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Geobiologist Joseph Kirschvink and research engineer Atsuko Kobayashi-Kirschvink in the clean room of their Caltech laboratory, where they have carried on their search for minute traces of the iron-containing mineral magnetite in human brain tissue.



Michael Tweed/New York Times Pictures

Of magnetite and men

Local reporter for a network affiliate: What is the practical application of the fact that we have magnets in our heads? I mean, if I were watching you tonight on the five o'clock news, and trying to understand the impact on me of what you have found, what could you say?

Joe Kirschvink: Well, basically, we can say that there will be a very slight attraction between you and your refrigerator.

Last month, at a Caltech press conference, Associate Professor of Geobiology Joseph Kirschvink and two colleagues announced that they had found crystals of the iron-containing mineral magnetite in human brains. The discovery, assuming it is confirmed, raises once again the question of whether humans, like many migratory animals known to carry magnetite, possess some type of directional "sixth sense," and could provide a possible explanation for the controversial correlation some researchers say they have detected between increased rates of

certain types of cancer and exposure to the electromagnetic fields (EMFs) generated by household appliances and power lines. Kirschvink, who earned his BS and MS (1975) at Caltech under the tutelage of paleoecologist Heinz Lowenstam, the scientist who first established that living creatures are capable of biologically synthesizing magnetite, carried out the research in collaboration with Atsuko Kobayashi-Kirschvink, a Caltech research engineer, and Barbara Woodford, formerly a Caltech research fellow, now at the University of Southern California. The group's findings have been accepted for publication in the *Proceedings of the National Academy of Sciences*.

The scientists reported that, based on their studies, the average human brain appears to contain roughly one millionth of a gram of magnetite, distributed across all areas of the brain. "The crystals we've found appear to be perfect, biologically formed bar magnets," said Kirschvink. "It's the first truly new material found in humans

since our ancestors noticed blood, guts, and bones."

At the press conference, Kirschvink was peppered with questions about the possible hazards associated with having metallic electromagnetic conductors in your head and huddling beneath your electric blanket as you vigorously plied your electric razor or hair dryer. He went to some pains to emphasize that no conclusions about any possible connection between his team's findings and EMFs could be drawn until scientists are able to pinpoint the magnetite's location in the brain tissue and figure out what purpose, if any, it serves there. "It's conceivable that exposure to alternating currents, such as those generated by power lines and appliances, might cause the magnetic material we've found in brain tissue to oscillate," said Kirschvink. "In theory, this type of motion could produce changes in nerve cells, although we don't know what these might be.

"Since we don't know the magnetite's function," added Kirschvink,

"or even whether it's located inside or outside the cell, we can't predict what effect this material would have. Obviously, we think future work is important, particularly because we depend heavily on the use of electricity and are surrounded by manmade electric fields. In the past, if you had asked physicists to discuss possible health effects, they would have said that there's nothing in the body that can be influenced by magnetic fields, so there will be no effect. Now we're saying there might be an effect."

Such questions, he said, are properly the domain of epidemiologists, whom he hoped would be interested in taking a closer look at his team's findings.

Equal uncertainty, according to Kirschvink, surrounds the question of how a "magnet head" (to use one reporter's colorful phrase) might respond to the type of field generated by a magnetic resonance imaging (MRI) scan. A patient undergoing this medical procedure is typically exposed to a

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CAMPUS UPDATE

Caltech's president, faculty, students, structures, honored

Several faculty have been elected fellows of the American Association for the Advancement of Science: *Clarence Allen*, professor of geology and geophysics, emeritus; *Sunney Chan*, George Grant Hoag Professor of Biophysical Chemistry; *Donald Cohen*, professor of applied mathematics; *David Goodstein*, professor of physics and applied physics, and the Institute's vice provost; *Richard Marsh*, senior research associate in chemistry, emeritus; and *Paul Patterson*, professor of biology.

James Bailey, Chevron Professor of Chemical Engineering, has been named a fellow in the College of Fellows of the American Institute of Medical and Biological Engineering.

Diana Barkan, assistant professor of history, has received a \$10,000 Arnold L. and Lois S. Graves Award from Pomona College. The award encourages "outstanding accomplishment in actual teaching in the humanities by younger faculty members." Barkan has also been awarded the Marc-Auguste Pictet Prize for 1992 by the Société de Physique et d'Histoire Naturelle de Genève for "excellent work concerning Walther Nernst and the transition to modern physical chemistry." The prize was presented on April 22, at the society's convention in Geneva.

Jacqueline Barton, professor of chemistry, has been awarded the 1992 Garvan Medal, which recognizes distinguished service to chemistry by female chemists. The award, sponsored by the Olin Corporation, consists of \$5,000, a gold medal, and a bronze replica. Barton received the honor this past spring at the national meeting of the American Chemical Society.

The Beckman Institute has been honored by the Pasadena Beautiful Foundation, which has presented the Caltech facility with its President's Award. A member of the foundation said of the Beckman Institute, "Its fountain-filled pool would be hard to equal for sheer elegance, and its inner courtyard is sheer grandeur."

Ronald Bush, professor of literature, has been awarded a fellowship for university teachers by the National Endowment for the Humanities for his study of Ezra Pound's *Pisan Cantos*.

Caltech's Division of Chemistry and Chemical Engineering has been ranked number one in the world for the impact of its research in chemistry. The rank-

ing, given by the Institute for Scientific Information (ISI), is based on how frequently technical papers published by Caltech faculty members are cited in other articles. According to ISI, papers from Caltech were cited about 3.5 times more than the average.

John Doyle, professor of electrical engineering, has been awarded the R. G. Baker Prize from the Institute of Electrical and Electronics Engineers, Inc., for the most outstanding paper during the past year. Doyle shares the prize with three coauthors.

Caltech President *Thomas Everhart* has been awarded the Clark Kerr Medal, presented annually by the chancellor's office and faculty awards committee of the University of California, Berkeley, to individuals who have "made an extraordinary and distinguished contribution to the advancement of higher education." Everhart received the medal in a ceremony on the Berkeley campus last month. His fellow recipients were former Harvard president Derek Bok and distinguished Harvard economist Henry Rosovsky.

Graduate student *Andrea Ghez* and incoming postdoc in astronomy *Donna Womble* have been selected as Hubble Postdoctoral Fellows by NASA and the Space Telescope Science Institute. Ghez, who is completing her PhD in physics, will conduct her research at the Steward Observatory of the University of Arizona, where she has a postdoctoral appointment. Womble will be coming to Caltech for her research project.

Gian Michele Graf, assistant professor of mathematics, and *Peter Weichman*, assistant professor of theoretical physics, are among ninety scientists of exceptional potential to be awarded Alfred P. Sloan Research Fellowships for 1992. Each will receive \$30,000 in unrestricted research funds over a two-year period. The Fellowships, which were established in 1955 to identify young scholars of exceptional promise and to offer them support at the outset of their careers, are awarded on the basis of recommendations from a committee of distinguished U.S. senior scientists, which this year included Caltech's Harry Gray, Arnold O. Beckman Professor of Chemistry at Caltech, and director of the Beckman Institute.

John Hopfield, Roscoe G. Dickinson Professor of Chemistry and Biology, received an honorary doctoral degree from his alma mater, Swarthmore, at the college's commencement exercises on June 1.

Hiroo Kanamori, director of the Seismo Lab, and John E. and Hazel S. Smits Professor of Geophysics, was awarded the Medal of the Seismological Society of America at the society's 87th annual meeting this past April in Santa Fe. The fourth Caltech faculty member to receive the medal, Kanamori follows

in the footsteps of seismologist Charles Richter, geophysicist Frank Press, and earthquake engineer George Housner. He was honored for his "fundamental contributions to seismology and his efforts on behalf of the society to further the understanding of earthquake processes and characteristics."

Shrinivas Kulkarni, professor of astronomy, has received the National Science Foundation's Alan T. Waterman Award, which is given annually to an outstanding young researcher. Kulkarni, one of 62 nominees, was selected for his work in radio astronomy. He will receive up to \$500,000 of research support over three years.

Windsor Lin, a fourth-year graduate student in aeronautics, has won top honors in an international Japanese-language competition, sponsored by the Japan Foundation for students who have had up to 300 hours of Japanese-language instruction. Lin, who has had only two years of Japanese (at Caltech), outperformed all other competitors in a statewide exam to win the prize—a two-week trip to Japan.

Rudolph Marcus, Arthur Amos Noyes Professor of Chemistry, has been chosen by the American Chemical Society to receive the 1992 Pauling Award, presented annually in recognition of outstanding achievement in chemistry.

Edward Stone, director of JPL and professor of physics, has been elected a Fellow of the American Institute of Aeronautics and Astronautics. Fellows are elected for "notable and valuable contributions to the arts, sciences, or technology of aeronautics or astronautics."

Amnon Yariv, Thomas G. Myers Professor of Electrical Engineering and professor of applied physics, has been selected to receive the 1992 Harvey Prize, in the field of technology, from Technion, the Israel Institute of Technology. Two Harvey Prizes are given each year—this year's other winner is Mikhail Gorbachev. Yariv receives his \$35,000 prize this month in Haifa.

Lew Allen to head SURF's board

Lew Allen, director of JPL from 1982 until last year, has been named the new director of the SURF Board—an advisory group that supports Caltech's Summer Undergraduate Research Fellowships program by raising money and establishing contacts with researchers on campus, at JPL, and in industry.

