

Biologists ask

How does the human brain "see" textures?

An air-conditioned electronic helmet that measures electrical output from 97 locations in the brain is being used by Derek H. Fender and his co-workers to chart pathways along which messages move within that organ.

Fender, professor of biology and applied science, is experimenting with the cap to determine such questions as how the human brain "sees" such things as textures, and whether its ability to identify them is limited by the complexity of textural designs.

A computer linked to the helmet records and processes data and screens out interference waves caused by scalp wrinkling and heartbeats. Air conditioning eliminates perspiration that would short-circuit the electrodes.

The computer translates the data into a visual contour map of the brain. In some experiments, Fender obtains a million bits of information in a quarter of a second.

Fender and his co-workers are studying the visual cortex—that small region in the back of the brain that processes nerve impulses carried to it from the eye by the optic nerve, and then passes them on to the higher levels of the brain where humans consciously see the world around them.

The subject's visual cortex is stimulated when he is shown pictures of computer-designed textures in the form of images made of black and white squares. A great deal of electri-

cal activity is produced, and the computer uses brain waves to locate, by electronic triangulation, the precise sites where activity is occurring.

Fender is attempting to determine whether textures that resemble one another excite—and are stored and remembered in—cells that are close to one another in the brain. If this hypothesis is correct, then the representations for the capital letters A and H would be stored close to one another, while the letter "O," for example, would be stored farther away.

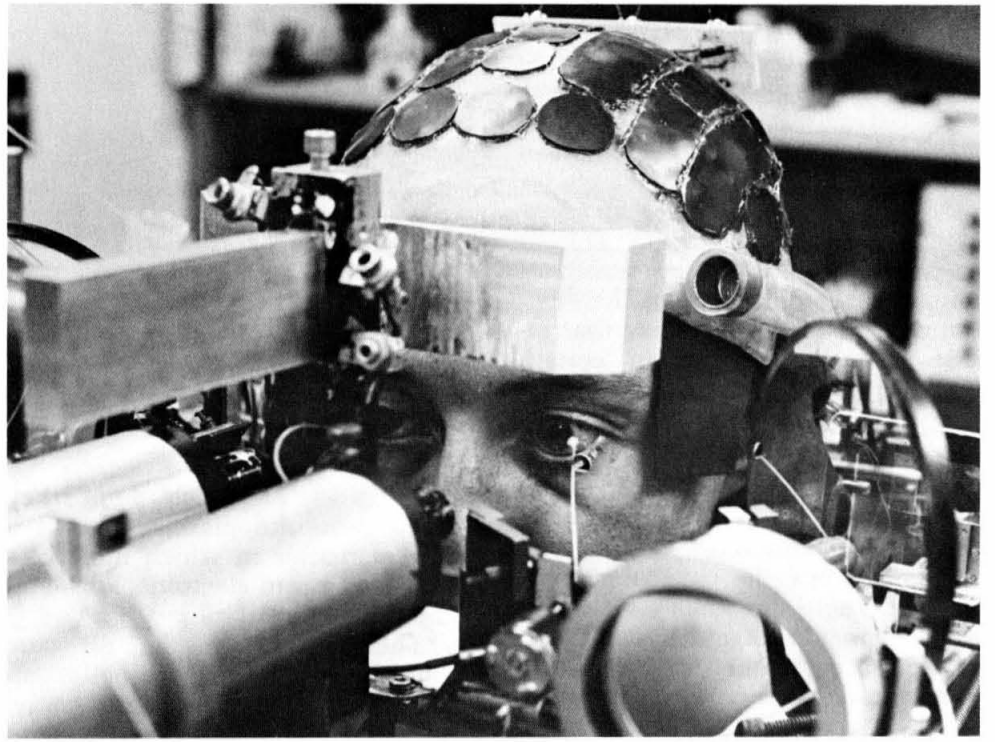
Fender's research indicates that the three layers of neurons in the visual cortex are wired to interact with one another. Altogether they are about a fifth of an inch thick. By using the helmet, he has been able to record in some detail the activity of the three layers.

In describing this activity he said, "One layer seems to be looking for randomness in textures, one for small-scale continuity, and one for large-scale continuity. This seems to be the way the visual system resolves texture problems. The brain appears to test the individual units of a textural pattern, or to test parts of the pattern against one another."

Fender emphasized that humans identify textures by networks of cells instead of by individual ones.

"You need a lot of cells to identify texture," he said.

Tests with texture patterns indicate that the human visual cortex is limited in the complexity of textures it can recognize, due to the basic wiring plan of the brain. Humans can compare images that include a maximum of three squares of black or white in a precise but apparently random pattern of black and white squares. But they can't go beyond that.



New electronic helmet helps biologists learn about visual processes.

Alumni invited

Mudd building to be dedicated October 31

The new Seeley G. Mudd Building of Geophysics and Planetary Science will be officially dedicated on Thursday, October 31, and all faculty, alumni, students, staff, and other interested friends of Caltech are invited.

The dedication will be at 10 a.m. on the inner terrace of the new building, at the northeast corner of California Boulevard and Wilson Avenue.

The structure being dedicated is named in honor of Seeley G. Mudd, M.D., former trustee and long-time friend of the Institute, in appreciation for his many substantial contributions.

