CALTECH NEWS

VOLUME 6, NUMBER 5, JUNE 1972

PUBLISHED FOR ALUMNI AND FRIENDS OF THE CALIFORNIA INSTITUTE OF TECHNOLOGY

$300,000 goal set for Alumni Fund

Caltech's Alumni Fund Council has established a goal of $300,000 for the 1972-73 Alumni Fund campaign. Chairman Donald D. Davidson, BS'38, announced the goal following the May 15 meeting of the Council, the governing body of the Alumni Fund.

Davidson said the Council hopes that all 11,500 alumni will support the Institute through this vital fund effort.

"In 1965-67, almost 2,100 alumni contributed to the Alumni Fund for the most successful year on record," he said. "If we are to reach our 1972-73 goal, a minimum of 3,500 contributions will be required.

"We are confident that all the alumni will respond at this time to the needs of Caltech. Gifts, both large and small, will be needed if the first-year goals are to be met and, we hope, exceeded," Davidson concluded.

Kieckhefer '45

Sharp '34

The Council also agreed that the Alumni Fund should direct annual gifts to the operating fund of the Institute. However, the Council emphasized that in no way should this decision be interpreted as an unwillingness on the part of Caltech to accept gifts for other purposes from alumni.

Davidson said, "The decision simply means that the principal effort of the Alumni Fund will be aimed at obtaining gifts for ultimate use as operating funds. We certainly don't want to close the door to alumni who wish to make other types of gifts to the Institute."

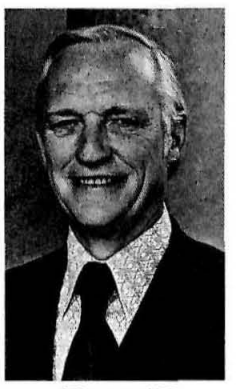
In preparation for the Fund's official launching on campus September 15-17 at a Leadership Conference for all Alumni Fund volunteers, Davidson announced four committees to direct operation of the Fund. These include:

1. Alumni Fund Leadership Conference. To plan the program of the conference. Members are: Charles F. Thomas, BS'35 (chairman); J. Benjamin Earl, BS'44; Patrick J. Fazio, BS'53; and Stephen H. Garrison, BS'65, MS'66.

2. Long Range Planning. To develop a master plan of action to insure the continued growth and future success of the Alumni Fund. Members are: Harrison W. Sigworth, BS'44, (chairman); William A. Freed, BS'50; Barton Jones, Ex'22; and Artur Mager, PhD'53.

3. Communications. To inform alumni of Caltech's needs and to explain how alumni giving can help fulfill these needs. Members are: Robert P. Sharp, BS'34, MS'35 (chairman); Horace W. Baker, BS'35; John L. Mason, BS'47, MS '48, PhD'50; and Reuben Moulton, BS'57, immediate past president of the Alumni Association.

Sigworth '44



Thomas '35

4. Area Chairmen-Alumni Fund Council Liaison. To serve as a sounding board for policies relating to alumni volunteer workers, particularly those alumni workers outside Southern California. Members are: Robert J. Kieckhefer, BS'45, (chairman); Frank W. Davis, BS'36; and Stanley R. Rawn, BS'52, MS'53.

After receiving a report from Davidson on the results of the first Alumni Fund Council meeting, President Harold Brown said, "I am pleased that the Council's activities are going so well, and I wish to thank you and the Council for their fine start.

"The Council's views on promoting annual gifts primarily for annual operating funds, but not closing the door to alumni who wish to make restricted gifts, appears eminently reasonable to me, as does the first-year goal adopted."

Prelude to future

Work begins on biology building

"This is a prelude to the remarkable advances that must be made in the behavioral sciences if man's life on earth is to be improved or even to remain tolerable."

With these words, George W. Beadle, Nobel laureate, trustee, and former chairman of the division of biology at Caltech, welcomed the beginning of construction of the Institute's new behavioral biology building.

Joining Beadle in speaking at the observance ceremony May 9 were Caltech's chairman of the board of trustees, Arnold O. Beckman, president Harold Brown, and biology division chairman Robert Sinsheimer.

The $6,100,000 behavioral biology building will rise across Beckman Mall from its virtual image, the new Donald E. Baxter, M.D., Hall of the Humanities and Social Sciences. Together with Beckman Auditorium, the two buildings will form Caltech's Court of Man.

Donors of the new building, scheduled for completion in the summer of 1973, are the Beckman Foundation and Dr. and Mrs. Arnold O. Beckman.

During the ceremony at the building site Beckman was honored for his many contributions to Caltech, and he and his wife were presented with a Hunt Lewis watercolor of the Court of Man.

Also honored at the ceremony were three scientists who pioneered in the field of behavioral biology at Caltech: C. A. G. Wiersma, professor of biology; Anthonie van Harreveld, professor of physiology; and Roger Sperry, Hixon Professor of Psychobiology.

Beckman told the assembled group that there is a great need for progress in understanding the biological basis of man's behavior and expressed the hope that behavioral biology research can increase man's ability to solve many of the mental and physical illnesses of the world.

Caltech's chairman of the board of trustees also announced that the Institute's five-year development campaign, which concludes next October, is within $1 million of reaching its $70.4 million goal set in 1967.

Sinsheimer, chairman of the biology division and professor of biophysics, said, "In this new building we will seek to couple the mind to natural science: behavior to currents, thoughts to circuits, and emotions to molecules. We will seek to explain perception and memory, logical analysis and emotional impulse, the roots of motivation and the springs of action.

"In good time we may even learn to ask intelligent questions as to how the brain turns currents into consciousness and electrical impulse into will, and how noiseless currents can become sound and invisible impulses become sight and color."

Sinsheimer said he believes behavioral biology will be the single field of greatest importance in fundamental science during the coming decades because of its potential contributions to man's life.

"In an age of stress," he said, "with recurrent crises ruled by the increase of population, fast rising expectations, racial and ethnic disharmony, and persistent international conflicts, we must look within ourselves for greater understanding of why we behave as we do. With such understanding, we might more successfully undertake change."

Research in the behavioral biology building, according to Sinsheimer, will concentrate on the genetics of behavior, on the physiology, neuroanatomy and biochemistry of the brain and nervous system, and on the physiological and psychological bases of perception, learning, and memory.

The new reinforced concrete structure will provide offices, laboratories, and other facilities for nine professors, 30 postdoctoral and research fellows, 30 graduate students, and several technicians.

There will be three floors above the ground and one floor below ground in the new building. The architect is Robert E. Alexander, F.A.I.A., and Associates of Los Angeles, and the contractor is Samuelson Brothers of Los Angeles.

President Harold Brown (left) presents a Hunt Lewis watercolor of the Court of Man to board chairman Dr. Arnold O. Beckman and Mrs. Beckman.

Douglas creates prize fellowship

"There could be no more fitting tribute to the great American aviation pioneer, Donald Douglas, than to make sure that some of the most promising young aeronautical engineers in the world will be trained to follow his path of technical excellence and vision."

With these words, President Harold Brown expressed the gratitude of Caltech for the establishment of the Donald Wills Douglas Prize Fellowship in aeronautics. The fellowship, to be awarded annually, will finance the education in aeronautical engineering of an outstanding student selected from the U.S. or other countries.

The Douglas Fellowship was initiated by Jackson R. McGowan, president of

Continued on page 2

Roberts receives an appointment to Caltech chair

Caltech has honored one of its faculty, chemist John D. Roberts, with an appointment as Institute Professor.

The chair is given for distinction in a particular field or in interdivisional study, and for service to Caltech. Roberts is the second faculty member to receive the honor. Physicist William A. Fowler became the first Institute Professor in 1970.

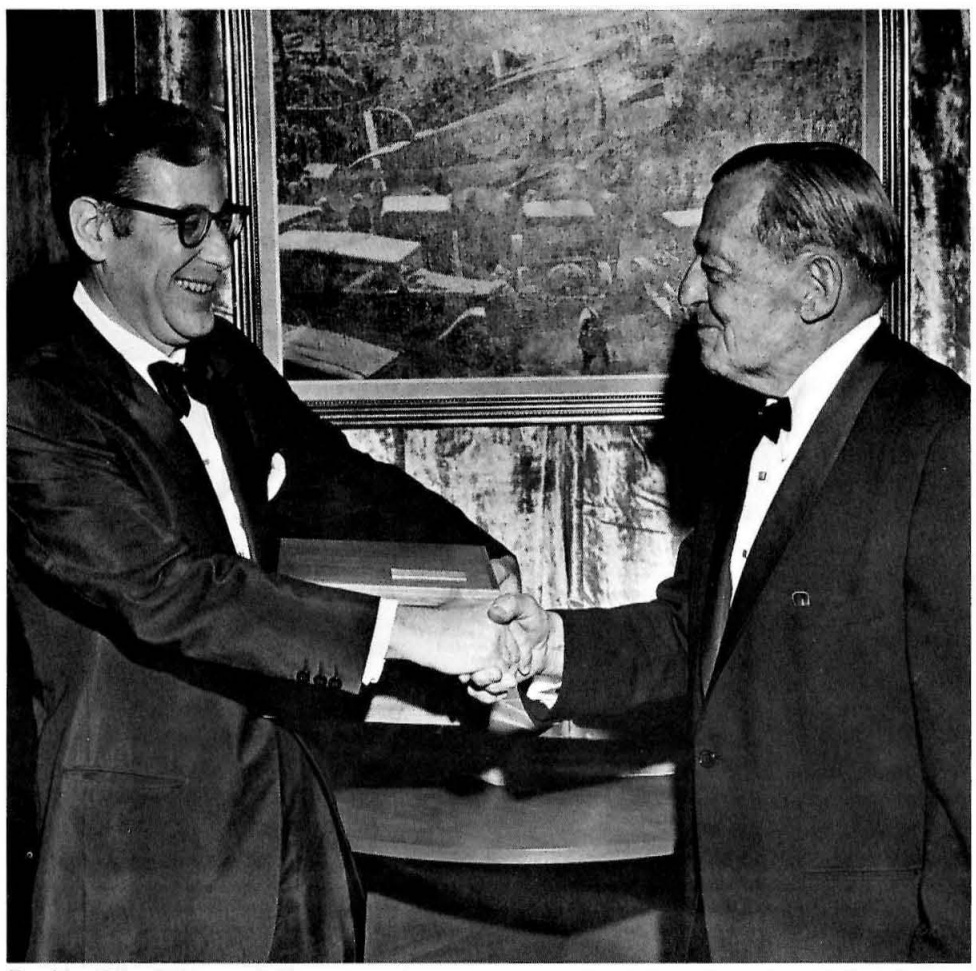
Roberts, a faculty member for 19 years, is known for his ingenious study of the ways atoms in molecules reorganize during chemical change. He has pioneered the use of nuclear magnetic resonance in determining the structures of complex molecules and very fast molecular reactions.

Although the organic chemistry professor is primarily an experimentalist, he has brought theory within the reach of all chemists in a series of small books dealing with molecular quantum mechanics and theories of nuclear resonance. He is also the principal co-author of a widely used textbook of organic chemistry.

Pioneer in chemical science

Roberts was honored in March by the American Chemical Society when he received the William H. Nichols Medal for his pioneering work in many areas of chemical science.

The former chemistry and chemical engineering division chairman (1963-67) has written more than 300 papers, has been a lecturer and visiting professor at universities throughout the country, and holds honorary doctorate degrees from the University of Munich and Temple University.



President Harold Brown (left) presents gift to Donald Douglas at dinner honoring aviation pioneer.

Fellowship will honor Douglas

Continued from page 1

Douglas Aircraft Company, to honor the famed aviation pioneer and company-founder on his 80th birthday. General chairman of the fellowship fund was W. A. "Pat" Patterson, honorary chairman of the board and director emeritus of United Airlines.

A total of 101 corporations, both domestic and foreign, as well as many personal friends of Donald Douglas, contributed to the fellowship fund. At the conclusion of a $100-a-plate black tie dinner-dance attended by 1,010 guests at the Century Plaza Hotel on May 5, it was announced that $300,000 had been received. This amount grew to more than $340,000 by the end of May and will be sufficient to finance a perpetual fellowship in honor of the man who played a leading role in aviation during its period of greatest growth.

Most of the top names in aeronautics and related industries were on hand for the birthday celebration entitled "Around the World in 80 Years," when the fellowship was announced.

In accepting the fellowship for Caltech, Brown praised Douglas as one of the great men of pioneering vision who made California a world center for the aerospace industry.

"They were dreamers of dreams and leaders of men, the entrepreneurs who created giant enterprises to serve the nation and to serve mankind in its need for quick transportation and its age-old dream of flight.

"Donald Douglas turned his own dreams and his own inspiration, through his leadership and dedication, into institutions and products that span the entire history of the aircraft industry, from tiny single-engined airplanes through giant military and civilian aircraft to the era of men walking on the moon and of unmanned flights to the planets.

"Caltech's connection with Donald Douglas has been long and close. And now this association is being established in perpetuity by setting up a Donald Wills Douglas Prize Fellowship in Aeronautical Engineering."

Vice chairmen of the fellowship fund were Burt F. Raynes, chairman of Rohr Industries; Donald W. Nyrop, president of Northwest Airlines; Frederick G. Larkin, Jr., chairman of the board, Security Pacific National Bank; L. Wallace Sweetser, Jr., senior vice president, Associated Aviation Underwriters; Otto N. Miller, chairman of the board, Standard Oil Company of California; and Richard L. Jones, Jr., president, Newspaper Printing Corporation and Tulsa Tribune Company.

Sturdivant noted for achievements

J. Holmes Sturdivant, professor of chemistry, whose genius for design helped to bring Caltech's chemistry division to its present importance, died in Pasadena April 21 at the age of 66. He was noted for his design and development of instruments used in determining the detailed structure of molecules by X-ray crystallography.

Sturdivant was a vital part of the development of Caltech's chemistry division since his early work with its creator, Arthur Amos Noyes. Along with the late Robert Corey, Sturdivant laid the foundation for many of the advances made during the 1930's and '40's by Linus Pauling and other structural theorists of that era. As a matter of fact, Sturdivant was Pauling's first graduate student. In commenting on Sturdivant's career, Pauling called him "responsible for the development of structural chemistry at the Institute."

Division chairman George Hammond described the Church Laboratory of Chemical Biology and the Noyes Laboratory of Chemical Physics as "the most obvious evidence of his skill . . . in the interior design of laboratories."

Secretary Peter Peterson (left), W. Morton Jacobs, BS'28, and Mrs. Jacobs at Associates dinner.

Secretary Peterson addresses Associates at annual dinner

The Associates of the California Institute of Technology held their annual black tie dinner in May, climaxing one of the most successful years in their 46 year history. Several hundred members and guests met at the Beverly Wilshire Hotel for the event which featured Peter G. Peterson, secretary of commerce, as the speaker.

W. Morton Jacobs (BS '28), serving his second consecutive year as president, shared the head table with Peterson, Dr. and Mrs. Arnold O. Beckman, Dr. and Mrs. Harold Brown, and Mrs. Jacobs.

Jacobs, Brown, and Beckman thanked the Institute's leading support group for their contributions to Caltech, referring to the unprecedented membership of 425, the new high set by gifts during 1971, and the Lee A. DuBridge Professorship established in 1970 in honor of Caltech's president emeritus.

The Associates expect to elect 50 new members in 1972.

CALTECH NEWS
Vol. 6, No. 5 June 1972
Issued nine times a year (Oct., Nov., Dec., Feb., Mar., Apr., May, June and July) and published by the California Institute of Technology and the Alumni Association, 1201 East California Blvd., Pasadena, California 91109.
Second class postage paid at Pasadena, California.
EDITORIAL STAFF
Executive editor: William K. Cassell
Associate editors: Janet Lansburgh, Winifred Kennedy, Kay Walker, and Kathleen Marcum.
Photographer: Don Ivers.

Alumni take time for discussion on the Athenaeum patio after lunch during Seminar Day.

35th annual Alumni Seminar Day

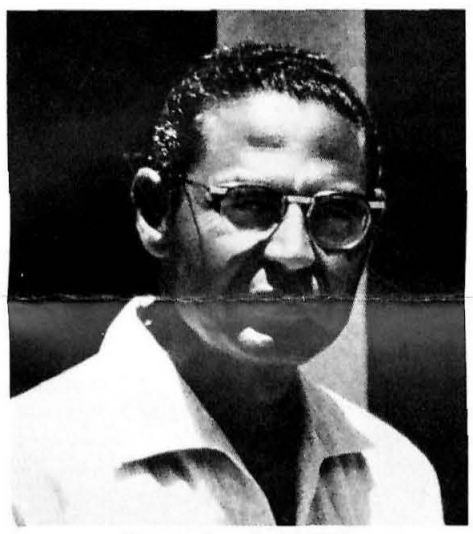
Ismail, Oliver receive Caltech Alumni Awards

Caltech alumni, with their wives and guests, filled Beckman Auditorium for the presentation of Distinguished Alumni Awards and a general session lecture by Wolfgang K. H. Panofsky, PhD '42, during the 35th annual Alumni Seminar Day, May 13.

