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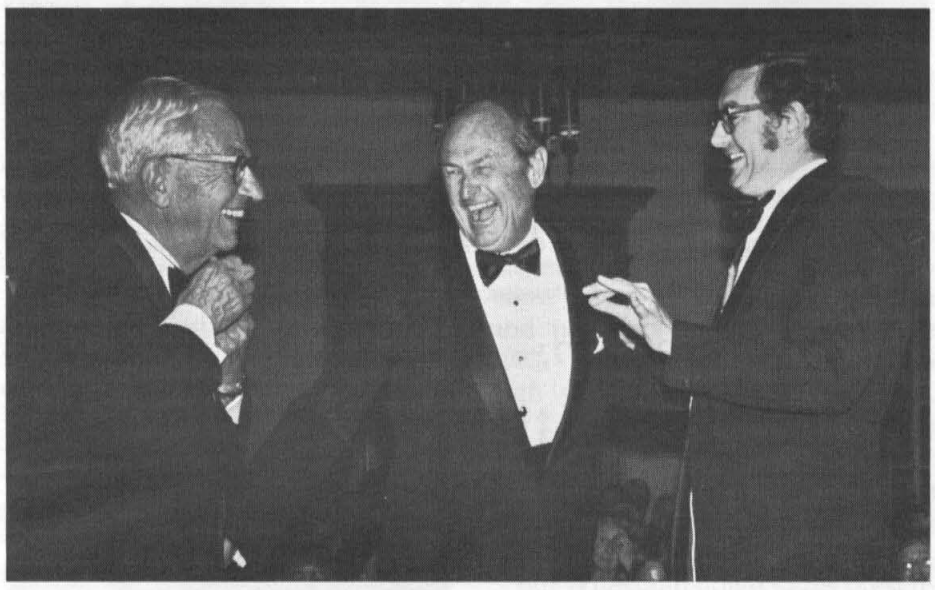
CALTECH NEWS

PUBLISHED FOR ALUMNI AND FRIENDS OF THE CALIFORNIA INSTITUTE OF TECHNOLOGY

Associates' 50th anniversary



The Associates of Caltech celebrated a 50th birthday in May. To commemorate the occasion, some 375 members and their guests met for a festive black-tie dinner in the Athenaeum. After dinner, they enjoyed a light, memory-filled dialogue between two men who have shared more than a little of the Institute's history: President Emeritus Lee A. DuBridge, left, and Harry B. Gray, William R. Kenan, Jr. Professor of Chemistry, right. Here DuBridge and Gray are joined by Howard Smits, center, president of The Associates. Additional coverage is presented on pages 4 and 5.

Norman Brooks named first Irvine Professor

Norman H. Brooks, PhD '54, distinguished for his work in environmental engineering, has been named the first James Irvine Professor of Environmental Engineering Science at Caltech. The professorship is made possible by a grant from the James Irvine Foundation.

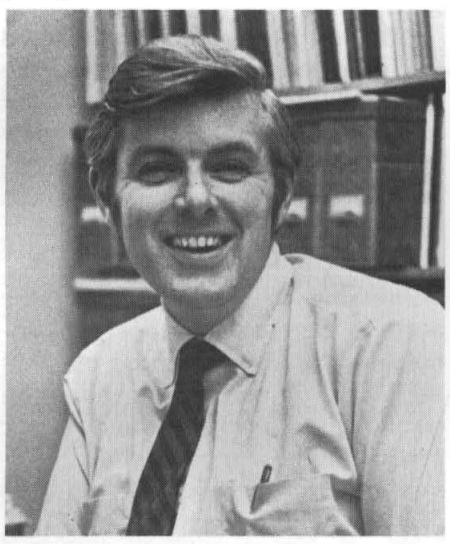
Director of Caltech's Environmental Quality Laboratory, Brooks is internationally known for his work in water pollution control, and research in sediment transport, stratified flow, and hydrology.

In the course of his 22 years on Caltech's faculty, Brooks has developed many of the concepts now widely used throughout the world for designing outfall systems for the dispersion of wastewater and cooling water into the ocean. He has served as a technical consultant on the hydraulic design of submarine outfalls for sewage disposal for numerous agencies.

Born in Worcester, Massachusetts, Brooks graduated magna cum laude from Harvard College in mathematics, and obtained his doctorate, summa cum laude, from Caltech in civil engineering and physics. He has won many awards in his field and is a member of the National Academy of Engineering.

