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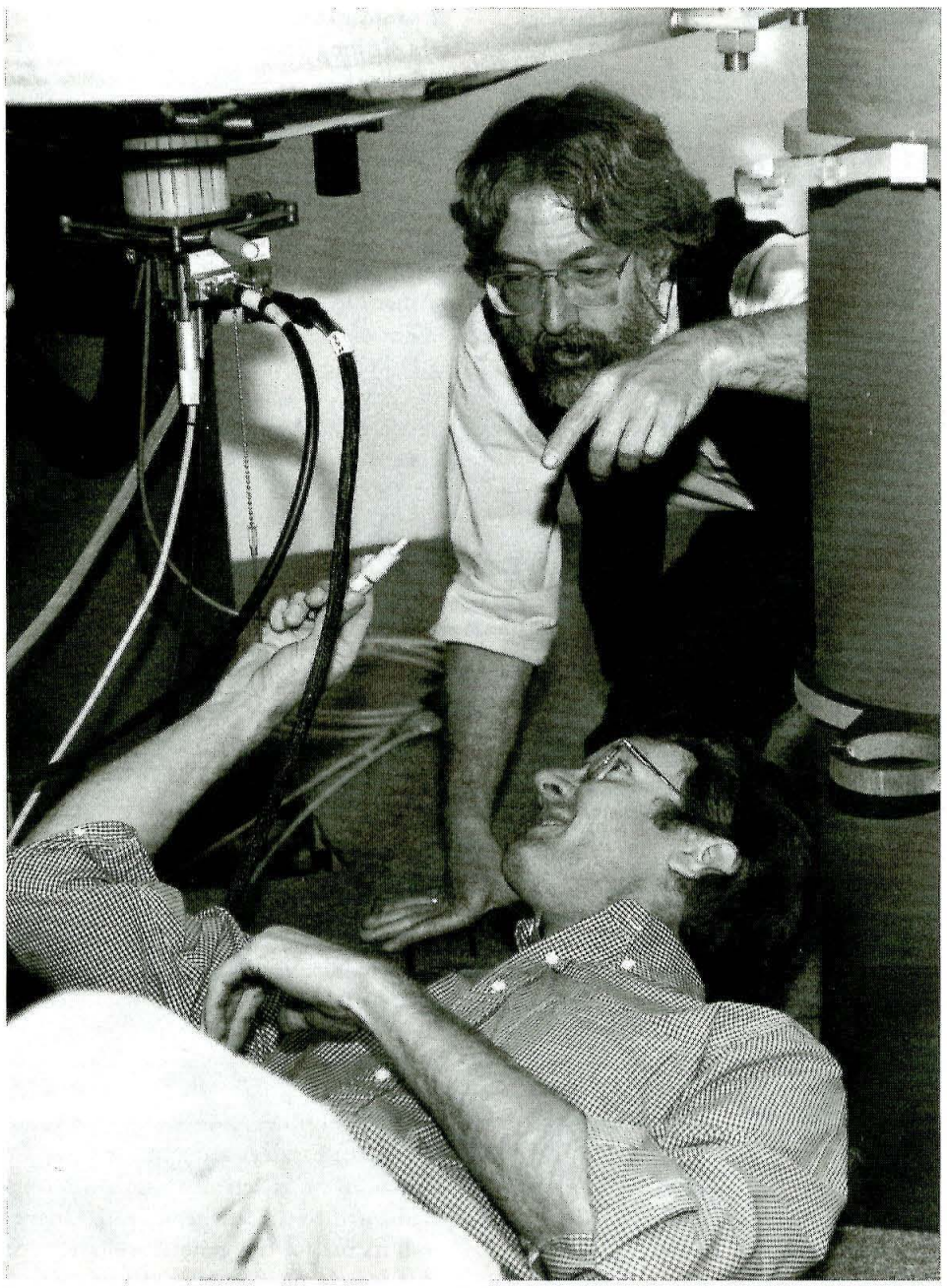


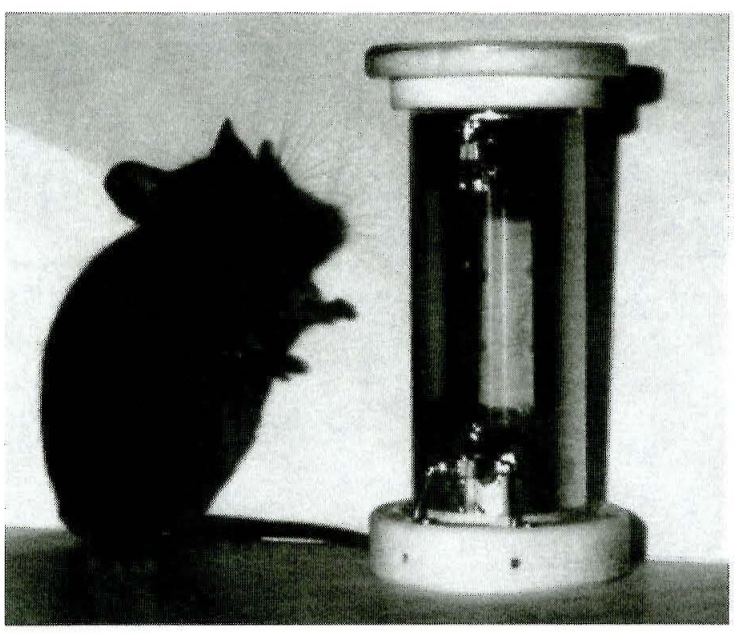
Positioning an animal inside the bore of the Biological Imaging Center's MRI machine is about as much fun as, and looks somewhat like, changing the oil of a car. Scott Fraser, under the magnet, demonstrates the technique, while Russ Jacobs makes sure Fraser doesn't damage the equipment.

The image-makers

By Michael Rogers

On a typical work day, Scott Fraser, the director of Caltech's innovative Biological Imaging Center, drives 120 miles round trip between his home in Newport Beach and his lab in Pasadena. With all that commuting, it's no wonder that when he discusses his work using magnetic resonance imaging (MRI) technology to follow cell migrations in living organisms, he describes it in terms of traffic patterns.

Imagine, he says, that you knew nothing about how traffic worked and decided to find out about it by taking still pictures from the sky of the streets and freeways below. One of the things you would photograph is cars stopped at a red light, but how would you know what this meant? "It would be hard to look at one picture of traffic and tell the difference between a final destination and a red light," says Fraser, the Anna L. Rosen Professor of Biology. "You might conclude that red lights are very attractive because cars pile up near them. You would mistakenly assume that the waiting period meant something more significant than it does."



This pregnant subject mouse is shown with the antenna that receives and transmits the information used to generate magnetic resonance images of the developing embryos she is carrying (see photos, page 4). The imaging procedure does not harm the mouse.

For years, biologists have studied the development of embryonic organisms in just this imprecise and potentially misleading way, looking at cells with high-powered optical microscopes that were best suited to studying dead organisms. This limitation forced biologists to examine many different embryos to get as complete a picture as possible, stopping at successive stages of development and deducing what had occurred in the gaps. But the technology developed by Fraser and his Caltech colleagues leaves virtually no gaps, as they watch individual cells and their progeny develop in vertebrate embryos. By watching the action unfold in live organisms, Fraser has been able to discover that development doesn't always occur the way the textbooks say it does.

"Big questions remain about how you go from a fertilized egg that's only a single cell to a complex working organism, made up of hundreds of billions of highly specialized cells," Fraser says. By tagging select cells in the developing embryo and watching what happens to them as the embryo matures, the Biological Imaging Center is providing new insights into central issues of developmental biology. The key question they are probing has to do with cell fate: How do a small number of localized cells that start out looking and acting pretty much the same in the newly formed embryo end up far from home in different parts of the developed organism, performing very different functions? Is it primarily genes or environmental cues from their immediate neighbors that determine whether one cell becomes part of the heart or hand while another migrates toward the brain or the liver? And what specifies a cell's function once it is assigned to a part of the organism and migrates there? In exploring these questions, the center is also initiating experiments that may have significant medical applications in the area of regeneration and recovery from trauma.

It's fair to say that the high-tech, $3.5 million Biological Imaging Center probably wouldn't exist without a low-tech coffee machine. That's where Fraser and Russ Jacobs, the scientist responsible for developing Caltech's imaging equipment, kept running into each other in the late 1980s. At the time, both were working at UC Irvine, and the coffee machine was located in a room between their labs. Fraser was an associate professor and later professor and chairman of the department of physiology and biophysics, conducting embryological experiments using optical microscopes. Jacobs ran a lab that used nuclear magnetic resonance imaging (MRI) equipment to understand the chemical structure of biological membranes and molecules.

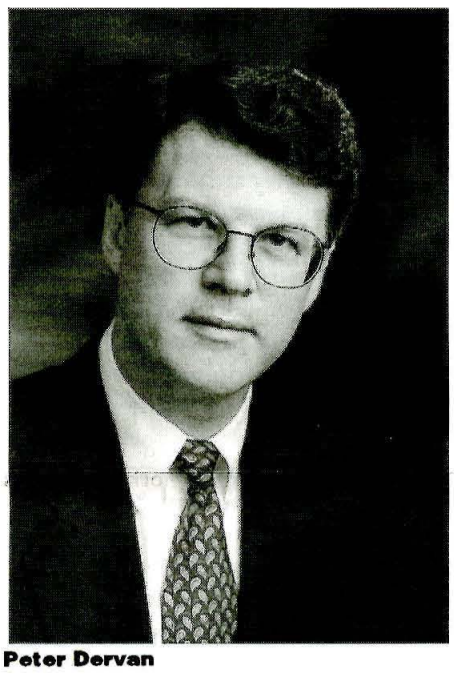
During many coffee klatches, Fraser and Jacobs discussed whether MRI equipment used for diagnostic purposes in hospitals could be applied to study developing organisms at the cellular level. While Fraser was able to get detailed images using confocal microscopes that use visible light, he found himself frustrated by the limitations of the microscopes, because they could only image living tissue to a depth of 100 microns below the surface. "So Russ's interests with his magnetic resonance work, developing microscopic techniques to look at the structure of smaller and smaller specimens, and my

Continued on page 4

CAMPUS UPDATE

Peter Dervan to chair Chemistry and Chemical Engineering

Peter Dervan, the Bren Professor of Chemistry and a member of Caltech's faculty for 21 years, has been named the new chair of the Institute's Division of Chemistry and Chemical Engineering. Dervan begins his new assignment July 1, succeeding Professor of Chemistry Fred Anson '54, who is stepping down as chair after ten years.



Peter Dervan

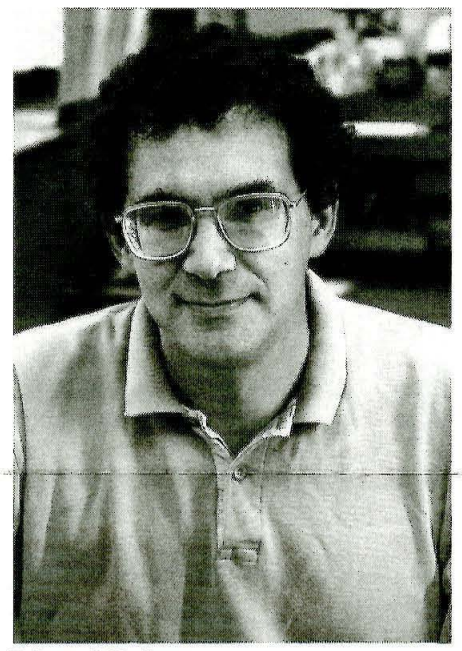
A native of Boston, Dervan received his BS degree from Boston College in 1967 and his PhD from Yale in 1972. He joined the Caltech faculty in 1973 as an assistant professor. He was appointed associate professor in 1979, full professor in 1982, and named to the Bren Chair in 1988.