President Harold Brown first announced the selection of Bernard M. Oliver, MS '36, PhD '40, and Hassan M. Ismail, PhD '49, as recipients of the Distinguished Alumni Award, highest honor that Caltech can confer on a member of its alumni.

The Alumni Award, consisting of a silver medallion and certificate, is made annually to those distinguished graduates of the Institute who have demonstrated outstanding achievements in their chosen fields.

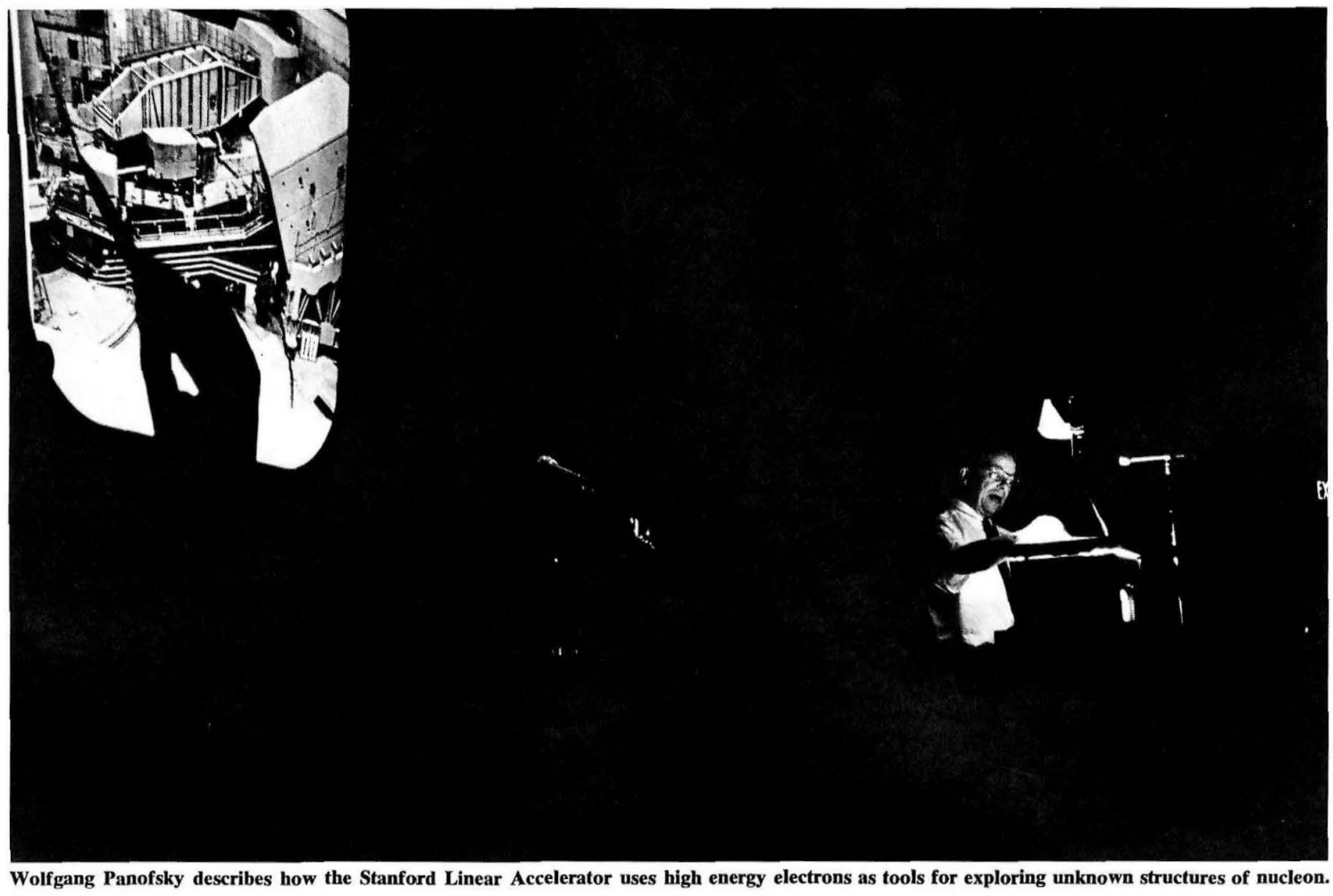
Oliver, vice president of research and development for Hewlett-Packard Company in Palo Alto, received his PhD in electrical engineering in 1940. He was a member of the technical staff of the Bell Telephone Laboratories from 1940 to 1952, where he worked on the development of automatic tracking radar, television transmission, information theory, and efficient coding systems.



Hassan Ismail, PhD'49

In 1952, Oliver joined Hewlett-Packard as director of research and was appointed to his present position in 1957. A member of the National Academy of Engineering, he is also on the Science and Technology Advisory Committee to the California State Assembly and has served as president of the Institute of Electronics and Electrical Engineers.

Oliver holds more than 50 patents in electronics and has written numerous technical articles. He recently headed a major study of a massive array of radio telescopes to search for extra-terrestrial signals.



Wolfgang Panofsky describes how the Stanford Linear Accelerator uses high energy electrons as tools for exploring unknown structures of nucleon.

Ismail, president of Egypt's Cairo University, sent a telegram regretting he could not attend the meeting and expressing his appreciation for being selected for the Alumni Award.

After receiving his PhD in civil engineering from Caltech in 1949, Ismail held the positions of professor, chairman of civil engineering, dean of engineering, and vice president of Cairo University before becoming its president. He has been a consultant for the Suez Canal Authority since nationalization of the canal administration in 1956 and has conducted important studies improving its navigation.

Ismail, regarded as Egypt's leading engineer, also has been chief technical consultant on sediment transport and erosion problems for the Nile River and its estuary since closure by the Aswan Dam.

Panofsky, one of the first recipients of the Distinguished Alumni Award, is a physicist and director of the Stanford University Linear Accelerator. He supervised the design and construction of the $114 million facility and has contributed significantly to understanding the meson particle of matter.

As a scientist-statesman, Panofsky has served as a negotiator on the Geneva test ban talks, as a member of the President's Scientific Advisory Committee, and as a consultant to the Federal Office of Science and Technology. He also is a member of the National Academy of Sciences.

On hand to hear Panofsky's seminar on "Exploring the Unknown Structure of the Nucleon with Known Forces" were his father-in-law, Caltech professor emeritus of physics, Jesse Dumond and Mrs. Dumond.

Panofsky discussed the recent experimental results of elastic and inelastic scattering of electrons using the SLAC 2-mile accelerator. He gave particular emphasis to the role of high energy electrons as tools for exploring unknown structures with known forces, a technique that was made possible by experiments establishing the validity of quantum electrodynamics at very high energies.

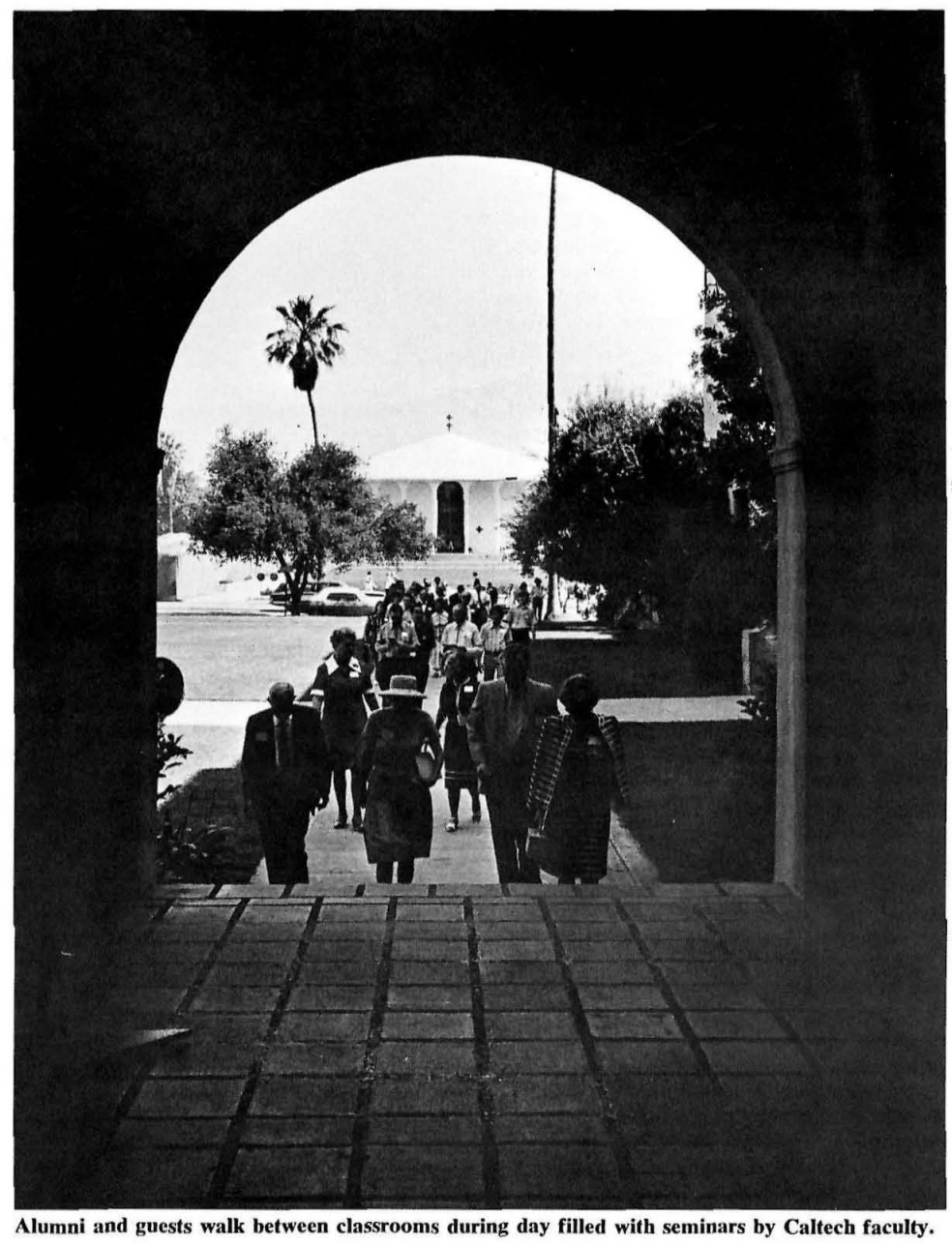
Experiments at SLAC show a strong indication that the nucleon has a granular or point-like substructure, according to Panofsky. "However," he said, "we know very little about the details of such structures, although there has been an enormous volume of theoretical speculation."

Panofsky believes the picture will become "very much clearer" once the experiments in which not only inelastically scattered electrons, but also the final reaction products observed, have made more progress.

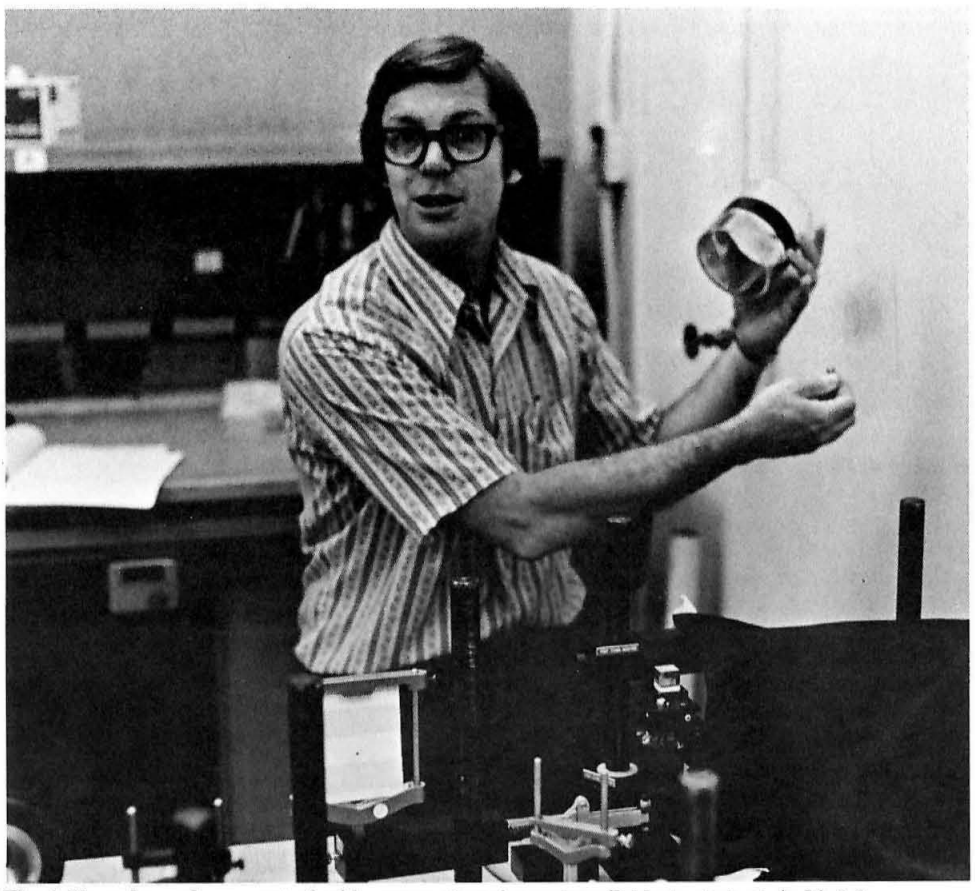
He told the general session audience that a large number of such experiments are currently being undertaken at SLAC and at other laboratories.

"Hopefully a clearer picture will emerge during the next few years," Panofsky said. "The nature of the physical questions today and those faced early in the century are really not different in spirit—only the scale of inquiry has changed."

Bernard Oliver, MS'36, PhD'40 (left), congratulated after receiving Distinguished Alumni Award.



Alumni and guests walk between classrooms during day filled with seminars by Caltech faculty.



Floyd Humphrey shows part of wide range of equipment available to students in his lab courses.

New experimental labs give students unique experience

Experimental lab courses form the foundation for teaching engineering and science, yet they are also a major source of disenchantment for both students and faculty.

Floyd Humphrey, professor of electrical engineering, believes the basic reason for this dissatisfaction with lab courses is the lack of flexibility and creativity in the classical laboratory.

It is important for a professor to perform experiments during his lecture to show the validity of what he is teaching, Humphrey said, but this does not mean the students should simply repeat the experiment in their lab time.

"Being able to decide what to do when it is not written down in the procedures is what is important for an experimentalist to learn," he said, "not simply to follow directions."

But Humphrey found project laboratories that allow students to do anything they want without an objective are also unsatisfactory.

"The critical thing for students to learn is how to make decisions; how to forge ahead on their own," he said.

To give students the opportunity to develop their own ideas, yet also teach them to make decisions, Humphrey developed the Senior Projects Laboratory courses in Electrical Engineering and Applied Physics (EE 91 and APh 91).

"If this sounds different from the laboratory courses you had when you were here," Humphrey told the alumni, "you are right."

He explained that the lab courses he teaches for seniors only look free. In many ways they put more demands on students than classical laboratory courses, but they have a different kind of structure that encourages an attitude of free inquiry and experimentation.

Students are given the opportunity to do comprehensive projects requiring a minimum of 60 hours of lab work. If they have the interest and desire they can increase their work load up to 250 hours for a 10-week project.

"The hardest problem for students," Humphrey said, "is not only to decide what they want to do, but what they are capable of doing."

Students in EE 91 and APh 91 first must write a proposal to show they have the theoretical background to accomplish the project they have chosen. As soon as they turn in their proposal they are given a key to the lab.

Key is important

"The key is important," Humphrey said, "because we have no hours. Students can come in whenever they want to, but this also requires a lot of self discipline."

Once inside the lab, students are given individual working areas, but it is up to them to decide what instruments they need to perform their experiments. Students are also required to record their daily progress in a laboratory notebook that is left on their workbench.

Except for private conferences, Humphrey communicates with the students mainly through the notebooks. He can see the progress they are making and write notes to them on points that are not clear.