Now a senior faculty associate on the Caltech campus, Allen was praised by SURF director Carolyn Merkel as "a good friend of undergraduate research for many years." As director of JPL, "Allen was the first to make JPL facilities available to SURF, in 1983," Merkel added. About a quarter of all SURF projects are now carried out at JPL each summer.

Allen, who joined the SURF board in 1991 after his retirement from JPL, has served as chairman of the program's donor and support committee, which works to develop new opportunities for SURF projects in industry. SURF dedicated its 1991 program to Allen, in recognition of his role as "an enthusiastic and dedicated supporter of undergraduate education and research." A record 192 students participated in the program last year.

President Everhart (left) shares a moment with (from left to right) new NASA administrator Daniel Goldin, Secretary of Commerce Barbara Franklin, and Secretary of Energy Admiral James Watkins at the opening session of the National Technology Initiative Conference, held on campus May 29. Organized by Caltech's Industrial Relations Center, the meeting brought together representatives of industry and academia in an effort to promote better understanding of private-sector opportunities to commercialize new technology advances, with the overall aim of strengthening America's competitiveness.





Thomas Ahrens

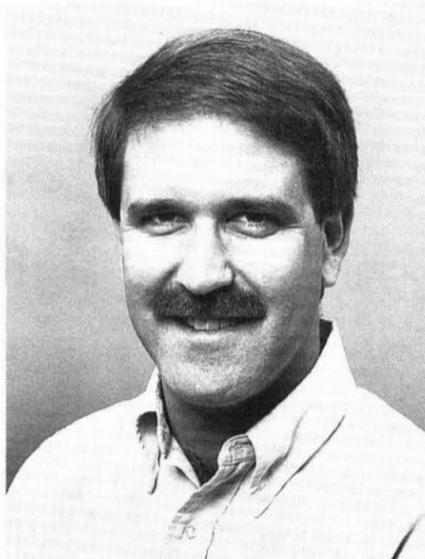
NAS elects Ahrens

Professor of Geophysics and Institute alumnus Thomas Ahrens last month became the 64th member of the current Caltech faculty to be elected to the National Academy of Sciences. Ahrens, who is known for his contributions to geological questions that range from the structure and properties of Earth's core and mantle to the issue of whether an asteroid's striking Earth 65 million years ago led to the extinction of the dinosaurs, has been on the faculty since 1967. He received a Caltech MS in 1958 and earned his BS from MIT and PhD from RPI.

Ahrens is well-known in geological and planetary-science circles for the unique brand of research he conducts in Caltech's "cannon lab" (the Helen and Roland Lindhurst Laboratory of Experimental Geophysics), in which small cannons are fired off to simulate the extreme conditions and pressures that characterize many geologic and planetary processes. In 1988, one such series of experiments led Ahrens and colleagues to propose that molten iron in Earth's core is likely to be much hotter than previously believed.

Much of Ahrens' recent work has dealt with the asteroid-impact theory of the Cretaceous extinction, most notably with the question of how Earth's climate might have been affected by such a catastrophe. In 1988, he and two colleagues conducted cannon experiments that called into question the then-widely held view that a direct hit on Earth by an asteroid would have wreaked havoc by touching off the equivalent of a nonradioactive nuclear winter. Rather, Ahrens and his colleagues suggested, chemical reactions in the atmosphere following an asteroid impact would have produced a significant rise in temperatures and carbon dioxide akin to a greenhouse effect, dooming many types of marine life and severely disrupting the land-based food chain all the way up to the dinosaurs. The merits of both scenarios continue to be debated, with some recent fossil evidence appearing to support the greenhouse theory.

Ahrens has been a Fellow of the American Geophysical Union since 1982, and with Caltech colleagues Sally Rigden and Edward Stolper was awarded the American Association for the Advancement of Science Newcomb-Cleveland Prize in 1984.



John Grunsfeld

Caltech researcher selected as Shuttle astronaut candidate

Caltech senior research fellow John Grunsfeld has been selected by NASA as one of 19 new astronaut candidates for the Space Shuttle program. According to NASA, Grunsfeld was chosen from 2,054 qualified applicants, 87 of whom received interviews and medical examinations in December 1991 and January 1992. Grunsfeld will report to the Johnson Space Center in Houston, Texas, in August to begin a year of training and evaluation, after which he will receive a technical assignment leading to his selection for a Shuttle flight crew.

A native of Chicago, Grunsfeld, 33, earned his BS in physics from MIT in 1980, and his MS and PhD degrees, both in physics, in 1984 and 1988, from the University of Chicago. He served as a visiting scientist at the University of Tokyo from 1980 to 1981, as a NASA graduate-student research fellow at the University of Chicago from 1985 to 1987, and as the W. D. Grainger Postdoctoral Fellow in Experimental Physics at the University of Chicago from 1988 to 1989. He came to Caltech in 1989 as senior research fellow in physics.

Grunsfeld, who admits to "dreaming about being an astronaut since I was 8 years old," says that his one regret is that "I'll have to leave my work at Caltech a bit sooner than I had planned."

A specialist in gamma-ray and x-ray astrophysics, Grunsfeld's areas of research include compact objects, such as neutron stars and pulsars, within our own galaxy, as well as the galactic center, high-energy cosmic rays, and solar flares. He is co-PI (with Caltech Associate Professor of Physics Tom Prince) on an investigation involving the timing of compact objects and the search for periodic sources such as accretion-powered pulsars, with instruments on the Compton Gamma Ray Observatory, launched by the Space Shuttle in 1991. Grunsfeld is currently working with a group of Caltech undergraduates on the design of a NASA Get Away Special, scheduled for Space Shuttle launch in 1993, which will measure gamma-ray bursts.

Bioimaging teaching center established

Caltech has received a grant of \$250,000 from the Fletcher Jones Foundation of Los Angeles to establish a Biological Imaging Center for Teaching and Research, to be located in the Beckman Institute. The center will foster the development of new technologies for imaging biological structures and processes, will train students in their use, and will use these tools to investigate phenomena ranging from the invasiveness of cancer cells to the embryonic development of the nervous system. The center is envisioned as an important training ground for future biomedical researchers and academicians. "Currently," says biologist Scott Fraser, who will head the new center, "few, if any, other facilities offer training in these important technologies."

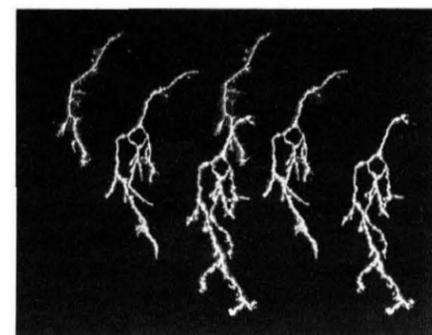
Fraser, the Anna L. Rosen Professor of Biology, has been a member of the Caltech faculty since 1991 and a pioneer in the development of biological imaging techniques. Fraser previously was chairman of the department of physiology and biophysics at UC Irvine. He earned his bachelor's degree in physics from Harvey Mudd College in 1976 and his Ph.D., with distinction, in biophysics, from Johns Hopkins University in 1979.

Biological imaging technology holds the great promise of permitting researchers to study biological processes as they take place in the living organism. For example, through the use of these techniques, scientists have been able to witness such phenomena as the development of a single optic nerve fiber in a living animal as the fiber formed its connections with the brain.

At Caltech, bioimaging techniques are also being used to explore one of the central mysteries of nervous system development—how neurons, which are all descended from a small number of ancestral, or "precursor," cells, develop

in the embryo into many different types of neurons that perform highly specialized functions. Some precursors give rise to cells that migrate in highly characteristic fashion to colonize the spinal cord, while others become part of the visual, auditory, or olfactory system in the developing brain.

"The key question," says Fraser, "is how these neurons, which are all descended from relatively few precursor cells, 'know' that they are destined to fulfill very different roles in the brain and nervous system. How do they



Biological imaging of a live frog embryo's retina produced this time-lapse image of a single optic nerve fiber forming connections with the brain.

receive and act on this information? For the first time, we have a technology that allows us to observe this type of fundamental cell behavior in living tissues—to watch what actually happens in the animals as it is going on."

The Fletcher Jones Foundation was founded in 1969 through a bequest by Fletcher Jones, cofounder, chairman, and chief executive officer of Computer Sciences Corporation, a pioneering firm in the field of software computer services. Mr. Jones died at the early age of 41, bequeathing a fortune of approximately \$30 million to the foundation, which today pursues philanthropic objectives in a wide range of areas.



Still awaiting the moment of contact with cows on distant worlds, the natives of the fields around Caltech's Owens Valley Radio Observatory roam daily across the road leading to the observatory. OVRO's three-dish millimeter-wave array can be seen in the background, one antenna partly hidden behind the facility's 40-meter dish, currently being used to study microwave radiation from the Big Bang. Two new dishes will be added to the millimeter array later this year, giving the OVRO instrument, already one of the most sensitive in the world, the capacity to create images of galactic and extragalactic star-forming regions with unprecedented speed. Funded by the NSF and Caltech, the telescopes are being constructed and engineered by OVRO's on-site staff, in collaboration with personnel on campus.



Eustace Lycett (right), behind the camera during the making of the 1965 Disney movie *Mary Poppins*, and (left) at his Yorba Linda home today.

