern for the suffering of the victims of the quake—which killed about 70,000 people—was her desire, as a trained scientist, to get a firsthand look at the region. She had been a graduate student at Caltech when the 7.1-magnitude Hector Mine earthquake struck in the Mojave Desert in October 1999. Liu volunteered to do field work near the epicenter, 32 miles north of Joshua Tree, and discovered that she loved the experience.

"Hector Mine was the first time I had experienced a big earthquake and everyone wanted to know what was going on," Liu says. "I went to do field mapping." With Doug Yule, then a postdoc working with Kerry Sieh, currently the Sharp Professor of Geology, she also went to the San Andreas fault near the Salton Sea, and checked whether this section of the fault moved as a result of being triggered by the Hector Mine earthquake. "You go to the fault and see the crack exactly where it should be. You see how the ground moved. That's very exciting. The fault is real."

Liu tried using all her diplomatic skills to get into Sichuan Province after the earthquake, but she got nowhere. "In the end, " she says, "I went there on my own."

Now confronted with a far more devastating temblor in her native country, Liu wanted a chance to observe and map the fault of the quake, and to do it before aftershocks shifted the land any farther and before any roadwork or rebuilding had begun. But her institute is only five years old and lacks the clout of the Chinese Earthquake Administration (CEA). She tried contacting colleagues there, using all her diplomatic skills, but she got nowhere.

"I said, let's do this together. If we investigate the rupture, we can do something to prepare for big aftershocks." While she doesn't believe in earthquake prediction, she was searching for any way to get to Sichuan Province. But her pleas didn't work. "In the end, they left without me," she says. "I went there on my own, with my students."

On May 26, two weeks after the earthquake, Liu and five students went to Chengdu, the provincial capital. By then, many roads had reopened, and they were able to get a driver to take them to the outskirts of Dujiangyan, which had become the rescue effort's official base camp after the earthquake. Dujiangyan had instantly become known around the world as the place where a middle school had collapsed, killing hundreds of students and leaving grieving parents outraged over suspected

Continued on page 8 . . .

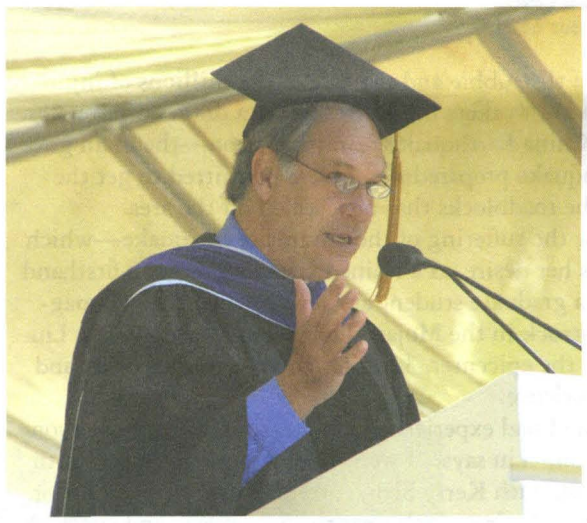
Once upon a time . . .

Graduates Were Asked to Tell Their Tales

Not long ago, on a campus not so far away, a familiar tale unfolded.

Just before 10 a.m. on Friday, June 13, families and friends of Caltech's graduating class of 2008 were handed programs announcing Caltech's "One Hundred Fourteenth Annual Commencement." They found seats on a sun-drenched Beckman Mall and prepared to stand and snap photos as a procession that included 522 students marched down the aisles and took seats just in front of the flower-banked stage. As tradition would have it, the students would listen to one last lecture before receiving their long-awaited diplomas.

Luckily that final talk was a good one. The commencement speaker was Robert Krulwich, a correspondent for National Public Radio and ABC who has explained science, technology, and far more esoteric topics like economics to the masses for more than 30 years. But this crowd did not necessarily qualify as "the masses." And the ebullient speaker began his talk by admitting he would be more likely to interview someone from Caltech than to lecture him or her.



Commencement speaker Robert Krulwich pulled metaphorical dinosaur bones out of a very real mortarboard to entertain and educate a high-tech crowd at Caltech's 114th graduation ceremony.

"So when I got my invitation asking me to give you a lecture," Krulwich told the crowd, "I thought, 'Come on. What could I tell you?' But I thought of something." And as tradition would have it, he proceeded to impart a bit of worldly advice to the soon-to-be graduates.

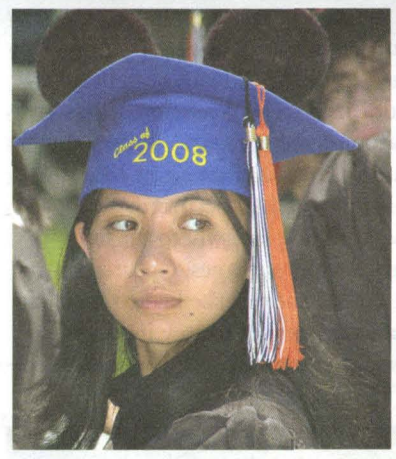
First he set the scene. "In the next hour or two, an uncle, a buddy—somebody—may turn to you and say, 'So, what were you doing at Caltech?' You might have to use certain words like 'protein' or 'quark' or 'differential' or 'hypotenuse.' So when asked, 'What were you working on?', should you think, 'There's no way I can talk about my science with this guy because I don't have the talent, or the words, or the patience to do it? It's too hard, and anyway, what's the point?'"

The point is that Caltech graduates and their peers must tell science stories to "regular folks," said Krulwich, because science stories "have to compete with other stories about how the universe works and how it came to be. And some of these stories—Bible stories, movie epics, myths—can be very compelling," he added. "But to protect science and scientists—and this is not a gentle competition—you've got to get in there and tell your version of how things are and why things came to be."

Krulwich shared this advice with 208 bachelor of science candidates (53 percent of them graduating with honors) made up of 145 men and 63 women; 128 masters of science (92 men and 36 women); one Engineer; and 185 newly minted doctors of philosophy (132 men and 53 women). Talk about science, he urged his highly specialized audience, but "don't do what Newton did." He then recounted how, when Isaac Newton was asked why he had made *Principia Mathematica*—"his earthshaking book about gravity and the laws of motion—so impossibly hard to read," Newton said he had considered writing a popular version that people could understand. "But—and I am quoting Newton here—'to avoid being baited by little smatterers in mathematics,' Newton intentionally wrote the book in dense, scholarly Latin with lots of math so that only scholars could follow it."

By way of contrast, Krulwich pointed to the example of Galileo, whom he hailed as "the great un-Newton." The protean scientist who discovered the rings of Saturn and the craters on the moon and was perhaps the first to publicly opine that the universe "is written in the language of mathematics" himself wrote so accessibly and provocatively—in Italian, not Latin—about the sun-centered solar system that he managed to get arrested and hauled before the Inquisition on charges of heresy.

"It wasn't just his science that was alarming," Krulwich suggested. "I think it was the power of his storytelling that made him extra dangerous. Stories have this power."



"If you have the patience to stare and stare and stare and stare, looking for a pattern in nature, you are welcome here."

It's been almost 400 years since Galileo, under threat of death, was forced to publicly renounce his view that the earth revolved around the sun, and legend has it that after recanting before a Church tribunal, he sat down still protesting under his breath, "Nevertheless, it moves." We no longer live in the age of Galileo, but as Krulwich reminded the hundreds of science graduates seated before him, the need to make the case for science remains as compelling as ever, particularly in the face of creationism and other antiscience movements in the United States and abroad.

He cited a 2006 survey that asked citizens from around the world if "human beings as we know them developed from an earlier species of animal. Only 25 percent of the Turkish public said yes. In Japan, 78 percent say humans evolved from a predecessor species. In the U.S., it's 40 percent." Krulwich paused. "But that's more than Turkey." He told how, in Turkey, a creationist group is using books and other media to "prove" to schoolchildren and the populace that fossils show no evidence of evolution. And now, in Turkey's secular high schools, "evolution and Darwin are disappearing from the curriculum."

With wry observation and contagious enthusiasm, Krulwich urged his science-oriented audience to think about how best to tell their own stories. Use "words and pictures and metaphors to remind people that there's a many-leveled beauty in the world, and that what scientists say is hard-won information, carefully hewn from the world, not a bunch of opinions from a tribe of privileged intellectuals."

In their welcoming remarks at commencement, both Caltech president Jean-Lou Chameau and trustee chairman Kent Kresa invoked the 1958 launch of Explorer—whose 50th anniversary was commemorated on campus last fall with a conference celebrating America's five decades of space exploration—and the successful arrival on Mars earlier this year of JPL's Phoenix lander. As Chameau launched the class of 2008 on its own new journey, he also invoked the Institute's legendary Richard Feynman, who once mused, "We are at the very beginning of time for the human race. It is not unreasonable that we grapple with problems. But there are tens of thousands of years in the future. Our responsibility is to do what we can, learn what we can, improve the solutions, and pass them on."

Take the time and make the effort, said Krulwich, and science stories will be heard and "very often, will win." And so will the values of a place like Caltech, with its "deep respect for open-mindedness, for going wherever the data leads no matter how uncomfortable," for welcoming everyone, regardless of background, who has "the patience to stare and stare and stare and stare, looking for a pattern in nature."

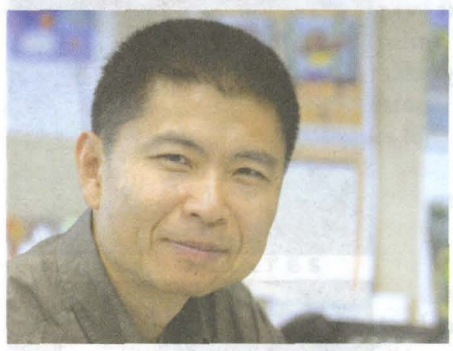
"There's a freedom in this way of looking that's precious in the world," said Krulwich. "And that freedom can be attacked or defended with stories.

"Which is why," he concluded, "when your brother, your aunt, your mom asks you, 'So, what have you been up to while you've been here?' take a chance. Find the words, find the metaphor, share the beauty, and tell them what's on your mind. Tell them a story."

To download Krulwich's entire speech and additional commencement footage, see pr.caltech.edu/commencement.

The Beavers took a bite out of the Big Apple this spring, when the Caltech–Occidental Concert Band played for the first time at renowned Carnegie Hall. A great time was had by all, says Caltech director of bands Bill Bing (standing third from right, third row), who accompanied more than 60 band members to New York City, including Associate Professor of Geology and Geochemistry Paul Asimow (standing far right, third row), vocal soloist (and trombonist) Kjerstin Williams '00, PhD '06—appropriately garbed in blue for singing Gershwin—and band president, physics major, and clarinetist Lauren Porter '08 (second woman kneeling from the right), who was—ahem—instrumental in helping to organize the trip. Inside the hall, the Techers, who shared the evening's program with two other universities, performed five pieces that Bing had handpicked both to suit the concert venue and to showcase the versatility and talents of his student, staff, and faculty performers. The Techers opened with "Chorale and Alleluia," chosen, said Bing, to suit the famous acoustics of the hall, and also performed "Prairie Hymn," selected for its "meditative quality," and "Be Glad Then, America," chosen and conducted by Asimow. Soloist Williams sang "S'Wonderful" and "Someone to Watch over Me," by George and Ira Gershwin, and the concert closed with a rousing rendition of "The Throop Institute March." The enthusiastic audience included many of the performers' family members, who traveled to New York especially for the occasion. While Carnegie's rules did not allow the program to be recorded, downloadable band selections and CDs for purchase may be found online at http://bands.caltech.edu/cds.php, and a CBS *Evening News* report highlighting Caltech's first-ever Carnegie concert can be viewed at http://www.youtube.com/watch?v=QuBw9cmzPLE.

Zhen-Gang Wang Receives Feynman Prize for Excellence in Teaching



Zhen-Gang Wang favors the tried-and-true chalkboard for his classroom lectures on thermodynamics and polymer physics. The clarity of these lessons and the admiration of his students have won the Caltech professor of engineering this year's Feynman Prize for Excellence in Teaching.

"What I teach is traditional topics, so I use traditional means," says Wang, adding that he was very pleasantly surprised by the news. "Excellent board work" is just one of many praises listed in student evaluations of Wang's classes. "He engaged me as no lecturer ever had before," says Andrew Downard, who came to Caltech from Notre Dame University for graduate studies in chemical engineering. "The class is a journey to seek the truth with basic postulates and a passionate expert in the field to help steer us."

Caltech's most prestigious teaching honor, the Feynman Prize comes with a $3,500 cash award and an equivalent raise in annual salary. Winners are selected by a committee of students, former winners, and other faculty.

Wang started teaching at Caltech 17 years ago, having never before taught or even served as a teaching assistant. He knew he was in trouble after his first class, in statistical mechanics, recalling that "the level was unreasonably high—the scores on exams were very low. I learned over the years to adjust the level of the presentation. You have to really understand the material well, from several different angles, and then find the best angle that would be suitable for the students."

The hard work paid off, and across the board Wang's students admire his "uncanny ability to cut to the heart of a question and provide an answer based on fundamentals," according to one. They appreciate how he challenges them to sharpen their questions, and how he "sets the intellectual bar high" but gives them the means to reach it.

"I love teaching," says Wang, adding that he finds nobility in training the next generation of scientists and engineers. "I enjoy research and I am devoted to it, but it feels more like a hobby. But my research is theoretical; it doesn't have an immediate impact on society. Through teaching, I feel like I'm having a more direct impact."

"Zhen-Gang is already becoming one of the legends of Caltech," says professor of chemical engineering Julie Kornfield '83, one of several who nominated the professor for the prize. "He profoundly affects our students and transforms the way they think. To me he represents the essence of what Caltech is all about."