President Harold Brown said that the Irvine Professorship will give great impetus to Caltech's outstanding program in environmental engineering science. Although it is administered by the Division of Engineering and Applied Science, the program also draws on the expertise of several other Caltech divisions. It is designed to help understand and solve problems related to the preservation and control of the environment and to train specialists in this growing field.

The James Irvine Foundation provides financial assistance to charitable causes and private educational institutions in California. It operates on the premise that the nature of American life depends upon institutions, such as foundations, that support private initiative.



Norman H. Brooks

"at the Leading Edge . . ."

Caltech passes half-way mark in 5-year campaign

The Institute is more than half way toward its $130 million goal as its five-year development campaign, "Caltech at the Leading Edge . . ." nears its halfway point, President Harold Brown announced.

Brown said that on June 1, the Institute had received $68,300,000 in gifts and pledges in the campaign that was launched in January 1974. These gifts included $30,928,000 in funds for current operating expenses; $19,762,000 in endowment funds, $10,657,000 for new buildings, and $6,953,000 in income trusts and annuities. The latter gifts create an income for the remainder of donors' lives.

The campaign goals in these categories are: $40 million in current funds, $50 million in endowment funds, $27 million for new buildings, and $13 million in income trusts and annuities.

Brown said the Institute is pleased with progress toward achievement of its $130 million goal, particularly in the areas of current funds. But he stressed that much hard work must be done in order to reach the goal in all categories during the next two and a half years.

He said special emphasis during this period will be placed on obtaining funds for endowment. "Endowment is the strength of any great university," he said. "Invested endowment brings a dependable return every year and, by the growth of its principal, it provides a solid foundation. This foundation makes it possible for a university to explore, to plan ahead, and to maintain its intellectual freedom."

He observed that an endowment gift is unique because it enables a donor to fund a specific activity for an unlimited period of time.

"In particular, Caltech has a need for more endowed professorships. We have 21 endowed or fully funded chairs," he said. "It is our goal to endow at least 20 more. We have one of the most distinguished faculties in the world, including many who are deserving of an endowed professorship."

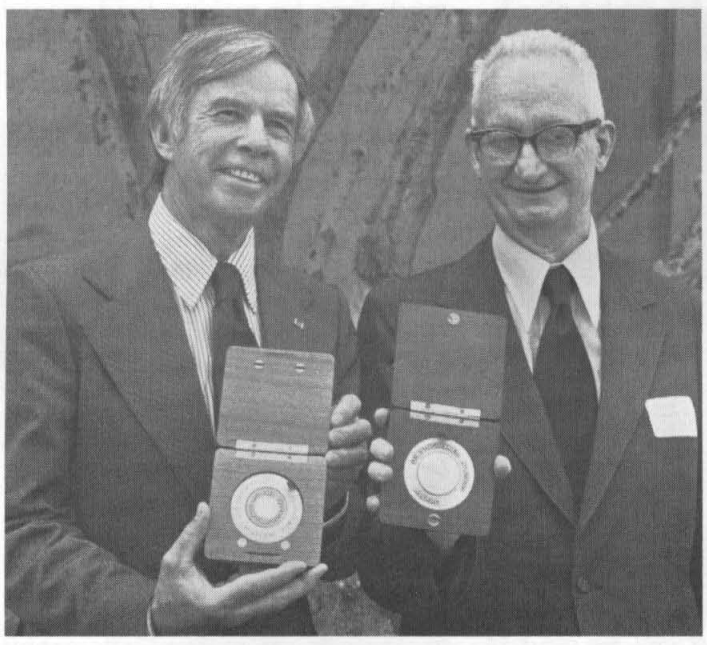
In this context, Brown pointed out that 49 members of the Caltech faculty are members of the National Academy of Sciences — a larger percentage than for any other institution in the nation.

Brown said an equally important priority during the remainder of the campaign will be that of obtaining funds for new buildings. Academic buildings to be constructed with campaign funds include an astrophysics building to cost $5 million, an engineering and applied physics building to cost $5 million, and a cell biology and chemistry building to cost $12 million and to house work related to medical science.

"Caltech has extraordinary competence in all of these disciplines," Brown said. "We want to expand our present efforts by bringing our research people in these fields together and providing them with increased working space. These new facilities will increase our ability to make significant contributions and to play a leadership role in research in these important areas.

"We believe deeply in the importance of our objectives in this campaign and of the rewards to society through their achievement," Brown concluded. "As we move into the second half of the campaign, we're confident of our ability to meet our goals through the hard work and dedication of all the campaign participants."