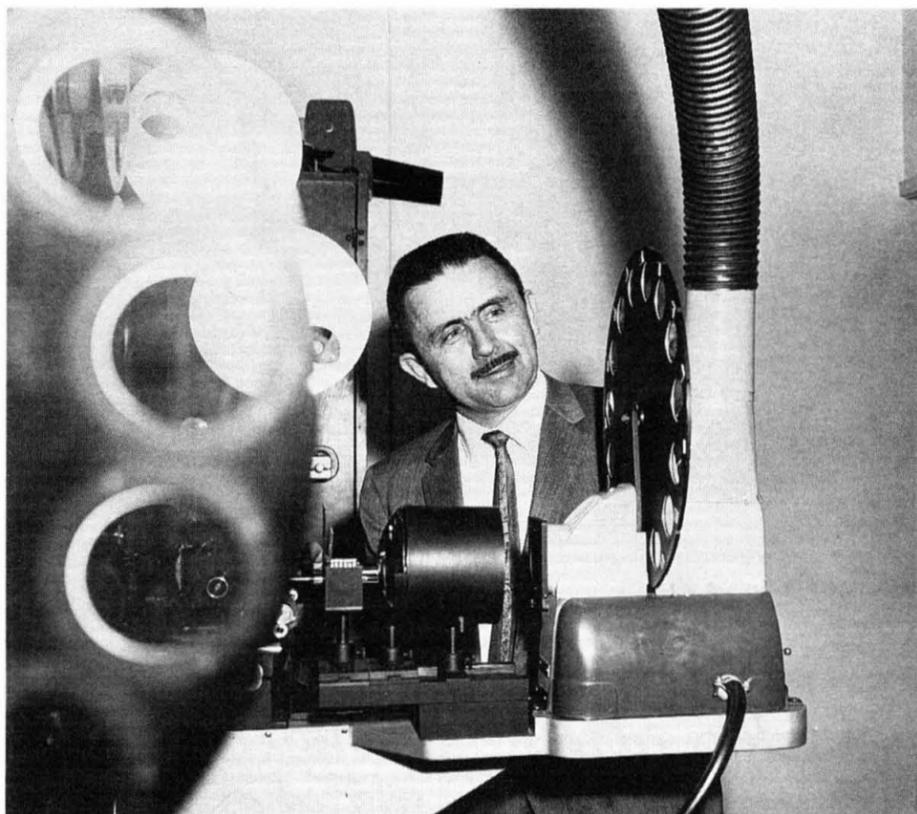


Photo courtesy of Walt Disney Company

The beaver, the man, the mouse, and two Oscars: Eustace Lycett '37 looks back on his career with Disney

By Winifred Veronda

Images of Julie Andrews and Dick Van Dyke soaring through the air in a cartoon fantasy land, mounted on carousel horses, flash through Eustace Lycett's mind as he contemplates the two Oscar trophies that grace the coffee table in his Yorba Linda, California, home. Winning two Oscars for special visual effects (for *Mary Poppins* in 1965 and for *Bedknobs and Broomsticks* in 1972) was exciting for Lycett (BS '37), whose career with Walt Disney Productions spanned 42 years, but what he remembers most was the day-to-day

oil or aircraft industry. The depression was winding down when he graduated with a mechanical engineering degree in 1937, but jobs were still scarce. "A Disney representative interviewed me, and I was hired on the spot," he says. "I was delighted to get the job—even though I might never have considered it if the market hadn't been so tight. Mine was the first Caltech class in several years in which all of the engineers found employment."

A cartoon studio in 1937, Disney Studios had moved to Hyperion

to plan and film intricate scenes that would surpass anything in animated motion picture history. Lycett's career suddenly expanded in scope, as he began to combine engineering skills with creative artistry. The movie *Bambi* came next, and Lycett was deeply involved in its production.

His work brought him into close contact with Walt Disney, already on his way to becoming a legend. "Walt had a magnetic personality, and he was exciting to work with," Lycett recalls. "When you were in a meeting with him, you quickly found yourself totally involved. He was a very talented man, constantly generating new ideas. But on the other hand, you didn't dare cross him, because he could be ruthless. You didn't want Walt as an enemy."

Lycett was still a relative newcomer when Disney Studios found itself in a new phase in its history, as World War II broke out and quickly overshadowed the Hollywood movie-making scene. Classified as a defense industry because its animation capabilities offered unique potentials for making training films for the armed services, the studio suspended work on all conventional productions and began to produce films for the military. Animated diagrams and charts replaced scenes of the seven dwarfs marching off to work, singing merrily as they swung their picks.

World War II ended, and Disney Studios completed the production of *Fantasia*, begun several years earlier. But cartoon films were becoming increasingly expensive and time-consuming to produce, and Disney decided to experiment with live action films that incorporated cartoon sequences. Technical problems abounded in these productions, and Lycett began to rely increasingly on his engineering back-

ground, glad that his Caltech education had stressed versatility in the application of knowledge. His success with the new medium led to promotions, and eventually he became head of the special photographic effects department, with supervisory responsibilities for 30 people.

New challenges awaited him in the filming of *Mary Poppins*, a production that broke new ground in its combination of live actors with animated characters and backdrops. When Dick Van Dyke and Julie Andrews arrived on the movie set to perform these scenes, they found themselves in the novel position of having to sing and dance on virtually empty sets, orchestrating every move with great care so that animated sequences could be integrated later. Lycett worked closely with both stars and animators, planning each scene in intricate detail.

Julie Andrews, fresh off the stage from *My Fair Lady* and appearing in her first major film, found the whole process mystifying, but performed with her usual magic, says Lycett, as she precisely envisioned the cartoon penguins that would be her eventual dancing partners.

Lycett's work in this film won him the first of four Oscar nominations. Although he was four times nominated for the coveted statuette, he was edged out for *The Absent-Minded Professor* in 1961 and *The Black Hole* in 1979—the latter his last picture before retirement.

One of Lycett's most interesting assignments involved the movie *The Parent Trap*, in which Hayley Mills played identical twins, a situation that created the need for the actress to carry on conversations with herself. The project involved the first use of a split-screen process, in which each scene in-



Photo courtesy of Walt Disney Company

Lycett won an Oscar for his technical achievements in combining live actors with animation in *Mary Poppins*. The film broke new cinematic ground with scenes such as this one, in which Dick Van Dyke and Julie Andrews danced in the park with animated penguins.

stimulation of working with ingenious people and using his engineering skills to devise special effects never attempted before.

"There were new challenges every day," he says with enthusiasm, "and solving them was always fun."

A career in the film industry was the farthest thing from Lycett's mind when he enrolled at Caltech in 1933 to study engineering. He had grown up in England and completed high school in New Mexico, and he expected a Caltech education to lead to work in either the

Avenue from the garage on Vermont Avenue, where its founder had launched it in 1928. The studio had recently embarked on a groundbreaking endeavor—a full-length technicolor cartoon feature called *Snow White*. "People had told Walt the concept was impossible," says Lycett, "and whenever he was given counsel like that, he was sure to forge ahead."

The innovative project required new cartoon camera equipment, which Lycett helped design—and someone to work with the camera crews in using it

volving Mills was shot two times, with the star and with a double. Then the two halves with Mills were combined.

Another favorite project was entitled *Darbie O'Gill and the Little People*. In this film, Lycett's task was to work with full-sized actors, making them appear as film images of people three feet tall. A lot of mathematical calculations were involved in this effort, says Lycett, as he utilized his Caltech math training in ways he could never have imagined.

As the years went by, cartoon animation became more and more expensive, and Disney turned increasingly to live action films. Models filled many needs—for example, the submarine and the giant squid in *20,000 Leagues Under the Sea*. The release of *Star Wars* in 1976 by another studio brought science fiction movies to the fore, as studios scrambled to produce increasingly complex visual effects. "At this point," says Lycett, "anybody who knew anything about special effects could name his price."

Financial pressures at Disney Studios increased after the founder's death. Without his leadership, the studio faltered for a time. Family pictures with "G" ratings had become the studio trademark, and these failed to draw well, as movie audiences sought spicier fare. "Now the studio has done what I pressed them to do," says Lycett. "They created a subsidiary that could make movies without the Disney label." "Touchstone" was the result, and its releases have been very successful, bringing yet another dimension to the studio's history.

When he joined Disney in 1937, Lycett never dreamed that he would stay with the studio throughout his career. "But the job was interesting and challenging, the pay decent, and working for a guy like Walt was always an inspiration," he says. "All and all, it was just too good a deal to leave."

After retirement, Lycett and his wife, Mary Ethel, moved to Yorba Linda where they have four sons living in the area. They also have eight grandchildren and one great-grandchild. Mary Ethel Lycett, a native of Hollywood, was an Occidental College student when she met her future husband on a blind date. "In those days," Lycett recalls, "we had to forage for dates. I consider myself very lucky in my good fortune." His wife's brother, Winfred Goddard, had enrolled at Caltech but transferred to Stanford.

Those Oscar statuettes that grace the coffee table at Lycett's home are only there to be shown to a visitor. One disappeared after a large group of people had been in the home. It was subsequently replaced by the Academy, and nowadays, both stay tucked away in a safe place. The missing Oscar (identified by its inscription) eventually turned up at a garage sale in Hollywood, its route there from Yorba Linda to remain a mystery. But for Lycett, who has spent a career creating fantasy scenarios, its strange journey seemed a fitting touch.