The Feynman Prize is named after legendary Caltech physics professor Richard Feynman, who wrote, "I don't believe I can do without teaching," in his book *Surely You're Joking, Mr. Feynman!* The prize is endowed through the generosity of Ione and Robert E. Paradise, with additional contributions from Mr. and Mrs. William H. Hurt, to annually honor a professor who demonstrates unusual ability, creativity, and innovation in undergraduate and graduate classroom or laboratory teaching.

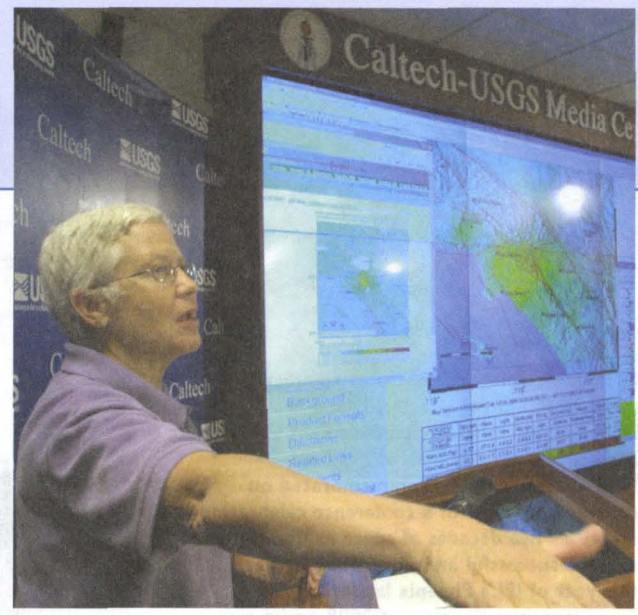
Andrew Lange named to head PMA

Astrophysicist Andrew Lange became the chair of Caltech's Division of Physics, Mathematics and Astronomy on September 1, succeeding Tom Tombrello, who has stepped down after 10 years in the position. Lange, who holds Caltech's Marvin L. Goldberger Chair in Physics and also serves as a senior research scientist at JPL, joined the Institute's faculty in 1994. He is internationally known for his work in observational cosmology, particularly for carrying out exceptionally precise balloon-based measurements of the microwave background radiation emanating from the Big Bang, the event that gave birth to the universe.

A native of Illinois, Lange received his BA in 1980 from Princeton and his PhD in 1987 from UC Berkeley, where he served on the faculty as assistant, then associate professor of physics for seven years before coming to Caltech. His research focuses on the very early history of the universe, with an emphasis on how conditions in the immediate aftermath of the Big Bang have molded the evolution of the cosmos, including the formation of the first stars and galaxies, and ultimately shaped the structure and dynamics of the universe in which we live today.

Elected to the National Academy of Sciences in 2004, Lange is also a member of the American Academy of Arts and Sciences and a Fellow of the American Physical Society. In addition to many other honors, he received the Balzan Prize in Observational Astronomy and Astrophysics in 2006 and was named California Scientist of the Year in 2003 (an honor he shared with Lawrence Berkeley physicist Saul Perlmutter).

Lange currently heads a research team that is working to create a new class of state-of-the-art detectors, with the aim of gaining new insights into the origins and composition of the cosmos. The six-year project, "Peering into the Heart of Darkness: Revolutionizing Detectors for Cosmology," is supported by a $12 million grant from the Gordon and Betty Moore Foundation and should make it possible to carry out fundamentally new observations of the microwave background, the birth of the most distant stars and clusters of galaxies, the mysterious dark matter that permeates the universe, and the planets that orbit nearby stars. The detectors are based on superconducting technology developed in a close collaboration between Caltech and JPL.



Just before noon on July 29, Caltech, along with much of Southern California, was jolted by an oddly familiar, if lately dormant, feeling. Almost immediately the TV trucks began pulling up outside the campus's seismo lab, and soon after that, the Southland was greeted by the reassuring sight of seismologist Kate Hutton (above right) on television. "I think people may have forgotten what an earthquake felt like," said Hutton of the 5.4 Chino Hills temblor, the region's largest quake in 10 years. Both she and Professor of Engineering Seismology Tom Heaton, PhD '78 (caught on the camera monitor, left), told reporters that they hoped the shaker would serve as a wake-up call, reminding residents and public officials that they need to be prepared for the Big One that is sure to strike Southern California one of these days.

Caltech's Richard Ellis finds himself between a Stone and an MBE

Caltech astronomer Richard Ellis and his wife, Barbara, a writer with *Caltech News*, were on their way to an appointment in London in early July when they were pulled over for a random terrorist check. The couple spent the next half hour standing in the rain while their car was searched and Ellis, Caltech's Steele Family Professor of Astronomy, was grilled about his ethnic background and what he was doing in the city. Eventually, the Welsh-born scientist and his spouse were sent on their way, and they arrived at their destination in time for Prince Charles to preside, as scheduled, over Ellis's investiture (top photo, right) as a Commander of the British Empire (CBE)—one of the United Kingdom's highest civilian honors.

Ellis, who is internationally known for his work in galaxy evolution and observational cosmology, received the CBE "for service to science." For those not entirely conversant with the graduated intricacies of Britain's civil honors system, the accolade ranks Ellis slightly above the Beatles (who received the MBE—Member of the British Empire—in 1965), on par with perennial rocker Rod Stewart, and slightly below such dignitaries as Sir Mick (Jagger) and Sir Salman (Rushdie). *Caltech News* will not quite be listing "Lady Ellis" on its masthead.

Caltech News has it on deep background that the prince and the professor spoke about dark matters—intergalactic dark matter, that is, which has been a primary focus of Ellis's recent research. In all, 116 men and women were honored at the ceremony, which Barbara described as "a splendidly organized event, with beefeaters, Life Guards, Gurkhas, ushers, equerries, and cavalry officers all dressed in the most delightful costumes." She adds that "the whole thing somehow reminded me of the staff service awards at Caltech, though we were not allowed to cheer or swing rattles." Afterward, outside Buckingham Palace (bottom photo), Richard displayed his CBE medal and Barbara her hat.

Art of Science . . . from page 2

John D. and Catherine T. MacArthur Foundation—which has funded dozens of proposals submitted by members of the Caltech community since 2003.

How do such projects improve student life? Contest participant Emily Hamecher offers a clue when she marvels at the remarkable colors found in nature, like those that appeared when she photographed the thin slice of rock seen on this issue's back-page poster. "The aesthetic pleasure that I receive from the natural world is one of the main reasons that I chose to study geology," she says. Hers is one of 32 entries that can be seen on the Web at artofscience.caltech.edu.

Additional images by second-place winner Heather Murrey and undergraduate Ashley Potts appear online and as overlays on the back-page poster (see page 19 for explanations of the art). Potts appreciates the contest's role in showing people "the beauty underlying all science." She notes that when curious scientists succeed in their quest for unique solutions to unique questions, "the data produced is extremely beautiful, and sometimes it's possible to express that beauty in a format that a wider audience can appreciate."

And Fuller tells his story. After being "much more into the arts in high school," and then combining a visual-arts concentration with mechanical-engineering studies at MIT, he found that he missed art as a bioengineering graduate student at Caltech. "So I'm really glad the organizers put this together to get me and others to think more artistically," he says. "There's a perception at Caltech that art is a waste of time, a self-absorbed and unproductive pursuit, so it's really nice when somebody puts on a show to get you motivated to produce something."

On that note, *Caltech News* invites readers to keep the images coming and the conversation going by submitting artful research results and thoughts about the link between art and science to hja@caltech.edu.

Recognition

For an up-to-date list of awards and honors bestowed recently upon Caltech faculty and staff, go to http://today.caltech.edu/today/on-campus.tcl and scroll down to Honors and Awards in the right-hand column, as well as to the Archives link in that section.

Mind over money? New Kirby Professor Colin Camerer studies how the brain manages and mismanages economic decision making.

Neuroeconomist Colin Camerer named first Kirby Professor of Behavioral Economics

Renowned American investment manager Robert Kirby never planned to retire from Capital Group Companies, stop lecturing at Stanford, or permanently park the black Porsche 914 he raced at Buttonwillow Raceway on Sundays. Even after the octogenarian died in 2005, his three passions kept going strong. His Porsche won a national championship in 2006. And he continues to shape economic theory and to drive education: a close friend has memorialized him by endowing Kirby professorships in economics at several premier universities. Endowed professorships are the highest honor that universities bestow on faculty. At Caltech, the Kirby Professorship will support the work of top scholars in behavioral economics and finance.

Colin Camerer is the inaugural Robert Kirby Professor of Behavioral Economics. Camerer, who had earned an MBA and PhD from the University of Chicago by age 22, came to Caltech after working at the Kellogg, Wharton, and University of Chicago business schools. Like Kirby, he spends his free weekends at racetracks, although he's watching horse races with his two-year-old son.

A founding scholar of neuroeconomics, Camerer applies biological research tools like fMRI imaging of brain activity, computerized eye-tracking, skin-conductance tests, and heart-rate monitoring to long-standing economic questions. He's known worldwide for pivotal research on speculative price bubbles and for demonstrating the surprisingly powerful influence of trust on economic decision making among strangers.

Camerer plans to spend his first year as Kirby Professor determining how experts' and novices' brains respond differently to economic tasks.

He and graduate student Alice Lin are scanning the brains of 15 poker experts and 15 novices as they play a simple card game. Though the game is harder for novices, preliminary results show more widespread and intense activity in the experts' brains. Camerer likes working with the poker experts because of their experience in valuing abstract objects. "They're pre-trained, hyperexpert subjects," he says. The research could yield insights into financial expertise by revealing how the development of valuation skills affects brain function.

Camerer is also teaming up this year with New York University cognitive psychologist Elizabeth Phelps to investigate loss aversion and emotional regulation. Most people have felt the dread involved in loss aversion and the heady confidence that accompanies good luck. In Camerer and Phelps' experiment, subjects participate in 14 sets of 10 bets. Subjects artificially down-regulate their fear of loss during every other set, betting as if it's not their own money. When they regulate, their palms sweat less, their heart rates drop, activity in their amygdalae changes, and they take more risks. This research may help explain why even the most experienced investors can get carried away by booms and busts. They may mistake biological impulses for intellectual choices as positive emotions stimulate them to take unwise risks during a speculative bubble, or a visceral aversion to loss pushes them to sell when the market crashes.

While Kirby, who investigated Black Monday in 1987 as a member of Reagan's Brady Commission, could not fully explain why veteran investors self-inflicted a crash, Camerer's research illuminates such crashes. Economists using tools and methods Kirby could only dream of will crack conundrums he faced, thanks to this professorship. And they'll do so in perpetuity: only interest on the gift's principal is spent to fund the chair.

Says Caltech president Jean-Lou Chameau, "It's hard to overstate the impact of this selfless gift; it will support one great scholar after another. By endowing the Robert Kirby Professorship, the benefactors, who have asked to remain anonymous, are establishing a permanent legacy at Caltech in recognition of their good friend and his commitment to teaching and scholarship at the highest levels."

A single professorship can help Caltech transform a field. The freedom to focus on research and teaching that the gift provides helps Caltech attract and retain scholars like Camerer, who, in turn, attract and guide brilliant students whose careers will shape the economy and academy of the future. In weekly sessions with his graduate students, Camerer listens intently, helping each scholar refine research ideas into groundbreaking science. "This work is ambitious," he notes after a postdoc outlines a proposal for complex eye-tracking research. "Another word for that is *quagmire.* Simplify what you're doing here, scale it back to one fundamental question that can only be answered with your methods." He offers other students insights into the peculiarities of publishers and directs them to important studies related to their work. To a student who's secured a teaching post at Texas A&M and just received word of the scheduled publication of his third paper, Camerer says, with clear pleasure, "This is good. You have a good start."

Ann Wendland

Caltech alum Blum to head Associates

Fred Blum, PhD '68, has been named president of the Caltech Associates for the academic year 2008–09. Blum, whose term begins October 1, will oversee initiatives to increase support for Caltech and expand the membership of the Associates.

Blum, who earned his PhD in physics, brings an extensive background in science and technology as well as strong Institute connections to his new position. A retired semiconductor electronics industry entrepreneur, he was the CEO of Nitres Inc. and a vice president of Rockwell International. Currently he chairs Trilience Research, a nonprofit corporation that works with Caltech scientists to connect neuroscience and brain research to behavioral science and economics. Trilience is sponsoring a research conference at Caltech in November 2008 called "Biological Origins of Human Group Behavior."

A life member of the Caltech Alumni Association and the Associates, Blum and his wife, Diane, joined the Associates in 2002 as President's Circle members. In 2004, Blum joined the Associates board of directors, and he has since served as its vice president and as chair of the program committee.

Associates Activities

September 16, *West Los Angeles Associates Dinner and Program, with Swaminathan Krishnan, PhD '03, assistant professor of civil engineering and geophysics*—"Will the 'Big One' Collapse our Big Buildings?" The Regency Club, Westwood, California.

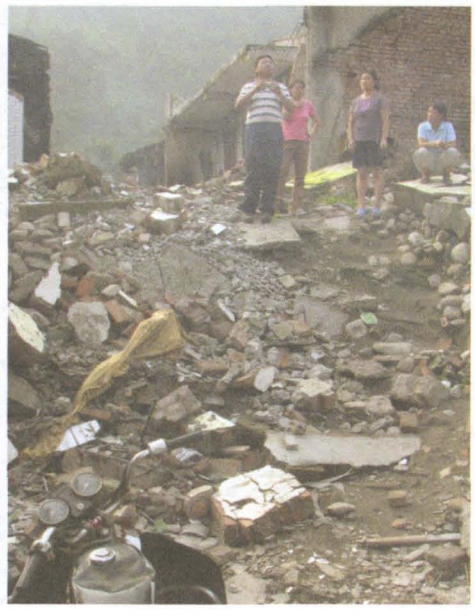
September 27, *President's Circle Garden Party at the home of President Jean-Lou Chameau and Carol Carmichael.*

October 1, *East Coast Associates Dinner and Program, Antonio Rangel '93, associate professor of economics*—"Neuroeconomics: The Neural Basis of Economic Decision Making," Lotos Club, Manhattan.