Students are also required to write a progress report during the term and then defend their work in an oral exam, which students affectionately call "being nailed to the wall."

The final exam consists of a paper that students write for a journal and a final oral exam, in which someone from outside the course is invited to participate in the questioning.

By requiring projects to be well defined, Humphrey believes he is teaching students to formulate a unit of work and tailor their objectives to the time and facilities available. By having well-established goals and time limits, students also learn to make compromises in the design and depth of their experiments.

Help from an instructor is always available, but students must learn to recognize their difficulties and know when to ask for assistance. Because proposals and technical papers are required, students learn the methods of technical reporting—both oral and written—that they will use throughout their careers.

Most importantly, Humphrey believes the Projects Laboratories for seniors generate an enthusiasm in the students to apply the knowledge they have acquired in the previous three years and to bring this knowledge into perspective.

The Projects Laboratories, designed to fulfill the creative needs of individual students rather than to provide a predetermined set of experiments, are more difficult to equip than the classical laboratory.

Fortunately, Humphrey said, many industrial sources have been enthusiastic about the concept and have contributed supplies and equipment to the Projects Laboratories. To keep pace with student interest and rapidly expanding technology, however, he emphasized that EE 91 and APh 91 have a continuing need for new equipment and materials.

Death of star forms black hole

Nature's perfect garbage dump awaits man in outer space—but he'll need a bit more technology before he can use it.

Speaking to alumni on Seminar Day, Kip Thorne, professor of theoretical physics, described an advanced society of the future, living in a city built on a sphere of super-strong steel and supported by its counterbalance with the gravitational pull of an immense, yawning black hole within it.

He described the black hole as the death bin of a former star which collapsed in upon itself. The result is a pit with a gravitational pull that requires an escape velocity beyond the speed of light, so that nothing can escape; a hole with matter compressed into densities of a million to a billion tons per cubic inch, into which things can fall but nothing can emerge.

Such ominous black holes, which scientists believe exist, have been depicted in several science fiction novels as a menace to space travelers. But black holes could have a positive side as well, Thorne asserted.

For citizens of the future, living in settlements safely balanced against the gravitational attraction, black holes could offer a perfect answer to garbage disposal problems.

Thorne pictured the following scene: "Every day from out of the city a train of trucks drives to the garbage dump, which consists of a series of garbage capsules. The garbage is dumped into the capsules and they are dropped, one after another, down toward the surface of the black hole.

"Then they are swung into orbit around the black hole by forces caused by its rotation. Each capsule could be programmed to open a chute at the right time to eject the garbage into the hole. The capsule would return from the hole at a high speed, hit and turn a flywheel to generate electricity for the city, then go back for more garbage.

"With a careful design of the garbage facility one can convert all the mass of the garbage into electrical energy. The particles of garbage go into the hole but the mass associated with them comes out in energy. And one can do even better than that: one extracts some of the rotational energy of the black hole. Thus, one manages not only a 100 percent conversion of the garbage into energy but gets energy out of the hole as well."

Thorne, describing analyses due to Caltech graduate students William Press and Saul Teukolsky, also suggested that black holes could be used to amplify radio waves. Waves propagating by the hole in just the right direction would be grabbed by the hole, swung around, and sent flying off again with more energy than when they went in.

"Part of the wave will always get swallowed but if you design it right the amplification you get can be greater than the amount of radio wave energy you lost down the hole," he explained.

Thorne admitted that black holes are not easy for astronomers to find, since they don't give off light. He said the best place to look for one is in a system where a black hole and one or more normal stars are going around each other in orbit. He added that scientists have catalogued about 11 cases in which a normal star is orbiting around a massive companion that can't be seen; these are prospects for black holes.

"If a black hole is orbiting with a normal star, it will suck gas off the star," he explained. "As the gas approaches the black hole, it becomes so hot that it radiates x-rays rather than normal light."

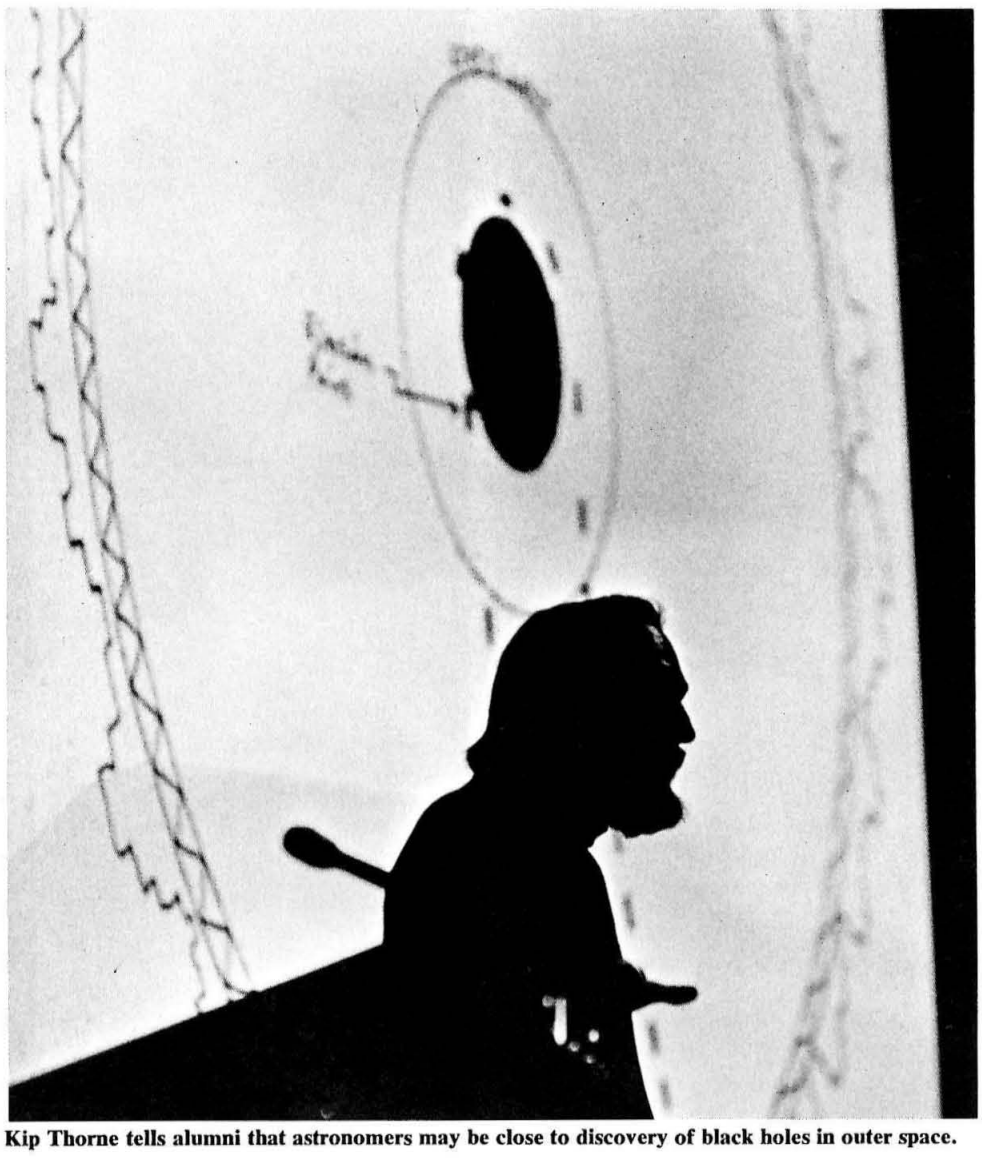
Since x-rays from outer space can't penetrate the earth's atmosphere, scientists must send an x-ray telescope above the earth in a balloon, rocket or satellite to search for suspected black holes.

During the last year an x-ray telescope in a satellite, Uhuru, launched off the coast of Kenya, has discovered a source called Cygnus-Xl, which emits both x-rays and light and shows all the optical characteristics of a normal star orbiting something that can't be seen, Thorne said. Detailed studies are under way to determine whether the x-rays are indeed from a black hole.

"The chief problem that confronts scientists trying to determine what produces the Cygnus-Xl x-rays is theoretical! They don't know what the properties of black-hole x-rays should be, whether they should be hard or soft, and whether they should fluctuate or be steady," Thorne said.

"Major theoretical calculations are going on at Caltech and simultaneously in Moscow to determine what those x-rays ought to look like. I hope that by autumn we will have a much firmer theoretical understanding of their properties.

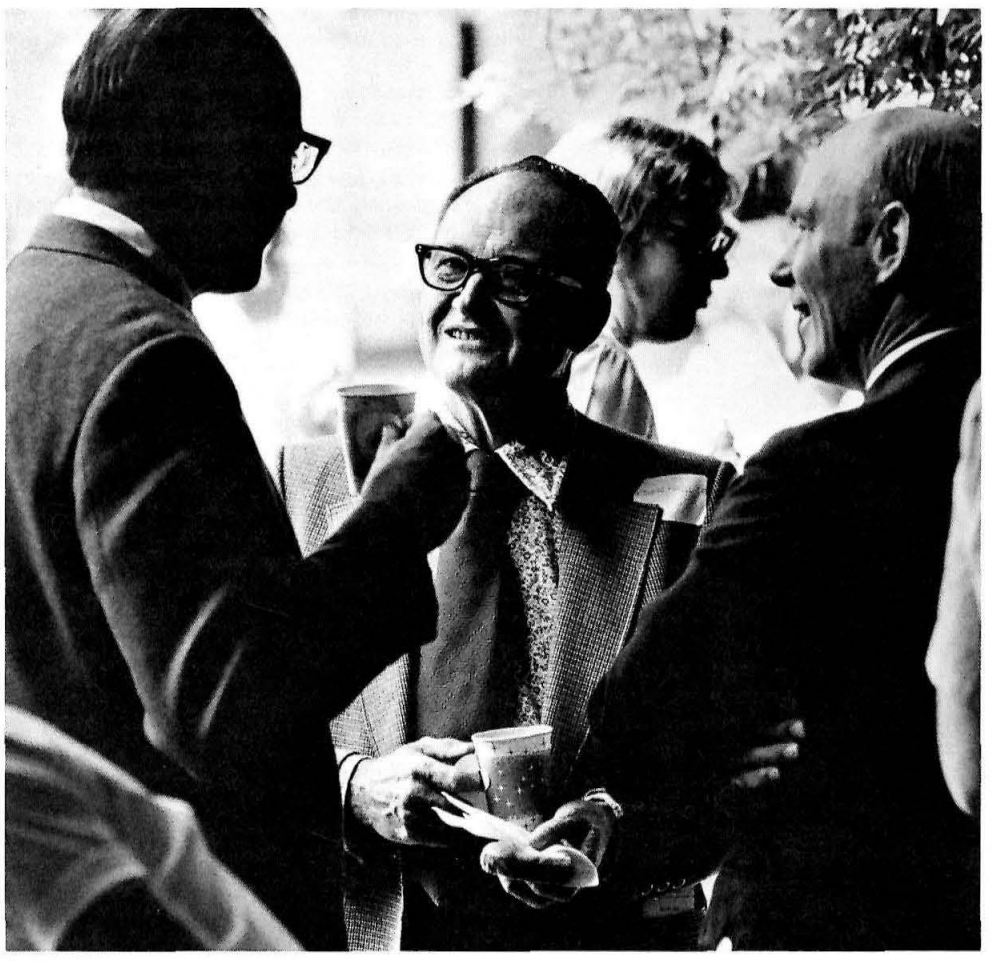
"I would estimate a 50 percent probability that in Cygnus-Xl we're seeing a black hole. If we're not, I'm optimistic that within the next five years we will see a black hole somewhere in our galaxy. Then we will begin an era of concentrated black-hole astronomy, as we study the detailed properties of this phenomenon."



Kip Thorne tells alumni that astronomers may be close to discovery of black holes in outer space.

Alumni hear seminars on Caltech research

Caltech alumni and wives and guests spent a lot of time figuring out where to go next on busy schedule of lectures, displays, concerts, and social events during Seminar Day on campus May 15.



'Gap junction' found key to cell interaction

Interaction between cells has wide-ranging effects which are most obvious and extensive in multicellular organisms such as man.

Interaction occurs in a number of ways, depending in many cases on the kind of jobs the cell has to do. Hormones circulate through the organism from cell to cell as signals to perform certain activities; nutrients are transmitted back and forth; electrical impulses are transmitted from one nerve cell to another or to muscle fiber via synapses.

But, according to Jean-Paul Revel, professor of biology, there is a new kind of cell interaction, a generalized interaction that occurs in the excitable tissues of the heart, smooth muscle, and nervous system, as well as in the non-excitable tissues of the rest of the body.

This cell interaction, he told alumni on Seminar Day, has been termed "electrotonic coupling" and appears to be associated with special intercellular contacts called "gap junctions."

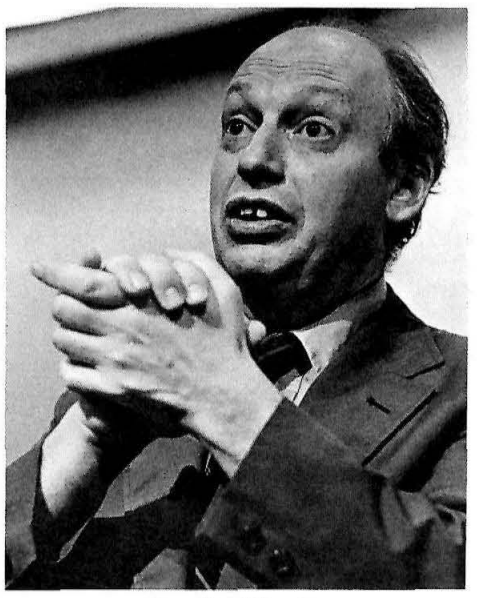
These junctions are about 20 Angstron units wide (80 billionths of an inch). Revel has found what appears to be a very regular array of subunits bridging the gap between two cells.

He said there is a high degree of circumstantial evidence to link electrotonic coupling—a diffuse electrical interconnection between cells—with the presence of gap junctions.

These contacts seem to be for the purpose of passing molecules between cells. The substances carried can vary greatly in molecular weight, and it is thought by some that molecules as large proteins may be able to pass from cell to cell.

"What the role of the gap junction and this peculiar kind of intercellular communication might be in the economy of the organism is not yet clear," Revel said.

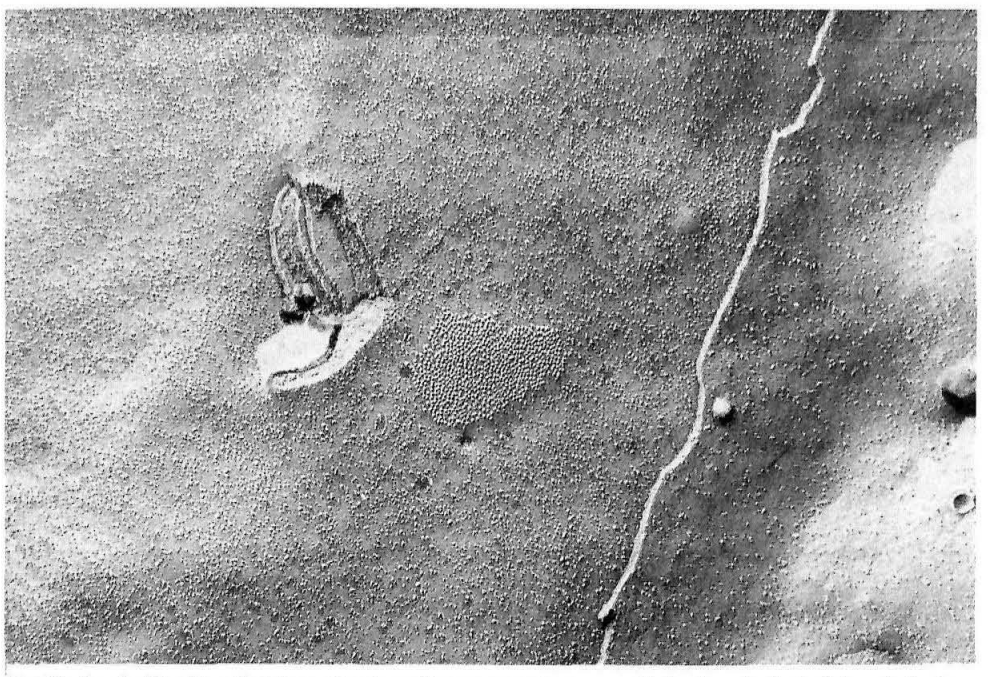
"One may surmise that it is an important role from the observations that gap junctions, albeit extremely small, can be found in the earliest chicken embryos, and also by the fact that their distributions, if not their properties, seem to be altered in some neoplastic (cancerous) tissues.