In his work, Dervan has pioneered research at the interface of chemistry and biology. His group is defining the principles for targeting single sites in DNA by chemical methods. In 1993 the American Chemical Society recognized Dervan for his research, honoring him with the prestigious Arthur C. Cope Award.

Dervan's numerous awards include the Willard Gibbs Medal and the William H. Nichols Medal. Well-known for his commitment to undergraduate teaching, Dervan received the highest honor given by Caltech undergraduates—the ASCIT teaching award in 1980 and 1981. Dervan is a member of the National Academy of Sciences, and a fellow of the American Academy of Arts and Sciences.

Caltech's Edward Stolper, four alumni elected to NAS

Caltech geologist Edward Stolper was elected in May to the National Academy of Sciences, one of the U.S. scientific community's highest honors. Stolper, Caltech's William E. Leonhard Professor of Geology, was one of 60 new members and 15 foreign associates named to the NAS in recognition of their distinguished and continuing achievements in original research.



Edward Stolper

Stolper, 41, was educated at Harvard, where he received his AB in 1974 and his PhD in 1979, and at the University of Edinburgh, where he earned a Master of Philosophy degree in 1976. In 1979, he joined Caltech's faculty as assistant professor of geology. He was named associate professor in 1982, full professor in 1983, and appointed to the Leonhard Chair in 1990. Since 1989, he has also served as executive officer for geology in the Division of Geological and Planetary Sciences.

Stolper's research centers on the origin and evolution of igneous rocks—rocks formed from molten or partially molten material. Igneous rocks come in many forms and ages, including lava recently erupted from volcanoes, ancient rocks formed deep in the earth, lunar and Martian rocks, and meteorites whose melting and recrystallization records events that occurred before the earth formed. Stolper's current work includes experimental studies of the properties of magmas at high temperatures and pressures; investigations of the behavior of volatile components such as water and carbon dioxide during igneous processes; studies of the origin and evolution of igneous meteorites; and studies of the processes by which igneous rocks from the ocean floor are formed. He is also involved in a project that has drilled out a 1-kilometer-long core from the volcano Mauna Kea on the Big Island of Hawaii, with the aim of clarifying the long-term history of magma production from this volcano.

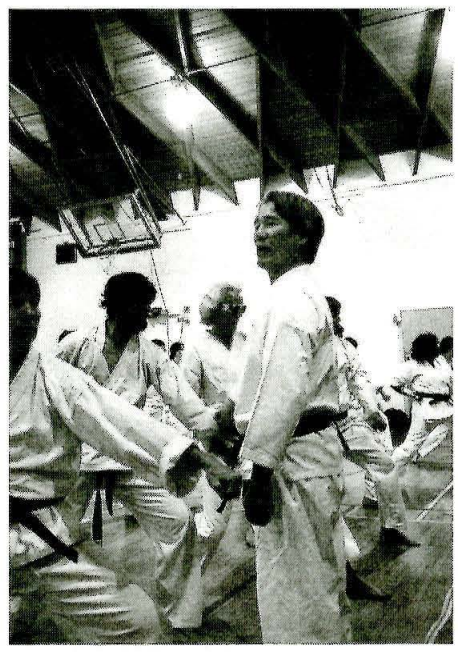
The honors Stolper has received for his research achievements include the Newcomb Cleveland Prize of the American Association for the Advancement of Science (1984), the F. W. Clarke Medal of the Geochemical Society (1985), and the James B. Macelwane Award, presented by the American Geophysical Union (1986). In 1991 he was elected a Fellow of the American Academy of Arts and Sciences. He is the author or coauthor of numerous papers in his areas of expertise and has served on the NAS Research Briefing Panel on Solid Earth Sciences, as well as on NASA's Planetary Geosciences Strategy Committee.

Joining Stolper as new NAS members for 1994 are four Institute alumni: Eric Adelberger '60, PhD '67, professor of physics at the University of Washington; Gerald Fasman, PhD '52, Rosenfeld Professor of Biochemistry at Brandeis University; Maynard Olson '65, professor of molecular biotechnology at the University of Washington; and William Press, PhD '73, professor of astronomy and physics at Harvard.

Established in 1863 by a congressional act of incorporation signed by President Lincoln, the NAS is a private organization of scientists and engineers dedicated to the furtherance of science and its use for the general welfare. The Academy acts as an official adviser to the federal government, upon request, in any matter of science or technology.

Three alumni elected to NAE

Mark Kryder, PhD '70, John Rice, PhD '59, and George Sutton, PhD '55, have been elected to the National Academy of Engineering, one of the highest honors that can be accorded a U.S. engineer. Kryder, who is professor and director of the Data Storage Systems Center at Carnegie Mellon University, was honored "for contributions to the understanding of magnetic domain behavior and for leadership in information storage research." Rice, the W. Brooks Fortune Distinguished Professor and chairman of the department of computer science at Purdue University, was elected for "leadership in founding the field of mathematical software and for fundamental contributions to its content." Sutton, who is director and chief scientist of the Washington office of Aero Thermo Technology, Inc., was recognized for "contributions to ballistic missile re-entry, lasers, medical devices, imaging systems, and aero-optics."



Tsutomu Ohshima has taught karate at Caltech for nearly 40 years, and more than 250 Karate Club alumni—from across the United States and as far away as Japan—came to the Caltech gymnasium in May to honor the internationally known karate master with martial-arts demonstrations, tournaments, and what the event's organizers termed "a final practice with Mr. Ohshima." Over the next few years, Ohshima, shown in the photo at right leading a warm-up drill at the exhibition, will be cutting back on his teaching at Caltech in preparation for opening an international karate headquarters near Santa Barbara.

FRIENDS

Lin Laboratory established in memory of alumnus Albert Niu Lin

Caltech has dedicated the Albert Niu Lin Laboratory of Structural Dynamics, named to commemorate Albert Niu Lin, a Caltech PhD in civil engineering who died in 1992 at the age of 34 after a short illness. Among those at the dedication of the new facility, located in Caltech's Thomas Laboratory of Engineering, were Institute Provost Paul Jennings, earthquake engineers and professors George Housner and Wilfred (Bill) Iwan, and Lin's parents, Tse-Wen and Tzi-Ing Lin.

The laboratory has been established through a gift from Lin's parents in order to provide Caltech with a state-of the-art facility for carrying out experimental studies of the impact of ground-shaking on structures and so continue the work on earthquake safety that was the focus of Albert Lin's research career.

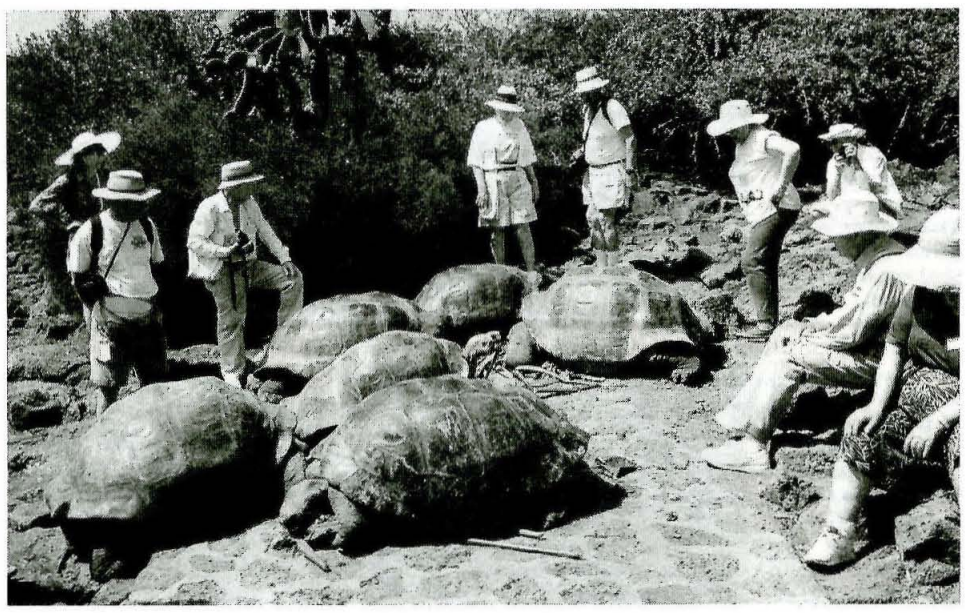
The new Lin Lab is planned as a site for both large- and small-scale experiments that will investigate the impact of ground-motion and shaking on a variety of structures. This research will be supported by the purchase of new equipment, including an electrodynamic shake table, a digital data-acquisition and analysis system, and a new vehicle for field studies.

Albert Lin came to Caltech as a graduate student in 1978, after receiving his BS summa cum laude in civil engineering from the University of Missouri–Columbia. At Caltech, he continued his studies in civil engineering, earning his MS in 1979 and his PhD in 1982.

After graduating, Lin became a partner in T. W. Lin Engineers in St. Joseph, Missouri. He became assistant professor of civil engineering at Kansas State University in 1984 and was named associate professor in 1988. In 1990, he joined the National Institute of Standards and Technology as a research structural engineer in the Earthquake Engineering Group, directing the analytical and experimental investigation of base-isolated structures.

In 1991, Lin was a member of the U.S. delegation that attended the Sino-American Earthquake Symposium in Kunming, China. A copy of the conference's research proceedings was presented to Caltech as a technical reference at the laboratory dedication.

A registered professional engineer, Lin was a member of the Earthquake Engineering Research Institute (EERI) and served as editor of the *EERI Newsletter*. He was also a member of the American Society of Civil Engineers, and chaired the society's Engineering Mechanics Division Technical Committee on Experimental Analysis and Instrumentation.



A recent President's Circle trip to the Galápagos Islands and Ecuador included a visit to the tortoise hatchery at Darwin Research Station on Santa Cruz Island.

Annual Fund honors top workers

Sixteen fund-raising volunteers have been honored by the Annual Fund for exceptional performance in the fund's Regional and Young Alumni campaigns.

In the Regional Campaign, the award for Highest Donor Participation Rate for a Regional Chair Outside California went to *Clay T. Smith*, who achieved a 28.2% contribution rate as chair for Region 07 (Southwestern Sun Belt). Last year's winner for Regional Chair Inside California, *Dr. Robert W. De Grasse*, was honored again this year, achieving a 29.1% rate in Region 5 (San Francsico).

Among Area Chairs, *Dr. Alfred B. Brown* achieved the highest rate for an Area Chair Outside California, with a 44% contribution total from Area 540 (Northern New Jersey). Carrying off the Area Chair Inside California honors for a second year was *James J. Kosmicki*, who achieved a 56.3% rate from Area 026 (Arroyo).

Five Volunteers achieved 100% participation for their areas: *Stanley G. Williamson*, Area 295 (San Diego City); *John E. Leib*, Area 310 (North and East San Diego); *Dr. John L. Honsaker*, Area 353 (Western Canada); *Joel H. Gyllenskog*, Area 361 ("Big Sky"); and *Dr. David H. Hall*, Area 540 (Northern New Jersey).

In the Highest Percent of Dollar Goal Attained category, the highest achievers were *Dr. E. Ted Grinthal,* who as Regional Chair Outside California, attained a contribution rate of 143.2% from Region 12 (Mid-Atlantic); and *Raymond K. H. Chow*, who realized the highest total for a Regional Chair Inside California—124.8% from Region 06 (East Bay/Northern California). *Dr. E. Ted Grinthal* also took top honors as Area Chair Outside California, with a contribution rate of 797.6% from Area 545 (Central New Jersey). *Dr. Alan M. Breakstone* got the nod as Area Chair Inside California, for achieving a total of 195.3% from Area 234 (Mountain View).

Recognized for achieving the Highest Donor Participation Rate in the Young Alumni Campaign were House Chair *Stefan Feuerabendt*, Fleming House—29.4%, and Class Chair, *Brian P. Daniels*, also of Fleming—88.9% from the Class of 1988. In the Highest Percent of Dollar Goal Attained category, the top achievers were House Chair *John F. Houde*, Blacker House—124.0%, and Class Chair *Robert C. Young*, Page House—368.9% from the Class of 1988.