October 4, *Northern California Associates Dinner and Program, with Gary Lorden '62, professor of mathematics*—"Caltech Knows *NUMB3RS*," the Fairmont San Jose, San Jose, California.

October 18, 2008, *President's Circle Biology Boot Camp, with Scott Fraser, Rosen Professor of Biology and professor of bioengineering, and Marianne Bronner-Fraser, Ruddock Professor of Biology*—Lecture, Laboratory Tour, and Luncheon, the Beckman Institute, Caltech.

An Associates luncheon talk earlier this year by Assistant Professor of Geophysics Jennifer Jackson on using diamond-based technology to simulate conditions at Earth's core drew an enthusiastic turnout. Following the lunch (from left) guest Paul Weinberg, Jackson, Associate Don Pinkerton, and June Wicks '08, a member of Jackson's research group, enjoyed a reception outside the Caltech Athenaeum.



Ground Zero . . . from page 3

shoddy construction. But there were many other places that suffered even more damage than Dujiangyan.

They did not venture into the city on that day; instead they headed directly to mountain areas and to places where they expected to find the surface rupture. Liu saw evidence of the appalling destruction everywhere. "It was very bad," she says. "We didn't see people dying, but all the houses had collapsed and everything was trashed. There were ruins everywhere we went. It was still in the early phase of trying to get tents to people. Army people were there trying to help. Many people wanted to talk. They had still not recovered from the loss of their homes and family. We listened patiently. Their loss and pain is tremendous."

Liu and her students spent the next month traveling across the province and taking measurements of the ruptures, starting in the southern part of Sichuan and moving northeast, mostly following the main fault but also veering off on secondary faults. They hired local drivers to take them around, usually staying in a hotel or camping out in each area for a couple of days before moving to the next town. They had brought backpacking gear with them, which came in handy as they hiked into the mountains to follow the faults and ventured cautiously across landslide debris fields.

An earthquake geologist is like a detective, Liu says. "You have a clue and follow that clue. We found a surface rupture over 200 kilometers long; maybe 225 kilometers." The biggest rupture they discovered was a six-meter rise in the land. In many places it was two to five meters. "This may be the world's largest oblique thrust on land over the last 150 years," Liu says, referring to thrusts that move both vertically and horizontally. Although the earthquake snaked along one major fault in the northern part of the province, to the south it touched off a tangle of interconnected faults.

Liu says that the Tibetan plateau, which is about half the size of the continental United States and contains eight of the highest peaks in the world, is a seismic tinderbox. The plateau sits atop a major tectonic flashpoint, where the underlying Indian plate is plowing into the Eurasian plate, periodically causing massive earthquakes. A scientist could study the region's tectonics for hundreds of years, Liu says, without ever losing interest.

"This is a prime example of mountain building," says Liu, who moved back to China with her husband, geologist Lingsen Zeng, PhD '04, after spending two years as a postdoctoral scholar at the Institut de Physique du Globe de Paris. "The Indian plate is moving like a bulldozer. You can observe the motion and how it's taken up by different faults and how earthquakes happen to release this motion. On the Tibetan plateau, there are quite a few faults like the San Andreas."

Liu believes that the Wenchuan quake "calls for a reevaluation of tectonic models." Many earthquake experts believe that as the Indian plate moves northward, it is pushing the Tibetan plateau toward the north and east, fueling the rise and uplift of mountains at the plateau's outer rim. At the same time, the relatively rigid Sichuan basin has constrained the plateau's eastward movement, as the Tibetan interior edges closer to the Sichuan basin. Earthquake geologists have long debated how much horizontal pressure (known as crustal shortening in geologist parlance) has built up along this constrained boundary, compared to the amount of pressure that has been released through mountain uplift. A strong thrust event like Wenchuan "demonstrates a strong upper crustal shortening," Liu says. Perhaps most alarming, the dynamics of the Wenchuan quake point to a "seismic hazard of blind structures"—or faults that develop underground— "beneath the heavily populated Sichuan basin," which could lead to new catastrophes.

Sizeable aftershocks rocked Sichuan almost daily during Liu's month in the province. "Something is really happening far below," she says. "It's not just shaking, but feels like a grinding."

Liu returned to Beijing in early July and set about writing up her findings, which she hopes to publish soon. While in Sichuan she crossed paths with CEA geologists, and says that they will likely be publishing as well. She figures that her paper and theirs may well put forward alternate theories about the quake's causes and implications, and hopes that this will spark further dialogue about how to interpret and address seismic conditions in the northern and eastern fringes of the Tibetan plateau. "Even with the same data, you can have different ideas."

While her research kept her occupied in the field, Liu says that there was no avoiding the devastation. "It was traumatizing in the beginning; painful. You really wondered how fragile and vulnerable those buildings were. So badly built, and the people so unaware of the coming disaster and unprepared. The biggest shock was when I saw the towns of Yingxiu and Beichuan. It was hell-like destruction, and I felt like I was in a Hollywood movie. It was surreal. After a while, we started to get used to it, but even to the end, walking through the rubble made me nervous. Everyone who works in the earthquake business in China should come to see this."

In the photos at top, Jing Liu (in red) and Chen Ji, PhD '02, an assistant professor of geophysics at UC Santa Barbara, analyze a rupture from the Wenchuan earthquake at a school yard in the town of Bailu and—with two survivors of the quake—destruction in Bailu's old town. The photos at right show damage to the Two Kings Temple in Dujiangyan and destruction in the city of Beichuan, one of the hardest hit areas. Running through the bottom photos is a representation of the seismogram from the Wenchuan temblor.

Alumni Assess Wenchuan Quake's Aftermath

During their holiday in Sichuan Province last November, Luke Wang (third from right) and Bill Iwan (second from right) posed with friends and family members in front of the main gate to Chinli Old Street in Chengdu, the provincial capital. Wang won a major contract to provide structural-monitoring equipment for the Bird's Nest stadium in Beijing, shown in the center photo.

Eight months after civil engineer Moh-Jiann Huang, PhD '84, took a pleasure trip to Sichuan Province with two other Caltech alumni, he returned to the region on a much different mission—that of helping to assess and evaluate the widespread devastation wrought by the 7.9-magnitude Wenchuan quake. A staff member for the past 23 years with the California Geological Survey, Huang and a colleague returned to the area as part of the Geo-Engineering Earthquake Reconnaissance project funded by the National Science Foundation.

Hosted by faculty members from Sichuan University in Chengdu, the provincial capital, Huang spent six days in early July touring the region. Although he was not allowed into areas with the worst destruction, such as Beichuan, he was able to see many examples of destroyed bridges and buildings. One modern high-rise hotel that he had stayed in last November now had severe cracks and was closed.

Throughout his career, Huang has seen the aftermath of many temblors, including the 7.3-magnitude Chichi earthquake, which occurred in 1999 in Huang's native Taiwan. He arrived four days after that quake, when the dead were still being buried, so he says that the destruction from Wenchuan did not overwhelm him.

"There will be damage, but few will die," Huang says. But the Wenchuan earthquake was much more severe, and its epicenter was within 60 miles of many towns. Compounding matters, many buildings were constructed with infill brick walls in which brick is used between concrete columns and beams. "Many of the infill walls broke during the earthquake," Huang says. "There seems to have been a lack of communication between architects and engineers in considering these brick walls in resisting earthquake forces."

What did upset Huang was the extent to which timely retrofitting and more up-to-date seismic design and construction might have spared the region some of the worst damage. Several years ago, engineers began to significantly change the way they design bridges, switching from a system of separate support beams to one in which the beams are unsegmented and covered in a continuous pour of concrete. Huang says that this provides greater flexibility, allowing bridges to withstand stronger earthquakes. In Sichuan, Huang discovered collapsed bridges only two or three years old, which used the outdated design. "I saw quite a few bridges like that," he says. "That shouldn't happen."

Huang says that after China's 7.8-magnitude Tangshan earthquake in 1976, which may have killed about 240,000 people, the country adopted modern seismic codes, which were revised in 2001. Buildings built to these modern standards should have been able to withstand a magnitude 6 earthquake 30 miles away or a magnitude 7 earthquake 60 miles away.

Huang and his engineering colleagues had already spotted the potential for trouble on the November trip, which was organized by Luke Wang, PhD '97, and also included Wang's Caltech thesis advisor, Professor of Applied Mechanics, Emeritus, Bill Iwan, '57, PhD '61, and several of the trio's relatives. The purpose of that trip was nature photography, but as the three engineers traveled through the quake-prone Sichuan Province, they naturally thought about how the region might fare during a major seismic event. You could see then, says Wang, that a sizable quake might lead to a catastrophe.

Wang, who grew up in Harbin in northern China, is a civil engineer with expertise in developing technologies and methods that reduce the shaking of large buildings during earthquakes. He says he was groomed to be an earthquake engineer by his father, Qian-Xin Wang, a professor at the Institute of Engineering Mechanics in Harbin.

In 2005, the China Earthquake Administration awarded Luke Wang's firm a major contract to equip several high-profile buildings and other structures, including Beijing's Bird's Nest Olympic stadium and Shanghai's 104-story World Trade Center, with instruments known as structural health monitoring equipment, which, among other things, can detect the effects of strong shaking. If any of these structures experiences a major earthquake, there will be data to determine if they remain structurally sound after the shaking.

Wang, Huang, and Iwan spent two weeks in China, flying into Chengdu in the southern part of Sichuan Province, and driving to the final destination of Jiu Zhai Gou, a scenic valley at the northern border of the province.

"Sichuan Province is an area that's bigger than California, densely populated with more than 87 million people, and with lots of big mountains and rivers," Wang says. "It was a 10-hour drive from the capital to the northern tip. We were driving on the only highway along a river. The region is supposed to have tons of trees, but the astonishing thing was to discover how many of them had been cut. About 100 miles from the city, we started to see a few trees."

For an area prone to earthquakes with cities and towns typically situated at the base of mountains, the deforestation seemed to Wang and Huang to pose a particular danger. In fact, they passed through a few places where earthquakes had caused landslides, including one that dammed a river. "We said to each other that you don't have to wait for an earthquake to destroy some of these towns," Huang says. "There will be landslides anyway."

Their worst fears were realized when the Wenchuan earthquake touched off landslides that buried buildings and cut off rivers, creating lakes that threatened to overflow and cause floods. "The landslides made it extremely hard for rescue forces to enter the region," Wang says. "This was a direct consequence of the deforestation."

Wang says that driving through towns, many of which were occupied by minorities such as Qiang and Zang, he also noticed the poor construction. "It was mostly masonry and concrete." After the earthquake, photos revealed that many of these buildings had not been constructed with the steel reinforcement bars commonly known as rebar. And on his return trip, Huang noticed many newer buildings that had been constructed with bricks and mortar, and were now just heaps of rubble.

"In an earthquake, the key to a building's survival is flexibility," Wang says. "That's provided by rebar. Many of these buildings were not structurally sound.

"Towns further away from Chengdu were relatively poor," he says. "So there probably wasn't much government inspection of building codes." One of the most horrific outcomes of the Wenchuan quake was the structural failure of schools that collapsed, killing thousands of trapped and helpless children, while buildings all around them stood virtually unscathed. Iwan, who served as director of Caltech's Earthquake Engineering Research Lab from 1992 to earlier this year, says that poor school construction is endemic in the developing world.

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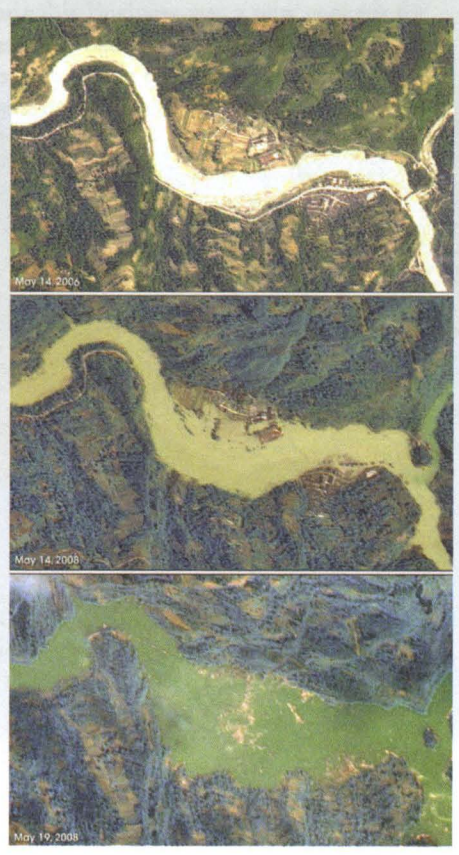


The series of satellite images at right shows the effects of the damming of a river in Beichuan country, a region that suffered severe damage from the Wenchuan quake. The image at the top was taken in 2006. The one in the middle, taken on May 14, two days after the quake, shows the water level rising and a lake beginning to form due to a landslide downstream. In the photo at the bottom, taken on May 19, the villages that had flanked the river are now submerged.

Green Matters

By Michael Rogers

Sustainability has caught fire at Caltech. Among many other initiatives, last year's olive harvest, the installation of solar panels atop the Holliston parking garage, the establishment of green cleaning procedures for campus janitors, and efforts to make campus buildings environmentally friendly testify to the groundswell of campus activity in projects related to sustainability. One of the newest and most ambitious efforts is the creation of the Linde Center for Global Environmental Science, announced in April. Established by Ronald Linde, PhD '64, and his wife, Maxine, the center will investigate global worldwide environmental change from a broadly based, multidisciplinary perspective. It is the latest in a series of Institute projects that not only focus on protecting local and global environments, but also extend to entrepreneurial ventures. Many of these are aimed at applying novel engineering solutions to improve conditions throughout the developing world.