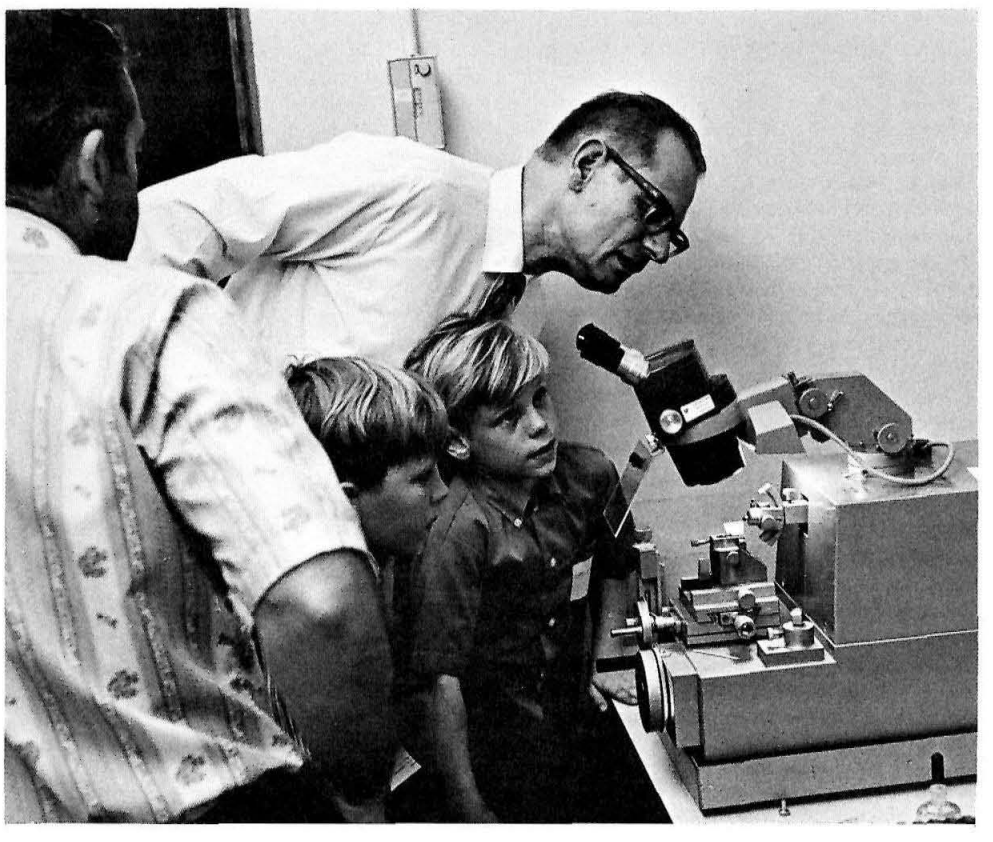
Jean-Paul Revel

"Preliminary evidence indicates," he said, "that electrotonic coupling is harder to detect in neoplasia. At the same time the number of gap junctions decreases, and in some cases, may even disappear."

It is conjectured that the junctions may have something to do with the control of cell growth. If this is so, he said, it would give scientists some clues about cell differentiation and development in multicellular organisms; why cells from the same ancestor diversify to form the various specialized organs and tissues.



On display in Dr. Revel's lab on Seminar Day were microscope (below) and photo (above) showing electron microscope view of cluster of structures in cell believed to form interconnection.



British disguised racism with laws

From an idealistic philosophy that stirred the "civilizing mission" of the British Empire grew the idea that the British race was the best race to rule the world. In his seminar on "Racism and Imperialism in the British Overseas," Robert Huttenback, professor of history and chairman of the division of humanities and social sciences, explained the imperial philosophy that operated in British colonies.

In conflict with a policy calling for equality for all British subjects, regardless of color, Huttenback said the colonies enacted a body of harshly discriminating legislation. This legislation formed the pattern for disenfranchising and restricting minorities in the decades that followed.

Huttenback told alumni that the idealistic concepts of fair play and equality which formed the basis of Britain's imperial philosophy quickly gave way to colonial laws aimed at preserving power for the white man when confronted with actual conflict and competition between the races.

An example of the colonial discriminatory laws was the "literacy test" devised to keep Indians out of Natal. Huttenback said the colonial government passed the law forbidding Indians from entering the country because they were an economic threat.

When the British Parliament objected to this law because it restricted the freedom guaranteed to all British subjects, Natal enacted the first of many colored laws that cloaked their discriminatory intent with a "veil of decency." The law specified that immigrants must pass a reading test before they could be admitted to the country.

"What the law meant," Huttenback explained, "was that all white men passed and all black men failed. It was widely copied in other parts of the empire."

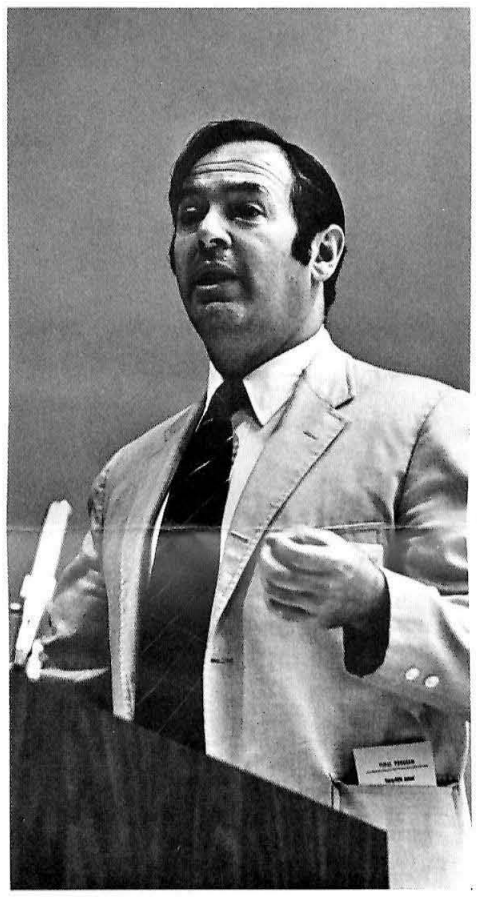
Discriminatory laws enacted by the colonial governments usually had one of three purposes: to exclude non-white immigrants, to eliminate non-white business competition, and to disenfranchise non-whites.

A literacy test was designed to keep non-whites out of the country and to prevent those in the country from voting. To drive non-whites out of competitive businesses, licensing boards were established. Business licenses for non-whites were simply not granted or renewed.

Huttenback said the most vehement racist campaign was launched in British Columbia, where laws were enacted to prevent Chinese from entering and to pressure those in the colony to leave.

Termed a "great curse to the country" by British Columbia legislators, the Chinese population was disenfranchised, excluded from employment on public works, and prevented from entering many occupations.

Huttenback described the clever means devised to keep Indians out of British Columbia. A law was passed that said no one could enter Canada unless he had come by direct passage from the country of his birth. Since there was no direct steamship line from India to British Columbia, this law effectively excluded Indians.



Robert Huttenback

Another ingenious piece of discriminatory legislation was devised by the Australians who were disturbed by an influx of thousands of Chinese into the gold fields. Under the guise of guaranteeing them a comfortable passage to Australia, the government enacted laws establishing a ratio between ship tonnage and the number of Chinese permitted entry on an incoming boat. The number of Chinese was eventually decreased to one Chinese for every 500 tons of cargo.

Other laws passed in Australia interfered with the rights of Chinese to operate a business, to vote, or to become naturalized.

"The question of whether the white or yellow race should be supreme became something of a state religion in Australia," Huttenback said. "These laws were not fully relaxed until the early 1960's, and even then the language created the impression that if a threat of change occurred the old literacy test would return."

Huttenback quoted a colonial governor who summarized the strength of white supremacy sentiment among the colonies saying, "The breakup of the empire would follow any real attempt to give all citizens equal rights. Our self-governing colonies will not tolerate the entry of colored races in any number. It is a question of life or death with them. Their's must be a white man's country!"

In the midst of all these discriminatory actions on the part of its colonies, Huttenback said the British government turned its head, insisting only that the "veil of decency" be drawn over the proceedings.

Mission to Mars

Russians may get first Martian soil

The Russians will be the first to bring Martian soil back to earth, Bruce Murray, professor of planetary science, predicted on Seminar Day.

Murray, a co-investigator on the television team for the Mariner 9 mission, said he believes the Russians will succeed in bringing a sample of Martian crust to earth in the 1980's.

"This will be the crowning achievement in Mars exploration, as it was when the U. S. brought samples back from the lunar surface, and I see it as a Soviet show," he said. "It will be such a long time before either country can go on a manned mission to Mars that this goal is not a relevant consideration."

Murray thinks the Russians will be first to bring back a sample of Martian soil because they're putting more priority on this accomplishment and because of a lack of U. S. programs under way capable of this achievement.

He said the Russians will probably try to obtain data from a lander on the Martian surface in 1973—the next time Mars and the earth are in proper conjunction for such a mission.

"They tried it this year and failed. I think the chances are very good that in 1973 they will succeed," he said.

Murray pointed out that the Russians say they put a lander on Mars which transmitted for a short time before its signals terminated. He said the lander contained a good camera and a mass spectrometer to analyze Martian atmospheric conditions.

He thinks the Russian lander can accomplish many of the experiments planned for Viking, the U. S. lander scheduled to arrive on Mars in 1976, although with less precision.

"Viking will carry on biological experiments, and highly sophisticated organic chemistry analyses, and therefore it is costly and complex to build and send," he said. "In addition, we're sterilizing it to reduce contamination. The Russians don't do that—sterilization is a limitation we've imposed on ourselves that they haven't undertaken.

"The outcome, I believe, is that they'll get to Mars first and acquire data that can be simply obtained. We'll get there second, getting more interesting and reliable data. We're trying to do a better job—they're trying to do it adequately, but earlier."

Murray commented that achievement in space is highly important to the Russian people in a symbolic way.

"They look on space as the symbolic areas in which the competing societies, the competing industrial systems, are displayed on relatively equal grounds. They believe that he who succeeds technically in space represents the wave of the future. They have had rather poor success in the past and this leads the Americans to think they haven't tried very hard, but they've tried very hard indeed."

Murray said he doesn't anticipate that either the U. S. or Russian lander missions will yield definitive answers to the question of life on Mars, but will produce circumstantial evidence pointing strongly in one direction or the other.

He said he considers space exploration one of the unique aspects of 20th century culture.

"It could never have been done before this era," he remarked. "We snatched the opportunity to send a man to the moon first and that opportunity doesn't exist for another country now. It happens only once in history and it's over. That's a cultural endeavor.

"Bringing back pictures of the moon and the planets, and helping people realize Mars isn't a point of light or an idea in Ray Bradbury's mind but a real place with real things on it—some similar to the earth and some different—all of these accomplishments we can claim.

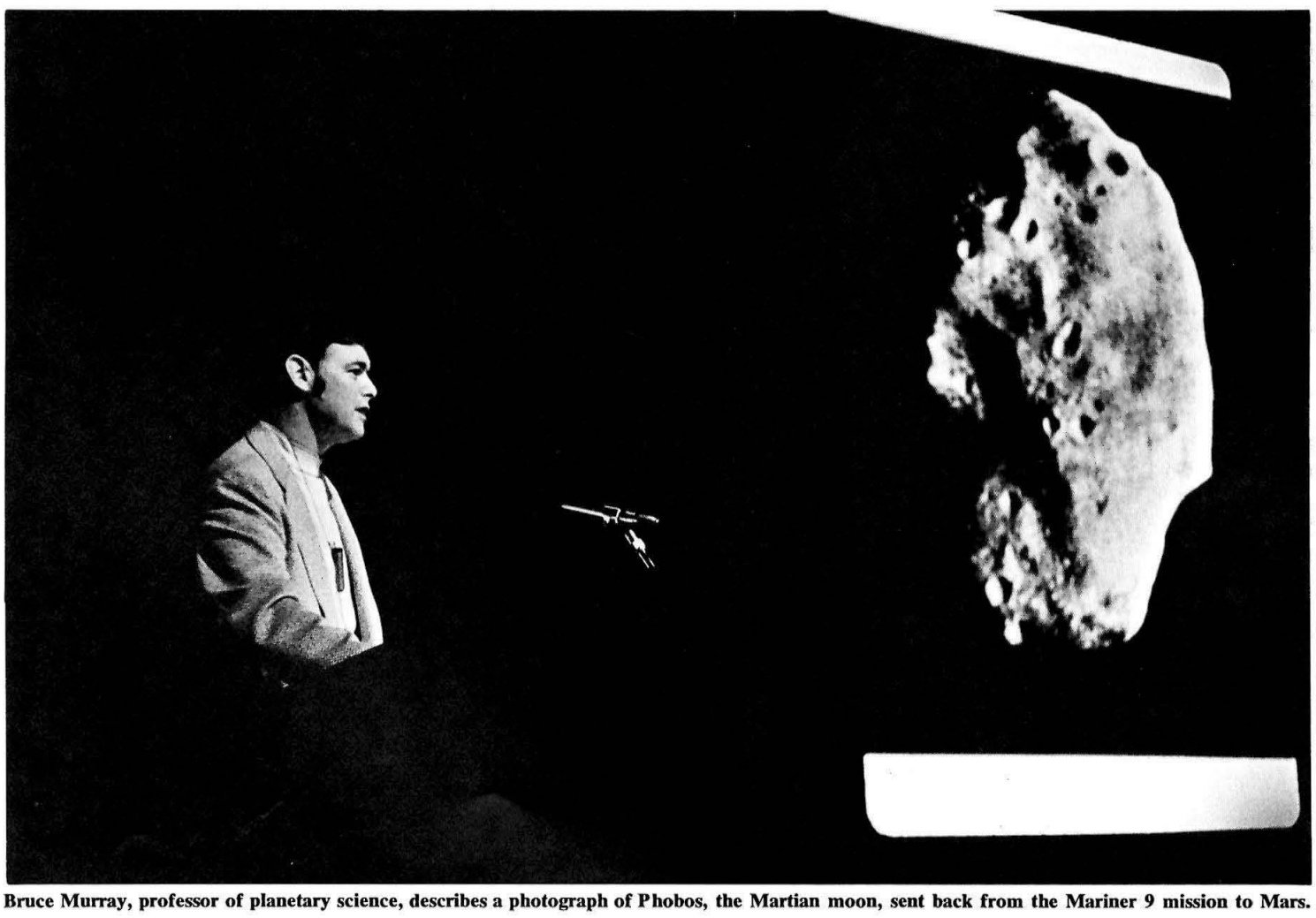
"As a result we've made a tremendous contribution to the culture of our era not just for ourselves but for the whole human race. To me, that's the real justification for the space exploration we're carrying out."

The Mariner photographs have revolutionized man's view of Mars, Murray told alumni.