Special areas within the building are named for individual donors. These include:

The Helen and Roland W. Lind-

hurst Laboratory of Experimental Geophysics, named in honor of Mrs. Lindhurst and her late husband, Roland, BS '29, a distinguished alumnus who was co-founder of the Applied Research Laboratories of Glendale, California

The Ross McCollum Space Photography Library, named to honor Mr. McCollum, petroleum producer, founder and president of the National Oil Company, and a leader in the Western Oil and Gas Association

The Henry Salvatori Seminar Room, named to honor Mr. Salvatori, founder of the Western Geophysical Company, distinguished geophysicist, philanthropist, and outstanding citizen.

The Kresge Foundation and the United States Department of Health, Education, and Welfare also provided grants that helped to make the building possible.

The new building will provide research and teaching facilities in seismology, experimental geophysics, and planetary science. Activities closely related but formerly geographically scattered are being centralized in the new facilities. A steady stream of personnel and equipment has been moving into the building during the late summer months, and most staff members expect to be working in their new quarters by dedication day.

ALUMNI EVENTS

October 25

Reunion, Class of 1949. Campus tours, 4 p.m.; no-host social hour, 6 p.m.; dinner, 7:30 p.m., the Athenaeum. Speaker, Bernard M. Oliver, MS '36, PhD '40, vice president, research and development, Hewlett-Packard Company, "The Search for Extraterrestrial Intelligence."

Caltech receives \$1 million gift

The Atlantic Richfield Foundation has presented a gift of \$1 million to Caltech, according to President Harold Brown.

"Of the total amount, \$800,000 is unrestricted," Brown explained. "The remaining \$200,000 is designated for work in Caltech's Environmental Quality Laboratory.

"Unrestricted gifts give us flexibility to support scientific research programs at critical stages when specially designated funding isn't available. We are also pleased at the recognition of the important work being done by the Environmental Quality Laboratory.

"The Institute is most grateful to the Atlantic Richfield Foundation for this gift, which is in response to Caltech's fund-raising campaign, Caltech at the leading edge . . ." Brown said. "The gift is a magnificent example to others in the business, financial, and industrial community, for it displays a keen awareness by the Foundation and the Atlantic Richfield Company of the way in which America's future depends both on business enterprise and on education and research."

Robert O. Anderson, chairman and chief executive officer of the

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Louis G. Dunn, BS '36, MS '37, PhD '40, receives Distinguished Alumni Award—highest honor Caltech can confer on a graduate—from Robert F. Christy, Caltech vice president and provost. Unable to attend the formal presentation on Alumni Seminar Day, Dunn was honored during September at a dinner in the Athenaeum attended by close friends. A member of the Caltech faculty when JPL was founded, Dunn was its director when the technical basis for the space programs of the sixties and seventies was being established. He joined the staff of TRW in 1954. As executive vice president and as president of Space Technology Laboratories, he was chief engineer for the Air Force Ballistic Missile Program—responsible for developing the Thor, Atlas, Titan, and Minuteman missiles. He is now a cattle rancher.

From stars: clues in energy research

When William A. Fowler, Institute Professor of Physics, and his astrophysics group began their study of the way in which elements are created and destroyed inside stars, their research had no obviously practical application.

Now, scientists believe these same processes may be made to work on our own planet, resulting in a clean way of producing nuclear energy for needs on earth through a combination of fission and fusion. For, as Thomas A. Tombrello, professor of physics, has pointed out, "The environment inside a star is like that inside a fusion reactor in certain ways."

Caltech physicists are working closely with physicists at the Lawrence Livermore Laboratory in Livermore, California, to see whether they can initiate and harness these nuclear reactions. In particular, they are studying the reactions of several light elements that are easily destroyed, accompanied by the release of tremendous amounts of energy.

Thus far, boron-11 has received the most attention, although the reaction rates of lithium and beryllium are also being studied.

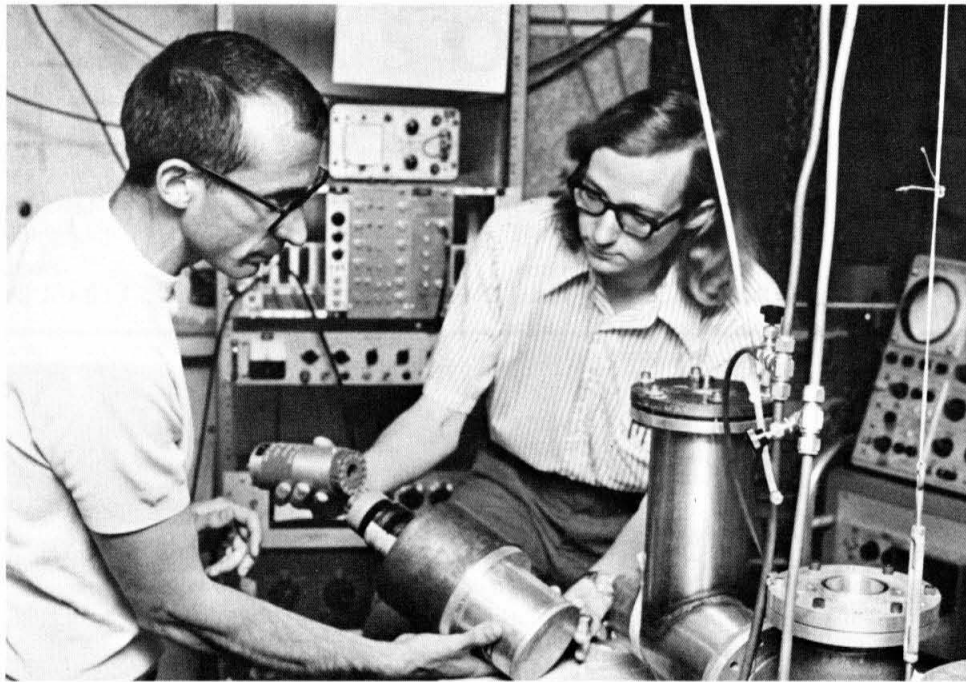
Still years in the future, the hoped-for outcome is the production of nuclear energy by injecting protons into the nuclei of some of these elements to initiate a fission process. This method would produce almost no harmful radioactive residues. The only thermal pollution would be the heat within the reactor itself.