Alumnus SanPietro endows scholarship

Institute alumnus Craig SanPietro has made a gift to Caltech of $250,000 to endow the SanPietro Undergraduate Scholarship Fund. The scholarship will provide full tuition support to an undergraduate, with preference given to students who have lost one or both parents. SanPietro's father died when he was 11, and his mother died when he was 15. A Sloan Foundation Scholarship and a later Hertz Foundation Fellowship enabled him to attend Caltech. He graduated from the Institute with a BS in 1968 and an MS in 1969, both in mechanical engineering. As a Caltech undergraduate he served on the board of control, and, he recalls, "spent much of my spare time rebuilding cars."

SanPietro is president of Craden Peripherals Corporation, a Pennsauken, New Jersey, company he founded in 1982 that designs and builds computer printers. He established the SanPietro Scholarship Fund to give other students with limited financial resources the same opportunity he had to attend Caltech and, he says, to give something back to the Institute for the outstanding educational, personal, and career benefits it has provided him.

"Friends made at Caltech led me to Cambridge, introduced me to my wife, and gave me consulting jobs that allowed me to start my own company," he says, adding, "I am still in close contact with a half-dozen former classmates. Most of the satisfaction in my adult life has come from the 20 computer-related products I've designed, the company I started, the family I've formed, and the friends I've made. Directly or indirectly, Caltech has had a major effect on my life in each of these areas."

After graduating from Caltech, SanPietro moved first to Cambridge, Massachusetts, then to Philadelphia, where, among other jobs, he designed a 1,200-chip, 36-bit computer that NASA has used for 20 years for spacecraft communication. In 1974 he became director of product development for Okidata, a Japanese computer printer manufacturer. In 1978, after Eric Garen '68 gave him a consulting contract to design and build an educational computer, he founded Craden, Inc., a consulting company whose next assignment was to design and build a bar-code ticket-reader for yet another Caltech classmate, Bob Lentz.

In 1982 SanPietro designed a document printer for financial and governmental applications and established Craden Peripherals Corporation. The company has since distributed more than 25,000 printers to 60 countries.

SanPietro and his wife, Gail, a psychologist, live in Conshohocken, Pennsylvania, with their daughter, Lara.

Bioimaging

Continued from page 1

need to look at embryonic events deeper into the tissues than one can conveniently do with light, really converged," Fraser recalls. "It was really a few chance interactions, leading to more detailed discussions, that basically got the experiment going."

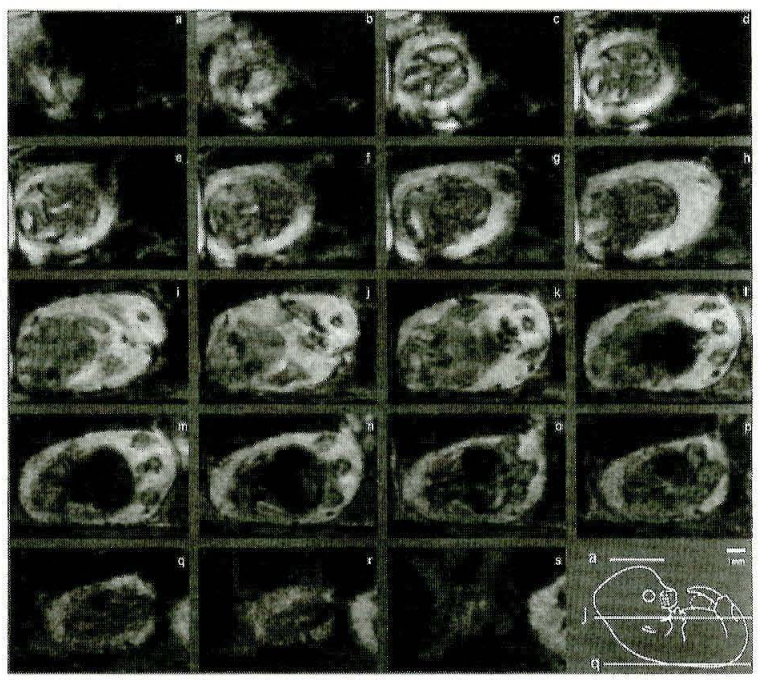
Fraser and Jacobs spent three years discussing the possibilities of applying MRI technology to small biological structures. The heart of the MRI machine is a tunnel-like magnet that creates a permanent magnetic field around the subject. The permanent field causes protons in the water molecules of the organism to align in a particular order. An oscillating field is used to perturb the protons. When this field is turned off, the protons return to their original state, generating an electric potential that is then analyzed by a computer and eventually transformed into a video image.

Fraser and Jacobs worked out such problems as how to increase the power of hospital MRIs so that the spatial resolution could be reduced from about one millimeter to 10 microns; how to decrease the time it takes to get an image, so that organisms wouldn't change much between pictures; and how to mark cells so that scientists could follow them through a developing organism. They started doing their first imaging together in 1990, and a year and a half later Caltech recruited Fraser to establish the Biological Imaging Center. He brought Jacobs and several other Irvine colleagues along with him, and they soon set up shop in the Beckman Institute, the research center that fosters development of new methods, instrumentation, and materials in biology, chemistry, and related sciences.

Fraser's equipment includes an MRI instrument whose resolving power is one million times better than the typical hospital model, four confocal microscopes, and five video microscopes that link sensitive video cameras to still other optical microscopes, yielding even more detailed pictures than confocal microscopes can produce alone. Some biologists have been skeptical about using an MRI machine to study live developing organisms, worrying that it might have insufficient resolution or fearing that the dyes used to mark cells could interfere with an organism's development and therefore taint results. But the results to date have put these issues to rest, and the scientific community is increasingly coming around to Fraser's point of view. A number of labs around the country are now using his imaging techniques, and Jacobs recently received a $5 million grant from the Human Brain Project, a consortium of government agencies, to study the developing anatomy of the brain. But like many pioneers, Fraser and Jacobs initially found themselves in lonely, sometimes inhospitable territory. A paper that Fraser and Jacobs wrote on frog-embryo research they conducted at UC Irvine took, Fraser says, "an inordinate time" to get published, appearing just this year in the February 4 issue of *Science*. Says Fraser, "Microscopic imaging is very new and there's been a lot of skepticism. We've had to work hard to convince people of its capabilities."

Taken last fall, this image reveals five embryos inside the mouse shown on the front page. She was 12 days pregnant, a period equivalent to the first month of a human pregnancy. The brains and paws of three embryos can be seen.

A series of images of one of the embryos taken at increasing depth makes it possible for researchers to witness the development of an embryo as it is taking place. Previously, such studies could only be made by removing the embryos at selected stages in their development cycle and slicing into them.



While there are now perhaps a dozen labs around the country using MRI equipment to study biological questions, Fraser says that Caltech is one of only two facilities looking at developing embryos. What's unique about the Caltech facility is that it involves active collaboration among three research teams: one group, headed by Tom Meade, a senior research associate, is perfecting dyes to mark the cells; another, led by Jacobs, is developing MRI technology; and the third group, supervised by Fraser, is applying the technology to study embryo development. "With three groups interacting on a daily basis, we've worked out better and better imaging protocols, made better and better chemical agents, and the embryologists in the lab have worked out better ways to apply the dyes and also much better surgical techniques for manipulating the cells," Fraser says.

Since leaving Irvine, Fraser says his group has implemented significant improvements in the signal-to-noise of the MRI equipment. This improvement allows researchers to get images in less time and so more accurately watch developments in the embryo. With fine tuning of the instrument software, postdoctoral fellows in the group have recently been able to image solids such as bones and teeth, objects that previously appeared only as blank spots in the images. Within the past few months, the imaging center has also been able to image embryos within a pregnant mouse. This achievement will be essential in a new research endeavor studying the effects of cocaine use on fetal development. Through imaging, Caltech scientists should be able to determine whether cocaine babies are abnormal because cocaine abates the blood flow to the placenta, because it interferes with cell migration, or because of some unrecognized mechanism. Fraser recently received a grant from the National Institute of Drug Abuse for preliminary work leading up to the cocaine study.

The imaging center's technology is already starting to pay off in terms of new discoveries. A recent study on the development of a frog's heart revealed surprises about cell migration. "It has long been known that a group of cells migrates from what you might think of as the top of the embryo down to the ventral part of the embryo to form the frog heart," Fraser says. "But what we were able to see in the MRI is that these cells actually initiate this migration, and some of them actually complete the migration before the time that the classical studies had reported that the migration started. That means that by watching things happen in real time from start to finish, you can learn far more than by observing selected steps leading up to the last phase and trying to deduce from those what was going on in between."

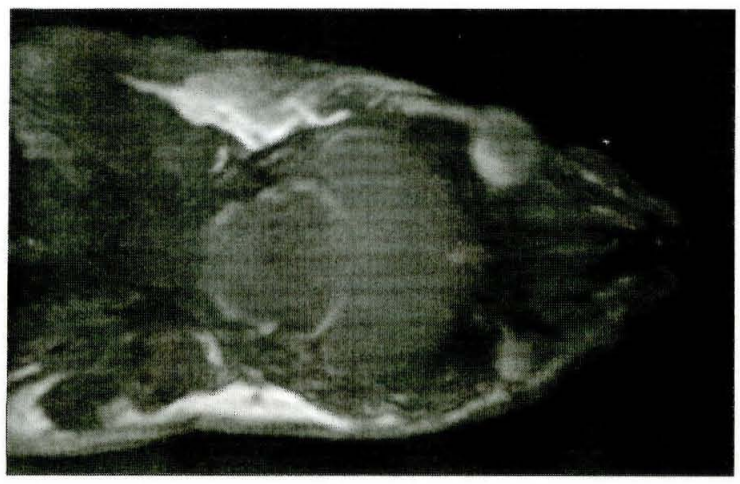
Bioimaging is also helping to answer important questions about cell differentiation—how initially identical cells assume different, highly specialized functions within the developing embryo. For instance, until recently, it was unknown whether cells in a specific part of the developing brain are genetically programmed to move off in different directions to perform different functions or whether their fates are determined not by genes but by their immediate surroundings, so that cells in a particular area stay there and perform the same task. By tagging cells in chicken, frog, and mouse embryos with dye, Fraser showed the former to be true, except in the case of the developing hindbrain, where all the cells follow the same course.

"Understanding how cells are generated in a given brain region might help you understand how to replace those cells once they die—or, perhaps even by understanding how they were born, understand what special trophic or nutrient factors those cells need to remain alive," says Fraser. These issues are especially relevant to devising therapies for neurodegenerative diseases, since nerve cells, or neurons, are unique among mammalian cells in that the body does not replace them once they die or are destroyed. "All of us in the lab," says Fraser, "believe that we'll have a better understanding about neurodegeneration and recovery of function by understanding the developmental mechanisms."

A few postdoctoral fellows in Fraser's group are conducting preliminary experiments studying cell movements in the visual system to see how they navigate around obstacles. Others are exploring what growth factors are involved in keeping retinal ganglion cells alive. Fraser expects that these experiments will lead in a year or two to further research on regeneration, as well as on trauma, an area in which he believes bioimaging will prove especially useful.

"Suppose someone suffers a serious injury following an accident," Fraser

says. "Instead of having to wait and see if the patient regains motion in, for example, an arm, physicians could use bioimaging techniques to label the damaged motor neurons and actually observe them regenerate. They'd be able to aggressively manage and treat the trauma by really watching what's going on. Neurologists treating patients with head injuries wouldn't have to rely solely on asking them questions and studying their outward functions to try to figure out where the injury was and the best way to manage it. They would have the ability to look within the patient to study the damaged neurons themselves, and on that basis to prescribe the most appropriate therapies."



This overhead image of a mouse embryo, taken at a depth of about 3 millimeters below the animal's skin, enables scientists to observe a high level of detail in the developing brain. In this image, the optic nerves can be seen coming from the eyes.