Distinguished Alumni awardees



A record number of alumni and their guests (1,571) returned to the Caltech campus on May 15 for the 39th annual Alumni Seminar Day. As a feature of the general session, President Harold Brown presented the highest honor that Caltech can confer on its graduates – the Distinguished Alumni Award – to four alumni. Above left: Displaying their awards are Victor V. Veysey, BS '36, assistant secretary of the Army, and L. James Rainwater, BS '39, Professor of physics, Columbia University. Above right: President Brown presents an award to Harold A. Rosen, MS '48, PhD '51, vice president of engineering for Hughes Aircraft Company's space and telecommunications group. Howard M. Temin, PhD '60, professor of oncology, the University of Wisconsin, was not able to receive his award in person. Alumni Seminar Day activities are reviewed in detail on pages 2, 6, and 7.

Four distinguished alumni honored on Seminar Day

The excellent private research institution faces greater pressures today than ever before, President Harold Brown told alumni on Seminar Day. "The need for new technologies to meet the problems of society, and for knowledge about human behavior and the universe, has never been more intense," he said.

"At the same time, we are faced with increasing competition for financial resources and with egalitarian pressures that seek equality in results. These pressures for equality are destructive to the climate that is necessary if first-rate science and technology are to advance.

"We must work within these conditions and let Caltech continue to evolve during a period of limited growth. Can this evolution take place? I believe it can, but the pressures upon us are very strong. Without good management, the financial constraints upon us would put us out of business in a short time. But we must not concentrate our attention exclusively on financial expenditures, for if we do so, then we face a slow but fatal decline."

Brown noted that this year the Institute has added 13 professors to its faculty, more than the number who retired. "By continuing to balance retiring faculty with new faculty, we are able to bring a consistent influx of new intellect to the campus — and this is essential if we are to avoid intellectual atrophy," he said.

"We must continue to be selective in choosing our fields of research and our faculty members and students," Brown said in conclusion. "We must meet the challenges that face us and we must continue to stay small and preeminent. If we are able to do so, then we will not only survive but we will flourish."

During the general session, Brown presented Distinguished Alumni Awards — the highest honor that Caltech can confer on its graduates — to one engineer and three scientists. Two of the scientists were Nobel Prize winners in 1975.

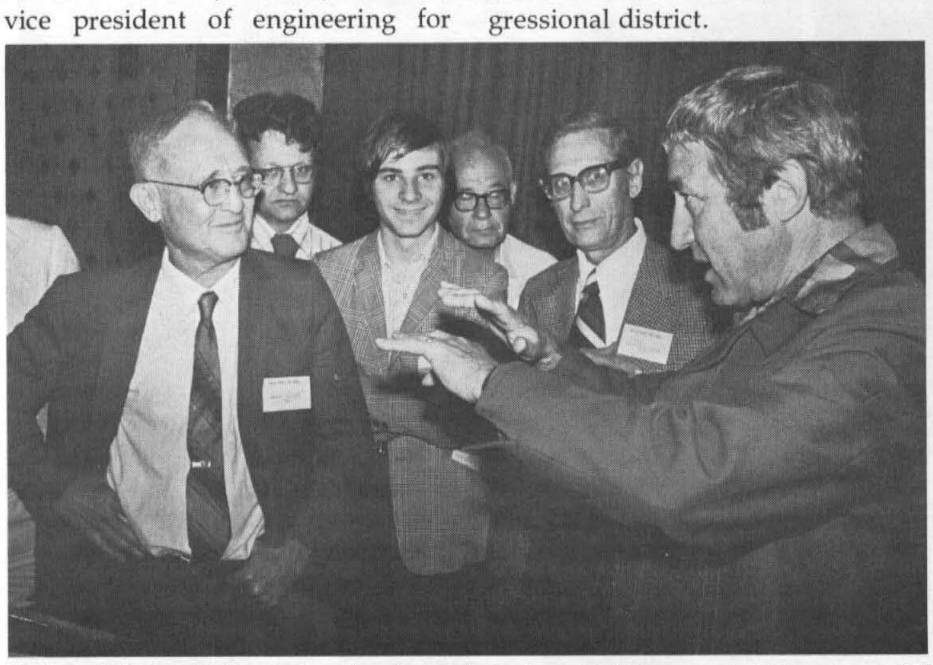
Those honored were L. James Rainwater, BS '39, professor of physics, Columbia University; Harold A. Rosen, MS '48, PhD '51, vice president of engineering for Hughes Aircraft Company's space and communications group; Howard M. Temin, PhD '60, professor of oncology, the University of Wisconsin; and Victor V. Veysey, BS '36, assistant secretary of the Army.