Helium, the by-product of this energy production, would present few environmental problems. In fact, it could be put to practical use, for the electrically charged helium nuclei could be used to generate electricity.

Whether the process can become a reality will depend to a large degree on a new superpowerful laser system, with 12 converging beams, now being developed at the Lawrence Livermore Laboratory at a cost of \$20 million. Spokesmen at Livermore have estimated that it will be at least ten years before the lasers reach the break-even point at which they produce more energy than is required for their operation.

Tombrello says of the process that may ultimately take place:

"The lasers would direct short-duration pulses of extremely high energy at BB-sized pellets of boron hydride with cores made of two other isotopes of hydrogen—deuterium and tritium. The objective would be to heat the isotopes to about 200 mil-



Thomas Tombrello and graduate student Michael Lowry prepare to calibrate the energy of protons coming from an electrostatic accelerator in Kellogg Radiation Laboratory. This is necessary because of the strong energy dependence of the reaction they are studying. The experiment is part of a long-range program that may lead to the production of nuclear energy through a fission-fusion combination.

lion degrees, at which point they would turn into plasma. This is a form of matter in which molecules break down into electrons, ions, and other charged particles.

"This process in the BB core would be initiated as the pellet imploded and its surface burned away. The resulting shock waves would cause an enormous increase in the density of the core, and fusion would occur there.

"The fusion would create the extremely high temperatures necessary to trigger the hydrogen plus boron-11 nuclear reaction. A boron-11 nucleus is composed of 11 nuclear particles

—6 neutrons and 5 protons, and is stable. But if an additional proton is injected, then it becomes unstable and bursts (fissions), into three nuclei of helium, and releases large amounts of energy."

Astrophysicists at Caltech have been firing beams of protons at targets of boron-11 and other light elements to pin down reaction rates and determine the temperatures necessary to achieve fission. They also are beginning to evaluate the effects of the process on the equipment used, the extent of damage to the reactor itself, and possible radioactive by-products.

Don't underestimate him

Trained fruit fly recalls odors, sights

The adage that you can't teach an old dog new tricks doesn't apply to the fruit fly. For fruit flies have been learning new tricks under the tutelage of Caltech geneticists William G. Quinn, Jr., William A. Harris, and Seymour Benzer, as described in proceedings of the National Academy of Sciences. Specifically, the flies have been learning to avoid certain smells and visual cues. Earlier experiments of this type had not met with any appreciable success.

During their training, the flies were exposed to two separate stimuli—either two odors or two differently colored lights—one of which was associated with a negative reinforcement such as an electric shock. When the flies were removed to a new apparatus and tested in a similar manner but without the negative rein-

forcement, the scientists measured their avoidance of the two stimuli.

The experiment was then repeated on a second group of flies, but with shock coupled to the other stimulus. In both sets of experiments the flies selectively avoided the stimulus that had been associated with shock during their training, but did not avoid the other stimulus.

Caltech biologists interpret these results as evidence that fruit flies can learn. The flies' behavior in the tests has the properties of conventional learning, they say, and can be extinguished or reversed by later training. Scientists at the University of Freiberg in Germany also have reported success in conditioning flies to discriminate between light of different wave lengths.

Dr. Seymour Benzer, professor of biology, said, "One mustn't underestimate the fruit fly. It is not a primitive antecedent of man, but is high up on the invertebrate branch of the evolutionary scale."

\$1 million gift

continued from page 1

Atlantic Richfield Company, who is a Caltech trustee, said: "The gift recognizes the value of Caltech as an important resource to our community, to industry, and to the world."

Thornton F. Bradshaw, president of the Atlantic Richfield Company and a member of the visiting committee for Caltech's Division of Chemistry and Chemical Engineering, expressed his pleasure concerning "this very supportive gift to an institution that is having such a major influence on technological and human progress."

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Placement Assistance To Caltech Alumni

The Caltech Placement Service may be of assistance to you in one of the following ways:

- (1) Help you when you become unemployed or need to change employment.
- (2) Inform you of possible opportunities from time to time.