One major obstacle the center faces in its experiments on trauma and regeneration is that these studies would best be conducted using animals larger than mice. And the bore hole of the center's existing magnet is too small to permit study of anything much larger than a mouse. "We're not pursuing the regeneration studies as actively as we could be because we really need to use a magnet that has a larger bore, so that larger, more mature animals can fit in it," Fraser says. A larger magnet would cost about $4 million.

While Fraser and his colleagues continue improving the existing equipment to make it more powerful, they are also making it easier to use. With a $250,000 grant from the Fletcher Jones Foundation of Los Angeles, Fraser hopes to automate the equipment to make it usable by students and researchers who don't have extensive training. He'd like to see the software and hardware become user-friendly enough to be operated by a relative novice. "Instead of students having to apprentice themselves to one of the imaging masters to slowly progress along to the level of journeyman imagers, the idea is to make the equipment easy to use, so that it helps tutor students and is actually forgiving of novices. So instead of it just being a hurdle for them, it's actually part of the learning experience."

For Fraser, the decision to leave Irvine for Caltech wasn't an easy one. Part of the reason he came was the offer of the Rosen Professorship, established by Caltech trustee and board vice chairman Benjamin M. Rosen, chairman of Compaq Computer Corporation and Sevin Rosen Management Company, and his brother Harold and sister Ruth Rosen Weisler, during the Campaign for Caltech.

"We've been trying hard to do unusual work, and by making this chair available, Caltech was recognizing that this sort of unique research is worthy and very interesting to the campus," Fraser says. "Because there's a small discretionary budget that comes with the chair, we're able to pursue our research goals more aggressively. That's a very tangible benefit."

So as not to leave Irvine entirely behind, Fraser insisted that the facility at Caltech come with a good coffeemaker. "We made sure we put in enough space in the lab to have a conference room, and that conference room has a nice coffeemaker in it to try to get people to linger and chat with one another. And while it's a little bit optimistic to hope that lightning will strike twice in the same place, there is a lot of synergism that's emerging from people sitting in that room together and chatting and sharing problems."

Chance meetings at a hallway coffee machine got the research relationship between Fraser and Jacobs percolating.

Letters to the editor: more on math, music

Dear *Caltech News*:

I was thrilled to read the article "Of Math and Music" in the February edition of your paper. (My husband, Eric Pan '84, is an alumnus of your institute.) It surprised me to hear that some Caltech mathematicians were also musicians and that some have had struggles similar to those I myself had when forced to choose between math and music. The discussion in the article invariably captured the story of my life.

Music and math, though vastly different, have always gone hand-in-hand in my experience. When I'm frustrated with a musical section as I practice the piano, I simply put the passage aside, do a few mathematical proofs or write a program in Fortran, and then I feel better. When I return to practice the difficult passage, say, in a Beethoven sonata, the problem is magically solved, seemingly without practice. This study has taught me that music and math are like two different languages, yet like computer languages they can be applied. When bugs and problems inevitably arise, one's mind with pure thinking can be used to debug or solve the problems. Though the phenomenon seems strange, it nevertheless works. God has blessed me with a mind to interpret both languages and to show forth the mysteries of both.

People have said to me that the best computer programmers are musicians. I decided to major in applied math and computer science at UCLA only after I debated for three years whether or not to major in music performance. I've played the piano since I was two, but math was always my easiest subject at school. I'm an American Chinese but the Chinese culture forbade a serious study of music, which strengthened my decision toward math.

I've performed, however, with the L.A. Bach Festival, the MTAC Branch Honors Festivals, and master classes at Biola University and UCLA. I was a Young Artist Guild winner in 1980.

Music will always have a place in my heart. I've enjoyed this correspondence with you.

Joanne C. Pan
Freemont, CA

Dear Editor:

The article in the February 1994 issue of *Caltech News*—"Of Math and Music"—was one of the most interesting I have ever seen in your publication. Since you invite comment, I will do just that. It may be a little lengthy, but perhaps a few things will provoke discussion. I am *not* a musician. I played the comb and toilet paper (it has to be British toilet paper to work) and the mouth organ (which I gave up during World War II after swallowing two of the leather dampers on the suck notes). I particularly enjoy dance music because in my younger, competitive days, ice dancing was my forte.

I want to bring up the question of how I can identify the key note in most music. And if I am watching the pianist, I can tell what key he is playing in. I have no idea how I do that, although I suspect it involves some optimisation that reduces the number of flats and sharps you'd have to put in. I'm talking in terms of "do re mi's" as Americans tend to call it, or "Tonic Sol-fa," as it was called in Britain in my formative years. . . .

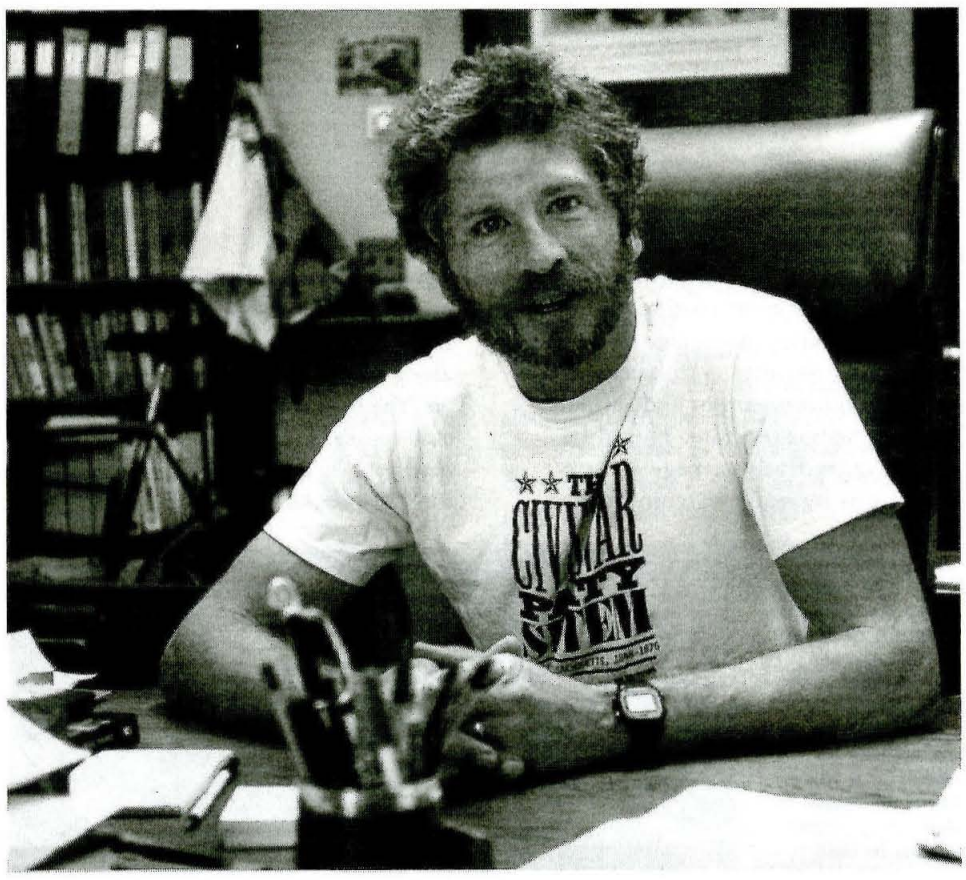
My mother's family had a piano and sang in harmony, without music. At school I was taught both staff notation and Tonic Sol-fa (which is independent of the key in which the music is sung). I gradually learned the relations of notes that sounded harmonic. In other words I was becoming sensitive to frequency relationships. . . .

In the early days of microprocessors, I built a one-key piano, which knew the succession of notes for eight Christmas carols and would play them if you supplied the rhythm. . . . Generating a near-perfect scale of about two octaves [required similar mathematical considerations to those discussed] in Helmholtz's book *On the Sensations of Tone,* Dover, 1954. . . .

The *Caltech News* article has caused me to read quite a bit of Helmholtz's book. [Before reading the book,] I had not realized that the Tonic Sol-fa was an English development in music (it seems to be almost unknown in North America), nor that if you sing unaccompanied you can hit true notes as determined by frequency relations. Basically, the theory is pretty simple, and perhaps that is why mathematicians and other scientists find it intriguing. There are simple patterns in tonal relationships that our ears somehow recognize, even with a tempered scale. But there is more to it than that. [My ability to] determine the "tonic" or key note after listening to only a few bars of music, at least in most cases, *must* have something to do with a more complicated process of minimizing the complexity of the music. I'd love to hear some discussion along these lines. Maybe [Visiting Associate in Biology] Polly Henninger has some thoughts on it?

George T. Skinner
PhD *AE* '55
Tullahoma, TN

Continued on page 9



Morgan Kousser goes beyond the classroom to make his case for civil rights

By Hillary Bhaskaran

Two doors lead into the office of Morgan Kousser, a professor of history and social science at Caltech. On the left-hand door is a small sign, which reads: "We'll treat you like a human being, even if you're a Republican." On the more serious right-hand door is a bulletin board papered with editorials, political newsletters, and a chart showing how each U.S. senator has voted on a number of fiscal policies.

Kousser opens the first door as he wraps up a telephone conversation with Dayna Cunningham, a top lawyer from the NAACP Legal Defense Fund. They're discussing what, in Kousser's estimation, may become the most important voting-rights case of the decade—a case that calls on the professor to serve as an expert witness yet again, this time under the scrutiny of the U.S. Supreme Court.

The case focuses on the shape of North Carolina's twelfth legislative district, which looks more like a ribbon of highway than a political unit (see map). In fact, the district weaves through the state along Interstate 85, encompassing pockets of minority voters along its way. The lines were drawn that way following the 1990 census and in response to a 1982 revision to the Voting Rights Act, which was widely interpreted to require states to create districts that would give minority candidates a chance at being elected. It worked. North Carolina sent its first two black representatives to Congress this century (from the twelfth and first districts), and the nation has seen a notable increase in minority representation.

But districts like North Carolina's twelfth have been criticized as gerrymanders that stretch erratically across states at the expense of geographic unity. In 1992, five white North Carolinians brought their complaint all the way to the U.S. Supreme Court and got a sympathetic ear from five justices. Writing for the majority, Justice Sandra Day O'Connor noted that, "In some exceptional cases, a reapportionment plan may be so highly irregular that . . . it rationally cannot be understood as anything other than an effort to segregate voters on the basis of race." Race-conscious plans, O'Connor continued, would be legal if based on "traditional districting principles such as compactness, contiguity, and respect for political subdivisions."

The 5-4 majority sent the case back to the North Carolina district court, which had originally dismissed it. The new trial was set for this past April and was called *Shaw v. Hunt* (the names representing the group of white plaintiffs from North Carolina and the state governor, respectively). The state was charged with the task of proving that "a 'compelling interest' made it necessary to treat people differently on the basis of race," as the *New York Times* reported.

In other words, says Kousser, the defense has had to show that there's "a really good reason" why the district is so oddly shaped. As of this writing, the case is still pending a decision by the three-judge panel that tried it.

Which side is Kousser on? "I'm almost always with whoever's being discriminated against," he says. In this case, he's on the defense team with the state and the NAACP.

But regardless of his allegiance, Kousser's job is to supply hard facts about the establishment and outcome of voting policies. For the North Carolina case, he wrote an 83-page paper in which he argued that "many nonracial interests and considerations compelled the state to act as it did" when establishing the new district lines. The details of the paper went unrefuted, and the case before the North Carolina court went so well, says Kousser, that the NAACP decided it didn't need to call him to the witness stand after all.

Now, as he awaits the verdict, Kousser is optimistic that the North Carolina judges will side with the defense and uphold the twelfth district's boundaries. But there will probably be a sequel to the story. Kousser expects the plaintiffs to bring the case back to the Supreme Court. If that happens, facts and perhaps even phrases drawn from his written report might well play a role in the high court's decision. That decision would be critical, for it would set a precedent for similar redistricting cases that have sprung up around the country.