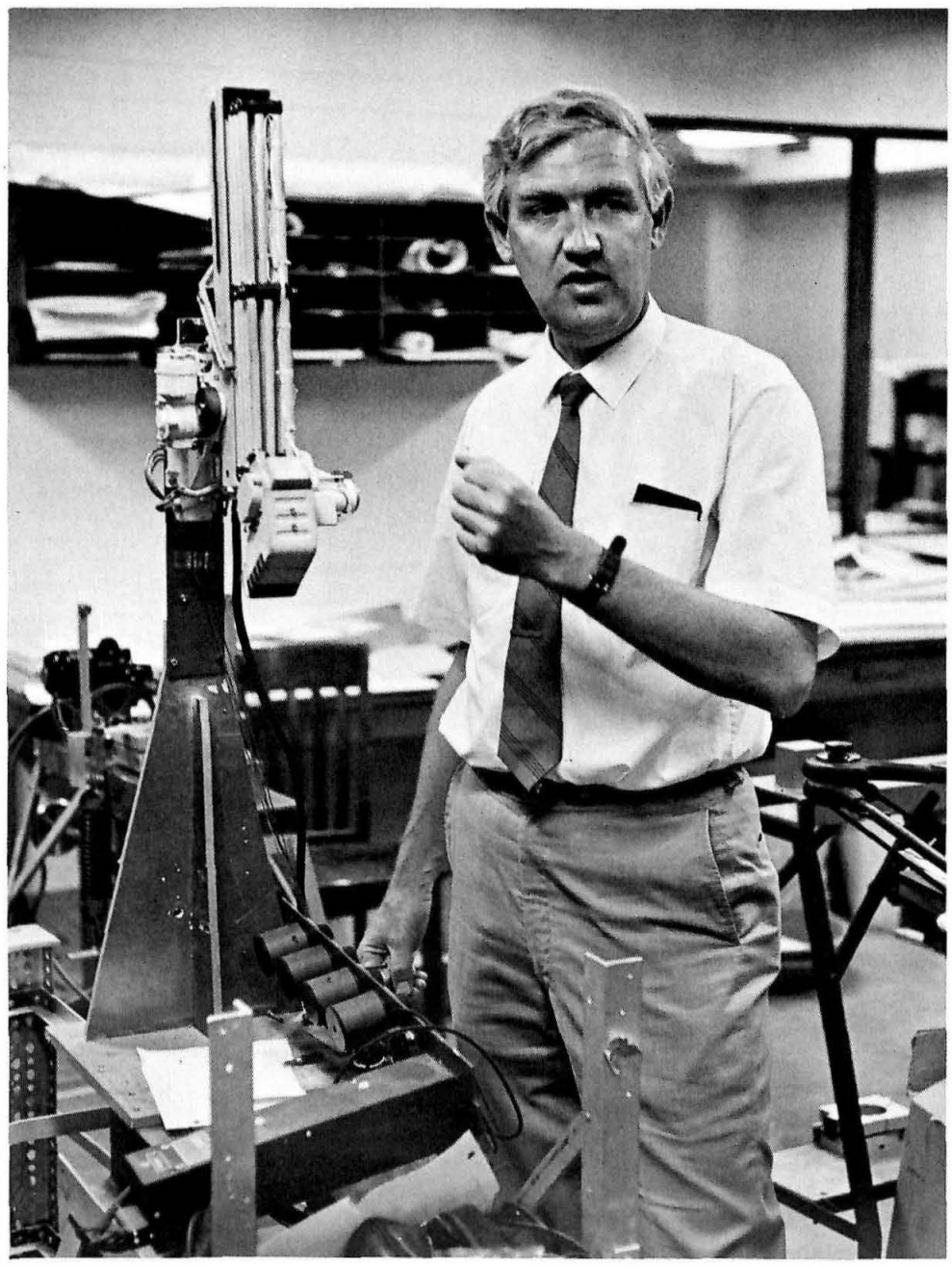
"The old view was that Mars had been like the earth but had dried up and lost its atmosphere," he said. "The new view is that it never has been like the earth but is becoming more like it. Scientifically, Mars is a more complex body than we had ever given it credit for. And it's complex in a subtle way because it manifests unusual phenomena in some places and not in others. The reason for that is that it is still relatively young geologically."

Although Mariner 9 has yielded magnificent data concerning Martian terrain and characteristics, we still are a long way from knowing as much about it as we know about the moon, he pointed out.

"Right now we know as much about Mars as we did about the moon before the space age," he said. "We're still quite ignorant. We were badly misled on some things about the moon at that point, and Mars is clearly a more complicated object than the moon. We're just beginning to learn about Mars and this is exciting."



Bruce Murray, professor of planetary science, describes a photograph of Phobos, the Martian moon, sent back from the Mariner 9 mission to Mars.



Ronald Scott's interests range from instruments that probe moon to liquefaction on earth.

'Liquefaction' believed cause of earthquake soil failures

One of the results of the 1971 San Fernando Valley earthquake was the near collapse of the Lower San Fernando Dam.

Upon examination later it was found that a major portion of the material forming the dam had simply become "unglued" and flowed a considerable distance out into the water in the reservoir, leaving just a shell of material to hold the dam intact.

According to Ronald F. Scott, professor of civil engineering, it is now believed a phenomenon called "liquefaction" was the prime factor in the near failure.

Speaking to alumni on Seminar Day, he outlined what is known about this peculiarly earthquake-related soil failure, where and how it occurs and what is being done to prevent it.

Scott said liquefaction only occurs in a certain class of materials—medium to fine grain sand—which frequently is deposited in a very loose state. These materials form a structure called "metastable" meaning the particles are rather delicately balanced on one another.

Sand liquifies

"This is fine as long as the load is static, unchanging," he said. "But if the material is subjected to a sudden shock or vibration, the grains lose contact and become a suspension of sand grains in water.

"Consequently the sand has no shear resistance or strength to bear loads at all. If it liquefies all the way to the surface, any structures on top denser than this sand-water will sink and anything beneath, that is lighter, pops to the surface."

It is a transient phenomenon that lasts only a few minutes until the solid grains settle out and take on some structural relationship again.

During an earthquake this causes a strange sort of damage. Buildings may be affected very little structurally, because the liquefied soil acts as sort of a buffer. If they were on solid ground the earthquake would jolt the buildings. On a semi-fluid surface the buildings move with the ground motions, and may be relatively undamaged. Instead they usually sink a few feet and tilt.

Scott said this is what occurred in the Niigata, Japan, earthquake of 1964. Few casualties resulted and a number of buildings were structurally unharmed in the liquefaction area. But millions of yen were spent to level the undamaged buildings to make them usable again.

Earth movements in Anchorage, Alaska, during the 1964 earthquake have also been attributed to liquefaction, Scott said, although on initial investigation this did not appear to be the case. Here, although liquefaction did occur, it did not do so all the way to the surface, because the liquefied layers were thin. Also, the upper zone of soil was frozen.

One way of avoiding this type of damage to buildings is to determine what sites in a seismic area will liquefy. This requires analyzing the characteristics of the soil and relating them to the intensity and duration of a possible shock to determine the earthquake hazard.

What are the basic conditions under which liquefaction might occur?

Scott said the material must first be saturated with water, although liquefaction has apparently occurred in circumstances where air was the pore fluid. Second, the vibration must occur faster than the water can move out. In coarse materials, this is nearly instantaneous, and there is no liquefaction. If the material is very fine, such as in clay, there is also no liquefaction, because of the natural cohesion of the grains. It is thus only in a very narrow range of grain size that liquefaction will occur.

When a possible liquefaction problem site has been determined at a construction site, it is necessary to make the soil denser, under strict controls. Since the problem is usually limited to the top 20 to 30 feet of soil profile, Scott said there are a number of techniques available.

One is to vibrate the soil by mechanical means. Another is to simply dig up all the soil and repack it in a denser fashion. What many builders do instead is support their buildings on piles, going down through the problem area to more solid material beneath.

"Such techniques are expensive," he said, "but alternative approaches must wait until there is a better understanding of liquefaction."

Archeologists discover clues to mystery of lost continent

Legendary Atlantis may not be mere fiction after all, and in fact it—rather than Greece—may have been the birthplace of our civilization.

According to Nicholas Tschoegl, a professor of chemical engineering whose avocation is Bronze Age archeology, evidence indicates the "Lost Continent" may have been located on the Aegean islands of Crete and Thera, devastated by volcanic eruption in about 1450 B.C.

The essence of the Atlantis story which is said to go back to ancient Egyptian sources, is contained in two of the dialogues of Plato (427 to 347 B.C.), the *Timaeus* and the *Critias*:

Long before the classical Greek civilization there existed in the same area an earlier Greek culture, which had a powerful rival, the great and wonderful island empire of Atlantis. At first it was an ideal commonwealth, but it became corrupted and attempted to enslave the rest of the world. These older Greeks defeated them, but afterwards there were violent earthquakes and floods. In a single day and night of disaster, Atlantis disappeared into the depths of the sea.

Speaking to alumni on Seminar Day, Tschoegl said the first strong hint that the old tale might not be mere fabrication came with the work of archeologists digging at various sites on the Greek mainland confirming that there was indeed another period of high civilization before the classical period in Greek history. This civilization is now called Mycenaean, after its main site at Mycenae on the Peloponnesus.

What about Atlantis?

"Plato unmistakably put it in the Atlantic Ocean," Tschoegl said. "But what we now know about the topography makes this virtually impossible.

"And because of the unbelievable logistics of conducting a war over such vast distances, it would make more sense to seek Atlantis much closer to the Greek mainland."

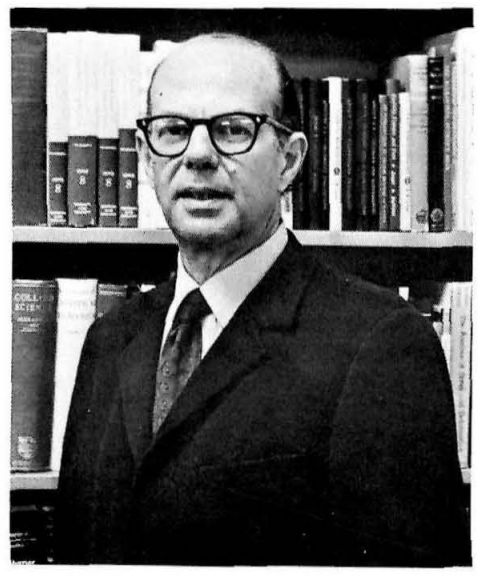
One possibility is Crete. At the beginning of the century archeologists unearthed on Crete what appeared to be another highly advanced civilization, somewhat older and artistically more refined and more original than the Mycenaean. This culture, called Minoan, was destroyed about 1450 B.C.

In 1939 the Greek archeologist Spyridon Marinatos became convinced that he had found the clue to the sudden catastrophe that befell the Minoans on Crete in 1450 B.C.: a gigantic volcanic eruption on the island of Thera, about 70 miles to the northeast of Crete. Research by vulcanologists, said Tschoegl, indicates an eruption occurred there in about 1500 B.C., several times more powerful than the largest atomic bomb, spreading volcanic ash over hundreds of miles. The blast destroyed Thera and smothered a burgeoning civilization on Crete which shows many remarkable similarities with Plato's Atlantis.

Studying the Atlantis problem in relation to volcanic activity in the Aegean area, the Greek seismologist A. G. Galanopoulos advanced the idea that the capital of Atlantis—Plato's Ancient Metropolis—should be sought on Thera.

Plato describes the Ancient Metropolis as being built on a circular island, clearly volcanic in origin, and shaped into alternating belts of land and sea. The rest of the country, the Royal State, is said to have been a large, roughly rectangular plain. Its exact geographical relation to the Ancient Metropolis is not clear.

Thera, which is roughly circular, volcanic in origin and about 5 miles in diameter, bears a resemblance to the site of the Ancient Metropolis. The Royal State is similar in many ways to that part of Crete, the plain of Messara, where Minoan sites have been excavated.



Nicholas Tschoegl

The Atlantaen-Minoan theory has gained even more credence with the excavation of a Minoan town on Thera. The art found there, said Tschoegl, surpasses anything contemporary found so far in the Mediterranean area, including Crete. He said these discoveries are exciting because of what they say about the origin of our civilization.

"Western civilization is founded on Greek civilization, which in turn has its roots in the Minoan culture," Tschoegl said. "If it is proven the Minoan and Atlantean civilizations are identical, then Thera, site of the Royal City of Atlantis, may have been the true birthplace of our civilization."

Frieze unearthed on Crete, showing harvest scene, provides clue to an ancient Minoan culture.

Environmental crisis caused by complex 'web of blame'

Changes in technology alone cannot solve man's environmental crisis, for the culprit is not a single cause but rather a tightly woven "web of blame," John Holdren, senior research fellow with Caltech's Environmental Quality Laboratory, told alumni on Seminar Day.

Holdren said, "The idea has been widely promoted in recent years that faulty technology, encouraged by shortsighted economics, has been almost entirely responsible for generating our environmental crisis, and that changes in technology are all that are needed to render the environment whole again.

"This conclusion is not only wrong but dangerous. It is dangerous because it is used to lull people into an unjustified state of complacency concerning the other components of the problem. Unfortunately, our difficulties are the result of several factors operating simultaneously.

"How many people there are, how much each one consumes, and the sort of technology used to make consumption possible—the impact of any of these factors multiplies in proportion to the growth of the others.

"The seriousness of environmental disruption today, and the frightening momentum built into the trends behind it, persuade me that we must face up now to all these causes in their complexity."

Holdren said man must work to stabilize population and slow the growth of consumption per capita at the same time he is seeking less environmentally damaging technologies.

"To do all these things and do them at once is a big order, but nothing less will do," he asserted.

Holdren said he does not mean that dramatic improvements in technology are not worthwhile and possible, but only that they are not enough to solve man's serious environmental problems. And he pointed out that, while some technologies are less damaging than others, none are perfect.

"There is no such thing as a free lunch," he said. "Zero emission—whether we are talking about automotive exhaust, power plant stack gases, or industrial water pollution—is an unattainable goal. Many attempts to eliminate environmental problems really only shift them."

He pointed out that incinerating solid waste aggravates air pollution; switching to electric cars shifts part of the pollution burden caused by transportation from polluted air over highways to polluted air over power plants; pollution control requires energy and energy itself pollutes.

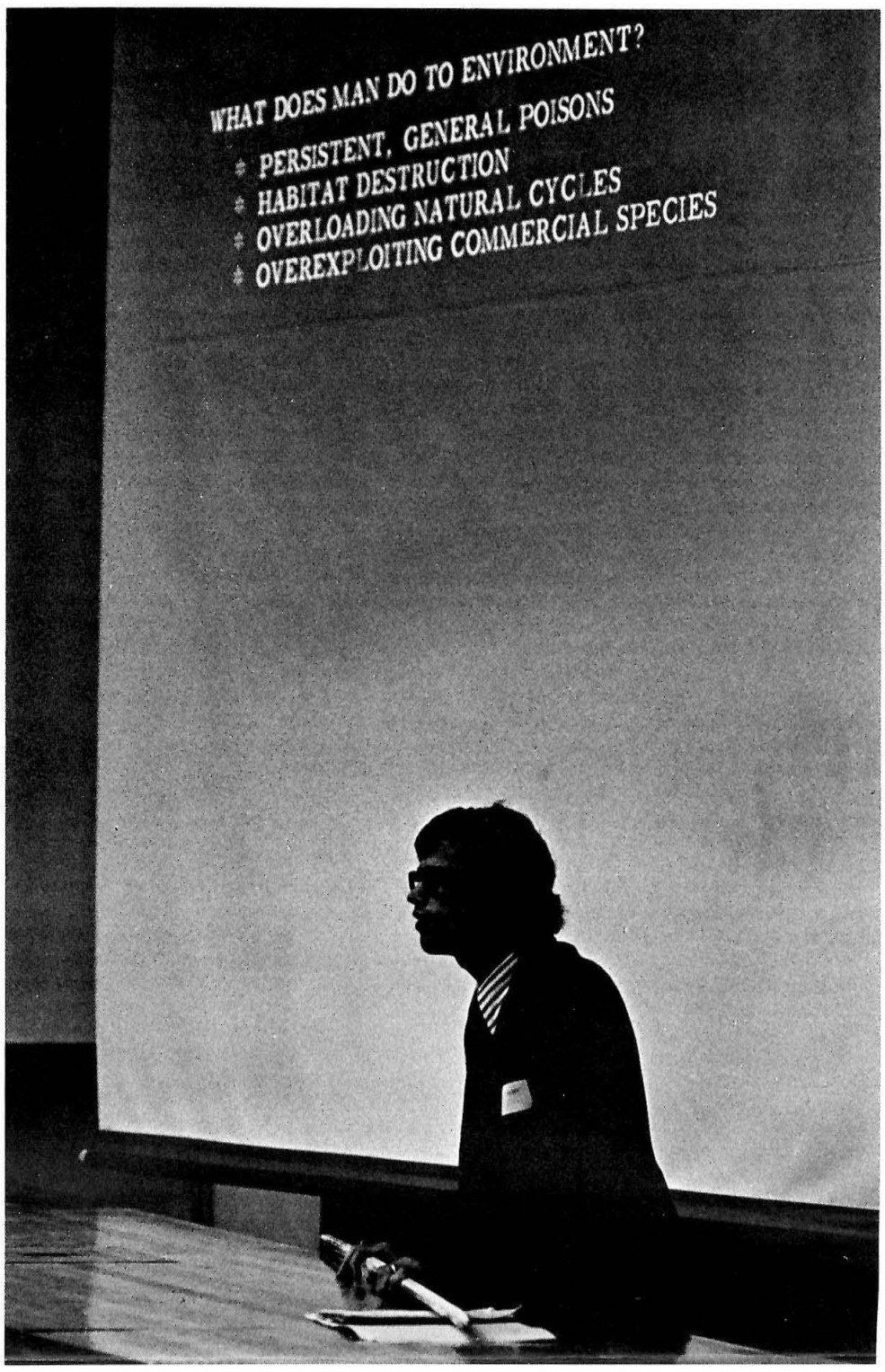
Holdren asserted that we are threatened "not so much by acute poisoning or suffocating in garbage as by threats to the integrity of the natural biological processes we depend on for indispensable services."