Sustainability at Caltech may now be on the front burner, but it is hardly new. In the early 1960s, a few graduate students started a small recycling program on campus that has grown over the years. Since the mid-90s, the Institute has had an Electric Vehicle Club, maintaining electric cars and sponsoring various events. The recent heightened interest is not surprising, either, given the widespread recognition that the world's growing population and rapid development in the Third World are straining Earth's resources. The spectre of global warming brings a new urgency to concerns about the future of the planet.

"Sustainability and green engineering are the new buzz words on campus," says Caltech senior Michael Ferrara, the president of the Caltech chapter of Engineers for a Sustainable World (ESW), an education and activist organization for young engineers. "Students are engaged because they have the knowledge and tools to contribute to the solutions of the global situation."

Ferrara is one of many Caltech students who are not just thinking green but are actively involved in issues related to sustainability and socially responsible entrepreneurship. Besides meeting to discuss the world's woes, some of them are starting projects, including companies, to address a variety of sustainability-related problems. One of their primary test beds is Guatemala, where a few Caltech initiatives are currently in various stages of development.

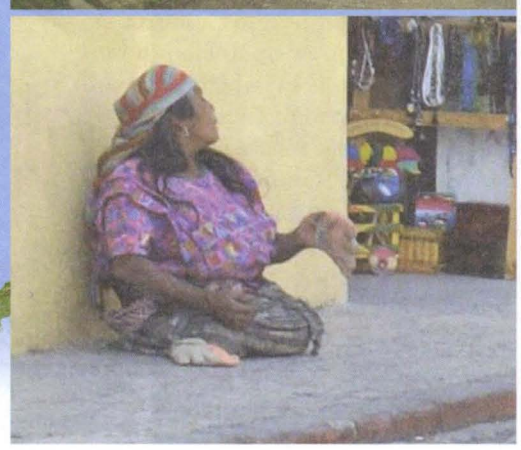
Two of these projects originated in a class called Product Design for the Developing World, which is taught each fall by Visiting Professor of Mechanical Engineering Ken Pickar, who introduced the course in 2004.

"I was teaching engineering and design of products for a few years," says Pickar, who worked at Bell Labs and has held senior research positions at General Electric Corporate R&D and AlliedSignal. "I was approached by the ESW group on campus, and they asked me if I could focus my class on engineering problems for people in the developing world. I agreed, provided they helped me write the curriculum."

The class, which welcomes undergraduates and graduate students, as well as students from Pasadena's Art Center College of Design, is basically a team-based crash course in solving small-scale but still significant engineering problems. It blends lectures and hands-on learning, with Pickar presenting classroom lectures on the product development processes—from conceptualization through prototype—while the students work to build a product to solve real problems of people who earn a dollar a day.

Guatemala entered the course syllabus in 2005 when a student who had traveled through Latin America suggested that Pickar focus on the Central American nation because of its needs and its relatively close proximity to California. With help from Mario Blanco, director of Caltech's Process Simulation and Design Collaboration in the Beckman Institute—who, along with his wife, Luz Marina Delgado, an anthropologist, has close ties to Guatemala—Pickar was able to make contact with faculty members Oscar Arce and Ovidio Morales at Rafael Landívar University in Guatemala City. They, and their students, soon became the class's partners as team members, providing a window into the country, suggesting potential projects via Skype, wiki, and e-mail. Members of the teams met in Guatemala prior to the start of classes, and for the last week of the quarter, the Guatemalan students flew up to Caltech to join their teammates and to make the final presentations together. In 2007, the lectures were teleconferenced, so that the Guatemalans could more actively participate in the class.

Deplorable living conditions in Guatemala influenced two Caltech start-up ventures that originated in a class focusing on improving conditions in the developing world through engineering.



Zeal for Wheels

In the fall of 2006, Rudy Roy '07 and Ben Sexson '07 took Pickar's course, and during a teleconference with the class, the students and faculty at Rafael Landívar University told them about the problems that poor, disabled people throughout Guatemala have getting wheelchairs. Many depend on their families for support, but with family incomes averaging just over $200 a month, wheelchairs, which can easily cost $400, fall into the category of out-of-reach luxury items. It's a situation that keeps many of the country's handicapped essentially imprisoned in their homes.

Roy and Sexson, together with their Caltech teammates Mike Easler and Cindy Ko '08, and Alejandra Antonucci of Rafael Landívar University, knew that to make a practical wheelchair for Guatemalans, they would have to devise a vehicle that would be both durable and affordable. Sexson was

sketching some prototype designs on a whiteboard when he realized that the profile of a wheelchair is remarkably similar to a bicycle's. A big difference, of course, is that wheelchairs have four wheels and bicycles have two. "It was Ben's idea to take two bikes and put them together to make a wheelchair," Roy says.

Initially, the team decided to construct their wheelchairs out of used bikes, since they figured that this would both bring down the manufacturing cost and promote recycling. By the end of the term, they had built a prototype, using two mountain bikes for the added durability that users would need to negotiate the unpaved roads and pathways in towns and villages. They cut up different sections of the bikes' frames and reassembled them to create handles and other parts of the wheelchair. The seat and back were taken from pieces of a hammock, and casters were added for the front wheels.

At the end of the term, the wheelchair team won the course's $500 first prize for the best design. After Sexson left Caltech in December 2006 and accepted a job as an analyst for a hedge-fund firm, Roy decided to continue the venture as an independent study project. He teamed up with classmate Dan Oliver '07, and the two used the prize money to take their prototype to San Francisco to consult with a wheelchair design firm. The company uncovered all of the chair's flaws, noting that it would probably give the users sores and could also tip over. "They ripped our chair apart," admits Oliver. "They told us it was unsafe and that people would either hurt themselves or die."

Undaunted, Roy and Oliver came up with new prototypes over the next two terms, using the Caltech student shop as their workshop. Although busy with jobs and other commitments, the rest of their former teammates, including Sexson, also volunteered their time. With the help of Charlie Pyott, a new team member from the Art Center College of Design, the group switched from reassembling old bicycles to using new ones, since it was hard to find two used bikes that matched, making it difficult to come up with a standard manufacturing procedure.

"During our years at Caltech, we wanted to apply our knowledge to a project that would help somebody. We've used our engineering skills to help solve a problem."

Over spring break in 2007, Oliver and Roy flew to Guatemala and met with the students who had given them the initial spark for the project. They also visited Transitions, a Guatemalan charitable organization that operates a wheelchair manufacturing and repair facility and donates wheelchairs to poor disabled people. Transitions has built more than 200 wheelchairs and refurbished more than 450, but Roy and Oliver discovered that in a country still recovering from a decades-long, brutal civil war, there is a need for thousands more.

After they got back to Caltech, the team started work on a business model, and when Oliver and Roy graduated, they launched Intelligent Mobility International (IMI), a nonprofit enterprise that will build wheelchairs for the poor in developing countries, starting with Guatemala. With the additional goal of empowering Guatemalans, Roy, Oliver, and several others who have joined the effort want their wheelchairs to be manufactured in Guatemala in shops staffed by disabled people.

"We don't just want to give people a wheelchair," Oliver says. "We want to involve them in society. We're looking for ways of providing jobs for disabled people." IMI also plans to design other mobility aids, such as improved prosthetics, crutches, and walkers.

"One of the biggest things we realized is that we could partner with Transitions to ease our way into the market instead of starting up our own shops," Oliver says. "This way, we have a shop with tools and people with skills." If that arrangement works, they say they might be able to expand their operation. But first, they have to perfect the chair.

Since neither Caltech graduate plans to give up his day job—Roy is a marketing associate for eSolar, a company in the Idealab group founded by Bill Gross '81, while Oliver is a systems engineer for Honeywell Aerospace—each is currently involved with IMI on a part-time basis. After they graduated, Pickar decided to continue the wheelchair project in his product design class. By last April, a new group of

Rudy Roy, Charlie Pyott, and Ben Sexson (left to right) prepare to cut a bicycle frame that will be transformed into a wheelchair. The computer design (below left) shows an early version of the group's wheelchair.

undergraduates—including Dan Oliver's brother, Thomas, and fellow junior Joseph Koehler—had helped design a new prototype that they were hoping would be suitable for production.

Intelligent Mobility International is currently talking with one of Central America's largest bicycle manufacturers about purchasing bikes at cost, and with that arrangement in place, IMI hopes to soon begin wheelchair production in Guatemala. Earlier this year, Thomas and Joseph traveled separately to Guatemala to work out production details with Transitions, and Joseph returned to Transitions this summer to collaborate on building wheelchairs. Meanwhile, Thomas plans to visit several American universities this fall, partly supported by a $10,000 scholarship from the Donald A. Strauss Foundation. He'll try to interest students on other campuses in launching IMI ventures in other developing nations.

As work moves ahead on finalizing the wheelchair, Thomas hopes that a new group of Caltech undergraduates will get involved in the fall. "There's still a lot of hands-on work that needs to be done," he says, including prototype testing.

"The first year is the hardest year," Roy says. "When the operation kicks in, we eventually could make 300 to 500 wheelchairs a year in a small shop. I'd be happy to have gotten out 50 solid chairs by this time next year."

"During our years at Caltech, we wanted to apply our knowledge to a project that would help somebody," Dan Oliver says. "We've used our engineering skills to help solve a problem."

"We've learned about people in developing countries and how what we have learned in school can help other people," Roy says. "The ability to make a contribution is great for us. It's been a great ride."

The Latrine Team

The inadequate living conditions of the underprivileged in Guatemala became the impetus for another Caltech project that originated in Pickar's class. George Cadena, MS '08, a graduate student in electrical engineering, got his idea during a trip to Guatemala that Pickar's students took during the first week of class in 2007. The students, whose expenses were paid by the Caltech Y, traveled to several towns and villages where Cadena was struck by discrepancies in the standards of living. The same towns that had elementary schools equipped with computers and many residents using cell phones often had deplorable living conditions, including unsanitary, filthy latrines and an almost total absence of plumbing.

"I had never traveled to a poor country before, and going there with the mission of wanting to make a difference and start a sustainable business was a new concept for me," says Cadena, who is interested in business and had previously taken Caltech's other courses on entrepreneurship. On the last day of the trip, when the students gathered to discuss the problems they had seen, he couldn't stop thinking about the local hygiene problems.

The Eco-Loo team hopes to improve the unsanitary conditions of latrines, such as the one shown above, which it found in a town in Guatemala.

"There have been latrine projects in developing countries before, but nothing has stuck," he says. "Nongovernmental organizations have come up with cool designs, and they've given out new latrines, but often people haven't used them" or didn't have the proper infrastructure to maintain them. Cadena noticed that one elementary school in a rural village had Western-style toilets, but there was no running water, and the facilities had become virtually unusable.

It didn't take Cadena long to realize that these sanitation problems were related to sustainability issues. Guatemalans with small farms often use human waste for fertilizer, and some latrine producers had come up with complicated designs that separate

Continued on page 12 . . .

The Caltech/Art Center group behind Eco-Loo includes (left to right) Adrianne Stroup, Bryce Butcher, George Cadena, and Albert Ng. Below is a scaled-down prototype of their portable latrine seat.

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liquids from solids to speed up the fertilizer-drying process. But those systems are expensive.

"We didn't want to be the 501st latrine project," Cadena says. "But I couldn't get past the fact that no solution had prevailed over others and that the problem still existed."

Cadena pitched the idea of designing a new latrine to Pickar's class, and several students signed on, including Adrianne Stroup '08 and two Art Center students, Bryce Butcher and Albert Ng. To determine why previous latrine projects had failed "we looked at as many latrine reports as we could get our hands on," Cadena says. "One main issue was cost. People couldn't afford them when they were struggling to put food on the table" or if they were a low priority. As for the latrines that were provided at no cost, the students, noting that they soon fell into disrepair, concluded that when the villagers got something for free, they didn't have as much incentive to maintain it as compared to something they had bought—an observation that has lately been buttressed by laboratory experiments in economics. So the challenge was to develop an effective product that came with a modest, affordable price tag. An added consideration was "the cultural side of how it would be received," says Cadena. "We could come up with a cool engineering solution, but this was going to be built over there and generate income for local Guatemalans. A complicated design would not be used."

The team had several ideas for improving the latrine, including the addition of rudimentary plumbing and a better ventilation system. "But Ken taught us not to spread ourselves too thin. He said, 'Don't think low tech. Think below-the-earth tech.'

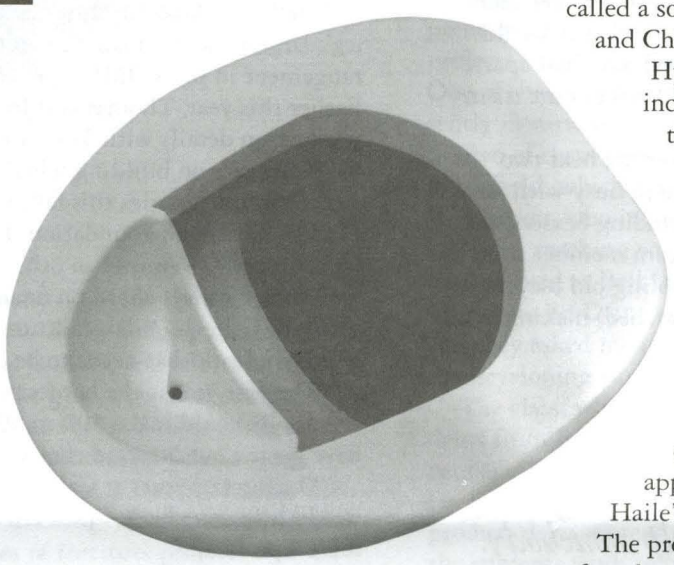
"We finally decided that the problem could be solved with simple products, and that first we should focus on the seat," Cadena says. "Low cost—big impact." The immediate solution was an inexpensive plastic seat that employs a funnel to separate different types of waste into different underground tanks. Since the seat is not attached to the latrine—a type of inner latch prevents slippage when in use—it can be easily removed and cleaned.