By serving as an expert witness for the NAACP, Kousser hopes to play a role in protecting the gains in minority representation that have been achieved under the Voting Rights Act. He feels that minority rights rather than majority rights are at stake here, rejecting the view that the whites in this instance are victims of reverse discrimination and segregationist politics. He says as much in his telephone conversation with NAACP lawyer Dayna Cunningham.

Southern roots

"That's not segregation," Kousser expounds into the receiver. "Segregation is growing up in the South and going to a school that doesn't allow blacks, and having water fountains labeled 'whites only.'" Once off the phone, Kousser elaborates on this theme, based on his experience growing up white and rather poor in Tennessee in the '50s and '60s. There, he says, "to be a moral person who treated everyone equally was to take a political stance."

The moral figure in Kousser's young life was his mother. "She was very racially tolerant. I never understood why, since she had grown up in the South and her mother had been a staunch segregationist. But she always told me I had to treat people equally, humanely."

When Kousser was five, his father was admitted to a Veterans Administration mental hospital for trauma incurred during World War II, leaving his mother in Chicago "with no savings, no job, no geographically close relatives, no rent money, and my one-year-old brother and me." Short-term aid from the government allowed them to get by until they returned to Tennessee to live with Kousser's grandmother. His mother went back to school and became a teacher, a job so low-paying that she had to work two other jobs on the weekends. Kousser came away from that background "unwilling to criticize people because they're poor." He knows that poverty can happen "to us—to anyone—regardless of education, upbringing, or force of character."

Coming from this racially tolerant and somewhat impoverished background, Kousser developed his intense interest in politics. By his teenage years, he was doing leg work and stuffing envelopes for local and national campaigns. Kousser later received scholarships and worked to pay his way through history degrees at Princeton and Yale.

A 1969 transplant to California and Caltech, Kousser has become even more involved in political outcomes. In fact, the last big case for which he testified dealt with redistricting in Los Angeles and made it possible for the first Latino in more than a century to be elected to the county's board of supervisors. That was Gloria Molina, who was elected following the 1990 case and, Kousser points out, has proven to be a vocal advocate for minorities and the poor.

The fact that the Caltech-based Kousser delves into legal and political struggles at all comes as a surprise to some. "For attorneys and others doing civil-rights work, Caltech isn't even on the map," says the professor.

This should change with Kousser's increasing visibility and the role he has played, along with colleagues Doug Flamming and Elisabeth Gerber, in establishing Caltech's new Race, Politics, and Region Program. Kousser would like to see Caltech become even more involved in the political, social, and ethical issues of its surrounding communities.

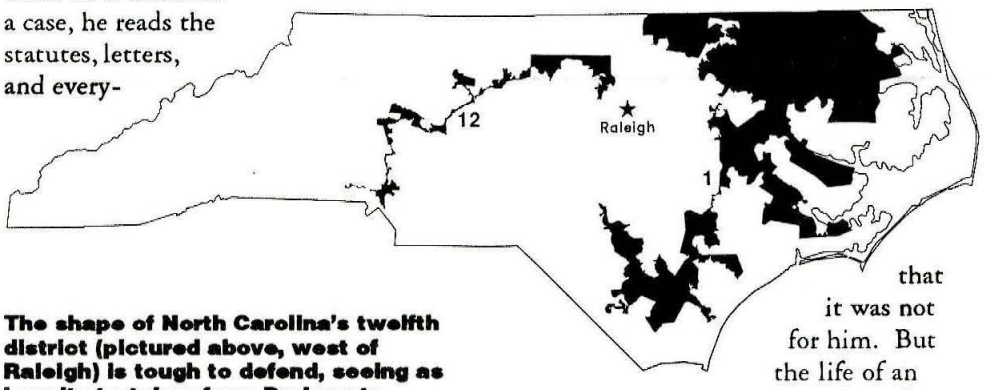
Interestingly enough, Kousser says the atmosphere at Caltech encourages him to get out there and make a name for himself, in case after case. "This is not a deferential place," he explains. "It's not like being at a state university and having a class of 600 people treating you like the Pope—based on a reputation you established decades ago." Instead, at Caltech "you can never really rest on your laurels. One can almost say that you're no better

than your last paper." And that mindset, he says, "helps me when I'm testifying. Just because I've testified in important cases in the past, there's no reason why the judge should accept what I say as a matter of faith. I have to prove myself right again and again."

Making waves

Serving as an expert witness is only a small portion of what this teacher-adviser-researcher does, but it is the avenue through which Kousser has the most influence on public policy. By helping to set legal precedents in voting-rights cases, his testimony can have a meaningful impact on who gets what, when, where, and how—what Kousser calls "the very meat of politics."

From his first case, which concerned disfranchised blacks in Alabama in 1979, to the L.A. and North Carolina cases of this decade, Kousser has established a reputation with lawyers as someone who can research, write about, and then testify effectively on the discriminatory history of election laws. Once he is hired for a case, he reads the statutes, letters, and everything else associated with the establishment of the voting practices in question. From these facts, he writes a detailed paper that is then submitted to a judge. This serves along with his oral testimony as evidence in the case.



The shape of North Carolina's twelfth district (pictured above, west of Raleigh) is tough to defend, seeing as how it stretches from Durham to Charlotte. Kousser has been in on the legal debate, the outcome of which may determine whether such odd district boundaries are permissible, not only in this state, but nationwide.

Kousser describes his influence through the legal system as "direct, tangible, and immediate."

For example, in 1991 he wrote a paper that led that same year to the election of the first black mayor in Memphis, Tennessee. Part of the paper criticized the run-off election procedure that Memphis had instituted in the 1950s, which, Kousser argued, had been intended as an obstacle to minorities seeking office. Even before the trial was set to begin, the judge had read Kousser's paper and granted a preliminary injunction that eliminated the run-off vote for that year's election. When three candidates ran for mayor that year, the two white candidates split the white vote, leaving the minority candidate, Willie Herenton, with the plurality of votes. Since Herenton didn't have to follow up the three-way race with a run-off election against one white candidate (and all the white supporters), Memphis's first black mayor proceeded directly to city hall.

Likewise, when Kousser went to testify in Selma, Alabama, in 1981, the city hadn't had a black county commissioner since 1879. Here, Kousser argued that the county's at-large elections effectively discriminated against minorities, as had the run-off elections in Memphis. As a result of his and others' testimony, single-member districts were established in Selma, giving each district its own representative. From the new five-district system, three black county commissioners were elected.

Not shaking hands

Kousser admits that he might have had even more influence on the political process had he become a politician himself. "But this way I don't have to kiss babies," he says. "And I don't have to give the same speech 100 times a day, or spend hours on the phone raising money, or hear myself being called names." In Kousser's early years helping with campaigns, he saw enough of what a candidate's life was like to know that it was not for him. But the life of an academic and expert witness definitely is.

"It's intellectually fun to analyze things that are somewhat hard," says Kousser. "I like to take a lot of information and make sense of it. That's why I'm a historian."

And this historian has been known to sift through dozens of boxes of government documents and boil them down to 100 or so pages of prose to prove a point. That's what he did in the 1990 Los Angeles redistricting case. Kousser was able to show that white incumbents on the board of supervisors had repeatedly extended L.A.'s third district into predominantly white enclaves to the west and north of Hollywood. The board's actions served to "whiten" a constituency that was becoming strongly Latino.

But it's not like there was "a smoking gun" for Kousser to present as evidence in the case. He searched out patterns of behavior, as well as paperwork that not only hinted at but substantiated the back-room deals of board members. "This is where you really need a historian. I not only have to show which scenario is true, I also have to show why another scenario is less plausible. This means testing each hypothesis against other hypotheses."

In court, Kousser convinced the judge that the pre-1990 redistricting didn't merely have the *effect* of discriminating against Latinos—it was *intended* to discriminate against them. As a result, the first district was redrawn to encompass a substantial Latino majority of the population, and Gloria Molina was elected to the board of supervisors.

Setting precedents

The L.A. case helped set a trend. "Nowadays, people have been looking to that case when they try to prove 'intent,'" says Kousser, who is pleased that he helped provide civil-rights attorneys with a new "weapon." The case also gave Kousser the visibility he needs if he wants to continually influence political policy. And he does. His grand strategy is "to take cases that raise interesting issues on the frontier of voting-rights law."

What's wrong with this picture? The map of Los Angeles County pictured below shows that, while the Hispanic population increased both within and east of the third voting district from 1960 to 1980, the boundaries of the district were extended westward and northward, across the San Fernando Valley. Was the extension intended to keep Hispanics in the minority? Kousser took on that question in a 1990 case that not only cemented his reputation as an expert witness, but also reshaped part of the political landscape of Los Angeles.

"Since the L.A. case, I can pick and choose which cases I want to be on. So I choose issues that I want to explore, that involve questions of intellectual interest to me, that I want to write about and publish, and that have a major impact on policy.

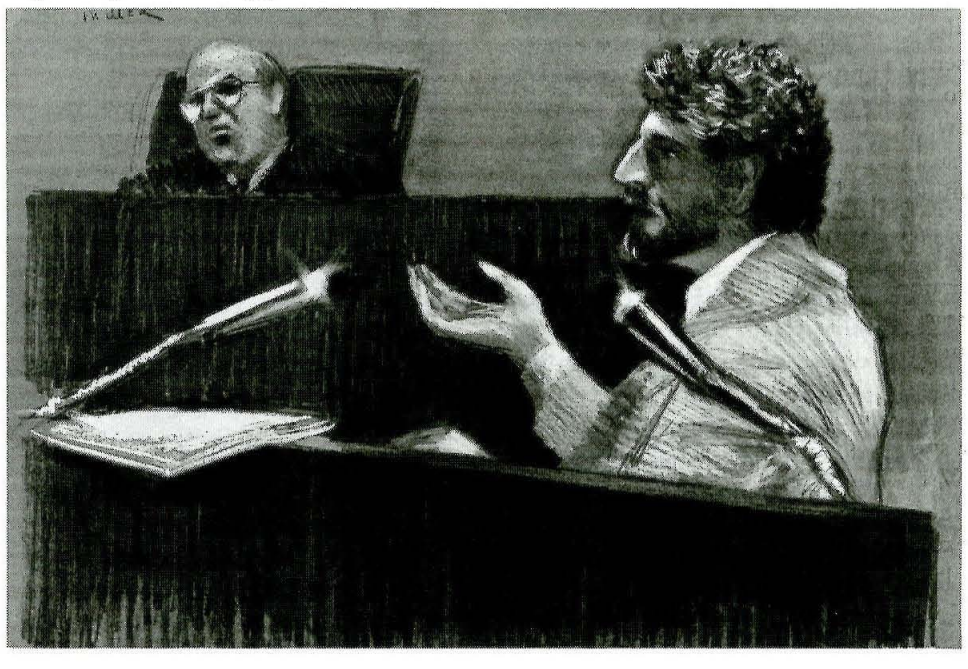
"Now, the biggest issue is 'compactness,'" says Kousser. And the biggest case on compactness is North Carolina's *Shaw v. Hunt*, because it questions the sprawling nature of a political district.

One of Kousser's graduate students, Micah Altman, is exploring the compactness issue as well, with his professor as a ready source of information for the paper he's writing. Altman is producing computer simulations of thousands of districting plans and measuring the compactness of each, using both imaginary and real data on California demographics. With this experimental information, Altman and others can study "whether a more compact district will help or hurt minorities," explains Kousser. "Bush pushed for compact districts. Democrats argue against them," saying that such a standard would put half of the minority office-holders (many of whom are Democrats) out of office. "But there are no empirical studies of this type." Altman's paper could have conceivably been used as evidence in the North Carolina case, but Kousser preferred that his student produce a good paper rather than rush to meet court deadlines.