Magnetite

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magnetic field roughly 30,000 times stronger than that of Earth. "On the one hand," said Kirschvink, "if you take some of the crystals that we've found and actually put them in an MRI field, you discover that they are indeed very energetic. Right there, theoretically, is cause for concern because we didn't think anything that active was in human tissues. But, on the other hand, if you put one of these crystals into a very strong but steady field of the type generated by MRI—as opposed to the weaker but fluctuating field produced by, say, a household appliance—the magnet aligns itself with that field and doesn't move at all. If, as we suspect, it's the motion of these magnetic crystals that might lead to biological effects, just having the magnet pinned in one direction sug-

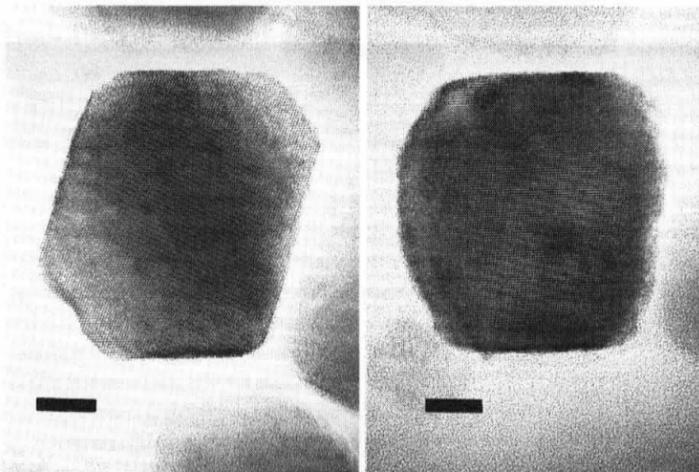


Photo by Atsuko Kobayashi-Kirschvink

gests that there will be no problem. But again, since we don't know where in the tissues these magnets are, we can't predict possible hazards."

Kirschvink and his colleagues first began looking for magnetite in humans about three years ago. The immaculate laboratories that this type of search requires had stymied similar efforts by others in the past, but here Kirschvink was better prepared than most. In the early 1980s, he was using glass knives to dissect tunas' nasal cavities, a study that demonstrated that these fishes—like some types of bacteria—possess almost perfectly shaped bar magnets in their brains and, like bacteria, may use them for navigational purposes. A few years later, he was one of a small number of researchers to observe that migratory whales have a tendency to beach themselves along anomalous lines in Earth's geomagnetic field, a finding he published, among other places, in Caltech's *Engineering & Science* magazine (March 1985), where it appeared under the title "A Tale of Dead Whales." More recently, he has been—and still is—using pairs of magnetic coils fastened to his office window-ledge to train honeybees to detect small magnetic anomalies. In the course of these

various studies he has built up at Caltech a magnetically shielded, dust-free clean room, where elaborate precautions are taken to keep even microscopic dust particles, some of which are magnetic, from contaminating the samples or the instruments used to study them.

Kirschvink's team has also pioneered in the development of instruments sensitive enough to ferret out minute quantities of magnetite from various types of tissue. To examine the human tissue samples, he and his coworkers used a device developed by Atsuko Kobayashi-Kirschvink, known appropriately as "Atsuko's finger." The "finger," a thin glass vial containing a magnet roughly 20 times the strength of a refrigerator magnet, was inserted into the various preparations of dissolved brain tissue, and after a week it was removed, and any particles found clinging to it were examined under the electron microscope. "What we found," said Kirschvink, "were crystals that are remarkably similar in size, shape, and structure to the biological bar magnets produced by bacteria. This

A magnetite crystal (left) isolated from a magnetotactic bacterium and (right) taken from a human brain. Each crystal is about 50 nanometers, or 2 millionths of an inch, in diameter. The scale bars on both figures are 10 nanometers in length.

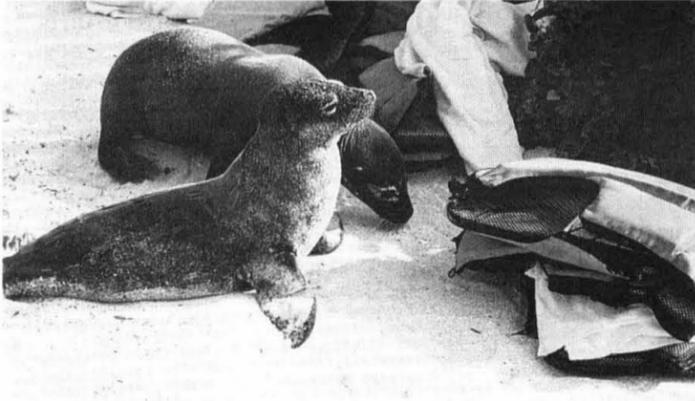
appears to be one of the few biological structures that seems to have been conserved evolutionarily from bacteria all the way to humans."

Of all the animals now known to manufacture magnetite—and these include many migratory species of fish and birds—only magnetic-sensing bacteria and honeybees have been proven to rely on the material as an internal compass. Bacteria use their home-grown magnets to find their way down (the usual direction of their food supply) in the mud. The slight attraction to the refrigerator aside, is it conceivable that magnetite may confer on humans, as on magnetotactic bacteria, some type of adaptively useful directional sense? While acknowledging that "many of the crystals we've found are shaped in such a way as to be optimal for use as magnets," Kirschvink points out that no behavioral evidence that humans possess a magnetic sensitivity has ever stood up under scrutiny. "There have been a number of experiments to test whether humans have a magnetic sense," he says. "Unfortunately, none of the results has been reproducible elsewhere." His own approach to this question remains somewhat more reductionist. "What

we need to do now is find out where these particles are in the tissues, unravel the biochemistry, and develop the antibodies to help us understand it. Until those kinds of studies are carried out, we simply can't say what, if anything, the magnetite is doing there."

It is precisely this litany of "many questions, few answers," according to a recent article in *Science* (May 15), that has prompted some scientists, while not questioning the validity of Kirschvink's findings, to ask whether he hasn't really found an iron-filings equivalent of the appendix. If magnetite is indeed present in human brain tissue, these researchers suggest, perhaps it is purely vestigial, a reminder of how far we have come since the heyday of 3-billion-year old ancestors who may have relied on Earth's geomagnetic field to distinguish up from down in the primeval slime. Contributing to this mixed reception may be the fact that Kirschvink, who holds a permanent appointment in Caltech's Division of Geological and Planetary Sciences, straddles several different disciplines in his research. The paper his team wrote announcing its findings was bounced editorially by *The New England Journal of Medicine, Science*, and *Nature* without peer review, possibly because, division chairman David Stevenson speculates, the editors on whose desks it landed may have been unable to decide where in the pantheon of scientific specialties it belonged.

Kirschvink has no quarrel with the view that the magnetite humans evidently carry in their heads may simply be a memento left in our genes by migratory ancestors. At the same time, he is aware that this iron-containing mineral, once thought to be exclusively produced by geologic processes, has a checkered and colorful history. When his undergraduate adviser, Heinz Lowenstam (now Caltech professor of paleoecology, emeritus), first tried to tell colleagues in the early 1960s that he had discovered an animal—a sea creature called a chiton—that manufactured its own magnetite, he won few converts. "I told my friends in geology and biology that I had found a marine animal with 'iron teeth,'" Lowenstam recalled once in a Caltech oral history interview. "'Oh,' they mostly said, 'that's such nonsense. Please go away.'" Lowenstam did go on to something else, but not before he had published an article that led, a dozen years later, to a phone call from Woods Hole Oceanographic Institution, where a young biologist had discovered magnetic-sensing bacteria. "I suggested that they run an X-ray diffraction test for magnetite," says Lowenstam, who is today sometimes called the "father of biomineralization." "Sure enough, that's what it was." By then, Lowenstam had been working for two years with Joe Kirschvink, who last month stepped forward to stake out the latest claim on a lode first mined at Caltech nearly a generation ago.



The locals check out the Caltech tour group.

This spring the Caltech Alumni Association sponsored its first travelstudy tour to Ecuador and Ecuador's Galápagos Islands, an archipelago made famous of course by Charles Darwin's musings over its peculiar flora and fauna. Today, a century after Darwin, the Galápagos, once known largely as a primitive stopover for whaling ships, are considered a national treasure, a mecca for naturalists and biologists, and—as this selection of pictures shows—a land of elemental beauty and considerable scientific interest. The text accompanying these photos is excerpted from a journal kept by Senior Research Associate in Chemistry William Schaefer, who accompanied the Caltech group—as travelstudy leader in Ecuador, and fascinated observer in the Galápagos.



From left, Margaret Schaefer, Barbara Bain, Elsie McPherson, and Sue Coombs listen as naturalist Fabricio Valverde explains the finer points of sea-turtle nesting on this Floreana Island beach.

We sailed during lunch to South Plaza Island and made landing there. Sea lions were everywhere underfoot and had to be shooed off the wharf so we could walk ashore. With lovely faces and expressive eyes, sea lions—the “seals” of the circus—are delightful creatures and offered much entertainment and pleasure over the next days. We saw them on every island. As we got to the beach we saw our first, bright-yellow land iguanas. These, like the sea lions, accepted us and neither moved out of the way nor attacked us; we were treated as if we were natural occupants of the island, sharing it with the birds and animals. . . .



Galápagos chronicler William Schaefer towels off after a “wet landing” on an island beach.

The cruise to Floreana Island was through rain squalls, with a double rainbow visible to the west in the early morning. We had a wet landing, and a short walk over a hill led us to a beach of fine white sand, a nesting ground for sea turtles. Their tracks were evident, regular tractor treads going up from the water to high ground where wash-tub-sized depressions had been dug for their eggs. And we visited the famous Barrel Post Office, where you can leave an unstamped letter to anywhere, and someone else will pick it up and mail it eventually. This relic from the days of whaling ships now boasts two barrels, but the technique hasn't changed. . . .