As some of these services, Holdren named natural control of pests and disease, nutrient cycling and waste disposal, maintenance of a livable atmosphere, natural fish production, control of floods and erosion, and provision of a library of genetic information.

Holdren said man already has reduced the capacity of these natural processes in a number of ways and continues to further threaten their efficiency. As most serious among these threats he listed overloading of natural cycles, overexploiting species for commercial purposes, destroying the natural habitat needed for certain species to survive, and injecting persistent poisons into the environment.

"Man is systematically diminishing the capacity of the environment to perform its pest control, waste disposal, nutrient cycling and other vital roles at the same time his growing population and rising affluence are creating larger demands for these services."

Holdren concluded, "Man's absolute dependence on these services makes broad environmental concerns a matter of human life and death and not, as some have asserted, a crusade to maintain some scenic places for the affluent to hike."



John Holdren explains some of the causes of the environment crisis in his lecture to alumni.

Chimeras reveal insights into genetic disease

The chimera of mythology was a monster with a dragon's tail, a goat's body, and a lion's head spewing flames. While present-day chimeras are not so exotic, they have more biological reality and significance according to Ray Owen, professor of biology.

Owen told his Seminar Day audience that chimeras occurring in nature and those produced by experiment are revealing fresh insights into how an individual emerges as an integrated entity, and into genetic disease and its correction —including cancer.

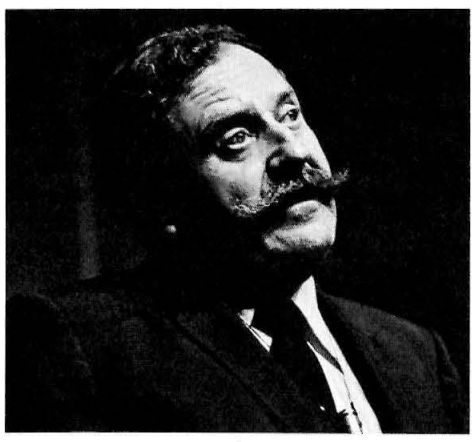
Back in the 1940's in the course of a study of cattle, Owen discovered that about 90 percent of twin calves carry a mixture of two or more different blood cell types. During embryological development, the extra-embryonic blood vessels of the calves fuse, and they give each other continuous and very complete reciprocal transfusions. Examination after the twins are born shows that there has been a transplantation of cells between them, and the red blood cell types of both are found in each—a situation that continues during the entire life of each animal.

When this phenomenon was discovered, it seemed to be a violation of the rules of transplantation; an organism is expected to reject transplants from a genetically dissimilar donor. Thus, it would seem that each twin's immune system should recognize that the cotwin's tissues are different, and respond by destroying them. The fact that the twins were tolerant of each other's cells not only suggested a new viewpoint on the immune system, but also offered hope that the barrier to organ grafting could be brought under experimental control.

Owen and others began making transplants between genetically dissimilar individuals (usually rats and mice) and inactivating the immune reaction by X-raying the prospective recipient of, for example, a bone marrow transplant. After such a transplant was made, the circulating blood cells in the resulting chimera derived from the transplant. Many a mouse lived on the transplanted bone marrow of rats, and a rat is *not* a mouse. Development of this kind of treatment has practical implications in the case of human beings who have been exposed to very high dosages of radiation.

The study of chimeras has been greatly expanded in recent years through development of a technique for fusing embryos, worked out in the early 1960's by Dr. Beatrice Mintz of the Institute for Cancer Research at Fox Chase, Philadelphia. Because of its great importance in the field, Owen discussed her work in detail.

Dr. Mintz takes a female mouse whose eggs have been fertilized but not yet implanted in the uterus and flushes them out of the oviduct. At this point the embryo is at the 8- or 16-cell stage. Using an enzyme called pronase, she removes the outer coating of this very early embryo from a white mouse. She does the same with a black mouse, and then pushes the two embryos together. Being sticky with respect to each other, they intermingle. After keeping the fused embryo in an incubator for a day, she then implants it in the uterus of a pseudopregnant female, i.e., a mouse that has been mated with a vasectomized male. The fused embryo readily adjusts to its new home—and to being a mouse from two very different cell types.



Ray Owen

The resulting babies are called "allophenic," a special designation for their particular kind of chimerism. In the case of the black-white mixture, the baby mice are striped more or less like a zebra. Mintz counted the stripes and concluded that coat pigment in the mouse comes from two longitudinal lines of cells down the embryo's back—17 cells in each line —and that the cells divide transversely to produce the eventual stripes.

The study of such allophenics throws light on the processes of normal development. For example, all the reproductive cells of a mouse derive from only two to nine original cells. It is easy to see that an early event affecting one of these few cells can have magnified consequences in the reproduction of the individual. Genetic lesions provide markers to map out the patterns of cell lineage in development.

Another example is in retinal degeneration. In allophenics derived from a normal mouse and one that is homozygous for retinal degeneration, the mice are born normal, but their retinas soon begin to deteriorate and they become blind. What Mintz found was that each retina begins with a circlet of ten cells that proliferate laterally to make sectors. Observing this, she was able to get a lineup on the cell lineage and pattern of development of the retina. The same kind of thing can be done for using marked genes that control enzymes, or genes that control antigens in the brain, and thus it is possible to see what the pattern of development of the brain is.

Sex development is a further example of the same process. When two early embryos are fused, there is a 50-50 chance that one of them will be female and one male. It might be expected that half the time a chimera of this sort would be an intersex of some sort with the male and female cells all mixed up. But only about 1 percent turn out this way.

In the sex development of the individual there is some way of assuring that the germ cells that are produced—sperm or egg—are consistent with the sexual phenotype of the organism. Female germ cells just don't work in a male; they don't make sperm. On the other hand, other cells in the reproductive tract—in the prostate gland, the seminal vesicles, the epididymis of the testis—are much more versatile than the germ cells.

So it is possible to have an allophenic mouse in which all of the seminal vesicle tissue is female (XX). But it differentiates into a normal seminal vesicle and makes the normal proteins that are thought to be male-specific. They are female cells, but they have the genes for making male proteins that ordinarily don't get turned on in a female. The male (XY) cells that are present elsewhere in the allophenic turn on the right genes to produce the compatible male substance to make sperm in this individual.

This type of chimerism offers an example of the way integrated individuals develop through the setting apart sequentially of a relatively small number of cells specific for the tissue that is going to be formed in number and in character. They are deployed in the embryo in a characteristic geographic way to give rise to the full complex organism, turning on sets of genes that are appropriate to those cells and then keeping them stable.

Chimeras are also of interest in studying disease and the correction of genetic lesions. Mice that are genetically anemic and should die of anemia soon after birth can be provided with normal cells from non-anemic co-partners in an allophenic and thus rescued. This becomes important in the further study of gene therapy and genetic engineering. It is possible to study to what extent lethal defects are part of the cells that express them, and to what extent they are affected by things in bud elsewhere in the organism.

Technology can improve indoor air

It is a paradox that while considerable time, effort, and money are being spent to clear our outdoor environment—particularly our air—most of us spend much of our time indoors.

This being the case, it is time to take a hard look at the quality of indoor air, according to Rolf Sabersky, professor of mechanical engineering and Fredrick H. Shair, associate professor of chemical engineering.

While the improvement of our external environment is all-important, Professors Sabersky and Shair believe the quality of our indoor environment should not be ignored for a number of reasons.

One reason, Professor Shair told alumni on Seminar Day, is that such research would yield immediate benefits in terms of improving the air we breathe each day indoors. Another is that the information gathered and techniques developed in the study of indoor air can in many cases be used to study and improve the outdoor air quality.

As an example, he described a new analytical technique he and his coworkers have used on their projects.

Working with Dr. Peter G. Simmonds of the Jet Propulsion Laboratory and Peter Drivas, a graduate student, Shair has improved an analytical chemical technique capable of measuring inert, harmless gas tracers in concentrations as small as one part in a million million parts of air. It involves the use of a gas chromatograph with an electron capture detector developed by Dr. James Lovelock in England.

With this technique, Professor Shair and his colleagues have studied:

1. Various aspects of air drawn into buildings by their ventilation and air-conditioning systems;

2. The mixing of old and new air in the air-conditioned rooms of many buildings;

3. The indoor air quality inside buildings containing research laboratories.

"Traditionally, ventilation and air-conditioning have been aimed at maintaining desired temperatures and humidities, and possibly filtering out dust particles," Shair said. "But very little effort has gone into really 'conditioning' the air; that is, maximizing the indoor air quality.

"The entire question of improving the air quality indoors should be reviewed. This new analytical chemical technique provides a ready means of obtaining information relevant to such a review."

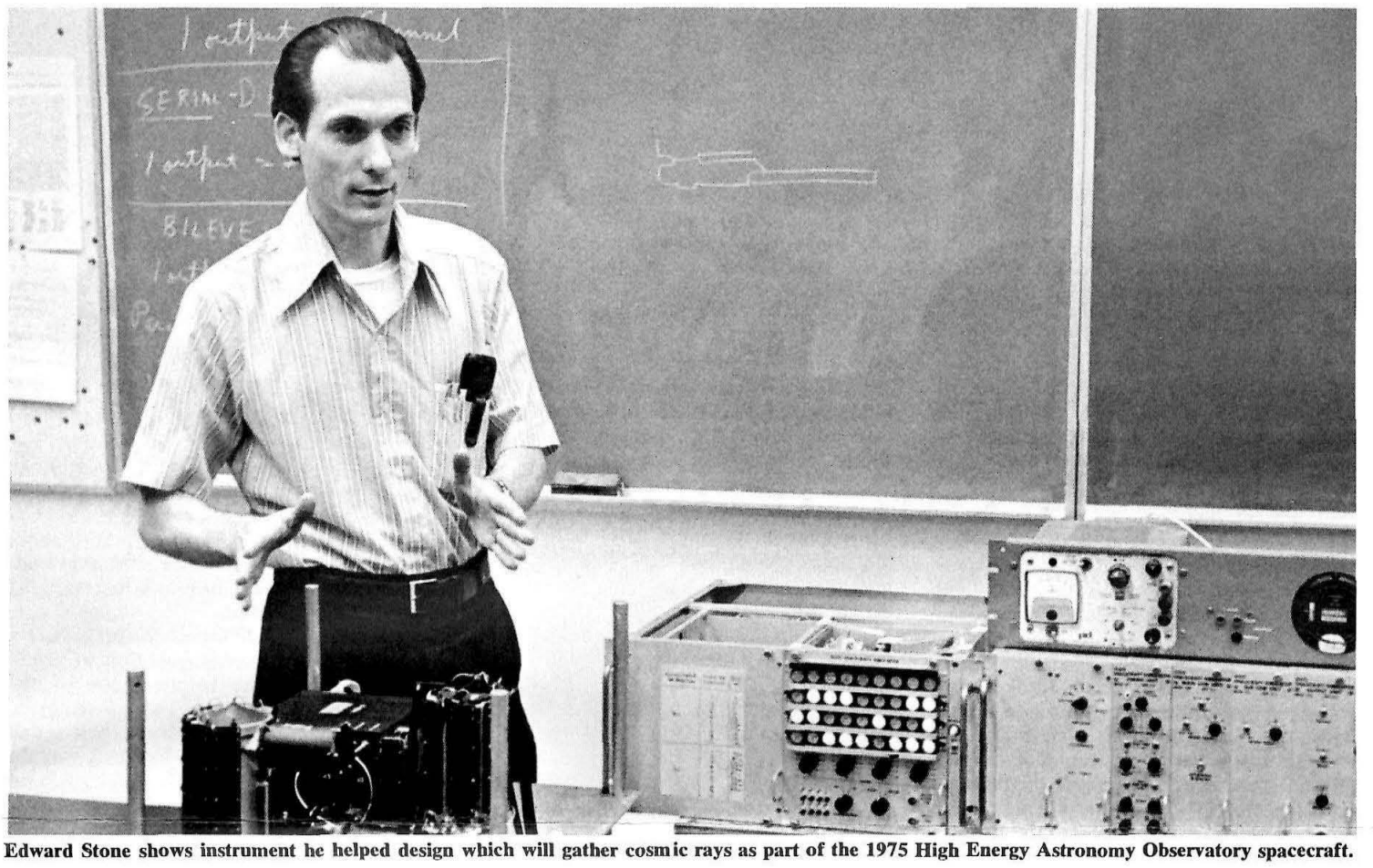
It has been found, using the technique, that buildings can contaminate their own air and that of neighboring buildings by the exhaust air being pulled back into ventilation intakes. Each building, because of dynamics of the wind blowing around it, appears to have a wake of protective, stagnant air. Shair feels it is important to determine exactly the characteristics of such wakes in order to determine the right locations for a building's intake and outlet vents.

So far, it has been found that one way to avoid this kind of problem is to have a stack that carries the exhaust high enough above a building's roof so that the exhaust air will adequately disperse before it returns to the intake. Placing covers atop exhaust stacks as a protection against rain generally tends to force pollutants down against the building, where they tend to be drawn back inside. It has been found with the tracer technique that there is considerable "short-circuiting" of fresh air, with as much as half of it moving directly from intake to outlet without mixing with the rest of the air in the room. The final result is stale air.

Conditioning systems need to be redesigned to solve this problem. "In addition," Shair said, "some buildings need a flexible ventilation and air-conditioning system so that during a peak attack of smog, less outside air will be drawn in and more inside air will be recirculated."

In the use of toxic materials in research and industrial processes, Shair emphasized the importance of finding out where toxic materials go. This can be done with the aid of the tracer technique. In one case, it was found that 20 percent of the gas emitted from protective fume hoods finally returned into the building. Sometimes the material pumped out through the exhaust system would get caught in the wake of the building only to be drawn back into the ventilation system.

The tracer technique has also been used to study a variety of other environmental problems. Among these are: the pollutant levels in freeway tunnels, the indoor air quality inside a moving vehicle on a freeway; the quality of air downwind of freeways, how it differs from the general basin air and how it affects the indoor air quality in buildings and cars; a number of microclimatology problems, such as how smog spills over mountains.



Edward Stone shows instrument he helped design which will gather cosmic rays as part of the 1975 High Energy Astronomy Observatory spacecraft.

Satellite will detect cosmic rays

Edward C. Stone, associate professor of physics, discussed cosmic rays—very fast-moving, charged particles that roam our Milky Way galaxy and bombard Earth continuously—in his Seminar Day lecture.

Stone described how he and a team of scientists will study cosmic rays with 78 square feet of instruments to be launched in late 1975 aboard the High Energy Astronomy Observatory (HEAO) spacecraft.

Staying in orbit for two years, the instruments will permit the team of six scientists from four different institutions to learn a great deal about these high-velocity "bullets" that shoot in from outer space.

Cooperating in the HEAO cosmic ray experiment with Stone and Rochus E. Vogt, professor of physics at Caltech, are W. Robert Binns of McDonnell-Douglas Research Labs, St. Louis; C. J. Waddington of the University of Minnesota; and Martin H. Israel and Joseph Klarmann of Washington University, St. Louis.

Although cosmic rays were first detected in 1911, their source remains unknown. Pulsars seem to be likely candidates for the origin of cosmic rays but this remains to be proven.

Even if we do not know where they come from, we do understand what cosmic rays are, Stone said. They are fast-moving, bare nuclei of atoms from which the outer electrons have been stripped away.

Traveling at speeds from as low as 10 percent to almost the speed of light, cosmic rays carry tremendous amounts of energy. It is no surprise, therefore, that cosmic rays can smash and break apart any atoms with which they collide and, in turn, be fragmented themselves. For this reason, the true nature of the primary, incoming cosmic rays cannot be studied using instruments on the surface of Earth.

Stone explained that as incoming cosmic rays whiz through the atmosphere that surrounds Earth, they collide with and smash apart the atoms and molecules that make up the air. Instruments on Earth's surface do not detect the original, *primary* cosmic rays that zoom in from outer space, but they do detect *secondary* cosmic rays—the atomic fragments and pieces produced by collisions between primary cosmic rays and air molecules.

To study the original primary cosmic rays, Stone said scientists either have to lift their instruments in balloons above most of the atmosphere to heights reaching 150,000 feet or orbit the instruments in satellites at heights of about 100 miles above Earth.

The 105 different kinds of atoms now known on Earth differ from each other according to the number of protons in their nuclei. Stone explained that since a proton has mass, the more protons in a nucleus, the heavier the nucleus will be.