Kousser's first "deadline" for *Shaw v. Hunt* was in January, when he traveled to North Carolina to be questioned for the court's deposition. In the process of being "deposed," he explains, the opposition tries to find out as much about his evidence as possible—before he's even had the chance to gather it all,

Continued on page 9

A sketch artist captured this 1991 courtroom scene in which an Atlanta judge listens to Kousser's testimony. As in numerous cases, the history professor here argues against voting practices that he has found to be unfair to minorities.



ALUMNI

Chapter News

Orange County alums hear from earthquake expert

More than 50 alumni and guests attended a May Orange County chapter meeting to hear Caltech Faculty Associate in Geophysics Tom Heaton, PhD '79, speak on "Southern California Earthquakes: Past, Present, Future." Heaton, a research geophysicist with the U.S. Geological Survey and head of the Pasadena USGS Office from 1985 to 1992, is currently president of the Seismological Society of America.

Tri-State gets Gray view of future

The future was also a topic at an April meeting of the Tri-State Chapter, where Harry Gray, the Arnold O. Beckman Professor of Chemistry and director of Caltech's Beckman Institute, neatly summed up the Institute's prime objective in the title of his talk, "Chemistry, Biology, and the Future." Gray, a 1986 recipient of the National Medal of Science, offered an overview of the Beckman Institute's work in fields at both the forefront and the interface of biology and chemistry—areas that include biological imaging, biomolecular design, laser spectroscopy, mass spectroscopy, molecular biotechnology, and molecular simulations.

San Francisco chapter highlights stars and start-ups

The San Francisco chapter has been playing to full houses and domes recently, with more than 60 alumni and guests attending a May talk on "Venture Capital in the 1990s," and capacity crowds of 40 each venturing to Mount Hamilton on June 4 and 11 for the chapter's highly popular "Evening at Lick Observatory." On May 10, William Davidow, general partner in Mohr, Davidow Ventures spoke on the prospects for entrepreneurial enterprises in the 1990s and on the types of start-up efforts likely to attract investors. The Lick tours included a viewing of the observatory's main instrument (the 120 inch reflector telescope), an opportunity to scan the skies through the 36-inch telescope, and a talk on the facility's astronomical research.

Arizona alumni attend brain biologist Bower

The Phoenix/Tucson chapter had the opportunity to hear about mammalian brains/computer brains last April when Associate Professor of Biology Jim Bower presented a talk on "Parallel Computers and Parallel Brains: Using Each to Understand the Other." Bower explained how his lab has pioneered the use of parallel computers as simulation models for computational neuroscience in an effort to better understand the relationship between structure and function in the brains of mammals.

Bill Whitney looks back on presidential year, ahead toward formation of alumni-Institute task force

By Bill Whitney '51

In my final column as president of the Caltech Alumni Association, I will highlight a few accomplishments of the past year.

Following a recommendation by the finance committee under Pete Mason, the board, at its June meeting, approved a change in our fiscal year so that it now is the same as that of the Institute. As a result, our next fiscal year will extend from October 1994 to September 1995. Officers' terms will still run from June to June, giving incoming officers three months to prepare budgets for the next full fiscal year.

The membership committee, chaired by Bob Bunker, has recommended, after careful study, that four groups of people be given the opportunity to become "Friends of the Association": parents of students or alumni; current and former postdoctoral students or research associates; spouses of living and deceased alumni; and current and former Caltech faculty and staff. "Friends" are not members of the Association and cannot vote or hold office, but by paying an annual fee they can receive *E&S*, *Caltech News*, an Association discount on Seminar Day, an e-mail account, and several other prescribed benefits.

With help from David Ritchie, an attorney on our board of directors, we have revised our bylaws. We have also drafted a restatement of our articles of incorporation with the goal of seeking a change in our tax status from 501(C)(4) to 501(C)(3). While bylaws can be (and have been) approved by the board, changes in the articles of incorporation must be ratified by the general membership. Approval will be sought during the coming year.

On behalf of the Association, Bill Whitney presents Ruben Mettler '44, PhD '49, with a resolution honoring him for his long, distinguished, and continuing career on Caltech's Board of Trustees, including his term as chair from 1985 through 1993.

The undergraduate admissions support committee, led by Jeanine Hoffman, has further refined the concept, put forward some years ago by Ponzy Lu, of giving awards to deserving high-school juniors at selected schools for the purpose of increasing Caltech's name recognition at those schools. The proposal has been transmitted to Gary Lorden, vice president for student affairs, and to Tom Anderson, vice president for Institute relations, for their review and recommendations.

The Seminar Day committee and Association staff put on a highly successful Alumni Seminar Day and reunion weekend, attracting an overall attendance of just under 1,700. The 50th reunion of the class of '44 was the largest ever, attracting 200 people, while 125 people attended the reunion of the Ceiling and Visibility Unlimited group, who studied meteorology at Caltech in 1943 and 1944. The Half Century Club luncheon drew a gathering of 500. Seven classes held regular reunions, and three more arranged dinners or other events.

The past year was the time for reviewing and perhaps revising or replacing the Trilateral Agreement, which defines the relationship between the Institute, the Alumni Association, and the Annual Fund. It is a contractlike document, written more than 10 years ago, in part to resolve some issues among the three parties. There is a consensus today, I believe, that relations between the Institute and the Association have steadily improved during the years since that document was negotiated and signed, and that the Alumni Association today has a good image overall with the people and groups with whom we come in contact. If there is a weakness, it is, perhaps, that we need to make contact with more people and more groups.

The Trilateral Agreement seems not to be a suitable model for representing the relationship between the Institute and the Association at this stage. Both parties have had many informal conversations about what form the next agreement might take. Far more appropriate today would be a high-level memorandum of understanding or statement of aims and objectives, outlining what Caltech and the Association, working together, want to accomplish. Any other document (e.g., an implementation plan) recording how the goals will be met, and what each party will bring to the table, should serve the more general statement, and be reviewed frequently and revised as needed.

Tom Anderson recently held a retreat of members of Institute Relations and of the Association board and staff to discuss alumni relations. There seems to be a recognition by Caltech that its alumni body is important today, that it will grow in importance in the future, and that the image and prestige of Caltech will continue to rest to a considerable degree on the success and accomplishments of its graduates

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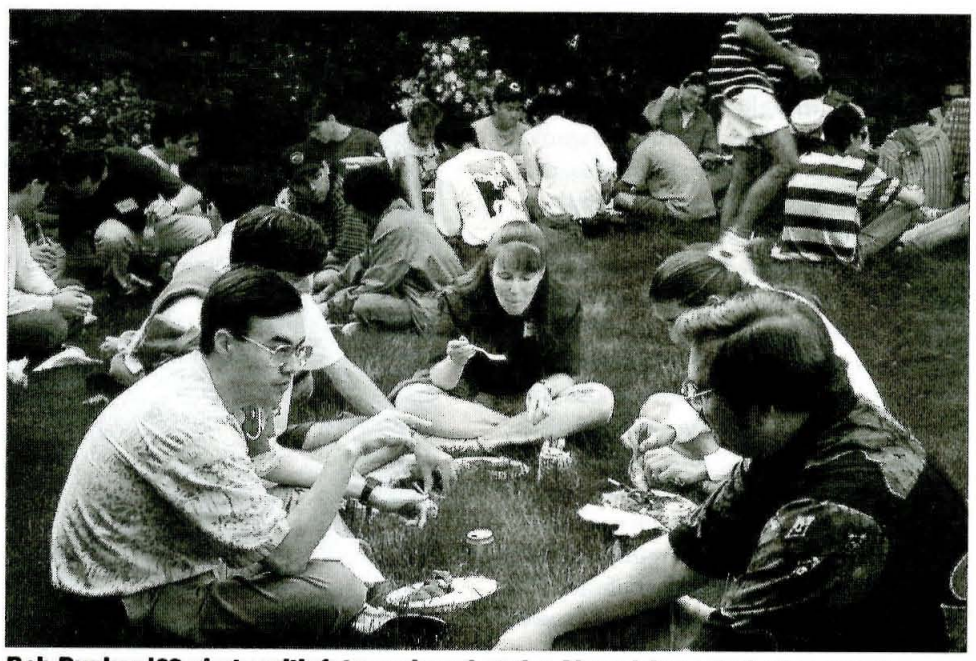
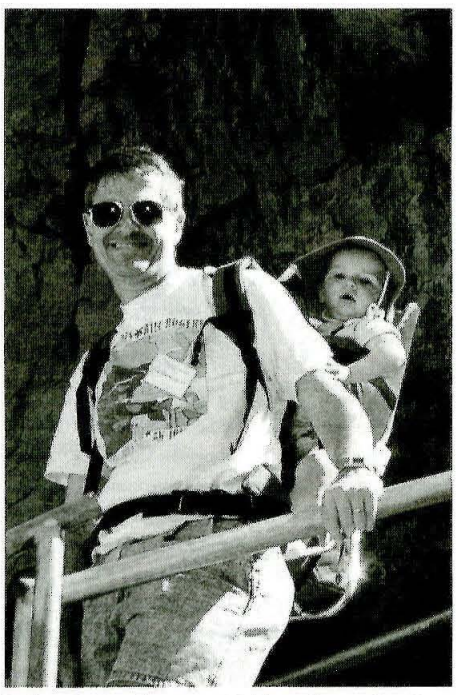


Bob Bunker '69 chats with future alumni at the Alumni Association's annual senior barbecque, held on May 1.



Caltech Professor of Chemistry Jack Beauchamp '64 and a passenger survey their surroundings from the entrance to Mitchell Caverns in eastern San Bernadino County. Beauchamp and his wife, Pat George Beauchamp, PhD '81, were among 27 alumni and family members who joined Bob Sharp '34, PhD '35, for a weekend campout in the desert below the caverns last April. Beauchamp's grandfather Jack Mitchell discovered the unique limestone caves and brought them to public attention in the 1940s; and that's Beauchamp's son, Ryan, riding on his back.

Kousser

Continued from page 7

says the professor, who likes to do his homework.

"And the lawyers [who've hired me] always want me to shut up. But they have trouble with this," he adds, half smiling but completely serious.

Yet, it's Kousser's gift of self-expression that brings his passion for politics home to his students. The two central themes running through his teaching are that politics *do* make a difference in people's lives and that race relations—and the struggle for equal rights—are central to the American experience.

These are hard cases to make with students who've had little exposure to minorities and their historical struggles, he says. "We live in an increasingly segregated society. Most students come here from middle-class white backgrounds where they may have had little or no contact with blacks or Latinos. Also, like many Americans these days, they tend to be cynical about politicians and political action, about reformers and the possibility of real reform, about altruism and overcoming barriers to understanding and equality. This leads to political passivity and social alienation.

"To overcome this syndrome, I have to teach the moral significance as well as the facts of history. Unless students see the optimism and idealism in the abolitionist and civil-rights movements, for instance, they'll never understand the fundamental struggles that have defined and continue to shape America." But given this perspective, says Kousser, students may see "the possibility that some small act of theirs can make a positive difference in other people's lives."

Letters

Continued from page 5

Dear *Caltech News*:

In your February 1994 issue, which I received since my son is a Caltech student, the article about math and music was featured. I was a bit surprised to notice that there was no mention of Einstein.

Einstein did play violin and played quartets frequently. He was also interested enough to have Yehudi Menuhin and my father, Ruggiero Ricci, play for

Photo provided by UPI/Bettmann

Albert on the violin.

him. They were both child prodigies and both students of Louis Persinger. After my father played, Einstein asked if he could try the Strad he was playing at the time.

How much do "they" know about Einstein's brain? It would be interesting to know.

Rosalin Ricci Relyea
Waterford, CT

Dear Editor:

This letter is written regarding the splendidly incisive "Math and Music" article in the February 1994 edition. I cannot and do not fault any of the data presented in this well-documented and researched article exploring the undeniable link between mathematics and music. But I do consider the subject was just a touch belabored on the pure science side. A small injection of art and philosophy could have been beneficially encompassed.