This service is provided to alumni by the Institute. A fee or charge is not involved. If you wish to avail yourself of this service, fill in and mail the following form to:

Caltech Placement Service
California Institute of Technology
Pasadena, California 91109

Please send me: (Check one)

- An application for placement assistance.
 A form indicating a desire to keep watch for opportunities although I am not contemplating a change.

Name

Degree(s) Year(s)

Address

.....

Seymour Benzer



Alumni Fund \$50,000 on way toward goal

The Alumni Fund already has received more than \$50,000 in gifts toward its 1974-75 goal of \$465,000 from 3,100 donors, according to Reuben B. Moulton, BS '57, national chairman.

Moulton made the announcement at the conclusion of the Alumni Fund Leadership Conference on campus Saturday, September 21. Alumni leaders from throughout the nation attended the meeting where they were briefed on Caltech programs and needs.

At a closing dinner, four area chairmen received special awards for their outstanding efforts in obtaining participation last year. Designated as "pro all stars" were two veteran area chairmen, Robert P. Sharp, BS '34, MS '35, who received 48 percent participation among alumni on the Caltech campus; and A. Allen Ray, BS '35, who achieved 48 percent participation in Alhambra, San Gabriel, and South Pasadena.

Two area chairmen who served last year for the first time received awards as "rookies of the year." They were Frederick H. Allardt, BS '35, MS '36, MS '37, with 47 percent participation in San Luis Obispo; and Charles Carstarphen, BS '39, MS '40, with 39 percent participation in Cincinnati and Southern Ohio.

These four alumni received individual plaques and Caltech baseball caps, in keeping with the baseball theme of the contest. Their names also are engraved on a permanent plaque to remain in the Alumni Fund office.

In a group contest between "pros" and "rookies" for the best percentage of participation in their areas, veteran area chairmen edged out newcomers with an average participation of 30 percent compared with 27.

Named "coaches of the year" were two chairmen who had recruited the largest groups of workers in their areas: Frank W. Davis, BS '36, Fort Worth; and Warren E. Danielson, BS '49, MS '50, PhD '52, New Jersey.

During the evening Arnold O. Beckman, PhD '28, chairman emeritus of the Caltech Board of Trustees, recalled some of his experiences as a Caltech student; he stressed the importance of Caltech to alumni.

During the morning session, ASCIT president Elizabeth McLeod answered questions concerning campus life; Ronald F. Scott, professor of civil engineering, discussed his work as a teacher and research scientist; David W. Morrisroe, vice president for financial affairs and Caltech treasurer, described Caltech's financial status; and Harrison W. Sigworth, BS '44, showed a slide presentation, "What's Going on at Caltech Today."

At lunch, Irving S. Bengelsdorf, director of science communication, outlined genetics research at Caltech.

After the meeting, participants returned home to conduct personal and telephone solicitation of alumni in their areas.

Alumni serving as area chairmen in their regions include:

Bruce E. Kirstein, PhD '72 San Diego
James L. Higgins, BS '56 Laguna Beach
J. R. Lester Boyle, BS '30 Corona del Mar
Walter R. Larson, BS '40 Anaheim
Richard K. Smyth, BS '51 Long Beach
J. B. Graner, BS '43 Palos Verdes
Thomas W. Cooper, BS '57 Torrance
Herbert A. Lassen, BS '43, MS '47, PhD '51 Marina del Rey

James M. Fox, MS '36 Whittier-Downey
Wilton A. Stewart, BS '41 Santa Monica
David S. Rathje, BS '51 L.A. Airport
William I. Rumer, BS '49, MS '50 Brentwood
Theodore Grossberg, BS '45 Beverly Hills
Glen H. Mitchel, Jr., BS '48 Hollywood
Jack R. McInturff, MS '62 Central L.A.
Don E. McFaddin, BS '28

Alhambra-South Pasadena
Thomas Vrebalovich, BS '48, MS '49, PhD '54 JPL

Herbert D. Strong, Jr., BS '39 Pasadena
Robert M. Lehman, BS '31, Pasadena
Stanley T. Wolfberg, BS '38 Caltech
Albert C. Whittlesey, BS '62

Altadena-La Canada
Stephen H. Garrison, BS '65, MS '66

El Monte-Covina
Perry H. Brown, BS '39 Arcadia-Sierra Madre
Donald Stewart, Jr., BS '47

Pomona-Claremont
Robert D. Boche, BS '34, PhD '38

Riverside-San Bernardino
Raymond G. Richards, BS '40

East San Fernando Valley
Allan M. Goldberg, BS '57, MS '58

West San Fernando Valley
Charles B. Shaw, Jr., BS '47 Thousand Oaks
Robert G. Rinker, MS '55, PhD '59