Butcher, one of the two Art Center students in the group, applied her design expertise and produced a scale model of the seat, using the center's 3-D modeling machine. As the course neared its conclusion, the team started writing a business plan for launching the seat as their first product. It won the class prize for best design at the end of the term.

Once the course ended, they decided to keep the venture going by starting a nonprofit venture called Eco-Loo. Says Cadena, "The goal is to establish businesses that will manufacture the seats in Guatemala and other countries, providing a source of income for local partners. We see this as a real business. We want to impact as many people in as many developing countries as we can reach. Hundreds of millions of people use latrines. Ideally, we will establish a sustainable business that local workers can run with higher wages than what they are currently receiving."

Eco-Loo expects that the seat will cost $10 and will come in a variety of colors. The company is also exploring different materials for prototypes and hopes to have a full-size prototype later this year, when Stroup plans on traveling to Guatemala to show it to potential manufacturers and customers to get feedback.

"This is a great opportunity to use design skills to help the world," says Butcher. Adds Cadena, "We see this as an affordable luxury. It's not something you definitely need, but you'll feel good having it. Doing this was so much fun and there was pride of ownership in seeing the product and knowing that we'll improve the quality of people's lives. We can't wait to see how it will impact people."



Fuel to Burn

At the high-tech end of Caltech's sustainability start-ups is Superprotonic, founded in 2003 by Dane Boysen, PhD '04, and Calum Chisholm, PhD '03, and their former adviser, Sossina Haile, professor of materials science and chemical engineering.

Based in Pasadena, Superprotonic is working to develop a new kind of fuel cell—an electrochemical device for converting chemicals into electricity. The timing would seem right: hydrogen-powered fuel cells have been touted by both energy experts and government leaders, including President Bush and California governor Schwarzenegger, as a promising alternative to oil because they produce only water as a byproduct instead of carbon exhaust fumes. But like many start-ups, Superprotonic has fought an uphill battle for recognition.

Most fuel-cell research has focused on polymer-based devices, which, despite substantial government support, have posed numerous problems, including an inability to operate at high temperatures, which greatly limits their effectiveness. Superprotonic is working on a nonpolymer-based alternative to this technology, called a solid-acid fuel cell, derived from research conducted by Boysen and Chisholm in Haile's lab.

Hydrogen fuel cells produce energy by controlling the natural inclination of hydrogen and oxygen to bond together as water. The cell separates the hydrogen from the oxygen with an electrolyte, a material that allows only ions—in this case, the hydrogen protons, stripped of their electrons—to pass through, while the electrons flow through a circuit, generating the desired electric current.

The Haile group's solid-acid research stems from a discovery by Russian scientists in the early 1980s showing that proton conductivity in solid acids jumps by 1,000 to 10,000 times at a certain temperature. They called this a superprotonic phase transition, from low to high protonic conductivity. While a fundamentally interesting phenomenon, applications for taking advantage of it did not materialize until Haile's group came along several years later.

The project began in 1997 when Chisholm, having just completed a year of graduate coursework at Caltech, walked into Haile's office to discuss research opportunities in her lab. "She described the superprotonic transition and said that no one knew why it was happening and that she wanted to find out. It was dramatic and unexplained," says Chisholm. But Haile, who came to Caltech in 1996 from the University of Washington, had another motive. She said that with the right materials, the superprotonic phase might serve as the basis for creating a new type of fuel cell. Intrigued, Chisholm signed on, and a few months later, Boysen, who had worked for Haile while he was an undergraduate at Washington, joined the effort.

Boysen and Chisholm began looking into exactly what makes superprotonic transitions occur. "It turns out that if you have just the right size ratio between the different atoms and molecules in the solid-acid compounds, they will transform to the highly disordered superprotonic phase because of greatly increased configurational entropy," Chisholm says. In effect, the phenomenon is a turbocharged state of the second law of thermodynamics, which holds that in a system that's not in equilibrium, "everything wants to get more disordered. If you drop a teacup, it will break, and if you have a cup of sugar, it will tend to spill. And these materials can get more disordered by going 'superprotonic.' However, there are some rules for determining if and when, at what temperature, a material can become superprotonic. Dane and I explicitly stated what those rules are. So you can say we wrote the rule book for making superprotonic materials."

Calum Chisholm (left) and Dane Boysen helped start Superprotonic when their PhD advisor, Sossina Haile, thought that there might be potential to build a new type of fuel cell by exploiting an obscure electrochemical reaction.

As the researchers were unraveling the mysteries of the superprotonic state, they became increasingly interested in actually building a solid-acid fuel cell. "We read some papers about how people make fuel cells and then worked out what we should do for our system," Chisholm says.

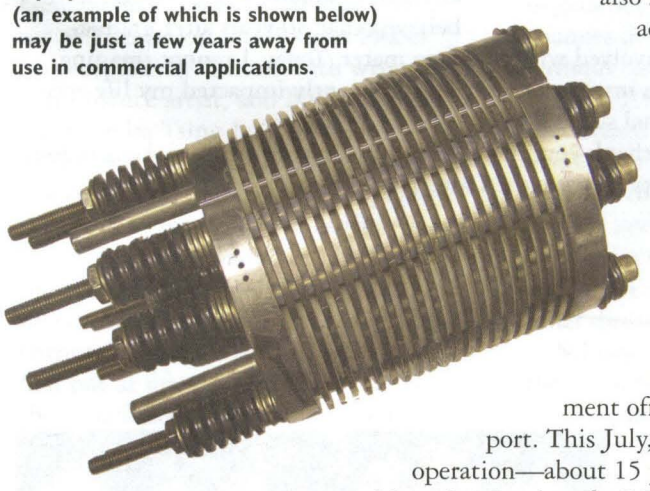
After creating a fuel cell the size of a pellet, they heated their test fixture to a point above the threshold temperature for the superprotonic phase transition and began taking measurements of the cell's voltage output. Their first fuel cell didn't perform very well, but after making a few adjustments, they got a convincing voltage measurement, establishing the credibility of the solid-acid cell. "So, we went out and celebrated with a nice meal at a French restaurant, using money my dad had given me for a Christmas present," Chisholm says. "No one had ever made a solid-acid fuel cell before. That was our eureka moment."

Despite their euphoria, the solid acid that they created—cesium hydrogen sulfate—had a number of problems. It dissolved in water and it also reacted with hydrogen, which reduced its energy output over time. So Chisholm and Boysen conducted more experiments, trying out numerous combinations of chemicals, until they finally constructed a fuel cell in 2003 with all the properties needed to make it viable, replacing the sulphate material with phosphate, which was more chemically robust. Over the next year, they refined the fuel cell until they demonstrated that it could run for 100 hours.

Despite this success, initial efforts to commercialize their prototype were not encouraging. "We expected a company to take serious interest, but people in industry were skeptical," Chisholm says. "They said, 'Come back to us when you can show thousands of hours of operation at a cost that's reasonable.' We realized that we had to start a company to do all that."

"It seemed that the only effective way to move this truly revolutionary approach to fuel cells into the marketplace was through a start-up," says Haile, who had never launched a company before. In November 2003, Haile, Chisholm, and Boysen founded Superprotonic. "This is really their company," says Haile, "and I never considered finding anyone else to do this. There is a view in the business world that a company should be run by someone who understands markets and not by scientists and engineers. I completely disagree. The deep knowledge that Dane and Calum have about the science of solid acids is what has made their success possible. They know precisely in what ways solid-acid fuel cells are better than other options, and they also know how to explain the advantages to a lay audience. I can't imagine anyone else having moved things forward this much in so little time."

Superprotonic's solid-acid fuel cells (an example of which is shown below) may be just a few years away from use in commercial applications.



Boysen and Chisholm have spent the past four and a half years both perfecting their fuel cell's technology and meeting with venture capitalists and government officials to secure funding support. This July, they moved their modest operation—about 15 people working in a facility roughly twice the size of a 7-Eleven convenience store—into a new Pasadena building that has five times the lab space.

"We're now in the phase of scaling up," Chisholm says. While their current fuel cell can deliver tens to hundreds of watts of power, or enough to run electronics like a laptop or a DVD player, "the juicy applications are more in the kilowatt range," which could supply energy for cars. "It can be done, but there's a lot of engineering work to do. We believe in the technology and believe it could make fuel cells a commercial success on a massive scale."

"At this point, we just want to see the technology out there," Boysen says. "There's too much potential for that not to happen." Predicts Haile, "I am hopeful that complete Superprotonic power delivery systems will be available on a competitive basis shortly. Let me gamble and say two to three years." And if the company decides to go public, Chisholm says, the earliest it would do an initial public offering would be in three years.

Now that they have shown the potential of the technology, Boysen and Chisholm aren't surprised to see that other research groups are beginning to investigate solid-acid fuel cells. Even more satisfying is the promise that their technology will actually help people. "You can do a lot of great science, but if it doesn't end up in the public sector, it doesn't benefit anyone but you personally," Chisholm says. "When we first started working on this, energy wasn't such a problem. Now it's becoming an urgent national and global issue. I'm hoping that solid-acid fuel cells will be part of the process that makes us dramatically more efficient in energy production."

For more information on these ventures, go to www.intelligentmobility.org, www.eco-loo.com, and www.superprotonic.com.

Tech Talk

Dear Editor,

On page five of the latest *Caltech News*, the article on the Grand Canyon remarked on the "eternal conundrum of how the camel got its hump." You may inform the writer that the "conundrum" has been solved (at least for believers in Lamarckian evolution), as follows:

"A peculiar beast is the camel,
Stranger than anyone thinks,
For that large and voluptuous mammal
Once tried to ravish the Sphinx.
But the Sphinx's most intimate organs
Are blocked by the sands of the Nile,
Which accounts for the hump in the camel
And the Sphinx's inscrutable smile."

—Robert Greenwood, MS '43

I enjoyed reading the article in the last *Caltech News* about the new analemmatic sundial recently constructed in the plaza south of Winnett Center. I was surprised to read, however, that our Caltech campus lacked a "good sun-drenched sundial."

I have fond memories of a sundial in the gardens immediately north of Dabney Hall. As I recall, it was a beautiful brass structure, about 30 inches in diameter, and inscribed to correct for the seasons. Despite a variety of searches, I have been unable to find an example that fulfills my memories. I certainly hope that someone else has similar memories, and, more importantly, that someone can find the missing sculpture.

If somebody finds it, and nobody wants it, ship it to me COD. Many thanks for your interest in this minuscule piece of Caltech history.

—Marc E. Boulé '70

In response to Boulé's letter, Caltech News put campus photographer Bob "Sherlock" Paz on the case. He was soon able to confirm that the campus does indeed own a sundial (see above) fitting Boulé's description and that it is located in the Sturtevant Iris Garden, west of Dabney Gardens (with Parsons-Gates in between). Readers who are familiar with the history of this timepiece, or who have memories or anecdotes of campus landmarks and sculptures that they would like to share, are invited to write the editor at hja@caltech.edu. Caltech News welcomes letters while reserving the right to select and edit them for publication.

Gary Demos (right) was one of Caltech's FX Men at Large until he turned himself in as a statuette-carrying member of the Academy. He was last seen on campus with his wife, Jill, when he finally became a bona fide alumnus at this year's Commencement.

Your article *FX Man* ends by saying that "Caltech's two known winners *{of technically oriented Oscars}* were already featured in 2007—Ray Feeney '75—and in 1992 —Eustace Lycett '37."

Attached is some background on me and my Oscar. I left Caltech in 1971 with an incomplete course for my degree in Engineering and Applied Science (specializing in Electrical Engineering). This course was waived and I just received my BS at the 2008 Caltech commencement.

—Gary Demos '08

To learn what Gary Demos was up to in the interim, leading to a Gordon E. Sawyer Award, go to www.oscars.org/aboutacademyawards/awards/sawyer.html. There you can click on his name and that of Feeney, who also received Distinguished Alumnus coverage on page 15 of this issue. Then there are the Oscars and acclaim that went to director Frank Capra '18.

The previous issue's article about Scott Townsend, *FX Man*, was very nice and reminded me of the Ray Feeney article from a few years back. I remember seeing Scott around campus and had no idea he was interested in visual FX. At the end of the article, I noticed your request for stories from other alumni that are in "the biz." Although you said we didn't need to win an Oscar to send something in, I actually have two "near red carpet" Oscar wins myself. While I was finish-

Continued on page 15. . .

Absence makes the heart grow fonder

On June 13 I became president of the Caltech Alumni Association. The event took place at our annual dinner in the main dining room at the Athenaeum. The room was filled with 21 past CAA presidents and an impressive array of honorary members of the Alumni Association inducted in years past. We had all gathered there for the investiture of our newest honorary members, Caltech president Jean-Lou Chameau and his wife, Carol Carmichael. I could not help but reflect on the circumstances that brought me to this tradition-filled venue with such a notable group of individuals.

I attended the Institute in the mid-1970s and graduated with a bachelor's degree in applied physics. Like many on campus, I traveled a rough road as an undergraduate. I was an average student at best, and struggled to soak everything in during those sleepless four years. Graduation day was one of the happiest days of my life—not so much because I had a diploma in hand as because "it" was over. Although nightmares about tests for which I was not sufficiently prepared would haunt me for years to come, at least in my waking hours, the rigors of undergraduate life as a Techer had ended. Ah, sweet relief at last.

I will admit that as a freshly minted Caltech graduate, I did not fully appreciate what I had accomplished, or how my Caltech experience had prepared me for life ahead. It was not until years later, after attending business school and embarking on a nonscientific business career, that I began to grasp the full impact of those four years in Pasadena. Caltech had shaped the way my mind tackled problems and prepared me mentally for many of life's tough challenges. Realizing this gave me a growing fondness and a new sense of gratitude for my time at Caltech. With this came a desire to reconnect with everything Caltech.