Cosmic rays that are hydrogen nuclei (1 proton) or helium nuclei (2 protons) up to those with about 10 protons are called light or medium cosmic rays; cosmic rays from about 10 to 30 protons, such as iron nuclei (26 protons), are called heavy cosmic rays; and cosmic rays from zinc nuclei (30 protons) to curium nuclei (96 protons) are called ultra-heavy cosmic rays. Those with more than 96 protons are called superheavy cosmic rays.

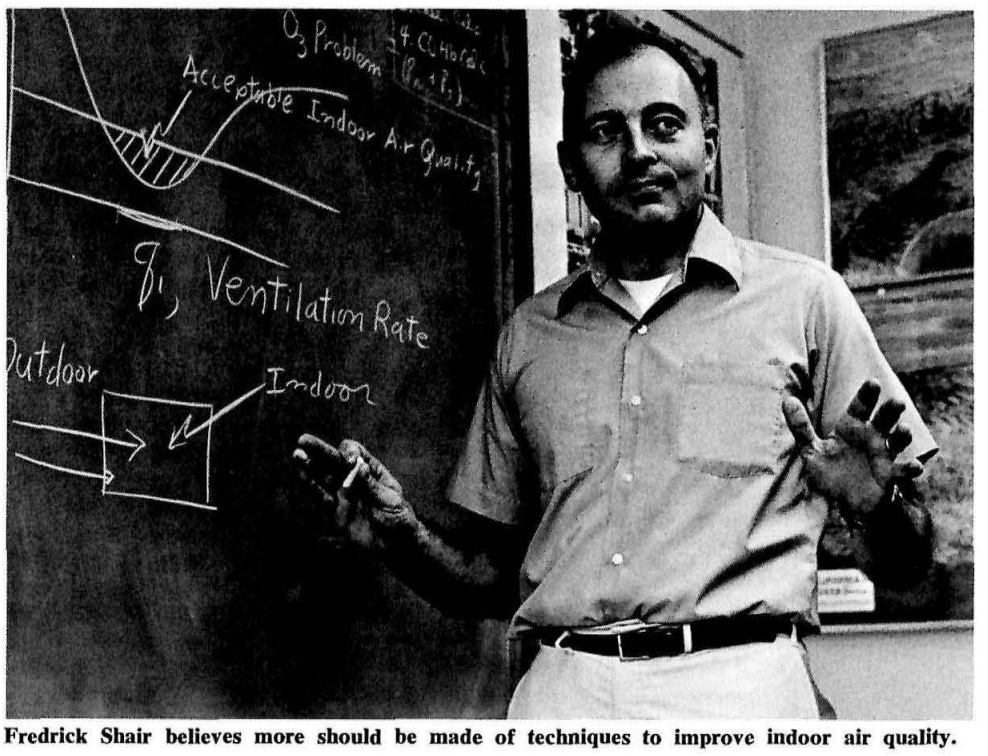
Superheavy cosmic rays are extremely rare, perhaps one such cosmic ray for every 1,000 million hydrogen cosmic rays observed. And there is one ultraheavy cosmic ray observed for every 5 million hydrogen cosmic rays detected. Using ordinary balloon experiments, scientists can detect one hydrogen cosmic ray every 5 seconds, but it would take them 300 years to detect one curium ray.

Stone said the large surface area of the instruments in the 1975-77 HEAO satellite experiment is designed to detect one superheavy cosmic ray each month. In the two years the satellite will orbit, scientists hope to detect about 25 superheavy and about 14,000 ultraheavy cosmic rays.

Stone believes that the data from the HEAO experiments may be enough to give new insight into how different kinds of atoms are produced inside stars, how long cosmic rays roam the galaxy before they disappear, and whether elements exist that are heavier than are now known (elements with more than 105 protons in the nucleus).

Patience is certainly a major requirement of cosmic ray research. The ultra-heavy and superheavy cosmic ray experiment, which Stone helped conceive in 1970, will be launched in 1975, will orbit until 1977, and the scientists hope to finish their calculations on the data collected by 1980—an experiment that spans 10 years.

But then, as Stone points out, man has been waiting a long time to uncover the secrets of cosmic rays.



Fredrick Shair believes more should be made of techniques to improve indoor air quality.

Alumni join glee club, under the direction of Olaf Frodsham, for traditional finale of Seminar Day home concert in Beckman Auditorium before club left for its first concert tour of Europe.

Alumni join glee club on Europe tour

Seminar Day 1972 ended traditionally with the glee club presenting its annual home concert in Beckman Auditorium.

This year the evening carried a special undercurrent of excitement. The excellent attendance enabled the glee club to meet the goal needed to finance their first concert tour to Europe.

Director Olaf Frodsham, who has brought the glee club to national prominence during his 19 years with the organization, described the European tour as the realization of a longtime dream and over two years of active work.

"All areas of the Institute," he said, "cooperated to make this one of the most exciting experiences these Tech men will ever have. Everybody who gave financial support—the Institute, the Alumni Association, the glee club support group, the Service League, and the members themselves—have made it possible for us to show another part of the world that the young American scientist can be versatile and proficient in choral music, and can communicate in many ways."

Among the 31 glee club members Frodsham will take to Europe this month are four alumni.

Reuben Moulton, BS'57, will re-live his undergraduate days as a glee club soloist in the 11 scheduled concerts. B. Kent Russell, BS'62, will be a member of the quartet, a place he has held since his undergraduate days. Oliver Seeley, BS'61, and Arnold Jones, BS'61, BS'62, MS'63, are also touring with the group.

The members chosen to make the trip paid a third of their own air fare. Harry Finklea, a chemistry graduate student, is tour director, and worked out itinerary and travel details with the Vienna-based Institute of European Studies.

After opening the tour in Vienna, the group heads for Yugoslavia where they are scheduled to visit Zagreb, Banjaluka, Sarajevo, Belgrade, Ohrid, Prizren, Zadar, and Pula. Their last concert on the three-week trip will be in Venice.

The glee club members will be the first such group to combine science with singing. They have been invited to give science talks before the Austrian Astronomical Society, and will hold discussions on American and European science education with groups of their European counterparts in various cities.

Frodsham and his young singing scientists agree that the trip will be an educational experience all of them will remember, and one that none of the students ever envisioned when they chose to attend Caltech.

Baseball called 'inefficient cartel'

"A wildly inefficient cartel." That's how economist Lance Davis described America's National Pastime on Alumni Seminar Day.

Davis, a long-time fan who has been analyzing and shaking his head over professional baseball's zany economic antics for several years, told alumni that a cartel differs from a monopoly in that it consists of an attempt by a group of firms, rather than just one firm, to maximize profits for all cartel members.

Davis plans to co-author a book on the economics of professional sports along with fellow Caltech Economist James Quirk.

"It's fun," he said, "from an economist's point of view, to study noncompetitive markets. Baseball's exemption from the Sherman Antitrust Act makes it one of the relatively few markets which is fundamentally noncompetitive and which keep records."

Davis raised the question: Given baseball's freedom from antitrust action, how efficient has its operation been? And how successful in maximizing profits for all members?

His answer: There's plenty of room for improvement.

"The cartel can point to areas of success," he admitted, "notably in holding players' salaries below levels which would have prevailed in competitive bargaining,

Lance Davis

relations with minor leagues, and to a lesser extent, handling broadcasting rights in a mutually profitable way."

But he said its areas of failure have been substantial. For example, it acted with almost unbelievable slowness in halting the bonus wars which cost the majors an estimated $12 million between the end of the Second World War and the middle 1960's.

Another and earlier decision not in the best interests of all cartel members was to let teams develop farm clubs. This decision meant that teams investing in scouting and farming—generally the richer teams—would excel, Davis pointed out.

"If every team had spent the same amount in a farm system, they would have ended up exactly where they started in terms of balance," Davis explained. "True, they would have had stronger teams, but they would simply have made baseball more expensive for themselves.

"Still another weakness has been the persistent tendency of owners to be seduced by visions of short-term profits, and to opt time and again for policies that sacrifice long-term growth for immediate rewards."

Citing other areas of inadequacy, Davis said the cartel made no effort to equalize player strength among teams until the early 1960's and little effort to equalize profits among teams. The result has been not only unprofitable franchises but noncompetitive teams.

"Enactment of a national television contract has been a move in the direction of more equality," he said, "but failure to give visiting teams a share of local broadcasting receipts left teams with small network areas at the mercy of those with large network areas. This may account for many of the franchise shifts that have occurred in the past two decades."

Davis believes the constant franchise shuffling of the past few years has reduced fan interest and produced immeasurable ill will on Capitol Hill among the same senators and representatives who enable baseball to retain its anti-trust exemption.

He said, "It is difficult to imagine, for example, what economic calculus could have produced the recent move of the Washington Senators to Arlington, Texas, particularly at a time when sensitive legislation affecting baseball was on the floor of the Congress."

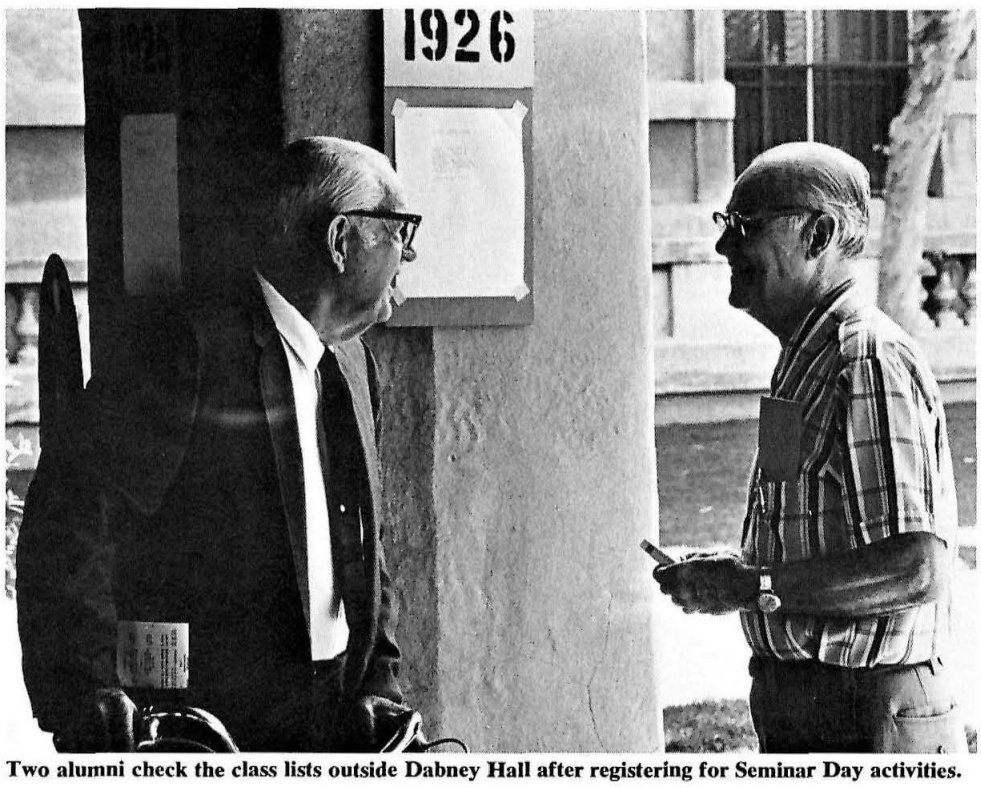
What can be done to help organized baseball?

Davis believes a total repeal of the antitrust exemption might—from the point of view of public and players—produce the most desirable results. He admits that such action could bring serious changes but he believes some of these would be for the better. For example, the two teams in New York probably would have to share their enormous market with new teams moving in.

But he pointed out, "Putting more franchises in big cities would reduce the economic power of teams already in those cities. It would bring their strength closer to the level of teams in smaller cities and thus have an equalizing effect."

He concluded, "Failing a total repeal of antitrust legislation, letting the present fractured and ineffective cartel continue to operate may be as much in the public interest as any other alternative."

Who's here this year?



Two alumni check the class lists outside Dabney Hall after registering for Seminar Day activities.

Roger Sperry named Scientist of the Year

The year 1972 has brought three important honors to Roger W. Sperry for his brain research. The Hixon Professor of Psychobiology was awarded $5,000 and the title of California Scientist of the Year by the California Museum of Science and Industry.

Sperry was honored for his work on the function of the brain's hemispheres, which has advanced understanding of the relationship between awareness and brain activity.

Sperry was also co-recipient of the National Paraplegia Foundation's first William Thomson Wakeman Research Award, which he shared with Dr. William F. Windle of Denison University in Ohio. The Caltech professor received $5,000 for his share of the honor. The award recognized his research into the factors responsible for functional regeneration in the central nervous system, and his development of concepts of chemical selectivity in nerve growth and connection.

Cambridge University added to the accolades by bestowing an honorary degree of Doctor of Science *honoris causa*, which Sperry journeyed to England to receive early in June.

Caltech names Athletes of the Year

Three outstanding athletes, Al Kleinsasser, '74, Randy Lewis, '72, and John Sheffield, '72, shared Caltech's "Athlete of the Year" award, based on their performance in conference competition.

Kleinsasser earned his share for his championship performance in the 880-yard run in the Southern California Intercollegiate Athletic Conference.

Lewis was the SCIAC wrestling champion in his weight class the past two years and placed third in the NAIA District III competition.

Sheffield, captain and high scorer of the water polo team, was chosen for both the all-SCIAC and all-NAIA teams.

The Vesper Trophy, given annually to the outstanding basketball player at Caltech, was presented to Jerome Feely, '73. Mark and Mike Sandhauer, '75, shared the Carl Shy Trophy as the best freshmen hoopsters.

Tom Hight, '72, earned the Campbell Trophy as the top swimmer and Max Kay, '73, was named the most improved swimmer.

Members of Caltech's 1972 varsity baseball team are: (from left, back row) manager Bob Cowan, Doug Schladweiler, Cliff Brown, John Stemple, John Ellis, Rick Mitchell, Tom Howell, Brian Luke, manager Gavin Claypool, and coach Ed Preisler; (from left, front row) managers John Denker and Janice Nicklas, Bob Pleva, captain Phil Gschwend, Steve Schnetzer, Walt Smanski, and manager Bob Doublin.

BASEBALL
Coach Ed Preisler

Tom Howell, a junior with a .367 batting average and a 4.0 grade-point average, received the 1972 Gene Waldron Memorial Award from the National Association of Intercollegiate Athletics (NAIA) at its baseball Hall of Fame banquet in Scottsdale, Arizona.

The Waldron Award is based on scholarship, citizenship, character, and athletic ability. As the 1972 recipient, Howell received a $300 scholarship to be applied to his school expenses in his senior year.

Howell and Phil Gschwend, another junior, were also named co-winners of the Caltech Alumni Trophy as the outstanding players on this year's baseball squad.

Despite a belated hitting spree by Walt Smanski and courageous pitching by team captain Gschwend, Caltech's horsehiders achieved only one victory in their 1972 campaign.

Smanski managed to bat well over .500 during his last seven games to raise his average to a respectable .271 in league play. The problem was that none of his teammates could get into scoring position to take advantage of Smanski's hot bat.

As expected, La Verne College won the SCIAC championship in a close race with Claremont-Mudd.

Caltech's lineup at season's end was:

Tom Howell, '73	CF	Mountain View, Calif.
Bob Pleva, '73	SS	Indianapolis, Ind.
Walt Smanski, '75	C, P	Chicago, Ill.
Doug Schladweiler, '75	1B	Sioux Falls, S. D.
Phil Gschwend, '73	P, C	Antioch, Calif.
John Ellis, '73	LF	Salem, N. H.
Rick Mitchell, '75	3B	Torrance, Calif.
Steve Schnetzer, '74	RF	Lawrenceburg, Ind.
John Stemple, '74	2B	Falls Church, Va.

TENNIS
Coach John Lamb

The 1972 Caltech Varsity Tennis Team had its best season record in several years, finishing with a 7-11 won-lost record. In the SCIAC Conference, we defeated Whittier twice and Occidental once, finishing sixth in conference standings. If we had been able to hold a five-two lead in the third set of our fourth singles match with La Verne, we would have won the match and finished one step higher.

Although we are losing two experienced men, the nucleus of an even better squad is returning, and we hope to get over a .500 average next year.

The league was dominated by Redlands, the National NAIA Champion; followed by Claremont-Mudd, Pomona, Occidental, La Verne, Caltech, and Whittier.