For every letter they leave at the Barrel Post Office, passersby are supposed to stamp and mail another in return. At least one Caltech tourist found that these letters reached their recipients faster than mail sent the usual way.



Galápagos

os album

A red-footed boobie eyes the latest visitors.

The evening's cruise took us to Santa Cruz Island, home of the Darwin Research Station and of most of the Galápagos' 10,000 inhabitants. The station is raising endangered Galápagos tortoises and iguanas, working with the National Park Service to prevent further damage to the island environments. Each island has its own distinct race of tortoise. . . .



Endangered tortoises at Darwin Research Station are hatched from eggs collected in the wild and are released once they are old enough to survive encounters with the cats and dogs introduced to the islands centuries ago by whalers.



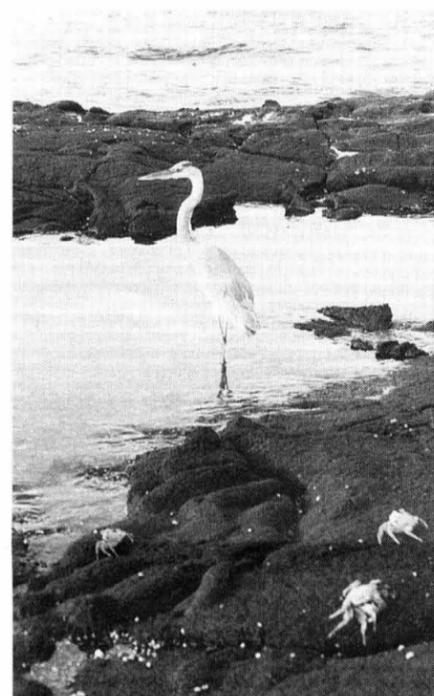
As we cruised from Santa Cruz to Tower Island, there were many seabirds on the cliffs, including red-footed boobies, webbed feet and all, perching in the trees. That afternoon we left for a hike on the beach and saw an exhibition of wildlife such as I've never seen before, even in a movie. The sky was filled with frigate birds, who were in their mating season. Some of them had paired up and were sitting by nests but most of the males were still available. They sat on the tops of the shrubs and inflated a large, brilliant red pouch on their throats to attract the females. The sight of perhaps 200 or 300 males, all puffed up with this gaudy pouch under their neck, trying to attract a dozen or so females, was both ludicrous and inspiring. . . .



From left, alum Gerald Hooper '55, wife Donna, and alum James Blom '50 hike through the tall grass in the Santa Cruz Island highlands.



A long overnight sailing took us to the western shore of Isabela Island, the largest of the group, with five active volcanoes on it and the highest point of the Galápagos, 5600 feet. We sailed during lunch across a narrow channel to Fernandina Island, the newest of the group, with raw lava adorning the flanks of the single volcano there and the barest covering of plants and bushes on older flows. A great blue heron stood guard over a tide pool while penguins stood at attention on the rocks. Life is moving in, colonizing the land almost as fast as it is being made.



On Tower Island, a female frigate bird apparently has little encouragement to offer one of her numerous suitors.

ALUMNI

CHAPTER ACTIVITIES

Boston, Tri-State chapters host computer scientist Stephen Taylor

Assistant Professor of Computer Science Stephen Taylor spoke on May 6 to a group of Boston alumni gathered at MIT, and on May 7, to a Tri-State Chapter audience in New York City, on his current research in "Composing Concurrent Programs" for supercomputers. Taylor described his involvement in a Caltech research team that is working to define and design the best techniques by which parallel programs may be "composed," or glued together. Many of the researchers' ideas, said Taylor, have been implemented and are publicly available in an experimental concurrent programming system.

Revived Houston Chapter welcomes President Everhart

About 40 Houston-area alumni got a firsthand update on life and times at Caltech from President Everhart, who spoke at the inaugural meeting of the newly reorganized chapter in Houston last month. Everhart's talk was preceded by a video showing of a Caltech Centennial program televised earlier this year in Los Angeles, and followed by a question-and-answer period. "Since many of these folks hadn't been back to campus in some time," said one participant, "the talk and the video sparked several questions about what was going on here." The chapter's new officers—Tim Murray MS '65 (see story, this page); Joe Yang '86; and Michael Callaghan '52—are putting together what they hope will be a lively calendar of events for future meetings, including a possible trip to Johnson Space Center.



From left, Al Atwood '32, Fred Selleck '49, and cochairs John Fee '51 and Ted Combs '27, consider ways to involve Alumni Association members in the Long-range Planning Committee process. Members are encouraged to contact the Association office at Mail Code 1-97, Pasadena, CA 91125 to express ideas about the future mission of the Association. Not pictured: Vic Veysey '36, Chuck Holland '64, Rhonda MacDonald '74, and Tricia Stoddard '82.

Stupian reflects on his term as president

This is my last "President's Column" for *Caltech News*. My term ends on June 18 when Le Val Lund BS '47 assumes office. It has been, quite simply, a fantastic year. I can't yet say whether 1991-92 will prove to have been the absolute high water mark of my life, but this year as your Association's president must at least rank very near the top. In addition to working closely with the Association staff, the Board of Directors and the Board's various committees, the Alumni Association president is invited to a number of functions both official and social and is privileged to meet many fine people in the Caltech community.

I'll use this soapbox to beat my favorite drum one more time. As of late April, we had 750 alumni accounts on our new computer system. About 280 people had actually used the system at least once, and the number of users is increasing daily. There have been some very interesting exchanges of views from both alumni and students in the "discussion" news group. Topics have included admissions, Interhouse and other matters dear to Caltech graduates. Alumni are beginning to send both offers of employment and resumes to the "jobs" group. I have received electronic mail from alumni in Japan, and have even communicated in "real time" through the server with an alum in Hong Kong (you and the other party can type back and forth!). Our system seems to be one of the first ever set up at a university specifically for alumni. We have received a congratulatory and slightly envious letter (electronically, of course) from MIT's Alumni Association. An account on the alumni computer system will let you keep in touch with campus affairs and will let your friends know where to look for you.

Although the Association is engaged in many worthwhile activities, I remarked in my last column that we, collectively, might be able to do even more for Caltech and for one another. The "jobs" news group represents a tentative first step in one of the directions I had in mind. We explored the possibility of joining a multi-university job placement network a few years back. That plan was not implemented for a number of reasons. The new era of electronic communications now allows the Association in essence to simply

provide a piece of electronic corkboard where members may tack up employment notices. I hope that this job-posting will develop into a significant and useful service. The success of this and other ventures depends on the degree of our involvement.

The Association doesn't have enormous financial resources, but Caltech graduates should be a rich source of ideas. What do we do next, either with electronic communications or with any other aspect of alumni affairs? The Committee on Long Range Planning, which I have described before in these columns, is now in the process of gathering comments from the Caltech faculty, administration and, of course, alumni. I direct your attention to another mention in this *Caltech News* in which the committee solicits your comments. Let us know what you think.

I'll wind down with an answer to a question that many of you may have long been wanting to ask. Did you ever wonder how someone gets to be president of the Alumni Association? My own involvement began innocently enough when I filled in a questionnaire on an Alumni Seminar Day program some years ago. I checked a box indicating that I would like to participate more fully in alumni activities. One thing led to another. This story has a moral of sorts: it's easy to get involved with the Association, and your participation will pay great dividends in terms of personal satisfaction. I hope that you will all consider playing an active role in the life of Caltech and the Association, if you do not do so already.

Finally, I want to thank all of the people with whom I have had the pleasure of working during my tenure as president. I especially want to express my appreciation for the efforts of the staff at Alumni House. I'll remain on the Board of Directors as Past President during 1992-93. Le Val has also appointed me the chair of the newly created Electronic Communications Committee for the coming year, which means that I will continue to be involved with the alumni computer server. You can still reach me by E-mail (stupian@alumni.caltech.edu), and you can of course direct general comments and inquiries to: Caltech Alumni Association, Caltech 1-97, Pasadena, CA 91125.

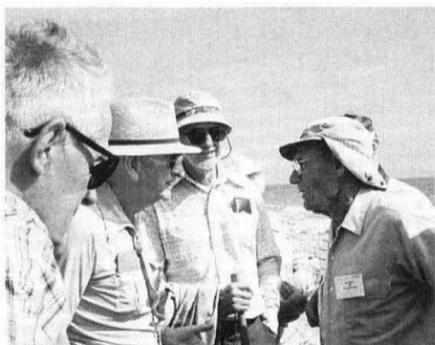
Murray heads Houston Chapter

Timothy O. Murray (MS '65) had not long been back in his native Texas when he was elected president of the newly organizing Houston alumni chapter. With Joseph T. Yang (BS '86, MS '87, PhD '91), vice president, and Michael J. Callaghan (BS '52), treasurer, he planned a meeting on April 29 that was attended by 40 of the 240 alumni who live in the area. The freshly organized chapter's first speaker was President Everhart, who spoke to the group in April about new developments at the Institute.

Quarterly meetings are planned for the chapter, with the next one to be held at Rice University at a date to be determined. In addition to keeping alumni informed about developments on campus, Murray is particularly interested in having the chapter play a role in the expansion of Project SEED (Science for Early Educational Development) into local schools. Project SEED is an elementary-school, hands-on science curriculum created by Caltech faculty.