I began by volunteering in the undergraduate admissions support area. As part of that experience, I traveled back to campus a couple of times and felt the pull of the Institute on my heart. I had not been in the scientific world since graduation, and it sure felt good to reconnect with my roots. I remember returning to my office after one particular trip to Caltech, having spent some time with the folks at the Office of Technology Transfer, and telling my business partners that I had been with "my people" and that it had been a great feeling. They did not understand. How could they? They had not been Techers.

Joining the CAA board several years ago brought me many more opportunities to reconnect and interact with just about every segment of the Caltech community. I have now had the opportunity to regularly meet with undergraduates, graduate students, faculty, administrators, staff, and other alumni. I feel like I am coming home every time I return for a board meeting or a campus function. Contributing time and energy to Caltech has become one of the most rewarding activities in my busy schedule.

As president of the Alumni Association, I will be on campus every few weeks over the coming year, and I hope to continue doing my part to give back to Caltech all that it has given me. As an undergraduate, I never would have believed that 30 years after graduation, I would be so deeply involved with my alma mater. Today, I cannot imagine *not* being connected with the institution that so significantly impacted my life and contributed to my professional success.

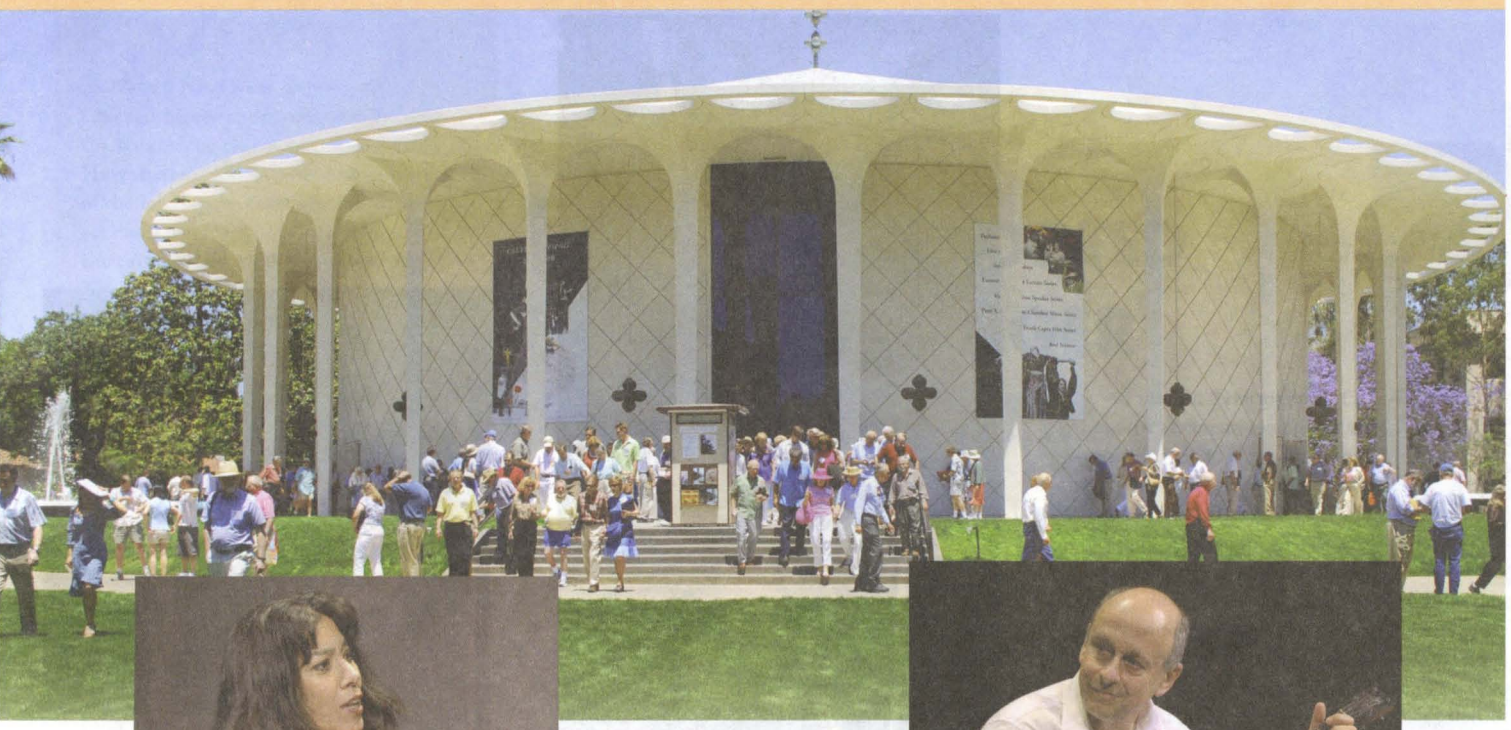
Thank you, Caltech, and thank you, members of the Caltech Alumni Association, for giving me the opportunity to serve the Caltech community.

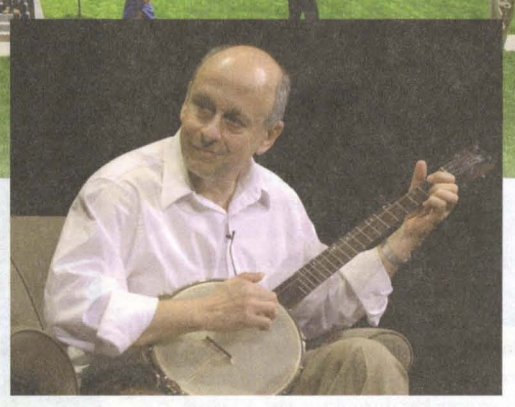
More than 40 alumni, family members, and friends explored the history and geology of Croatia's storied Dalmatian coast this summer, traveling aboard the *M.Y. Monet*, in a travel/study program led by Professor of Geology Jason Saleeby and staff geologist Zorka Saleeby. To see more photos from the trip, and to learn more about the Caltech Alumni Travel Study program, see http://alumni.caltech.edu/learning/travel.

His youthful zeal for life in the fast lane was duly recorded in his Caltech *Big T* yearbook photo (right), but Chris Wheeler '78 has more recently donned the mantle of sober respectability in his new role as president of the Caltech Alumni Association. He's shown below (second from right) with fellow 2008–09 CAA executive committee members (from left) Tom Lloyd, PhD '99, treasurer; Bob Kieckhefer '74, past president; Jasmine Bryant '95, vice president; and Charles Halloran '94, secretary.

Six new members have been appointed to the Alumni Association Board of Directors. They are, from left, Nathan Hurvitz '86, Armando Pauker '82, Alice Lin '05, Blair Folsom, PhD '74, Heather Dean '00, MS '00, and Jim Simmons '72. In addition to serving on the CAA board, Folsom also chairs the Caltech Alumni Fund Advisory Council.

At the CAA annual dinner, board president Bob Kieckhefer (center) welcomed Caltech president Jean-Lou Chameau and his wife, Carol Carmichael, faculty associate in engineering and applied science, into the ranks of the honorary members of the Alumni Association for their role in advancing the Association's "aims and activities." Chameau and Carmichael, the citation noted, "came to Caltech in September of 2006, but in their relatively short tenure, they have made extraordinary contributions to the Institute. Their efforts in engaging students, interacting with faculty and communicating with the staff have had a direct, positive impact on the Caltech community as a whole."





Banter and Banjos Highlight Seminar Day General Session

Caltech's Alumni Seminar Day has occasionally been likened to a more traditional university homecoming, although it has notably lacked those homecoming staples, a king and queen.

Was this year the exception that proved the rule? The Seminar Day General Session paired Tolman Professor of Theoretical Physics and Nobel Laureate David Politzer with writer, performance artist, and NPR commentator Sandra Tsing Loh '83 (pictured above), who waltzed the Nobelist through a fleet and freewheeling Q&A. Words flew left and right, as the two ranged over matters that included life at Caltech, dark energy, physics nomenclature, and Politzer's youthful enthusiasm for the banjo (he built his first one at fifteen). On this occasion, the song followed the dance as Politzer, accompanying himself on the banjo, sang a tribute to Einstein for the finale and urged the appreciative audience to join him in praise of Albert.

Speaking of praise, earlier in the General Session, President Jean-Lou Chameau (pictured below, far right) presented Caltech's Distinguished Alumni Award, the highest honor the Institute bestows upon its graduates. The 2008 recipients are (left to right) Arthur Riggs, PhD '66; Warren Schlinger '44, PhD '49; William H. Press, PhD '73; Ray Feeney '75; and Alexis Livanos '70, PhD '75.

Riggs, the emeritus director of the Beckman Research Institute at City of Hope and a member of the National Academy of Sciences, has been a pioneer in the field of epigenetics, a branch of genetics that seeks to understand the changes in gene function that occur without changing the DNA sequence. In the 1970s, his work on the bacterial production of human insulin helped launch the genetic-engineering revolution and the biotechnology industry, and his later research into recombinant antibodies set the stage for their successful use in treatment of cancer and other diseases.

Schlinger, a longtime member of the National Academy of Engineering, taught at Caltech for several years before embarking on a successful career in industry. He played a large and vital role in the development of chemical technology involved in coal gasification during three decades at Texaco Inc., where he also wrote 65 patents and most recently served as director of the company's Montebello Research Laboratory, before retiring.

Press, a member of the National Academy of Sciences, has pursued a distinguished career in science and science administration. After two highly productive decades as professor of physics and astronomy at Harvard, he became the deputy director for science and technology at Los Alamos National Laboratory. Most recently he has embarked on a new research path in computational biology at the University of Texas, where he currently holds the Raymer Chair in Computer Sciences and Integrative Biology.

Feeney, who received an Oscar in 2006 for lifetime achievement for contributions toward the science and technology of filmmaking, is the president of RFX, which he founded three years after graduating from Caltech to help provide leading-edge scientific and engineering solutions to the film industry and which has for 30 years developed groundbreaking visual effects for both feature films and television. Working in conjunction with filmmakers and software engineers, Feeney has helped to pioneer and implement new technologies that have become standard throughout the entertainment industry.

Livanos, a native of Greece, came to the United States in the mid-1960s "because of NASA and the excitement of space exploration." After a decade at Caltech, Livanos, who was elected this year to the National Academy of Engineering, worked his way through the aerospace industry to his current position as the corporate vice president and president of Northrop Grumman's space-technology sector. He has pioneered space-systems innovations in microelectronics, high-power spacecraft buses, and advanced communications payloads and serves on many boards, including the Graduate Aeronautical Laboratories (GALCIT) Advisory Council at Caltech.

For more on this year's awardees, go to http://mr.caltech.edu/media/Press_Releases/PR13104.html.

Tech Talk . . . from page 13

ing up my PhD in Applied Physics at Tech, I worked at Digital Domain and was a member of the 1997 Oscar Winning Visual FX team that worked on *Titanic*. Six years later, I received a 2003 Technical Achievement Award from the Motion Picture Academy for my contributions to the Deep Canvas process used on the Walt Disney films *Tarzan*, *Atlantis* and *Treasure Planet*. Currently, I am a Sequence Lead (i.e., Lighting and Compositing supervisor) at Walt Disney Animation Studios where I am finishing up work on the CG-animated film *Bolt,* which is due out this Thanksgiving.

I thought you might be interested in the significant number of Caltech alumni that are currently working with me at Walt Disney Animation. Besides the two other alumni that work with me in the Lighting department (Steve Hwan and Jason Macleod), there are several other alumni that have worked on *Bolt* and are currently working on other films at Disney (Tal Lancaster and Yun-Chen Sung). It's very interesting how our Caltech experiences have helped us thrive in this incredibly artistic and technical atmosphere.

—Chris Springfield, PhD '98

You tracked down Scotty, which is what he liked to be called in his undergrad days of purple hair and genie pants. *{Ed.note: He still goes by "Scotty."}* You know, I really liked students from the Chemistry Animation Project like Scotty, because they combined the Caltech math/engineering/science skills with really great artistic and animation talent. Scotty was very creative, valuable, and really fun to be around and was most definitely not in the standard Caltech undergrad mold.

I have had many students involved with CAP, who, like Scotty, have gone on to use CAP as a launching pad for FX careers in Hollywood and the industry in general. For example, Todd Allendorf is a game developer extraordinaire, credited on *The Godfather: The Game* (2006), *007: Everything or Nothing* (2004), and *007: Nightfire* (2002), all by Electronic Arts, Inc. Sean Upchurch is at City of Hope now and was on campus and at JPL for a long time, and Chris Bryant is now at Microsoft. I'd like to know what the other students who were involved in CAP are up to now.

—Nate Lewis '77, MS '77

Lewis is Argyros Professor and Professor of Chemistry at Caltech.

Alumni Notes

1952

Henry L. Richter, PhD '56, was invited by the American Institute of Aeronautics and Astronautics to join Jet Propulsion Laboratory director Charles Elachi and past directors Ed Stone, Lew Allen, and Bruce Murray in receiving the 2008 AIAA Foundation Award for Excellence, which was presented to JPL at the AIAA's Aerospace Spotlight Awards Gala on May 14 at the Ronald Reagan Building and International Trade Center, in Washington, D.C. "I guess they needed 'an old guy,'" Richter comments. The invitation included being called to the stage during the presentation, with the opportunity to make some brief remarks. The award citation recognizes JPL for its "50 years of historic space exploration which began with the first Earth-orbiting U.S. satellite—Explorer 1—and continues today throughout the solar system, and beyond."

1956

Don Lewis reports that in April he was awarded an honorary membership in the 33,000-member American Association of Petroleum Geologists; this followed a term as vice president in 2002 and his receiving the Distinguished Service Award in 2003. He retired at the end of 1995 as chief geologist for Chevron after 37 years with the company. His wife, Sue, and their family lived overseas for five of those years, he adds, "and we are now keeping the airlines afloat by traveling a lot."