Our line-up in order of ladder position was:

Ken Pischel, '72; Santa Ynez, Calif.
David Dummit, '75; San Mateo, Calif.
Andrew Chow, '72; North Highlands, Calif.
Jeffrey Shellan, '75; Renton, Wis.
Mamoru Nakatsui, '75; Los Angeles, Calif.
Bruce Jacobsen, '74; Cupertino, Calif.
Bruce Eisenhart, '73; Wyckoff, N. J.
David Beatty, '75; Arcadia, Calif.

In doubles, Pischel and Chow played first; Dummit and Jacobsen, second; and Nakatsui and Eisenhart, third. When Dave Beatty pulled a muscle playing at Claremont-Mudd, we lost a strong fourth singles player on the way up, and had to rearrange our doubles line-up. Bruce Jacobsen hurt his shoulder skiing and started the season at about half speed. Thus we never played to our full potential.

The most exciting match of the season was our win over Occidental at home. We had lost on their courts eight-one, so were distinct underdogs. After splitting the singles three-three, we won second and third doubles to clinch the match.

Although Caltech's singles entries lost in the first round of the conference tournament, the doubles team of Pischel and Dummit won from La Verne's number one team and put up a good struggle before losing to Claremont-Mudd in the next round.

JV TENNIS

The JV Tennis Team played a limited schedule, finishing above Whittier in the conference. At season's end, the only school with junior varsity teams were Redlands, Claremont-Mudd, and Caltech.

The line-up in order of play at season's end was:

Eric Vella, '75; Honolulu, Ha.
John Allen, '75; Seaside, Calif.
Greg Zima, '74; Phoenix, Ariz.
Neil Risch, '72; Los Angeles, Calif.
Don Slankard, '75; Albuquerque, N. M.
Roland Lee, '75; Palos Verdes, Calif.

GOLF
Coach Hal Cassriel

The Caltech golf team started the season as one of the favorites to capture the conference championship with outstanding returnees Roger Goodspeed and Jim Simmons. These two seniors continued to play excellent golf throughout the season, but the team was able to post only 5 wins against 11 losses, as often they were unable to field a complete six-man team. They enjoyed victories over Whittier and La Verne in league play.

Jim Simmons, who comes from Scottsdale, Arizona, was the second low medalist in the 36-hole Conference Tournament at Red Hill Country Club with a 153 score, and third in the NAIA District III Championship with 148. Simmons and Captain Roger Goodspeed were selected as co-winners of the J. B. Earl Trophy for the "Outstanding Golfer" of 1972 (based on attitude, sportsmanship, and golfing ability). Roger, who was team captain for two years, was named to the All-Conference Team for the second time in his career at Caltech, and was also awarded the Jesse Clark Memorial Trophy by his conference competitors for his fine personality, good character, and golfing skill. This was the first time that a Caltech player has received the honor.

The starting line-up at the close of the season was:

1. Roger Goodspeed, '72; Santa Barbara, Calif.
2. Jim Simmons, '72; Scottsdale, Ariz.
3. Jeff Borders, '74; Solano Beach, Calif.
4. Phil Nygren, '75; Winnetka, Ill.
5. Joe Fahle, '75; San Diego, Calif.

With principally a lower classman line-up, the team did well and appears to have a bright future.

TRACK AND FIELD
Coach Bert LaBrucherie

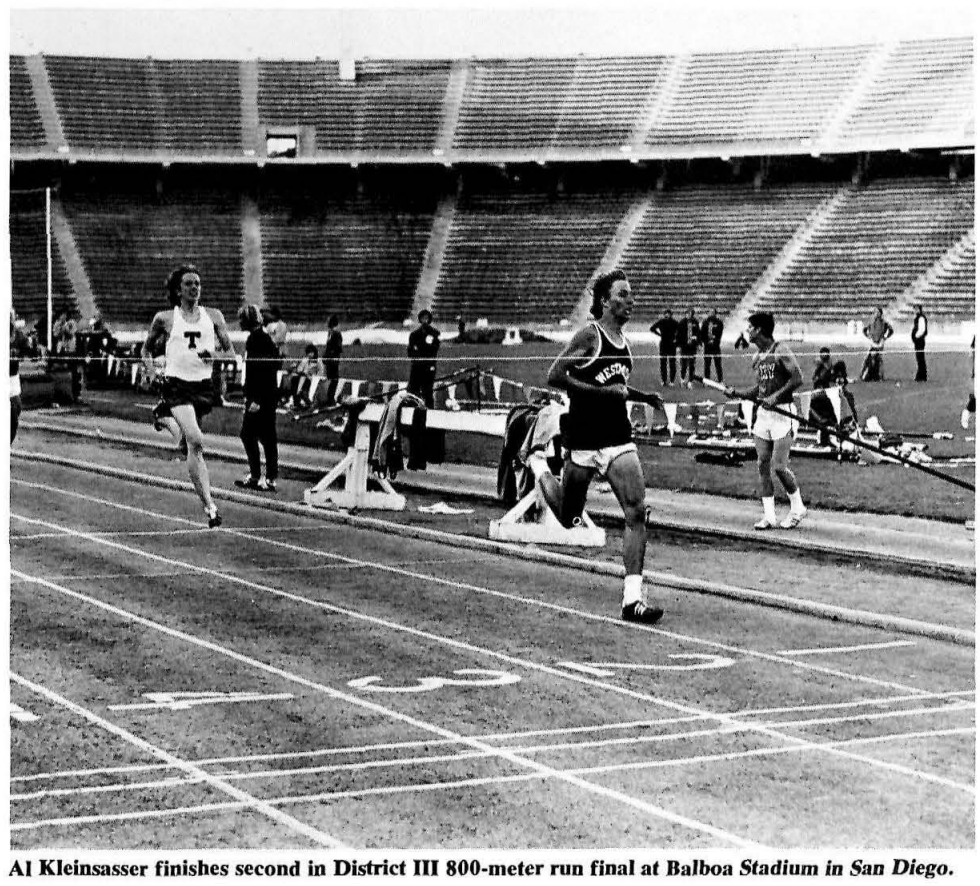
Caltech's track and field team was not overpowering in dual competition this season, winning only two of nine meets with other schools, but it did produce some promising individual performances.

Sophomore Al Kleinsasser, junior Charley Almquist, and senior Gary Stormo were chosen co-winners of the Goldsworthy Trophy as the outstanding Caltech athletes in track.

Kleinsasser climaxed an undefeated

Continued on page 12

Haywood Robinson (T) qualifies in this heat for 100-meter dash final in NAIA District III meet.



Al Kleinsasser finishes second in District III 800-meter run final at Balboa *Stadium in San Diego.*

PERSONALS

1945
DONALD C. TILLMAN, MS '47, has been appointed to the post of city engineer by the Los Angeles Board of Public Works. As chief engineer, he will head the bureau of engineering.

1947
EITAN GONEN, MS, is now president of Eidan Engineering Ltd., in Ramat Efal, Israel.

HARVEY J. LAWRENCE has been elected a director-at-large of the American Society for Quality Control.

1948
PAUL B. MacCREADY, JR., MS'48, PhD'52, formerly president, Meteorology Research, Inc., is now president of AeroVironment Inc., Pasadena.

1950
DANIEL MARKOFF, formerly associate engineer, Dept. of Water Resources, State of California, is now a senior engineer in the hydraulic design and planning division of the engineering department of San Luis Obispo County.

1952
JOHN D. BAUGHER, formerly with Rowan Industries in New Jersey, is now an engineer manager with Allis Chalmers in Wichita Falls, Texas.

1956
WILLIAM H. HILDEMANN, PhD, was appointed director of the Dental Research Institute at UCLA. Hildemann, who joined the UCLA faculty in 1957, last year was a visiting professor of immunology at the University of Otago, New Zealand, and a senior fellow of the Australian National Academy of Sciences.

1957
RICHARD O. HUNDLEY, MS '59, PhD '63, is now a research staff member at R & D Associates in Santa Monica. He was formerly with Rand Corporation.

1961
CHARLES J. SIEGEL, a major in the USAF, has been assigned to the 48th Tactical Fighter Wing Safety Office at Lakenheath, England. He completed the Aerospace Safety School at USC with honors.

1964
DONALD W. DAVIES is now a senior physicist with Andros, Inc., Berkeley.

MALCOLM C. MORRISON, PhD '69, is a chemical engineer with Chemical Systems, Inc., Santa Ana, California.

WILLIAM J. ROSENBERG, MS '66, formerly on the technical staff at Hughes Aircraft Co., is now an assistant professor at City College of New York.

1968
JOSEPH D. TITLOW, formerly an engineer with Standard Oil of California, is now self-employed and living in Tacoma, Washington.

1969
WU-SUN CHIA, PhD, formerly with Aerojet-General Corp., is now a senior engineering specialist with the Envirogenics Company, El Monte, California.

AUGUST L. SCHULTZ, MS '70, earned his silver pilot wings upon graduation from the air force flight school at Laredo AFB, Texas. After further training, he will be an F-4 pilot with the Tactical Air Command, Luke AFB, Arizona.

Obituaries

1923
GEORGE C. KUFFEL, in December, 1971. Associated with Shell Oil Company for many years, he was retired and living in Long Beach.

1928
LARS THOMASSEN, PhD, on March 11. He had been associated with the University of Michigan from 1929 until his retirement from an active appointment in 1966. He pioneered in early x-ray defraction work with particular emphasis on analysis and structures. He received the university's distinguished faculty service award in 1958.

Kleinsasser reaches NAIA semis

Continued from page 11
season in 880-yard dual meet competition by winning the SCIAC 880 championship in the excellent time of 1:53.2.

After finishing second in the 800-meter run at the NAIA District III meet in San Diego, Kleinsasser competed in the national meet at Billings, Montana. He advanced to the NAIA semifinals before placing fifth.

Although he did not quite match the 1:52.4 school record he set in the 880 last year, Kleinsasser established a new mark of 4:19.4 in the mile, eclipsing the 4:22 time of Pete Gross, '67. He also competed in the mile relay and helped the Caltech cause in the SCIAC meet with a fine 44.2 anchor lap.

Almquist was also undefeated in dual meets in the 440-yard intermediate hurdles. He broke the school record held by Pete Wyatt with a 54.9 performance, took third in the all-conference meet, and finished fifth in the NAIA district competition. He also competed in the 440-yard dash, the 440 relay, and the mile relay.

Stormo was an all-around performer who competed in the 100, 220, and 440-yard sprints, the mile relay, the long jump, triple jump, and high jump. He has been the high-point man, or close to it, in most of the dual meets he has entered in the past four years. He was fifth in the long jump and triple jump in the SCIAC meet and ran on both the mile relay and 440 relay teams for Caltech.

Sophomore Haywood Robinson blossomed into a 9.8 sprinter in the SCIAC meet, garnering a third place in the 100-yard dash. Robinson had been running between 10 flat and 10.2 all season. In the NAIA district meet he qualified for the finals of the 100 in a classy field and finished in seventh place. He also competed this year in the 220 dash and 440 relay.

Greg Griffin, a freshman distance runner, improved tremendously during the season. He lowered his mile time from the 4:40's to 4:31.3 and set freshman standards in the two-mile (9:42.0) and the three-mile run (15:08.9).

Another first-year man, Greg Hoit, set a freshman record of 56.4 in the 440-yard dash. He also developed into a hurdler who reached the conference finals in the 440 intermediate hurdles and competed in the NAIA district meet.

Caltech's mile relay team deserves recognition for its remarkable improvement in the last four weeks of the season. The team of Almquist, Stormo, Kleinsasser, and Jeff Hurn improved almost 10 seconds from 3:32.5 to 3.22.8. After finishing a surprising fourth in the conference meet, the foursome qualified for the finals in the NAIA district meet, only to fall one place short of scoring.

Assistant coach Rick Sloan, former UCLA star and 1968 Olympic decathlon competitor, helped to improve the performances of Caltech athletes in the field events and hurdles with his excellent coaching.

Personnel with the best marks, by event, included:

100—Robinson, 9.8; Hurn, 10.3; Stormo, 10.3.
220—Robinson, 22.6; Hurn, 23.1.
440—Almquist, 50.7; Hoit, 52.8; Stormo, 52.8.
880—Kleinsasser, 1:52.4; Tom Hermen, 2:07.9.
Mile—Kleinsasser, 4:19.4; Griffin, 4:31.3.
2 Miles—Griffin, 9:42.0; Ratchford Higgins, 10:00.9.
3 Miles—Griffin, 15:08.9.
120 High Hurdles—Almquist, 15.6; Dave Evans, 16.9.
440 Intermediate Hurdles—Almquist, 54.9; Hoit, 56.4.
440 Relay—Stormo, Hurn, Robinson, Almquist, 43.0.
Mile Relay—Almquist, Hurn, Stormo, Kleinsasser, 3:22.8.
Shot put—Monte Ragland, 41'1½"; Doug Herbert, 40'7".
Discus throw—Ragland, 126'1"; Herbert, 125'7".
Javelin throw—Charley Thoele, 174'3½",
Bob Miller, 166'10½".
High jump—Stormo, 6'½".
Long jump—Stormo, 22'1¾"; Bob Ellgas, 20'7¼".
Triple jump—Stormo, 43'3"; Ellgas, 40'9".
Pole Vault—Junro Hiramatsu, 9'6".

Charley Almquist, Caltech's record-holder in the 440-yard intermediate hurdles, is shown on way to fifth-place finish in NAIA District III meet.

ALUMNI ASSOCIATION OFFICERS AND DIRECTORS

PRESIDENT Reuben B. Moulton '57
SECRETARY Raymond L. Heacock '52
VICE PRESIDENT Arthur O. Spaulding '49
TREASURER George E. Solomon '50

Clifford C. Burton '40
Stuart M. Butler '48
Spicer V. Conant '64
William A. Freed '50
Earl C. Hefner '51
William C. House '40
Douglas Josephson '65
Wayne MacRostie '42
Wayne T. McMurray '45
Mike O'Haver '29
Cornelius J. Pings '51
Warren G. Schlinger '44
Stanley T. Wolfberg '38

Secretary Emeritus: Donald S. Clark '29
Treasurer Emeritus: John R. Fee '51

EXECUTIVE DIRECTOR James B. Black

ALUMNI CHAPTER OFFICERS

BOSTON CHAPTER
President Duane Marshall '53, 9 Hadley Road, Lexington, Mass. 02173

CHICAGO CHAPTER
President Howard E. Jessen '46, 225 Ridge Ave., Winnetka, Ill. 60093

NEW YORK CHAPTER
President Rodman Jenkins '50, 400 East 57th Street, New York, New York 10022
Vice President Kaytaro G. Sugahara '61, 111 Cobb Lane, Tarrytown, New York 10591
Secretary-Treasurer Harry J. Moore Jr. '48, IBM Corp., Route 22, Armonk, New York 10504

SACRAMENTO CHAPTER
President William D. Pyle '49, 3920 Dunster Way, Sacramento, Calif. 95825
Vice President Dudley E. Bennett '47, 4124 Zephyr Way, Sacramento, Calif. 95821
Secretary-Treasurer Harris K. Mauzy '30, 2551 Carson Way, Sacramento, Calif. 95821
Meetings: University Club, 1319 "K" St. Luncheon first Friday of each month at noon. Visiting alumni cordially invited—no reservation.

SAN DIEGO CHAPTER
President David B. Wilford '48, 6581 Avenida Wilfredo, La Jolla, Calif. 92037

SAN FRANCISCO CHAPTER
President Charles E. Auerbach '47, 82 Lagoon Rd., Belvedere, Calif. 94920
Vice President Thomas M. Menzies '65, 801 Cotton, Menlo Park, Calif. 94025
Secretary-Treasurer Robert T. Jenkins '65, 1191 Yorkshire Ct., Cupertino, Calif. 95014
Meetings: Engineers' Club, 16th floor, Hong Kong Bank Bldg., San Francisco. Informal luncheons every Thursday at 11:45 A.M. Contact Mr. Sigworth, 894-2918, on Thursday morning for reservations.

SAN JOAQUIN-MOJAVE CHAPTER
President Bruce Robinson Jr. '50, 3219 Christmas Tree Lane, Bakersfield, Calif. 93306
Secretary-Treasurer William F. Edmondson '52, 1831 Truxton, Bakersfield, Calif. 93306

WASHINGTON, D.C., CHAPTER
President Bernard B. Watson '35, Research Analysis Corporation, McLean, Va. 22101
Vice President John T. Cookson Jr. '66, 1225 Noyes Drive, Silver Spring, Md. 20910
Secretary-Treasurer Edwin C. James '71, 6111 Temple St., Bethesda, Md. 20034

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 of opportunities although I am not contemplating a change.

Name .....

Degree(s) ..... Year(s) .....

Address .....

.....