Rainwater, a former director of the Nevis Cyclotron Labs, shared the 1975 Nobel Prize in physics for his research on the inner structure of the atom. He helped to show that the components of the atomic nucleus spin and vibrate so as to distort the nucleus into an ellipsoid instead of a sphere — an insight important to the advance of particle physics.

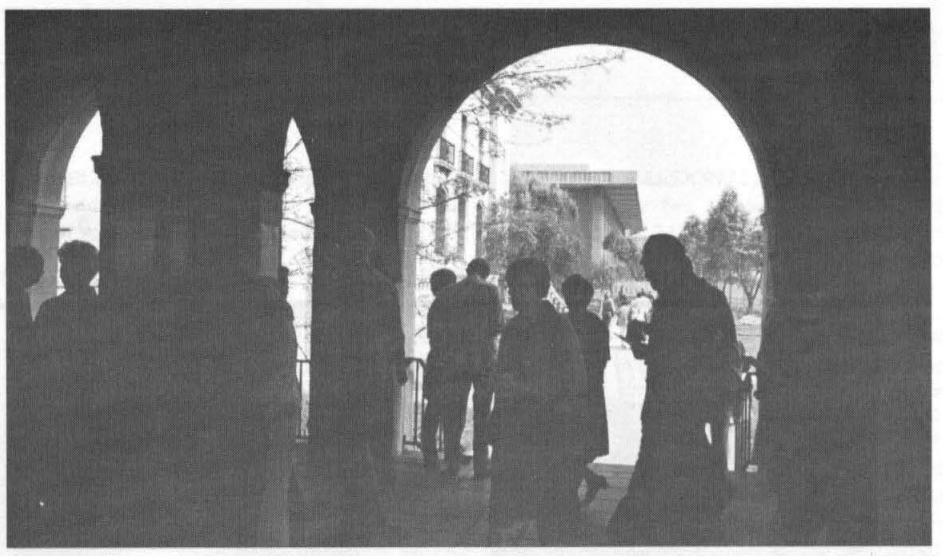
Rosen, the developer of Syncom, the world's first synchronous communications satellite, earned worldwide recognition for proving the effectiveness of the synchronous-orbit concept. The engineer has directed the development of communications satellites in the international and domestic fields, and he has been involved in developing a variety of earth terminals for rebroadcasting television programs and for direct reception of instructional television by schools. He is recipient of the 1976 L. M. Ericsson Prize for significant contributions within telecommunications research or engineering.

Temin was one of three scientists who won the Nobel Prize in 1975 for increasing our understanding of the replication system of viruses. Temin helped to determine that RNA can pass information to DNA — an insight that was contrary to the central doctrine at the time of this discovery. Independently, he has done research into possible links between viruses and cancer. Temin received the Albert Lasker Award in Basic Medical Research and is a member of the National Academy of Sciences Editorial Board.

Veysey, assistant secretary of the Army for civil works, is responsible for the Army Corps of Engineers' civil works program for development of water resources, for the Army's environmental policies and programs, and for policy on guidance to the Panama Canal Zone government. He was state assemblyman in California for eight years and a congressman for four years as a representative of California's 38th congressional district.



Harrison S. Brown, professor of geochemistry and of science and government, right, was one of 12 faculty members who described his research on Alumni Seminar Day. At noon, guests ate picnic-style lunches to the background music of the Caltech Dixieland Band – composed primarily of faculty members. There was a special session for sons and daughters of alumni who are interested in attending Caltech, with campus tours and information on admissions requirements and student life. The alumni concluded a busy and stimulating day with dinner in the Athenaeum and a chance to hear the Caltech Glee Club in concert.



From proteins to planets and from gems to genetic engineering – Alumni Seminar Day guests heard 12 faculty members describe their most recent research. Among the guests was Robert W. Flory, BS '18, age 81. Flory maintained his perfect record; he has attended all 39 Seminar Days. On the roof of Thomas Laboratory, the alumni viewed Caltech's geotechnical centrifuge, used to test models of earth dams for their capacity to resist earthquakes, as well as for other purposes. A pictorial display described the centrifuge's historic development. Above: Alumni mingle between sessions.

At general session:

Seamans outlines strategies for meeting energy needs

It is the federal government's responsibility to assist the private sector in developing and marketing new energy technologies, but it is the private sector that will bear the primary responsibility for bringing new energy technologies into use, Robert C. Seamans, Jr., administrator, U.S. Energy Research and Development Administration, told alumni in his address at the Alumni Seminar Day general session.

"ERDA acts as a catalyst and accelerates the research, development, and demonstration phases of technology so that the payoff work can be absorbed into the private sector," he said.