Santa Barbara
Leo L. Baggerly, BS '51, MS '52, PhD '56

Bakersfield
Everett T. Eiselen, BS '56, MS '57, PhD '62

South Peninsula-San Jose
William N. Harris, BS '49, MS '50

Atherton-Menlo Park
C. Richard McEwen, BS '46

Stanford-Palo Alto
Hubert E. Dubb, BS '56 Los Altos

North Peninsula-San Francisco
Harrison W. Sigworth, BS '44

Marin County
Chandos A. Rypinski, BS '48
Davenport Browne, Jr., BS '49

Oakland-Berkeley
Elvin B. Lien, BS '34 Orinda-Moraga

San Luis Obispo
Frederick H. Allardt, BS '35, MS '36, MS '37

Frederick J. Groat, BS '24, and Wayne MacRostie, BS '42 Sacramento

Paul R. Moore, MS '43 Hawaii

Gordon D. Long, BS '60 Oregon

Martin J. Poggi, BS '37 Washington

Lowell E. Clark, BS '60 Phoenix

Donald C. Stinson, MS '49 Tucson

Fred W. Dorr, Jr., BS '64 New Mexico

David B. MacKenzie, BS '50 Colorado

Richard W. Flygare, MS '53, ME '55 Utah

Robert E. Foss, BS '32, and Glen E. Woodward, BS '34 Dallas

Frank W. Davis, BS '36 Fort Worth

Sidney Schafer, MS '36 Houston

Paul B. Harris, BS '49, MS '50 Oklahoma

Donald S. Remer, MS '66, PhD '70 Louisiana

Peter A. Howell, BS '50 Minnesota

Robert J. Kieckhefer, BS '45, and Peter T. Rux, BS '62 Illinois-Wisconsin

Robert W. Wayman, BS '40 Michigan

Samuel M. Savin, PhD '67 Cleveland

Charles F. Carstarphen, BS '39, MS '40 Cincinnati

Charles R. Penquite, BS '58, MS '59 Missouri-Southern Illinois

Thomas A. Cole, PhD '63 Indiana

John C. Porter, MS '63 Tennessee

Ernest B. Wright, PhD '45 Florida

Lothrop Mittenenthal, BS '48 North Carolina

Merle G. Waugh, BS '45 D.C.
Richard A. Wallace, ID '49 Eastern Pennsylvania and Delaware

Ulrich Merten, BS '51 Western Pennsylvania

Warren E. Danielson, BS '49, MS '50, PhD '52 New Jersey

John E. Young, BS '56 Manhattan and L.I.

Harry J. Moore, Jr., BS '48 Westchester Co.

Duane B. Erway, BS '57, MS '58 Upstate New York

Richard R. Dickinson, BS '52 Connecticut

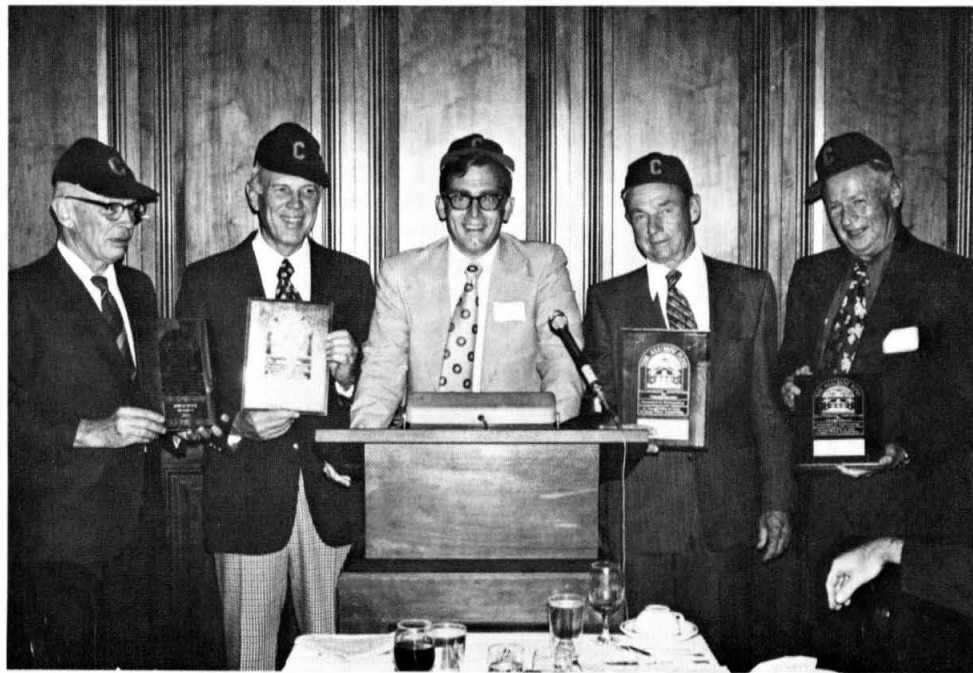
Ira Richer, MS '60, PhD '64 Massachusetts

C. Warren Hunt, BS '45 Alberta, Canada

Gerard E. Bloch, MS '67 and P. Claude Mahieux, BS '56 France

Lanny L. Lewyn, BS '59 West Germany

Robert L. Blakeley, BS '58 Australia



Four area chairmen were honored at the Alumni Leadership Conference for their outstanding efforts: Left to right—Frederick H. Allardt, Charles F. Carstarphen, Jack R. McInturff, chairman of the conference planning committee, who presented the awards; Robert P. Sharp, and A. Allen Ray.

New star cluster found by astronomers

Infrared astronomers at Caltech have discovered a new cluster of embryonic stars condensing out of a cloud of gas in the great nebula of Orion. They estimate that the stars are less than 100,000 years old, and are 1,600 light years, or 10 million million miles, distant.