I submit that the correlation of math and music is indisputable and that it stems from a deep primordial hunger within man for truth, order, and harmony. Math and music provide these. 2 x 2 = 4; C, E, and G combine to produce a C chord; Kepler's laws have yet to be repealed. The harmony of the spheres endures. And music is the universal language that transcends boundaries: geography, race, politics, war, even time.

Music has played an important role throughout history. Primitive man sent signals by beating on hollowed logs in a certain pattern. This practice carries over to the present in a still primitive form known as "Rock." Long before the deleterious effects of sonic booms on structures became known to modern man, the ancients, using trumpeters, caused the walls to come tumbling down in Jericho and gave Joshua a walk-in victory. And, reflect on how Ulysses testified to the power of music when he had himself bound to the mast of his ship so that he would not be shipwrecked and enslaved by the sirens with their seductive songs. . . .

Let not the satisfaction of beautifully reasoned analysis overshadow the pure pleasure of just listening. . . .

(Following a lifelong love of music, I now play piano at a large country club in Las Vegas. The psychic rewards are great and nontaxable.)

Robert J. Trauger
MS and Eng *AE* '46
Las Vegas, NV

Sigma Alpha Pi, a Caltech fraternity active from 1914 to 1939, held its annual luncheon at Alumni House earlier this year, with Caltech's director of athletics, Dan Bridges, as special guest. After lunch, Bridges treated the Sigmas to a tour of Braun Athletic Center. From left, Mike Brunner '25; Dick Folsom '28, PhD '32; Walt Dickey '31; Bob Grossman '33; Bridges; Frank Alderman '30; Jack Sturgess '30; and George Pickett '33, MS '34.

ALUMNI ACTIVITIES

July 9, *Caltech Big Bear Solar Observatory Tour.*

July 10, *Orange County Chapter/MIT Joint Alumni Meeting*, with guest speaker Mark Wrighton, PhD '72, Caltech Distinguished Alumnus and MIT provost.

July 14, *Santa Cruz Area Monthly Luncheon*, Peachwood's at Pasatiempo Inn, noon. For reservations, call Bob Shacklett at 408/722-6021. Luncheons are held on the second Thursday of each month—the next two will be August 11 and September 8.

July 21, *San Francisco Peninsula Monthly Luncheon*, Ming's Restaurant in Palo Alto, noon. For reservations call Hugh Dubb at 415/362-3800 or 408/773-9100. Luncheons are held the third Thursday of each month—the next two will be August 18 and September 15.

August 19–September 5, *Safari in Botswana and Zimbabwe*, led by Thayer Scudder, professor of anthropology.

September 13, *Seattle Chapter Dinner/Meeting*, with guest speaker Tom Heaton, geophysicist, U.S. Geological Survey.

September 20, *Chicago Chapter Dinner/Meeting*, with guest speaker Judith Goodstein, Institute archivist and faculty associate in history.

October 6, *San Francisco and East Bay/Marin County Chapters Joint Dinner/Meeting,* with guest speaker Egill Hauksson, senior research associate in geophysics.

October 27, *Sacramento Area Alumni Dinner/Meeting*, with guest speaker Morgan Kousser, professor of history and social science.

November 9, *Orange County Chapter Dinner/Meeting*, with guest speaker Joel Burdick, assistant professor of mechanical engineering.

November 3, *Washington, D.C., Chapter Dinner/Meeting*, with guest speaker Tom Soifer, professor of physics.

For information regarding the above, please contact Arlana Bostrom for chapter events (818/395-8363), Patsy Gougeon for Seminar Day/Reunions (818/395-8366), and Helen Shafran for travel/study and local programs (818/395-8364).

PERSONALS

1942
JOSEPH B. FRANZINI, MS '43, Eng '44, of Palo Alto, California, has been inducted into the Silicon Valley Engineering Hall of Fame. There are now 20 engineers in the Hall, mostly from the fields of electronics, computers, and astronautics. Franzini is one of the four civil engineers in the Hall of Fame.

1953
THOMAS H. APPLEWHITE, PhD '57, has been elected as the 21st honorary member of the American Oil Chemists' Society (AOCS), an international organization founded in 1909 for professionals involved in the science and technology of animal and vegetable fats and oils and related materials. The honorary membership was conferred at the AOCS 1994 annual meeting, May 8–12, in Atlanta, Georgia. A past president of the society (1977), Applewhite has served as editor for two of its journals (*Journal of the American Oil Chemists' Society* and *International News on Fats, Oils and Related Materials—INFORM*) and as chair for two world conferences (1976, Amsterdam, the Netherlands, and 1987, Hamburg, Germany). He has also served as an editor for a standard reference work in the field and has been active in U.S. fats and oils trade organizations. An AOCS member since 1959, he retired in 1986 as a research director for Kraft Inc. He has since been a consultant to the fats and oils industry from his homes in Austin, Texas, and Bailey's Harbor, Wisconsin.

1956
ALAN POISNER writes that he "is still in the Pharmacology Department at the University of Kansas Medical Center in Kansas City and has had a very busy year. The most important event of the past year was the arrival of our granddaughter, Hannah, in Folsom, California. We have visited with her in California, Florida and Kansas. She really gets around. My research on placental endocrinology has taken me to a number of national and international meetings, including Hawaii, England and Germany. I've also been busy with my racewalking hobby, having participated in numerous regional and national masters and senior olympic competitions. The national senior olympics in Baton Rouge in June of '93 was particularly exciting, with 7000 athletes, including 500 in the racewalking division. I've picked up some gold medals in Kansas and Missouri and some bronze in national meets. In July '94, I will move to Cincinnati Children's Hospital for a year-long sabbatical where alums can find me in the Endocrinology Division."

1957
FRANK KOFSKY, professor of history at California State University, Sacramento, has seen publication of his book, *Harry S. Truman and the War Scare of 1948: A Successful Campaign to Deceive the Nation*, on which he began working about a decade ago. The book was published late last year by St. Martin's Press. "It has been gratifying that some eminent scholars have seen fit to praise this work," he writes. "And in its appraisal, *Kirkus Reviews* described the book as a 'hard-digging study of how US foreign policy was reshaped by Truman and his cabinet members by means of disinformation,' concluding that the work comprises 'post-*glasnost* history of real substance.'"

1962
C. ROLAND HADEN, MS, formerly vice chancellor for academic affairs and provost at Louisiana State University, has been named the Texas A&M University System vice chancellor for engineering and dean of the Texas A&M College of Engineering, effective last November 1. Prior to his tenure at LSU, he had served as dean of the College of Engineering and Applied Science at Arizona State University, where he was also vice president for academic affairs. He had also taught electrical engineering at Texas A&M early in his career, and in 1969 he was director of the Institute of Solid State Electronics at Texas A&M.

1966
HERB SCHILLER, MS, of Wheatley Heights, New York, has been awarded the designation of CIRM (certified in integrated resource management). The CIRM program is a product of the American Production and Inventory Control Society (APICS)—an international, not-for-profit educational society for resource management, representing 70,000 business professionals. "As a learning tool, CIRM helps business professionals adapt to structural changes in the workforce—changes that sometimes lead to downsizing, outsourcing and flattened management ranks. The program helps companies with cost-effective education to create a better trained, knowledgeable and flexible professional staff—promoting productivity, quality, profitability and overall competitiveness." A management consultant and an adjunct professor, Schiller specializes in the integration of materials management and information systems and the reengineering of business processes.

1969
MARTIN H. ISRAEL, PhD, professor of physics and dean of the Faculty of Arts and Sciences at Washington University in St. Louis, will become a vice chancellor effective July 1. "Professor Israel joined Washington University in 1968. He became acting dean of the faculty in 1987 and dean in 1988. During his tenure, Arts and Sciences engaged in extensive planning, achieved fiscal stability and improved physical facilities. . . . As vice chancellor, Israel will be a member of the central administration with a special responsibility for ensuring that Washington University remains a national leader in research and education."

1971
FRANÇOIS WILDENBERG, MS, and Sylvie Dufour, of Contrexéville, France, announce the birth of a son, Thomas, on March 30.

1978
MIKE AZIZ writes, "In June 1992 I married Michele Forinash, a music therapist who had been teaching and doing research at New York University. We shared with a bunch of our lunatic windsurfer friends the first week of a wonderful, sunny, two-week honeymoon on Cape Cod. Soon thereafter I became tenured at Harvard and am now the Gordon McKay Professor of Materials Science. Michele and I are proud to report the birth of our first child, Adele Forinash Aziz, on December 2, 1993. She's healthy, happy and a veritable bundle of joy, but the rest of the family could use some more sleep!"

AJIT P. YOGANATHAN, PhD, has been promoted to Regents Professor of Chemical Engineering at the Georgia Institute of Technology. Regents Professor is the highest academic position that can be attained within the University System of Georgia, and is awarded to faculty who have made outstanding contributions in research and education. Professor Yoganathan, who joined Georgia Tech in 1979 as an assistant professor, is also Co-Director of the Bioengineering and the Emory–Georgia Tech Biomedical Technology Centers. The Bioengineering Center and its associated graduate program recently received a $3 million biomedical engineering development grant from the Whitaker Foundation.

1983
RITA GITIK, MS, an assistant professor with the University of Michigan's department of mathematics, writes that she and her husband, Professor Peter Scott, have a new baby, David Yekutiel Scott, born in Jerusalem on April 27, 1993.

1984
A. GREGORY SORENSEN, of the department of radiology at Massachusetts General Hospital, has received the 1994 Dyke Memorial Award for original work in neuroradiology. The title of his manuscript is "Functional Magnetic Resonance Imaging of Brain Activity and Perfusion in Patients with Chronic Cortical Stroke." The award was established in honor of Cornelius G. Dyke, one of the pioneers in neuroradiology, and "is given to a trainee or junior faculty member in neuroradiology for excellence as demonstrated in a paper which represents original, unpublished research in some aspect of neuroradiology." It is widely considered the most prestigious award for young radiologists.

1987
JOHN VIDALE, PhD, a research associate at the Institute of Tectonics at the University of California, Santa Cruz, has, along with two other researchers, received the American Geophysical Union's 1994 James B. Macelwane Medal. Named for the Reverend James B. Macelwane, who established the first institute of geophysics in the United States and who had a deep interest in teaching and encouraging young scientists, the medal is given annually to scientists of outstanding ability who are age 35 or younger, and is one of the nation's leading awards for young geophysicists. Vidale, who is also employed by the U.S. Geological Survey in Menlo Park, specializes in using seismic records from earthquakes or artificial explosions as tools for exploring various features within the earth, and he received the medal for "his contributions to the study of subduction zones, upper-mantle discontinuities, core-mantle structure, and earthquake monitoring as a means of probing below the crust and lithosphere." He publishes frequently in *Nature*.

OBITUARIES

1922
CLYDE R. KEITH, on February 15; he was 94. He is survived by a daughter, Jean.

1931
EDWARD B. "JIM" CROSSMAN, of Alexandria, Virginia, on February 26; he was 84. During his 30-year career with the U.S. Army, he served in World War II and the Korean War, had a special assignment in Vietnam, and worked at the Army Materiel Command Headquarters; he retired with the rank of colonel. He was also a member of the California National Guard, and he retired from the military in 1987. He most recently was a consultant in small-arms investigations. A champion shot with rifle, shotgun, and pistol, he coached the U.S. rifle team for the 1932 Olympics. In 1968 he wrote a book, *Olympic Shooting*, about American Olympic shooters, and in 1975 he was selected as one of the top 10 American handgunners. A leading advocate of small-arms safety, he wrote the Boy Scout Merit Badge pamphlet for rifle and shotgun shooting. He served on the national executive council of the National Rifle Association. He was a life member of the NRA, the Amateur Trap Shooting Association, the Virginia Rifle and Pistol Association, and the NRA Whittington Center Founders Club. He was also a longtime amateur radio operator and a member of the Mount Vernon Amateur Radio Club. He is survived by a daughter, Silver; a son, Alan; and three grandchildren. His wife, Edith, died in 1971.