Murray, whose career has involved general-management and sales-management roles with a variety of companies, is vice president of Charter Capital Corporation. After leaving Caltech, he earned an MBA from UCLA in 1968, while working at Douglas Aircraft Company; and work has taken him from Fort Worth, Texas, to Hickory, North Carolina, and back to Los Angeles, where he was owner and president of Coast Telecom Corporation. After several years in southern California, he and his family moved to Houston so that his wife, Dr. Natalie Murray, could accept a post as a hepatologist with the Baylor College of Medicine at the Texas Medical Center. Dr. Murray, who earned her medical degree at USC in 1985, is the only liver specialist on the staff.

The parents of two sons, the Murrays like to travel (their favorite destination is Cambria, California). Both have been deeply involved in church activities, and in national politics at the county level.



Forty-five Orange County chapter members, among them (left to right) Lee Carleton '33, Mort Jacobs '28, and How Bailey PhD '41, joined field geologist par excellence Robert Sharp on a day-long trek last May into the geological past of Orange County. Their itinerary included a visit to San Onofre Beach Park, where the alumni group heard Sharp explain the relationship between the region's geology, as revealed in its spectacular sea cliffs, and the local nuclear generators, and took the opportunity to get up close and personal with the Cristianitos Fault, a beautifully exposed formation whose ability to generate an earthquake, Sharp told the group, continues to be debated.

Sorry about that

The address of Conway Snyder PhD '48, whose request for information and anecdotes about alumnus and faculty member Bill McLean ran in the April *Caltech News*, was incorrectly printed in that issue. Snyder, who is assisting authors of a book about McLean and his invention of the air-to-air guided missile "Sidewinder," lives at 21206 Seep Willow Way, Canyon Country, CA 91351.

ALUMNI ACTIVITIES

June 18, *Alumni Association Annual Meeting and Honorary Alumni Dinner*, the Athenaeum.

June 21–28, *Yellowstone Travel/Study Program*, with Robert P. Sharp '34, Robert P. Sharp Professor of Geology, Emeritus; Leon T. Silver PhD '55, W.M. Keck Foundation Professor for Resource Geology; and John Good, former superintendent for the National Park Service.

July 13–21, *Iceland Travel/Study Program*, with Robert Sharp, Sharp Professor of Geology, Emeritus, and Susan Kieffer MS '67, PhD '71, Arizona State University.

August 8, *Mt. Wilson Observatory Tour*, Robert Jastrow, director, Mt. Wilson Institute.

August 15–23, *Ashland/Crater Lake Travel/Study Program*, with Jenijoy La Belle, professor of literature, and Dr. Charles Bacon, U.S. Geological Survey.

August 29, *"San Sylmar" Merle Norman Classic Beauty Collection Tour*. Private collection of fine functional art owned by J.B. Nethercut '35.

October 24–31, *Hawaii Travel/Study Program*, with Robert P. Sharp '34, Sharp Professor of Geology, Emeritus; and Dan Dzurisin PhD '77, U.S. Geological Survey, Cascades Volcano Observatory.

November 7, *San Gabriel Mountains Geology Trip*, with Bruce Carter '65, Associate Professor of Geology, Pasadena City College.

For information, please contact Arlana Bostrom for chapter events at 818/356-8363; Patsy Gougeon for Seminar Day/Reunions at 818/356-8366; and Helen Shafran for travel/study programs at 818/356-8364.

iol Price, founder of the Price Club, and his wife, Helen (left), joined Arrola DuBridge and her husband, Caltech President Emeritus Lee DuBridge (right), at a luncheon last month celebrating the establishment of the Arrola DuBridge Scholarship Fund and honoring the first recipient, freshman Rhonda Morgan (center). Established with a \$250,000 gift from Price Charities, the scholarship will provide support for undergraduate women. The DuBridges, who have a longstanding interest in increased opportunities for women in science, admit to thinking of Rhonda as their "academic grandchild."



FRIENDS

Two new grants support EQL work

Caltech has received two grants of \$250,000 each, one from the William and Flora Hewlett Foundation and the other from ENVIRONMENT NOW, to fund projects undertaken at Caltech's Environmental Quality Laboratory (EQL). The funding will be used to create an endowment that will generate discretionary funds to support special EQL projects.

Established in 1970, the EQL is a research center for multidisciplinary policy-oriented studies on problems related to natural resources and environmental quality. Its principal areas of investigation are air-quality management, water-resources and water-quality management, control of hazardous substances in the environment, and public policy regarding environment and resources. Its mission is to support systematic studies of environmental and resource problems and to contribute to the education and training of people in these areas of study. As an organization, EQL refrains from advocating particular policies, but seeks to point out the implications of the various policy alternatives. The laboratory is directed by Dr. Norman Brooks, the James Irvine Professor of Environmental and Civil Engineering.

According to Dr. Brooks, programs to be supported by the new endowment "may include sponsorship of seminars and conferences on environmental and resource issues affecting public policy, support of senior visiting scholars or exceptional postdoctoral fellows, and new research initiatives."

The William and Flora Hewlett Foundation of Menlo Park, California, was established in 1966 to promote the

well-being of mankind by supporting selected activities of a charitable, religious, scientific, literary, or educational nature, as well as organizations or institutions engaged in such activities.

ENVIRONMENT NOW, a foundation created by Luanne and Frank Wells in 1989, is dedicated to protecting, preserving, and restoring the natural environment by influencing public opinion and promoting responsible resource management. The foundation is working on a wide spectrum of environmental problems, including water pollution in the Los Angeles area, habitat destruction in the Sequoia and other ancient forests, and a variety of environmental issues in the Sierra Nevada.

Parsons Foundation gives grant for biology research

Caltech has received a grant of \$665,950 from the Ralph M. Parsons Foundation to support research into the mechanisms by which a single-celled egg becomes a highly complex organism. The grant represents a continuation of the \$330,000 award that the foundation extended to Caltech last year, bringing its total amount of support for this project to just under one million dollars.

The Caltech research team is headed by Eric Davidson, Norman Chandler Professor of Cell Biology, and Leroy Hood, Ethel Wilson Bowles and Robert Bowles Professor of Biology. Although Hood is relocating to the University of Washington, the relevant portions of the NSF Science and Technology Center laboratory that he heads will remain at Caltech. This collaborative project will continue at Caltech, where Hood will also have an appointment.

The researchers will use the funding to continue their research into one of the fundamental questions of modern biology: how an organism that starts as a single cell, the fertilized egg, becomes a complex organism made up of hundreds of millions of specialized cells. A major goal of the project is to identify and describe what actually happens in the genes as an egg begins to develop into an embryo. In addition, say the scientists, this research will lead to a far clearer understanding of how complex structures and organs are formed later on in development.

The Parsons Foundation was established in 1961 by the late Ralph M. Parsons, founder of the international engineering and construction firm that bears his name. The Foundation, since 1974 a separate, free-standing charitable organization independent of the corporation, awards grants focusing in the areas of higher education, social-impact programs, and health, civic, and cultural endeavors.

Booth Ferris Faculty Fund established

Caltech has received a grant of \$100,000 from the Booth Ferris Foundation to establish the Booth Ferris Faculty Fund, a provost's discretionary fund to encourage more women and minorities to join the Caltech faculty.

"We recognize the untapped pool of talent that exists among women and underrepresented minorities, and the shortages in the science and engineering professions that have resulted from their underrepresentation," said Caltech President Thomas E. Everhart. "Caltech has attempted to take a leadership role in increasing their percentage on our faculty, but their numbers here continue to be lower than we would like. The Booth Ferris Foundation grant will assist us in correcting this imbalance. The fund will enable the provost to supplement division budgets in recruitment efforts, particularly when an unusually talented woman or minority candidate is being sought."

The Booth Ferris Foundation originated in 1957, through trusts established by Mrs. Chancie Ferris Booth and from the estate of Willis H. Booth. The combined trusts were created by the Booth Ferris Foundation in 1964. The foundation's primary funding area is education and smaller colleges.

Gifts by Will

Trusts and Bequests provide welcome support to Caltech's operating and endowed funds. Recent gifts received by the Institute include:

Jack Carlton Smith—Unrestricted funds of \$62,050 from Dr. Smith's estate have been distributed to the Institute. Smith received his PhD in physics from Caltech in 1942.

John A. McCone—A bequest in the amount of \$2,500,000 has come to the Institute to create a professorship in high energy physics as well as to fund a library and staff to support the chair. McCone was a trustee of Caltech from 1946 to 1949 and 1951 to 1958. A story about the new McCone Chair appeared in the April *Caltech News*.

Thomas M. Hotchkiss—\$383,020 in unrestricted funds has been received from Mr. Hotchkiss's estate. He received his BS from Caltech in electrical engineering in 1925.

For information about wording for bequests to the Institute, call the Office of Gift and Estate Planning (818) 356-2927.

PERSONALS

1921

ROBERT WILLIAM CRAIG, of Los Angeles, writes, "I've been all over the world, and I'm still very proud to be an alumnus of Caltech."

1935

CHARLES M. BLAIR, PhD, received Rice University's Distinguished Alumnus Award at the school's 1992 commencement ceremonies. During his career he served as the president of Petrolite and as the vice chancellor of finance at Washington University in St. Louis. He has 110 U.S. patents in chemical and pharmaceutical processes, including for his work in the production of penicillin; his work on a key step in the penicillin-extraction process made it possible to produce thousands of pounds of penicillin a day as opposed to a few grams. In 1988 he "retired" by starting Blair Petroleum Company with a few partners. He works out of his retirement home in Fullerton, California.