Invisible to optical astronomers, the stars—five in number—can be detected only by their infrared heat radiation. Associated with them is a much larger cloud of molecules that is producing intense radiation from excited carbon monoxide gas.

The embryo stars were discovered with sensitive infrared detectors attached to the Mt. Wilson Observatory's 100-inch telescope; their discoverers were Ian Gatley and Michel Penston. Gatley is a graduate student in physics and a member of an infrared astronomy group led by Gerry Neugebauer. Penston works at Britain's Royal Greenwich Observatory.

The molecular cloud was discovered by Nicholas Scoville, Caltech research fellow in radio astronomy, while working at a 16-foot radio telescope at Fort Davis, Texas.

The newly discovered cluster is the second to be found in the Orion Nebula—a great glowing cloud complex in the Milky Way Galaxy that covers a span of some 26 light years.

Eric Becklin, a member of the Caltech-Hale Observatories infrared group, said, "Until the new discovery, the relationship between the embryo stars and the molecular cloud

was unclear. Now it appears certain that in both instances the infrared sources are very young and have been formed within the clouds only recently."

Stars are believed to form in clusters from dense condensations in gas and dust clouds. Later they are expected to drift gradually out of the cloud. The fact that the two star clusters are still "sitting" in their clouds is an indication of their youth.

Mrs. George Mayhew expresses thanks

Mrs. George Mayhew has asked *Caltech News* to express her thanks for the many letters Professor Mayhew has received since news of his illness was published in the May issue.

Unfortunately, Mayhew's illness is much more serious than was indicated in the article, and he is unable to respond to the messages addressed to him. Mrs. Mayhew requests us to assure all those who have written that she has received the letters as tributes to her husband.

She would like readers to know how much she appreciates the thoughtfulness of the many friends and associates who have taken the time to write, and how much the letters have meant to her personally in providing comfort and encouragement.

This man-made three dimensional model at Caltech's Azusa laboratory is used in research concerning the behavior of waves in harbors. Like tall buildings in earthquakes, harbors respond to stress from wave action in differing ways. Fredric Raichlen, professor of civil engineering, and Vito A. Vanoni, professor of hydraulics, emeritus, are principal investigators.



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Photographer: Floyd Clark

PERSONALS

1922

RICHARD M. BOZORTH, PhD, received an honorary life membership in the IEEE Magnetic Society during May in Quebec.

1923

HUBERT K. WOODS, retired director of research for the Portland Cement Association, Skokie, Illinois, and now a resident of Guadalajara, Mexico, was named a Fellow of the American Society for Testing and Materials and received the ASTM Award of Merit on June 28. Woods received the award for "valuable technical contributions, distinguished administrative leadership, and long-time committee service and dedicated commitment to the principle of voluntary standardization within the cement industry."

1927

ALAN E. CAPON retired as general manager of the Public Service Department of the City of Burbank this year.

THOMAS S. SOUTHWICK writes, "I have been retired from the U.S. Weather Bureau since 1963 when I took a three-year post in Thailand for the World Meteorological Organization. We lived abroad for a few years (Switzerland and Spain) and recently have settled in San Antonio."

1929

STANLEY W. LOHMAN, MS '38, retired on June 30 after 44 years of service with the U.S. Geological Survey. One of his last official duties was to appear before the Secretary of the Interior in Washington, D.C., on June 27 to receive a Distinguished Service Award.

1930

WARREN N. ARNQUIST, PhD, retired from McDonnell Douglas Corporation in 1971. He was a research associate in astronomy at UCLA, and in June 1973, led the airborne solar eclipse expedition to Africa sponsored by the National Science Foundation.

J. R. LESTER BOYLE, founder and chairman of the Boyle Engineering Corporation, retired from active participation at the end of 1973, but still acts as a private consultant for the firm.

1931

EDWIN F. GREEN, MS '32, retired on June 1 from the materials and processes group in the engineering department of the Rocketdyne Division of Rockwell International at Canoga Park, California.

He writes, "It has been a long and interesting career with never a dull moment. I've played tennis for many years and still play a mean game of doubles. We live in Valencia about 100 yards from the Vista clubhouse and I've taken up golf. Photography has always been my hobby and I am spending more time in my darkroom now. My son, Don, has a new daughter, and my daughter, Marcia, two children; taking pictures of the grandchildren keeps me busy. My wife, Frances, and I are planning a few long automobile trips to the Northwest and the Midwest later this year."

FRANCIS W. HUTCHINSON has been appointed professor emeritus after 34 years of teaching mechanical engineering at UC Berkeley.

1934

ELVIN B. LIEN, former sales service manager with Union Oil Company of California in San Francisco, retired on July 1.

1935

WILLIAM B. McLEAN, MS '37, PhD '39, retired as technical director of the Naval Undersea Center in San Diego on June 30. He is the inventor of the Sidewinder air-to-air missile and in 1956 received a federal government award of \$25,000 for his invention.

1938

JOHN A. BONELL, MS, was elected vice president and chairman of the Professional Engineers in Education Practice Division of the 68,000-member National Society of Professional Engineers. He is the chairman of the department of civil engineering at the University of Nevada.

SAMUEL H. KELLER is president of the Los Angeles section of the American Society of Civil Engineers and an active member of the Naval Reserve in the civil engineer corps with the rank of captain.