1959

Izzat M. Idriss, MS, a professor emeritus at UC Davis, has been named a distinguished member of the American Society of Civil Engineers (ASCE). The society's highest accolade, the honor recognizes members who have achieved eminence in a branch of engineering—ASCE's active roster of distinguished members comprises only 193 of the society's more than 140,000 members worldwide. Idriss, who is being honored for his contributions to understanding soil behavior during earthquakes and to the development of analysis procedures now widely used, will be formally inducted in November, at ASCE's Annual Civil Engineering Conference in Pittsburgh. Over the past 43 years, Idriss has developed or codeveloped procedures used in ground-response studies, liquefaction evaluations, the performance evaluation of embankment dams during earthquakes, and analytical as well as empirical procedures for assessing the effects of local site conditions on earthquake ground motions. He has investigated numerous major earthquakes during the last 40 years, including the Great Alaska Earthquake of 1964 and earthquakes in Japan and Southern California, and he has directed more than 100 projects pertaining to the earthquake safety of dams, industrial facilities, nuclear power plants, bridges, and pipelines, and has consulted on many other such projects nationally and internationally. Idriss is a member of the National Academy of Engineering and an honorary member of the Japanese Geotechnical Society and has received numerous awards, including ASCE's H. Bolton Seed Medal, Norman Medal, Walter L. Huber Civil Engineering Research Prize, J. James R. Croes Medal, and Thomas A. Middlebrooks Award, as well as UC Davis's Distinguished Public Service Award.

KEEP US INFORMED THROUGH THE CALTECH NEWS ALUMNI NOTES!

Keep us informed so we can keep your fellow alums informed! If you're a Caltech graduate (BS, MS, Eng, or PhD) *Caltech News Alumni Notes* is the place to let us know what you've been doing. Send us news about you and your family, about a new job, promotion, awards, etc., that you'd like to see printed in *Caltech News*. All notes submitted to *Caltech News* will also be posted quarterly on the Alumni Association's Online Notes website, unless the writer specifically requests otherwise. Please return this coupon and any additional materials to *Caltech News*, 1-71, Pasadena, CA 91125.

Name_____

Degree(s) and year(s)_____

Address_____

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Day phone _____ E-mail_____

NEWS_____

1962

Kip Thorne, Caltech's Feynman Professor of Theoretical Physics, received an honorary doctor of science degree from the University of Chicago on June 13. The award citation reads: "Kip Thorne has deepened our understanding of space, time, and gravitation through his research on black holes, gravitational waves, and other aspects of general relativity. He has trained and inspired generations of graduate students, and has provided leadership and vision to scholars and students in the general relativity community." The recipient of numerous honors, including election to the National Academy of Sciences, Thorne is also the recipient of several awards for science writing, and his books include *Black Holes and Time Warps: Einstein's Outrageous Legacy*, with a foreword by Stephen Hawking, and the classic textbook *Gravitation*, coauthored with Charles Misner and John Wheeler.

1966

Axel Meisen, MS, who holds the position of chair of foresight with the Alberta Research Council (ARC), has been named a member of the Order of Canada, Canada's highest civilian honor, in recognition of "his important contributions to the economy of Newfoundland and Labrador through his leadership of the Memorial University of Newfoundland, which led to a significant increase in enrolment, unprecedented funding and enhanced research capacity." Meisen served as president of Memorial University from September 1999 until December 2007, then joined ARC in January 2008 as chair of foresight. The Order of Canada, whose motto is Desiderantes Meliorem Patriam (They desire a better country), is the centerpiece of Canada's honors system and recognizes a lifetime of outstanding achievement, dedication to the community, and service to the nation. At ARC, Meisen works to identify key areas of research for the council and to help focus the council's activities where they will have the greatest benefit for Alberta. He recently headed ARC's inaugural Jasper Innovation Forum, held June 11–14, which, according to the council, "gathered top innovators from around the world with the intent of identifying potential areas for research that will have significant and long-term impact on the province and the globe." Meisen received his PhD from McGill University in 1970.

Elette Boyle '08, shown above in competition last spring at Pomona–Pitzer, left Caltech in June with honors in mathematics, an outstanding record in track and field, and a coveted NCAA Postgraduate Scholarship, awarded in recognition of her all-round athletic and academic achievements. The scholarships, which include a one-time grant of $7,500, are awarded each sports season to 29 men and 29 women in their final year of intercollegiate athletics competition for outstanding performance in both sports and scholarship. A native of Yamhill, Oregon, Boyle led the Caltech Beavers' track and field program as she earned All-Southern California Intercollegiate Athletic Conference (SCIAC) honors in the high jump, received the SCIAC/President's Award as Caltech's female scholar-athlete of the year, and won the Institute's 2007 Robert P. Balles Caltech Mathematics Scholars Award in 2007. She now heads to MIT to begin graduate studies with support from a National Defense Science and Engineering Graduate Fellowship.

1974

Jack Geltosky, PhD, senior vice president of business development, life sciences, for Arizona Technology Enterprises, has been appointed to the board of directors of Enzon Pharmaceuticals, which develops, manufactures, and commercializes medicines for patients with cancer and other life-threatening conditions. With more than 20 years of pharmaceutical experience, Geltosky has worked for companies such as Bristol-Myers Squibb, SmithKline Beecham Pharmaceuticals, and Johnson & Johnson, where he collaborated closely with R&D and marketing. He is known for his expertise in developing business strategies for the commercialization of proprietary, breakthrough technologies across a variety of therapeutic areas. After receiving his doctorate from Caltech, Geltosky completed an NIH Postdoctoral Fellowship and an American Cancer Society Fellowship, California Division.

As *Caltech News* went to press, the Chicago-based media company Tribune Co. announced that it had named **Eddy Hartenstein**, MS '74, the new publisher of the *Los Angeles Times*, the fourth largest daily newspaper in the U.S. One of the principal developers of the satellite TV industry, Hartenstein was working for Hughes Electronics Corp. when he got the idea to use satellites and digital technology to bring television programs into consumers' homes. The idea became DirecTV, which was launched in 1994, using a small 18-inch dish that could be mounted on any rooftop or the side of any apartment building. Hartenstein left the company in 2004, when its revenues totaled $11.4 billion, a year after Rupert Murdoch's News Corp. acquired a 34% interest in the firm. Hartenstein, a member of the National Academy of Engineering and a 2007 recipient of an Emmy for lifetime achievement from the National Academy of Television Arts and Sciences, has been praised for his vision. The newspaper industry has suffered major declines in circulation and advertising revenue over recent years, and Hartenstein will be the fourth publisher since Tribune acquired the *Times* in 2000 to attempt to reverse the paper's fortunes. "I love challenges," Hartenstein told a *Times* reporter. "I love complex issues and problems, and this certainly met all that."

Ken Suslick writes that he has received the 2007–08 Sir George Stokes Medal from the Royal Society of Chemistry. This year marks his 30th year at the University of Illinois. He adds, "Even harder to believe, my son Ben will be getting his driver's license this fall." At UI Urbana-Champaign, Suslick is Marvin T. Schmidt Professor of Chemistry, professor of materials science and engineering, and a professor in the Beckman Institute for Advanced Science and Technology. According to the Stokes Medal citation, he has been honored "for his interdisciplinary research on the chemical effects of ultrasound, including pioneering work on acoustic cavitation, sonocatalysis and sonoluminescence, and research on the bioinorganic and materials chemistry of metalloporphyrins and their applications as chemical sensors."

Robert Wieting has been hired as vice president of research and development at Stion, "a next-generation solar photovoltaic company developing high-efficiency thin-film modules using proprietary materials and device structures." Wieting, who has 28 years of product-development experience in photovoltaics, will lead all of Stion's day-to-day R&D activities. He comes to Stion from Regenesis Power LLC, where he served as the company's chief technical officer. Prior to that he was director of engineering at Shell Solar Industries, and earlier he worked at Shell predecessor companies Siemens Solar, PV Electric GmbH, and Arco Solar in a variety of management positions involving both R&D and engineering. Wieting received his PhD in physical chemistry from Stanford University. He holds five U.S. patents focused on photovoltaics.

1975

John Richard "Dick" Bond, MS, PhD '79, University Professor in the University of Toronto's department of astronomy and astrophysics, and director of the Canadian Institute for Advanced Research (CIAR) Cosmology and Gravity Program, has been named the recipient of the 2008 Peter and Patricia Gruber Foundation Cosmology Prize in recognition of "his pioneering contributions to our understanding of the development of structures in the Universe." The award citation continues: "Professor Bond's work has provided the theoretical framework to interpret the observed inhomogeneities in the fossil radiation left over from the early stages of expansion of the Universe—the Big Bang. Professor Bond's research has helped us understand the transition from the nearly featureless early Universe to the wonderfully structured world of galaxies, stars and planets today." The award carries a gold medal and an unrestricted cash prize of $500,000. According to the Gruber Foundation website, "J. Richard Bond's approach to cosmological questions combines a unique blend of original theory and full involvement in the observations made by experimental teams. He has helped usher the field through three decades of what has been described as its 'golden age.' Bond's work is known for the solution of outstanding and important problems through detailed and thorough calculations and comparisons with observation."

1981

Manos Maragakis, MS, PhD '85, has been named interim dean of the College of Engineering at the University of Nevada, Reno, effective July 1. A Foundation Professor in the department of civil and environmental engineering and a longtime chair of the department, Maragakis is an internationally known researcher into the seismic response of large-scale structures such as buildings and bridges, and has directed a pioneering $3.6 million National Science Foundation project to study the seismic performance of ceiling-piping-partition nonstructural systems, which represent 75 percent of the value of buildings exposed to earthquakes in the United States. Maragakis joined the university in 1984, and in 1994 became both full professor and chair of the department, which was recently recognized by *U.S. News & World Report* as ranking in the top 50 civil-engineering programs among the nation's public institutions.

1986

Taylor W. Lawrence has been named president of Raytheon Missile Systems, headquartered in Tucson, Arizona. Lawrence, who joined the Raytheon Company in 2006, had been serving as vice president of engineering, technology, and mission assurance at Raytheon Company headquarters in Waltham, Massachusetts, where he provided leadership in the areas of technology and research, engineering, operations, performance excellence, Raytheon Six Sigma, and mission assurance. He was responsible for 45,000 engineers across the company working on more than 8,000 programs. Prior to joining Raytheon, Lawrence served as a divisional vice president and general manager at Northrop Grumman. He has also served as the staff director for the Select Committee on Intelligence for the U.S. Senate and been deputy director of the Information Systems Office of the Defense Advanced Research Projects Agency. Lawrence currently serves as vice chairman of the Air

Force Studies Board of the National Academies. He received his PhD in applied physics from Stanford in 1992.

1989

Steve Sogo, MS, reports that in May he received an Amgen Award for Science Teaching Excellence. The award honors teachers based on their creativity and ability to motivate students and provides total prize monies of $10,000. "I have been teaching chemistry at Laguna Beach High School for the past seven years, and my crowning achievement has been the creation of a chemical research class." He adds that, while the class hasn't published a paper yet, it is "investigating a few exciting projects" that may produce results worthy of publication in the coming school year.

Holden Thorp, PhD, chair of the department of chemistry and dean of the College of Arts and Sciences at the University of North Carolina at Chapel Hill, has been named the next UNC chancellor, effective July 1. A member of the UNC faculty since 1993, Thorp also served as director of UNC's Morehead Planetarium and Science Center from 2001 to 2004. He has in addition been involved with several companies, his latest venture being Viamet Pharmaceuticals. He is a partner as well with venture-capital firm Hatteras Venture Partners, and he has been involved with Novalon, a Durham, North Carolina, company that was purchased for about $106 million by Sweden's Karo Bio in 2000. Other companies include Xanthon, Osmetech, OhmX, and MaxCyte. Thorp's selection as chancellor reflects a growing emphasis on research at UNC.

1990

Bill Softky, MS, PhD '93, has been appointed chief algorithm officer at Epic Advertising. While the online performance marketing company has its headquarters in New York, Softky will be based in the firm's San Francisco office. He will be responsible for managing, designing, and prototyping the company's ad-serving and retargeting optimization algorithms and architecture. Prior to joining Epic Advertising, Softky served as principal investigator at the Redwood Neuroscience Institute, where he created the architecture for a brainlike processing network. He has also worked in the field of neural statistics, and he introduced an innovation into Microsoft's PreFix automatic debugging technology that came close to eliminating system crashes in Windows 2000 and XP.

1991

Michael P. DeLisio, MS, PhD '96, cofounder and chief technology officer of Wavestream Corporation, has received a 2008 Outstanding Young Engineer Award from the Institute of Electrical and Electronics Engineers (IEEE) Microwave Theory and Techniques Society (MTT-S). The annual award recognizes MTT-S members under the age of 39 who have distinguished themselves through technical achievements, service to the MTT-S, or a combination of both. DeLisio was honored for his contributions to the development and commercialization of techniques for combining microwave- and millimeter-wave spatial power, as well as for service to the MTT-S. He has served as Wavestream's chief technology officer since its founding in 2001. An internationally recognized expert on spatial-power combining, DeLisio holds three patents and has published more than 50 papers. Prior to cofounding Wavestream, he taught engineering at the University of Hawaii and was a visiting associate at Caltech. The MTT-S promotes the advancement of microwave theory and its applications, including RF, microwave, millimeter-wave, and terahertz technologies, and Wavestream develops and produces high-power solid-state amplifiers for communications and sensing systems.