1936

FRANK W. DAVIS, of La Jolla, California, has married Jean Swanson, widow of WILFRED E. SWANSON, BS '36.

1942

IRVIN P. SEEGMAN, of La Cañada, California, reports that he is celebrating his 50th year in the elastomer business.

1956

RAYMOND L. ORBACH has been appointed chancellor of the University of California at Riverside; a nationally prominent physicist, he had been provost of UCLA's College of Letters and Science for the past decade. After earning his bachelor's degree at Caltech and a doctorate at UC Berkeley, he won a National Science Foundation grant to pursue postdoctoral work in physics at Oxford University. He taught physics at Harvard University for two years.

PAUL O. P. T'SO, PhD, has received the Michigan State University College of Natural Science Alumni Association 1992 Outstanding Alumni Award. A world-renowned scientist born in Hong Kong, T'so is currently a professor of biophysics at Johns Hopkins University in the Department of Biochemistry, School of Hygiene and Public Health. His research areas include nuclear magnetic resonance, chemical and viral carcinogenesis, aging and differentiation, and the application of computerized microscopic imaging to cell biology. He has organized and coordinated many worldwide conferences and symposia on cancer research, aging, and medical genetics, edited several books, and served on the editorial boards of numerous journals and as consultant to the Department of Energy and the Office of Energy Research. He is currently chairman of the Central Laboratory for Molecular Biology, Academia Sinica, Taiwan.

1960

RAYMOND L. TAYLOR, PhD, received one of the 1991 Optical Society of America Engineering Excellence Awards presented at the society's November meeting, in San Jose, California. He, Jitendra S. Goela, and Michael A. Pickering, an engineering team at Morton International, of Woburn, Massachusetts, were recognized for "contributions to the development of chemical-vapor-deposited polycrystalline SiC and Si and their applications in large lightweight Si/SiC mirrors," work that has led to optics that can withstand extreme environmental stresses and produce more precise, lower-cost data. Taylor was a researcher with the Avco Everett Research Lab from 1959 to 1973, and from 1973 to 1980 he was with Physical Science Inc., in Andover, Massachusetts. He joined Morton International in 1982 and is currently vice president for research and engineering.

1964

BRUCE R. BEEGHLY, of Youngstown, Ohio, has been appointed by Ohio Governor George V. Voinovich to the board of trustees of Youngstown State University. Beeghly is president of Altronic Inc., which designs and manufactures state-of-the-art electronic products for industrial engines.

1965

STANLEY A. CHRISTMAN, of Houston, Texas, has accepted an assignment with Exxon Company, International, as a senior technical advisor for its drilling organization; he will be involved in all technical aspects of ECI's worldwide drilling program. Prior to this he was an operations technology coordinator for Exxon Company, U.S.A.

1966

SEAN C. SOLOMON, professor of geophysics at the Massachusetts Institute of Technology, will become director of the Carnegie Institution's Department of Terrestrial Magnetism in September 1992. The central focus of his research career has been investigations into the interiors of Earth and other planets—he is an acknowledged leader in understanding the geology and geophysics of Venus, and last year published with several colleagues a "Scientific Rationale and Requirements for a Global Seismic Network on Mars." He has been involved in many oceanographic expeditions, and he is currently a member of the Lunar and Planetary Science Council of the Universities Space Research Association. He is a fellow of the American Geophysical Union, and served as president-elect and president of that organization's planetology section from 1984 to 1988. He is also a member of the American Association for the Advancement of Science, the Seismological Society of America, the Geological Society of America, and the Division for Planetary Sciences of the American Astronomical Society. His honors include a 1982–1983 John Simon Guggenheim Memorial Fellowship, and a 1977–1981 Alfred P. Sloan Research Fellowship.

JERRY M. YUDELSON writes that he and his wife, Jessica Stuart, are now living in Beaverton, Oregon, where he is vice president for sales and marketing with Rabanco Company, a Seattle-based firm offering environmental services. He has also just finished his first year in the Oregon Executive MBA program at the University of Oregon. In addition, with Jessica, he teaches "The Inner Game of Business," a seminar on business creativity.

1971

ALLEN T. CHWANG, PhD, of Iowa City, Iowa, has been named a Fellow of the American Society of Mechanical Engineers; the Fellow grade is conferred upon a member who has at least 10 years of active engineering practice and who has made significant contributions to the field. Chwang is also a Fellow of the American Society of Civil Engineers. He is professor of mechanical engineering at the University of Iowa, and he is a registered professional engineer in California.

1975

CLAUDE W. ANDERSON, associate professor of computer science at the Rose-Hulman Institute of Technology, in Indiana, has received a \$5,000 grant from Lilly Endowment Inc. to develop a computer-programming module for the college's integrated first-year curriculum in science, engineering, and mathematics. The module, "Exploring Applied Programming Concepts with Mathematica," which utilizes the Mathematica computer language, will make it easier for first-year students to integrate the introductory computer-programming material with other material from the course.



An airborne acrobat who executes spins, rolls, steep dives, and loop-the-loops high in the sky at 250 MPH, Cecilia Rodriguez Aragon '82, of Vacaville, California, is one of 8 world-class aerobatic pilots who will represent the U.S. at the World Aerobatic Championships in Le Havre, France, this July. The 31-year-old systems analyst and flight instructor, who took up flying only 6 years ago, defeated many more experienced pilots to win a position on the National Aerobatic Team last fall. Aragon, who with her teammates will compete against more than 80 pilots from 15 countries at Le Havre, hopes one day to work full-time in aviation and eventually to open her own aerobatic school.

ELIAS S. W. SHIU, PhD, has been appointed Principal Financial Group Professor of Actuarial Science at the University of Iowa.

1976

MEDHAT A. HAROUN, MS, PhD '80, professor and chair of civil engineering at the University of California, Irvine, has received two awards honoring his contributions to research and education. For his original research on seismic-response analysis and the design of liquid-storage tanks—including ground-based, elevated, buried, and submerged tanks—he has been awarded the 1992 Walter L. Huber Civil Engineering Research Prize of the American Society of Civil Engineers (ASCE); he will receive the prize at the ASCE national convention in New York in September 1992. He has also received the Outstanding Engineering Educator Award from the Orange County Engineering Council, because "his teaching has been superior, his research accomplishments are widely acknowledged by both the research and professional communities, and as an administrator and facilitator, he has provided effective and responsible leadership of his department." He is currently serving on the steering committee of the ASCE Structures Congress, to be held in Irvine in 1993, as well as chairing a working group to update and revise the ASCE report on "Fluid-Structure Interaction During Seismic Excitations."

1977

ELLIOT FISCHER, PhD, has recently been appointed to the position of distinguished member of the technical staff at AT&T Bell Laboratories, in Whippany, New Jersey. The award was given for sustained superior technical performance and leadership. Fischer was cited for his contributions in the application of knowledge-based systems to computer-aided detection/classification problems, parallel algorithms, control systems, and active sound control.

1980

THORNE LAY, MS, PhD '83, professor of Earth science and the director of the Institute for Tectonics at the University of California, Santa Cruz, has been awarded the James B. Macelwane Medal, which is given for significant contributions to geophysics by a young scientist. He was cited for his studies of the structure of Earth's lower mantle.

1981

RUSSELL M. SCHMALENBERGER and his wife, Lori, announce the birth of their first child, Ruth Janette, on March 27. They live in Chino. He is a software engineer at Interstate Electronics Corporation, in Anaheim, California.

1983

DAVID S. DANDY, MS, PhD '87, formerly a senior member of the technical staff at Sandia National Laboratories, in Livermore, California, has accepted a faculty position in the department of chemical engineering at Colorado State University, in Fort Collins, Colorado, where he is continuing his research in chemical vapor deposition of advanced materials, particularly diamond and silicon nitride films. He is married to SONIA M. KREIDENWEIS-DANDY, MS '85, PhD '89; the couple live in Fort Collins.

SANDRA TSING LOH performs 11 original compositions on her debut solo piano CD, *Pianovision*, which has been released by K2B2 Records. According to Art Lange, the former editor of *downbeat*, "Loh's jazz influences provide a curve on [the] classical point of view that is distinctly American. The music on *Pianovision* is accessible, personal, vibrant."

1984

GREGORY P. BALA, of San Jose, California, and his wife, Colette, are happy to announce the arrival of a son, Christopher John Ryan Bala, born January 17. Bala is a software engineer with IBM Research/AdStaR.

1985

DONNA L. (POST) HALE, MS, of Albuquerque, New Mexico, writes that, after more than six years as a senior member of the technical staff at TRW Inc., in San Bernardino, California, she has accepted a position as senior engineer for Science Applications International Corporation, in Albuquerque. She was selected last summer as an associate member of the AIAA applied aerodynamics technical committee, and she will chair a session on missile and reentry vehicle aerodynamics at the 10th AIAA Applied Aerodynamics Conference, in June. She has also authored two technical papers on aerobraking in the Martian environment; the papers have been published by the American Astronautical Society. She has been accepted by the mechanical engineering PhD program at the University of New Mexico and is attending part-time. Her research involves new applications for boundary-element methods on the NCube computer. She married Captain John Hale, United States Air Force, on May 23; he is a flight-test engineer at Kirtland Air Force Base. "Caltech was a very special place," she writes. "I'll never forget my time spent there."