JACK W. KNIGHT is the assistant to the executive vice president of Norris Oil Company.

1939

JACK H. GOODELL has been transferred to the Houston office of Bechtel Power Corporation as vice president and area manager.

1940

WILLIAM J. HOWELL, MS, formerly with the Council of Profit Sharing Industries, is now a management consultant.

ROY E. MARQUARDT, MS '42, was appointed vice president and assistant to the president of American Jet Industries, Inc. on May 27. He was president and director of Consolidated Utilities, Kenai, Alaska, and a general partner in Malibu Beach, Ltd., and he also founded the Marquardt Corporation in 1944, serving as president and chairman until 1967 when the firm merged.

1942

WARREN GILLETTE, a physician in private practice in Boulder, Colorado, writes, "In June and July of 1973 I accompanied the eclipse expedition to Mauritania, West Africa, and had four exciting weeks at a large oasis in the rolling sand dunes of the Sahara. The total eclipse was magnificent."

1943

LEON KATZ, PhD, head of the department of physics at the University of Saskatchewan, has been appointed an officer in the Order of Canada by the Canadian Government. This is the highest honor which the government can confer for work within Canada.

1944

WILLIAM E. LOCKWOOD, JR., former general manager of manufacturing of the Continental Can Company, has been promoted to corporate vice president.

FRED W. MORRIS, JR., former president of Fred W. Morris, Jr. & Associates of Washington, D.C., is now president and chief executive officer of TRT Telecommunications Corporation.

JOHN B. NELSON has moved to New Brunswick, Canada, to become a construction engineer with the Irving Refining Company. He was formerly with Chevron Pipe Line Company of Salt Lake City.

NEIL S. ESTRADA, MS, has been elected corporate vice president and general manager of Reichold Chemicals, Inc., Pacific Northwest Division.

1945

JEROME S. HARRINGTON, MS '47, has been promoted to the newly created position: director of solid state and computer component products of the Micro Switch Division of Honeywell.

IVAN W. KEITH, former manager of engineering with Teledyne Inet, is now manager of engineering placement with the Professional Management Agency, a division of Career Management, Inc.

1946

JOHN H. BARBER, MS, retired from the U.S. Foreign Service in 1970 and is interpreting and translating for the State Department. He is living in a rented farm house, eight miles from Chestertown, on the eastern shore of Maryland.

BENNETT BOVARNICK, a former senior staff member with Arthur D. Little, Inc. of Cambridge, Massachusetts, is now initiating an independent consulting practice for management in metal producing and metal working companies.

CHARLES H. KING, JR., MS, is the director of engineering for the Apollo-Soyuz Test Project, co-sponsored by NASA and the Soviet Union.

1949

DAVENPORT BROWNE, JR., is a projects manager with Bechtel Corporation.

RALPH S. CHANDLER, AE, retired in April as naval science instructor of the junior ROTC at Southside High School, Florence, South Carolina.

PAUL W. HUBAY, former sales manager of Miner and Associates, has started his own business as a manufacturer's representative in the aerospace industry.

WALTER G. PREVOST is a student at the Cincinnati Christian Seminary. Last year he traveled around the world with the Traveling College of the Puget Sound College of the Bible, visiting seminaries in Asia.

1955

WILLIAM F. LAPSON is a senior staff engineer with Acurex Corporation in Mountain View, California.

F. CURTIS MICHEL, PhD '62, has been appointed chairman of the department of space physics and astronomy at Rice University.

1956

JOSEPH P. GIBBS has been appointed general manager of Spectrol Electronics Corporation, City of Industry, California.

1957

FRANK BORMAN, MS, has been promoted to executive vice-president and general operations manager with Eastern Airlines. He was also elected to the board of directors.

1958

WILLIAM J. KLENK, MS, is a senior staff engineer with TRW Systems.

DONALD R. REITERMAN writes, "Have just defected to the University of California, moving to the top of Mt. Hamilton as superintendent of the Lick Observing Station. Drop by when you're in the San Jose area; we'll be glad both to see old friends and to make new ones among the Caltech alumni."

1959

DONALD D. CLAYTON, MS, PhD '62, is professor of space physics and astronomy at Rice University.

TIMOTHY M. HARRINGTON writes, "I recently joined with HOWARD J. MARSHALL III, BS '57, PhD '65, and others in forming MDH Industries, Inc. in Pasadena to do electronic consulting and instrumentation development."

1960

BRUCE R. DOE, PhD, resigned from the vice chairmanship of the NASA Lunar Sample Analysis Planning Team in April to resume a study of lead isotopes as applied to ore prospect evaluations.

ROBERT BRUCE EGLINTON writes, "I am currently employed in the engineering department of the Chromizing Company of Gardena, California. My wife, Barbara, gave birth to our first child, Lisa Ann, in June 1973."

EDWARD G. GIBSON, MS, PhD '64, spoke at the opening session of the 20th annual meeting of the American Astronautical Society held at USC in August.

1962

JOHN D. CROSSMAN writes that he and his wife, Betsy, and their two children, Michael and Tod, have relocated to southern California. After 11 years with Ford Motor Company in Michigan, Crossman has accepted the position of technical compliance manager for Toyota Motor Sales in Torrance. The Crossmans live in Rancho Palos Verdes.