Francis J. "Frank" Doyle III, PhD, has been appointed associate dean for research at UC Santa Barbara's College of Engineering, where he will help identify, create, and pursue new research initiatives within the college and collaboratively across the campus and with external partners, particularly at the confluence of medicine and technology. Doyle came to UC Santa Barbara as the first Duncan and Suzanne Mellichamp Chair in Process Control in Chemical Engineering, and he holds additional appointments in biomolecular science and engineering and in electrical and computer engineering. As associate director of the Institute for Collaborative Biotechnologies, he led the initiative in network science, creating a campus nexus for systems biology. He is also principal investigator for the newly announced UCSB–Pfizer Insulin Resistance Pathways Project. Immediately prior to UCSB, Doyle held a Humboldt Research Fellowship in the Institute for Technical Process Systems Theory at Stuttgart University in Germany, and he has also held tenured faculty positions in chemical engineering at the University of Delaware and Purdue and has worked in industry. He recently was elected a fellow of the IEEE, and his current research interests include systems biology, circadian rhythm, and diabetes.

1997

Christopher J. Chang, MS '97, an assistant professor of chemistry at UC Berkeley and a faculty scientist in the Chemical Sciences Division of Lawrence Berkeley National Laboratory, is one of five UC Berkeley faculty members appointed Howard Hughes Medical Institute (HHMI) investigators. One of the most sought-after honors in biomedical research, the appointment offers guaranteed research support for five, 10, or more years. The five are among 56 researchers "given the opportunity" by HHMI "to tackle their most ambitious, risky research plans" and join 300 other HHMI investigators, nine of them at UC Berkeley, from academic institutions around the country. An engineer turned chemist, Chang develops novel small molecules and uses them to probe the roles of metals and oxidation chemistry in the normal brain as well as in aging and in neurodegenerative diseases such as Alzheimer's and Parkinson's. His laboratory creates "smart probes" to study communication in the brain, specifically the roles played by metals such as copper and molecules such as hydrogen peroxide. HHMI is a nonprofit medical research organization that has invested more than $8.3 billion over

the past two decades in the support, training, and education of the nation's most creative and promising scientists.

Blythe Chad Deckman, MS, PhD '00, has been appointed vice president, engineering, by Wavestream Corporation, a manufacturer of compact, highly efficient solid-state power amplifiers. A cofounder of Wavestream, Deckman had served as the company's director of research and development since its inception in 2001. Prior to cofounding Wavestream, Deckman was a hardware design engineer at Agilent, with responsibility for designing a variety of microwave components. Noted for his deep knowledge of and design experience with high-power, high-efficiency Grid Amplifier modules, Deckman holds six patents across a variety of technologies and has a patent pending on power management for active-loop spatial-power combiners. In addition, Deckman's 38 GHz, 5-watt single-chip Grid Amplifier holds the record for the highest output power from a single chip at that frequency. He has also authored several papers for industry conferences and trade publications.

1998

Stephen Glade, MS, PhD '01, reports his graduation with a JD last May from UC Hastings College of the Law, in San Francisco. After taking the bar exam in July, he will be an associate at Weaver Austin Villeneuve & Sampson LLP, in Oakland, California, practicing patent prosecution.

1999

Matt Gregori and **Ben Kulick** '01, recently completed an epic journey by car from San Luis Obispo, California, to Panama City, Panama. Equipped with two modified Ford Bronco IIs, the pair spent seven weeks navigating through eight countries. Along the way, they explored the Mayan ruins of Mexico, dove the barrier reef off the coast of Belize, met the indigenous Mayan people in the pristine highlands of Guatemala, visited an American-made 500-pound bomb crater in El Salvador, paddled the rapids of the Rio Cangrejal in Honduras, climbed to the active crater atop the Masaya volcano in Nicaragua, petted a 15-foot-long crocodile named Fidel Castro in Costa Rica, and transited the Mira Flores and Pedro Miguel locks on the Panama canal in a boat once owned by Al Capone.

2000

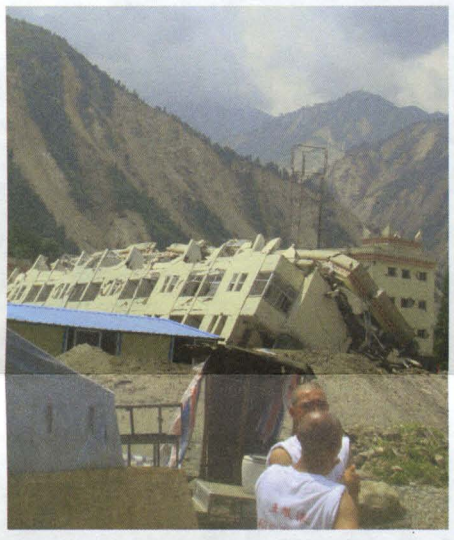
Ryan Patterson, currently Richard Chace Tolman Postdoctoral Scholar in Experimental Physics at Caltech, is a corecipient of the Fermilab/URA Graduate Thesis Award. He and fellow recipient Peter Wagner of the University of Pennsylvania will split a $3,500 prize funded by the Universities Research Association. Patterson's dissertation, "Search for Muon Neutrino to Electron Neutrino Oscillations at Delta M Squared > 0.1 eV Squared," presented findings declared by the American Institute of Physics to be among the top science results of 2007. Patterson received his PhD from Princeton this year.

2002

Michael Russo has joined the California Public Interest Research Group, or CALPIRG, as staff attorney. Based in the organization's Los Angeles office, he also works as an advocate regarding health-care and public-health issues. He graduated from Columbia Law School in 2007 and has previously worked in the areas of human rights and of First Amendment issues.

Quake Engineers . . . from page 9

"Often schools are the first buildings that towns build when they grow from farming communities to urban centers," says Iwan, who has been a member of an international committee that studied school seismic safety. "There's certainly no intention to make them the worst constructed buildings, but because they are older, and may even have been built by volunteers, the quality of design and workmanship may not be as good" as subsequent buildings. "It's not surprising then, that when there is an earthquake, schools tend to suffer the most damage. If schools



Due to inadequate construction, many schools in Sichuan collapsed during the Wenchuan earthquake, including this middle school in the town of Yingxiu.

are the most valued by a community, they should be continually upgraded or replaced to maintain their higher level of safety."

Like Huang, Wang says that buildings constructed to code in earthquake zones should be structurally sound after a small earthquake, suffer repairable damage during a moderate earthquake, and remain standing after even a major temblor like the Wenchuan earthquake, although some will probably be seriously damaged. He speculates that "for the schools, there's no clear stakeholder. That's why they were built so shabbily. Floors collapsed like a waffle."

Another sad outcome of the earthquake, Huang says, is that buildings that are habitable remain unoccupied, since as yet there doesn't appear to be a national procedure for local building officials to quickly evaluate the standing structures for occupancy. So thousands of people who could be sheltered remain camped out in tents. The lesson, Huang says, is that "we should not compete with nature. Instead, we should learn to live with it by understanding the earthquakes and doing good planning and design for infrastructure and construction. I always feel bad for the people who suffered, but hopefully, this will improve conditions for the next generation."

Obituaries

1933
Harold E. Pearson, Ex, on July 22.

1935
Robert H. Dourson, BS '40, Eng '42, on May 8.

1937
Noel R. Park, on March 23.

1939
William R. Frampton, on July 22; **Kenneth G. Macleish**, on May 31.

1940
William E. Brown, on November 26, 2002; **Harold B. Crockett**, MS, on June 10, 2007; **Leo Davis**, MS '42, on October 4, 2002; **William E. Gentner**, MS, on February 14, 1989; **Forrest H. Hall**, MS, on September 2, 2007; **Clark L. Hosmer**, MS, on June 27, 2001; **Charles S. Palmer**, on May 5.

1942
Edwin "Ted" Reed Fay, MS, on July 2.

1945
Arthur C. Wilbur, on September 24, 2007.

1946
James F. Chalmers, BS '47, on December 11, 2006; **Rowland Prideaux-Brune**, Ex, on May 21.

1948
George S. Holditch, on May 21.

1949
Donald E. Tryk, on May 28; **Thomas A. Turner**, on May 11; **Robert L. Walquist**, on July 20.

READ COMPLETE *CALTECH NEWS* OBITUARIES ONLINE

The full Caltech News *obituaries may be found at http://alumni.caltech.edu/network/obituaries, where readers can browse expanded content and additional biographical information about the alumni listed here.*

1950
Robert H. Korkegi, MS, PhD '54, on June 11.

1951
Robert G. Boyer, on May 9; **G. Berk Welch**, on June 21.

1954
Hugo Wahlquist, MS, on June 14.

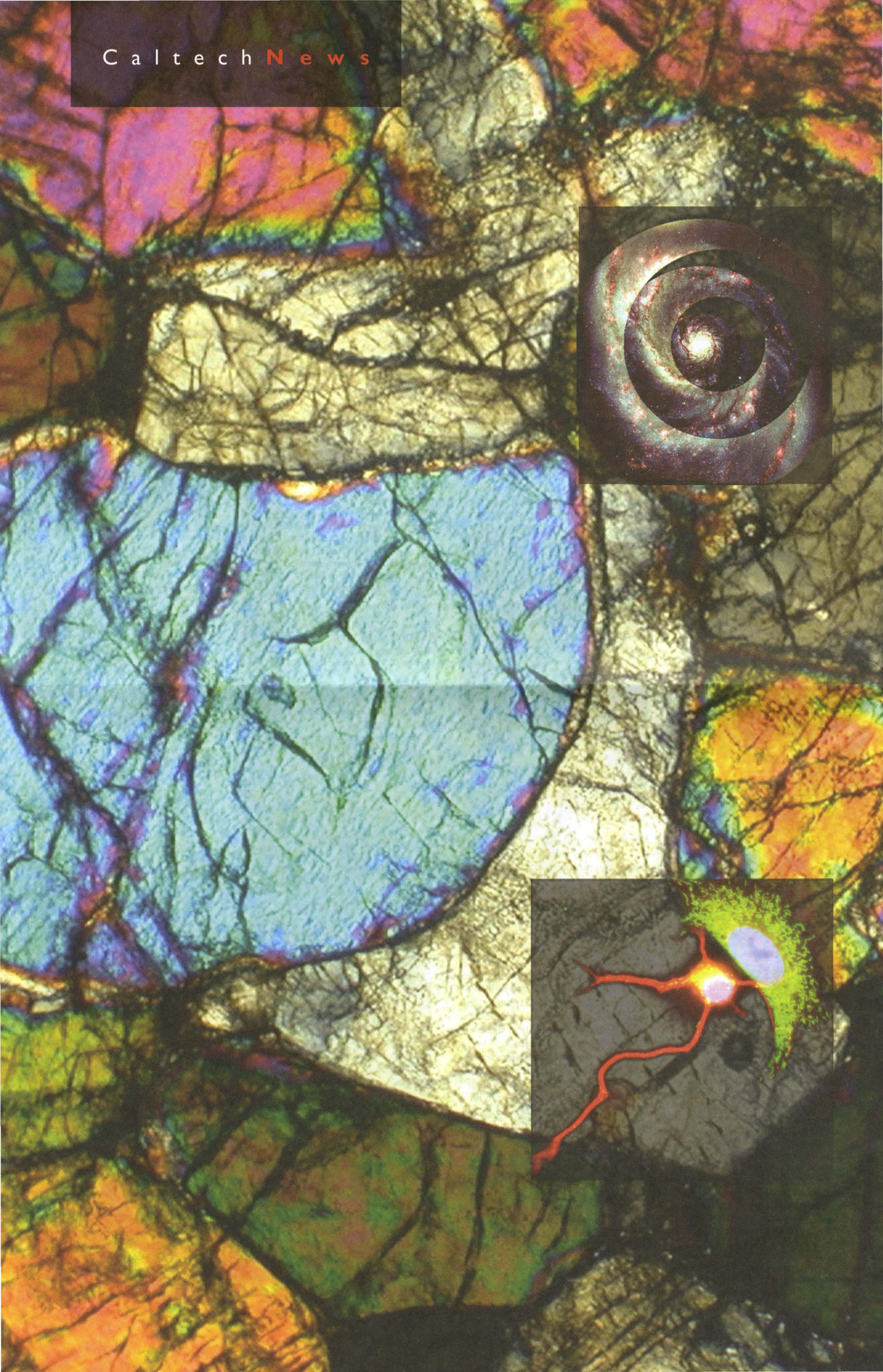
1956
Wilmot G. Brownlee, MS, PhD '59, on December 7, 2007.

1968
Jerome M. Auerbach, MS, PhD '75, on September 4, 2006.

1972
Carol L. Kornblith, PhD, on July 4.

ARTSY SCIENCE ROCKS

What do the three images on the back-page poster have in common? Students created them for Caltech's first Art of Science contest (see UpFront, page 2). To do this, they manipulated light with such tools as microscopes and filters to illuminate the physical properties of their subjects. Geology grad student Emily Hamecher focused her petrographic microscope on a thin slice of rock melted on a slide to produce "Seeing through Rocks." Using crossed polarizers—one above and one below the sample of peridotite xenolith—the dominant rock of the upper part of Earth's mantle—she created colors that vary according to the form of the crystal and helped her to identify its components of olivine, orthopyroxene, and clinopyroxene. *Caltech News* took artistic license in lightening the backgrounds of the two images overlaying the rock. In the upper right corner of the poster is "Mistakes Can Be Beautiful," by undergraduate Ashley Potts, who happened upon her creation in the course of a SURF project while looking at Hubble Telescope images of the M51 Whirlpool Galaxy. The galaxy's brilliantly lit core is believed to be a hotbed of star formation, and Potts was busy rescaling the brightness of concentric rings around the galactic center to get a better look at the details when she accidentally switched two variables and produced overlapping rings. She then deliberately combined three Hubble images taken at different wavelengths in order to assign colors to each wavelength and illuminate features of particular star-forming regions. Below Potts' otherworldly image is "Neurons with Glia," which garnered a second-place award for chemistry grad student Heather Murrey, who was reminded of objects in space when she created her entry by photographing magnified co-cultures of neurons and glial cells from the brain.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