1933
JACK N. SPARLING, of Carlsbad, California, on January 9. He is survived by his wife.

1937
LE VAN GRIFFIS, MS '38, PhD '41, of Houston, Texas, on December 23, 1993; he was 77. Until his retirement in June 1982, he had been the director of industrial relations and professor of civil and mechanical engineering at Southern Methodist University. Prior to that, he had served as vice provost, as director of the office of research grants and administration, and as Research Professor of Engineering. Earlier in his career he had held various engineering positions and had been dean of engineering at Rice University and vice president of the Southwest Research Institute. He had been a member of the E-Systems board of directors since 1966, serving as a member of its audit committee and as chairman of its compensation and benefits committee. He is survived by his wife, Alice, and by six children.

ALFRED E. MUNIER, MS, of Huntington, New York, on December 16, 1993; he was 78. He began his career as a civil engineer with a New York consulting firm, working on the designs for the 1939 World's Fair Unisphere and the Whitestone Bridge, among others. He joined the Grumman Corporation in 1943, where he helped design fighter aircraft for the U.S. Navy. From 1958 to 1969, he directed Grumman's Future Space Systems Group, which designed the prototype for the Lunar Excursion Module, as well as space satellites for NASA, which in 1970 honored him for the development of the lunar module. Later he was director of Advanced Civil Systems and worked on alternative energy sources such as solar power and nuclear fusion. The latter included collaborating with Princeton University on its construction of the Tokamak Fusion Test Reactor, which recently fired landmark bursts approaching 5.3 megawatts of power. For his work, Princeton in 1983 honored him with its Plasma Physics Laboratory Award. He retired from Grumman three years ago, after 47 years with the company. He is survived by Elizabeth, his wife of 53 years; two sons, Denis and Quentin; a daughter, Frances E. Ziegler; and 10 grandchildren.

1938
HARRY D. EVANS, MS, of Newport Beach, California, on April 3, 1993. He is survived by a son, Harry Kent Evans.

LOWELL H. HULBIRT, of Solana Beach, California, on October 23, 1993. He is survived by his wife and a daughter.

1939
WILLIAM F. ROPP, of San Jose, California, on February 23; he was 77. He was a navigator in the air force during World War II. A retired structural engineer, he was former associate vice president with Daniel, Mann, Johnson & Mendenhall of Los Angeles, past president of

the Structural Engineers Association of California, a fellow of the American Society of Civil Engineers, and a member of the State Building & Safety Board from 1973 to 1983. He is survived by a son, William; two daughters, Melissa Ropp-Lane and Robin Piatshon; and four grandchildren.

1940
ROSS D. F. THOMPSON, of Los Angeles, on January 1; he was 75. Professor emeritus of physics at California State University, Los Angeles, he had received his PhD in physics from Cornell University in 1950. His doctoral thesis was supervised by Richard Feynman. Thompson worked in the area of quantum electrodynamics and, according to a friend, regarded himself as a "quantum mechanic." He taught at the University of Southern California from 1950 to 1959, when he became a founding member of Cal State L.A.'s department of physics and astronomy. He played a major role in the department's personnel selections, helped develop the undergraduate and graduate programs, and taught nearly every course in the physics curriculum. He retired in 1980, but continued to teach as a Faculty Early Retirement Program lecturer until 1987. An enthusiastic backpacker who possessed an encyclopedic knowledge of High Sierra and California-desert trails, backroads, and botany, he was deeply concerned with conservation and environmental issues. He was known for his exquisite photographs of mountain and desert flora, and he occasionally gave nature talks. His broad interests encompassed history, politics, Impressionist art, classical music, and linguistics, and he was fluent in several languages, including French, German, Spanish, Russian, Greek, and Mandarin Chinese. He traveled extensively worldwide, his last trip abroad being a cruise down the Volga River and to remote areas of Russia and Georgia in 1992. "Ross will be sorely missed by the many colleagues and former students who have benefited from his broad knowledge and good judgment."

1942
S. KENDALL GOLD, of Greenwich, Connecticut, in December 1993. He is survived by his wife.

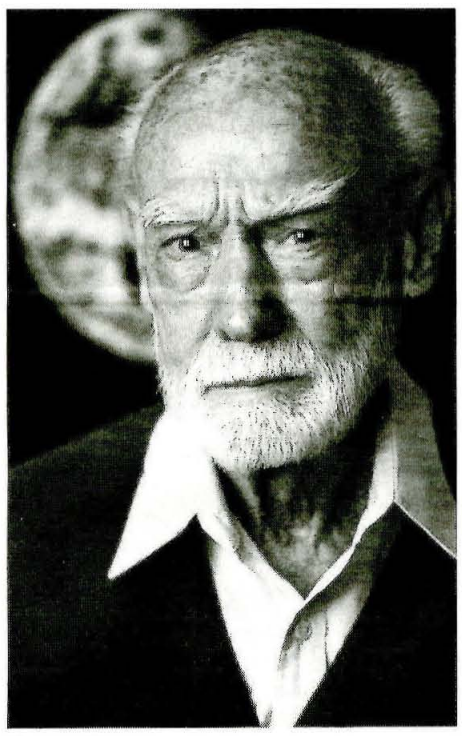
1951
JOHN F. KINKEL, of Irvine, California, on June 28, 1993. He is survived by his wife.

1965
T. NEIL DIVINE, PhD, of Los Angeles, on January 27, of AIDS-related complications; he was 55. "During his 25 years at the California Institute of Technology's Jet Propulsion Laboratory, Neil made many fundamental scientific contributions, helping to define the diverse and complex environments to which many well-known JPL space probes would be exposed. His specific contributions in support of the Voyager, Galileo, CRAF, and Cassini missions included defining the radiation belts around Jupiter, Saturn, Neptune, and Uranus and the dust environment around Halley and other cometary targets. During his tenure at JPL, he often served as a mentor and inspiration to many younger space physicists who benefited from both his scientific incisiveness and quick wit. Neil enjoyed an outstanding international reputation. Recently, he was a guest at Germany's Max Planck Institute in Heidelberg, where his just-released seminal work on predicting meteoroid and space debris environments was greeted with great interest and may form the basis for all future models of these complex environments. Through his work, Neil made a significant contribution to the success of some of our nation's greatest space missions and to mankind's peaceful exploration of space. For this kind and unassuming man, this represents a fitting legacy. Donations may be made in Neil's name to AIDS Project Los Angeles."

Roger Sperry
1913–1994

Roger W. Sperry, 1981 Nobel laureate in physiology or medicine and the Institute's Board of Trustees Professor of Psychobiology, Emeritus, died on April 17, 1994, of a heart attack and of complications associated with a neuromuscular degenerative disease from which he had suffered for many years. He was 80.

A native of Hartford, Connecticut, Sperry earned his bachelor's degree in English literature from Oberlin College in 1935, then focused his attention on psychology, earning his master's in that field in 1937, also from Oberlin. For his doctorate, he studied zoology, earning his degree from the University of Chicago in 1941.



Roger Sperry

Sperry's academic career was as diverse as his educational background. After graduating from Chicago, he held fellowships at Harvard from 1941 to 1946, where he worked in the Yerkes Laboratories of Primate Biology, and he performed military service from 1942 to 1945 by taking part in the federal government's Medical Research Project on Nerve Injuries. After the war he taught as an assistant professor in the University of Chicago's department of anatomy until 1952. During 1952 and 1953, he served as associate professor of psychology at the same institution while simultaneously serving as the section chief for neurological diseases and blindness at the National Institutes of Health. In 1954 he became the Hixon Professor of Psychobiology at Caltech, where he remained for the next forty years. He retired from teaching as professor emeritus in 1984.

Among Sperry's many accomplishments is research he carried out in the early 1950s showing the nervous system to be characterized by a very high specificity of neural reconnection—that is, by the ability of neurons, when severed, to regenerate connections to their original targets. This work led in the early 1960s to a new theory explaining how neurons grow, assemble, and organize themselves in the brain by means of amazingly intricate, genetically determined chemical codes.

Sperry is best known for his "left-brain/right-brain" research, work that has had an incalculable impact on fields ranging from neurophysiology to psychology to education. Working in the 1950s and early 1960s with patients who had had their corpus callosum—the bundle of fibers connecting the left and right cerebral hemispheres—surgically cut in an effort to control epileptic seizures, he demonstrated how the two hemispheres function, independently and in concert. The most striking of his discoveries and the one with which his name continues to be most widely associated is the finding that under certain conditions, each hemisphere has the seeming capacity to behave like a separate consciousness, with the left side of the brain generally more specialized for verbal and analytical thinking, and the right side for spatial and visual thought.

In later years, Sperry's own ever-active brain turned increasingly to philosophy, particularly to issues associated with the mind–brain question—that is, the relationship between the observable physiological structure of the brain and the quality of subjective, conscious thought that characterizes the mind. In pondering these questions, Sperry broke with the behaviorist school, which then dominated psychology and the behavioral sciences, and advocated a new approach that placed far greater emphasis on the role of mental states and experiences in influencing the physiological functioning of the brain. He first set out these ideas in 1965 in what the January 1994 issue of *Humankind Advancing*, which was dedicated to Sperry, described as "a remarkable series of philosophical papers"; and he continued to write and publish provocative and influential writings on the nature of consciousness up until the time of his death. It was for this work, more than for his studies of vision, neuronal growth, or split-brain patients, that Sperry wished most to be remembered.

For his work on hemispheric specialization, Sperry was awarded the 1981 Nobel Prize in physiology or medicine, along with David H. Hubel and Torsten N. Wiesel. He also received the National Medal of Science in 1989 from President Bush, the Wolf Prize in Medicine and the Albert Lasker Medical Research Award in 1979, and the California Scientist of the Year Award in 1972, among many other honors.

In addition to his talents as a researcher, Sperry was "the most artistic person I've ever known," said long-time laboratory assistant Lois MacBird in a 1981 interview. "He sculpted phenomenally. The Sperrys' home is filled with his work." Sperry was also an avid paleontologist, with an extensive collection of prehistoric mollusks.

"He was one of the premier experimental neurobiologists of his time," said Norman Davidson, the Norman Chandler Professor of Chemical Biology, Emeritus, and executive officer for biology at Caltech. "Those of us who have known him since those early years will always remember the courage and tenacity with which he continued to carry on his work in later years in spite of a debilitating degenerative disease. It was an inspiration to all who knew him."

The late Caltech professor is survived by his wife of 45 years, Norma Deupree Sperry, of Pasadena; his brother, Russell L. Sperry, of Bend, Oregon; his son, Glenn Tad Sperry, of Philadelphia; his daughter, Janeth Hope Sperry, of Cleveland; and two grandchildren.

The family asks that donations in Sperry's memory be made to the Muscular Dystrophy Association, or to the Children's Lung Fund, Cleveland, Ohio.

Whitney

Continued from page 9

and on how they view the quality of their experience here. There is also a feeling on the part of many graduates that they would like a closer continuing involvement with Caltech, and that they can be called upon to help the Institute in ways other than, or in addition to, making financial contributions.

Following that meeting, President Everhart asked Tom Anderson and me to form a task force to "review the relationship of the Institute and its alumni and to make recommendations for an alumni relations program for the next few years." The president added that he is "anxious to involve and engage all of our alumni in a two-way communication on a national, and perhaps international, level." The review must of course focus on all alumni, not just members of the Association. Tom Anderson and I begin working on this assignment in early July.

Finally, in closing this column, I welcome the incoming officers: Pete Mason, president; Frank Dryden, vice-president; Ed Lambert, treasurer; and Tom Tyson, secretary. I thank them and the other members of the board of directors for their energy and leadership in Association affairs during the past year, and look forward to working with them as past president. I thank Alumni Association Director Judy Amis and her staff for the wonderful support they have given me during my term of office; and I thank the members of the Association for the opportunity to serve as President.

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In this issue