BRUCE T. KUJAWSKI, MS, an electronics engineer in the U.S. Air Force, has been assigned to Holloman Air Force Base in New Mexico from Wright-Patterson Air Force Base in Ohio. Major Kujawski will be working with the 658th Test Group.

KENNETH LOCK, PhD, is management systems manager for the Burroughs Corporation in San Diego.

ARTHUR C. LUDWIG is manager of the antenna and microwave department, Raytheon Electromagnetics Systems Division, Goleta, California.

1963

WILLIAM F. FRANCIS is a product adviser, advanced system development, for IBM in Yorktown Heights, N.Y.

LOGAN K. KUIPER, MS, formerly with the South Dakota School of Mines and Technology, is working as a hydrologist with the Iowa Geological Survey in Iowa City. GEORGE F. SOULE, MS '64, is working for JOHN W. MATTHEWS, MS '63, PhD '67, and MILTON M.T. CHANG, MS '65, PhD '69, with the Newport Research Corporation.

1965

JAMES M. BARDEEN, PhD, was promoted to professor of physics and astronomy at Yale University.

DONALD R. CHIVENS, MS '66, is a project engineer with Lexitron Corporation, Chatsworth, California.

JAMES H. CRABTREE was promoted to air pollution research specialist at the California Air Resources Laboratory in El Monte, California. He and his wife, Helen, have a 10-month-old son, Andrew.

STEPHEN H. GARRISON, MS '66, is executive vice president of California Growth Real Estate, Inc.

1966

JOE CHING, MS, is a research instructor at the University of Tennessee.

LARRY COOPER, MS, has completed his doctorate at Washington University, St. Louis, and is working with Acurex Corporation in Mountain View, California.

SANKARAIYER GOPALAKRISHNAN, MS, received his doctorate from MIT in 1969 and worked for four years at Arco Lycoming in Connecticut. Since 1973 he has been at the Borg Warner Research Center as a specialist in turbomachinery research.

MARK E. GRANOFF is a medical intern at UCLA hospital.

1967

MICHAEL P. BURKE, MS, is a law student at the University of Michigan and is due to graduate in 1975.

GARY G. IHAS writes, "After graduate school (PhD '71 in Physics) at Michigan, Renee, my wife, and I spent two years in Juelich, West Germany. I was a scientist at the Nuclear Research Center, and we were both full-time travelers. I'm now enjoying a 'cushy' assistant professorship at OSU while Renee tries to get back into the teaching profession which she left to learn German among the Germans."

1968

PHILIP DOBERNE writes, "I work near Caltech at a corporation rich in Caltech alumni and other Caltech affiliates: Caine, Farber, & Gordon. I have been a systems programmer there for the last year and a half and have found it a stimulating experience."

TOBY M. KOLSTAD, JR., MS, is a trainmaster with the Illinois Central Gulf Railroad. He and his wife, Linda, live in Vicksburg, Mississippi.

1970

JOHN J. COYLE, JR., is a second-year medical student at the University of Oklahoma College of Medicine.

TORRENCE V. JOHNSON, PhD, writes, "I recently joined JPL's planetology group as a senior scientist doing research on the moon, minor planets, comets, and asteroids. My son, Aaron Torrence, was born May 21, 1973."

RICHARD LOHMAN is enrolled in the American Graduate School of International Management in Glendale, Arizona.

TRINH X. THUAN received his PhD in astrophysics from Princeton University in May. After a trip to Saigon, which he has not seen in eight years, he joined the department of astronomy at Caltech as a research fellow.

1971

WEI-TOU NI, PhD '73, has joined the faculty of the National Tsing Hua University in Hsinchu, Taiwan, Republic of China, as associate professor of theoretical physics.

OBITUARIES

1923

CHARLES EDWARD FITCH on July 12. He retired in 1959 from the U.S. Patent Office in Washington, D.C., and returned to California. He had been a member of Caltech's Half-Century Club since June 1973.

1927

LOUIS H. MESENKOP, MS '28. He was retired.

1934

PAUL C. ROBERTS of cancer on August 5 in San Diego. He had been a design engineer with the Naval Undersea Center for 28 years, and a member of the Registered Professional Engineers of California. He is survived by his wife, Elsie, two sons, three daughters, and eight grandchildren.

1937

FRANK A. RECHIF of a coronary on July 31. He had been the senior electronics attorney for Sun Oil Company in Philadelphia for the last 11 years. Surviving him are his wife, Edith, and two daughters.

1945

LOUIS GORDON POOLER, MS, on May 31. A retired Navy commander, Pooler spent most of his military service in naval ordnance research and development. He is survived by his wife, a daughter, and two grandchildren.

1949

CLAYTON M. ZIEMAN, PhD, on January 30 of a heart attack. He was a professor of electrical engineering at the Air Force Institute of Technology in Dayton, Ohio. His wife survives.

1958

GLENN LELAND CONVERSE, MS '59, buried in an avalanche on July 16 in the Peruvian Andes on the 22,950 foot Huascaran Peak. He was a geophysicist with the Seismological Field Survey in San Francisco and a member of the Gnome Club.