SONIA M. KREIDENWEIS-DANDY, MS, PhD '89, formerly assistant professor of chemical engineering at San Jose State University, California, has accepted a faculty position in the department of atmospheric science at Colorado State University, in Fort Collins, Colorado, where she is responsible for the development of

the graduate program in atmospheric chemistry, and is continuing her research in tropospheric chemistry and atmospheric aerosols. She is married to DAVID S. DANDY, MS '83, PhD '87; the couple live in Fort Collins.

NABEEL A. RIZA, MS, PhD '90, of Clifton Park, New York, recently received the first GE Corporate Research Center Technical Hour Distinguished Patent Honor, for his innovative contributions to radar control using optics.

1990

ROBERT A. GROTHE, JR., of St. Louis, Missouri, has received a research assistantship from the Department of Computer Science at Washington University, St. Louis, and the Laboratory of Neuro Imaging at that university's medical school. He is completing his research for a master's degree in computer science—the research involves “developing an efficient way of automatically matching two digital images by ‘looking’ at the images of multiple scales of resolution.” He has also received a graduate fellowship in biomedical engineering from the Whitaker Foundation. This fellowship will support doctoral studies and research at the Electronic Signals and Systems Research Laboratory at Washington University. He will be working with a group there “to develop an algorithm for improving the determination of protein conformation from diffraction data.” In addition, he writes, “I am currently living in St. Louis with my wife, KAREN (BYERS), a former Caltech undergrad, and our 14-month-old dynamo, Michael. Karen is studying Electrical Engineering at WU, and made the Dean's List last semester.”

Stone & Webster Engineering Corporation and the U.S. Army Corps of Engineers. In 1981, he earned a PhD in political science from the University of Oregon, and from the 1950s through the 1980s published a number of books, and a variety of articles in publications ranging from *Contemporary Philosophy* to the *New England Journal of Medicine*. He was a member of Tau Beta Pi, Sigma Xi, and the Institute for Advanced Philosophic Research. He is survived by his wife, Sue; his sons, Robert and Clyde; and his sister, Marguerite Wharfield.

1933

L. EUGENE ROOT, MS, MS '34, of Menlo Park, California, on January 23. He was 81. After graduating with master's degrees in mechanical engineering and aeronautical engineering, he went to work for Douglas Aircraft Co., where he helped improve the DC-3 transport plane and the Dauntless dive bomber and participated in the design of a number of passenger and military aircraft. He was also one of the four charter members of Douglas's RAND project, which later evolved into the nonprofit RAND Corp. In the early 1950s he helped create the Air Force's development planning office in the Pentagon. In 1953 he joined the Lockheed Aircraft Co., in Burbank, and created its Missile Systems Division, in Van Nuys. After winning the contract for the U.S. Navy's Polaris missile, he moved the division to Sunnyvale, California, becoming its vice president and general manager; the division also built the Agena rocket, a key NASA spacecraft. He later became president of the renamed Lockheed Missile & Space Co. In 1962, as president of the Institute of Aeronautical Sciences, he combined that organization with the American Rocket Society to form the American Institute of Aeronautics and Astronautics. During his career he received the Air Force's Exceptional Service Award, the Navy's Distinguished Public Service Award, and the Public Service Award of the National Aeronautics and Space Administration. He is survived by two sons, Kirby and Brian.

1936

LEONARD F. UHRIG, MS, of Midland, Texas, on March 18, 1991. He is survived by his daughter, Judy Coleman.

1937

WALTON A. WICKETT, EX, of Atherton, California, on February 10. He is survived by his wife. A memorial fund has been established at Caltech. Those wishing to contribute should write to: The Walton Ames Wickett Memorial Fund, Caltech, 1201 East California Boulevard, 105-40, Pasadena, CA 91125.

1945

DEAN L. BRYNER, of Salt Lake City, Utah, on November 16, 1991. He is survived by his daughter, Sue.

JOHN S. DAVIS, of Glendale, California, on March 13. He also held degrees from the U.S. Naval Academy and from Princeton University, and was a member of Sigma Pi Sigma. He was president of Sicomoro Canyon Inc., and retired in 1986 from Eaton Industries. He is survived by his wife, Gracie; a son, John; two daughters, Gracie and Linda; two grandchildren, Dani and Jenifer; and one great-grandchild, Morgan.

TERRY M. PRUDDEN, of Silver Spring, Maryland, on January 23. He is survived by his wife.

1946

GUY H. DREWRY, JR., MS, on December 4, 1991. He is survived by his wife.

GLENN R. JONES, of Lakewood, California, on September 16, 1991. He is survived by his wife.

1948

JOHN D. HOLM, MS, of San Antonio, Texas, on January 20, 1991. He is survived by his wife, Theresa.

ROBERT L. MILLS, MS, of Los Alamos, New Mexico, on October 2, 1991. He is survived by his wife, Rene.

RONALD B. RUDDICK, of Pico Rivera, California, on October 6, 1989. He is survived by his wife.

DARIUS E. SUKHIA, MS, of Macon, Georgia, on February 26, 1990. He is survived by his wife.

BYRON L. YOUTZ, of Olympia, Washington, on January 23. He spent three years as a research physicist at UC Berkeley and was awarded his doctorate in physics there in 1953. He then became acting chairman of the physics department at American University in Beirut, Lebanon. In 1956 he joined the faculty of Reed College as a professor of physics. He was an executive assistant to the president for about six months before being named acting president in 1967, a post he retained for about 18 months. After spending two years as academic vice president and professor of physics at the State University of New York College at Old Westbury, he joined the staff of The Evergreen State College in Olympia in 1970. There, he was involved in the committee that shaped that college's highly acclaimed curriculum, and, during a sabbatical, he studied energy projects around the world, including solar-energy use in the United States. He held the position of provost 1978–1983, was appointed to the Evergreen College Foundation's board of governors in 1990, and retired to emeritus status in 1991. He is survived by his wife, Bernice; a daughter, Margaret Wolcott; two sons, Gregory and David; and three grandchildren.

1949

MALCOLM C. MCQUARRIE, MS, of Oakland, California, on January 3. He spent most of his career as a patent attorney for Kaiser Aluminum. A supporter of the arts, he was also a member of the ACLU, Pacific Friends, and Mensa. He is survived by a daughter, Karen; a son, Steven; a brother, Bruce; a sister, Margaret Farmer; and his mother, Florence.

ESTAL D. WEST, of Sun City West, Arizona, on March 2. Prior to attending Caltech, he had been a lieutenant in the U.S. Army during

World War II, and was stationed in Italy and North Africa 1941–1944. After graduating, he earned his doctorate at the University of Maryland. He worked for the National Bureau of Standards 1969–1974, and after his retirement he started Calorimetrics Inc., of which he was owner and president for the next 12 years. He was chairman of the 1972 Calorimetry Conference, and in 1985 he built the calorimeters for the Lawrence Livermore National Laboratory's Nova laser. He was a member of Sigma Xi. He is survived by his wife, Doris; a daughter, Janet; a son, Jon; a sister, Terry Miller; a brother, Verlyn; and two grandchildren.

1950

RICHARD S. PIERCE, PhD '52, of Tucson, Arizona, on March 15, of cancer. He was a professor of mathematics at the University of Washington for 15 years, at the University of Hawaii for five years, and at the University of Arizona for 16 years. He retired in 1990. He is survived by his wife, Marilyn; his son, Eric; four stepchildren; and four grandchildren.

1951

ROBERT P. DAY, of Seal Beach, California, on May 26, 1989; he had been retired on disability since 1974. He is survived by his wife, Jackie.

1953

STANLEY J. MINTON, MS, of Woodland Hills, California, on April 11, 1991. He is survived by his wife.

1954

ROBERT L. SMITH, MS '55, of Claremont, California, on March 2. He is survived by his wife.

1955

SHANKAR LAL, PhD, of Monterey, California, on September 25, 1991. He is survived by his wife, Claudia.

1957

JAMES H. SNYDER, of Palmyra, New York, on March 11, of a heart attack suffered while helping a stranger push her car out of a snow drift. He is survived by his wife, Joan; three children, Gregory, Jeffery, and Johnathan; and a grandson, Benjamin.

1965

DOUGLAS E. GRIFFIN, MS, of Palm Beach Gardens, Florida, on January 22, 1990. He is survived by his wife.

OBITUARIES

1918

EDISON R. HOGE, on December 4, 1990. He is survived by his wife.

1928

JACKSON G. KUHN, of Santa Barbara, California, on March 15. He worked for a time for Walt Disney, participating in the making of *Snow White*. He was later an engineer at Hughes Aircraft Company, in Culver City, California. He was one of the principals involved in founding what eventually became the Santa Barbara Research Center, and for many years was head of the center's mechanical engineering department. He is survived by his wife, Joy, and two sons, Robert and Donald.

1930

ORRIN M. ELLIOTT, of Media, Pennsylvania, on August 7, 1991. He is survived by his wife.

1932

CLIFFORD C. CAWLEY, MS '33, of Eugene, Oregon, on January 13. While at Caltech, Cawley participated in research into the problem of predicting earthquake stresses in buildings. During his career, he worked for both the

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Geobiologist Joseph Kirschvink finds "perfect bar magnets" in the brains of human beings

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Caltech sends another researcher to the National Academy of Sciences, and an Institute physicist is chosen as a shuttle astronaut candidate

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Although he never planned it that way, alumnus Eustace Lycett spent more than 30 years using his engineering training to create fantasy effects for Disney Studios

Page 4

Photo feature highlights an Alumni Association visit to the islands Darwin made famous

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