"The private sector is motivated and prepared to take the risks," he noted. "It has the inherent flexibility to act, the preponderant share of new investment funds, and the managerial talent for carrying out the research and development and for introducing the technology into the market."

Stressing the seriousness of the need to develop new energy technologies, Seamans pointed out that the U.S. is 75 percent dependent on oil and gas for energy. "But domestic production is dropping while necessary imported supplies are costing us dearly," he said. "At the same time, both domestic and foreign supplies are estimated to run out in the early decades of the next century — only 30-40 years away. This does not leave much time for making fundamental changes in the production and utilization of energy throughout our economy.

"To correct this situation, the president has proposed a comprehensive program to move this nation toward energy independence. One of its fundamental conclusions is that no single or limited mix of energy technologies can provide our nation with the flexibility required to meet our growing needs."

Both coal and nuclear energy will be of enormous importance in our energy future, he stressed, particularly in the next few decades. He pointed out that coal accounts for 70 percent of our total estimated recoverable fossil fuel resources but currently provides less than 19 percent of our annual energy consumption. And he said that by the end of the century, nuclear energy will be able to handle more than 20 percent of the nation's energy requirements, or 10 times its present contribution.

"In the future we foresee solar-electric power systems, and fusion breeder reactors coming on the line but we do not feel they can make significant contributions before the year 2000," he said. "These energy resources, if successfully commercialized, could provide us with essentially inexhaustible supplies of energy, virtually forever."

Other sources of energy that can help to fill our needs, especially in the next few decades — and where ERDA has been giving unified leadership and direction — are solar and geothermal energy, he said. In this context he described SAGE, the JPL-Southern California Gas Company project to fit buildings with solar water heaters backed up by gas systems, and geothermal projects in California's Imperial Valley.

Allen and three other alumni elected to NAS

Clarence R. Allen, MS '51, PhD '54, professor of geology and geophysics at Caltech, and three other Caltech alumni have been elected to membership in the National Academy of Sciences in recognition of their distinguished and continuing achievements in original research. Allen was also elected this year to membership in the National Academy of Engineering.

Election to membership in the NAS is considered to be one of the highest honors that can be accorded to an American scientist or engineer. Forty-nine members of the Caltech faculty belong to the National Academy of Sciences — a higher percentage than for any other institution.

Other Caltech alumni named to membership were Julian D. Cole, MS '46, Eng '46, PhD '49, professor and chairman, the department of engineering, applied science, mechanics, and structure, UCLA; Gary Felsenfeld, PhD '55, chief, physical chemistry section, laboratory of molecular biology, National Institutes of Health; and David S. Hogness, BS '49, PhD '53, professor, department of biochemistry, Stanford University School of Medicine.

Whitcomb predicts:

Major quake may occur in the area within a year

An earthquake with a magnitude between 5.5 and 6.5 may occur within a year somewhere in an area of southern California that extends from Santa Monica Bay north to the western Antelope Valley and from the town of Fillmore east almost to Mt. Baldy. This prediction was made by James Whitcomb, geophysicist at Caltech, based on data from a method being developed to predict earthquakes.

Whitcomb reported on the data in a paper he read before the annual meeting of the American Geophysical Union in Washington, D.C. He

James Whitcomb discusses his earthquake prediction at a press conference.

emphasized that the theory on which his prediction was made, the "velocity-bay theory," is still being refined and that "the uncertainty as to the magnitude, location, and time prevents the test from being of great use to the public."

The velocity-bay method of prediction is based on a study, within a specific area, of certain seismic waves called P waves. A slowing down of these waves suggests that a phenomenon called dilatancy is occurring, in which microscopic cracks develop in rocks due to increased seismic pressure.

According to the theory, rocks along an active fault zone become strained as the land masses on either side slowly move in opposite directions. This kind of strain is happening along the San Andreas fault, as the land to the west of the fault moves northwest in relation to the land to the east of it.

Eventually the tiny cracks created by the seismic strain may either close again or fill with water. Then the P waves move once more at their normal speed. The theory holds that this return to normal signals the approach of an earthquake. The longer the waves were slowed, the more intense the quake is likely to be.

On the basis of this theory, in December 1973 Whitcomb predicted an earthquake in the Yucaipa, California, area, with a magnitude of at least 5.5, within three months. The magnitude of the quake that occurred, several weeks later, was 4.1 — less than the evidence suggested. "This makes it clear that the theory requires modification and that additional studies are needed," Whitcomb said.

Don Anderson, director of Caltech's seismological laboratory, noted that the magnitude assessment "is based on limited previous experiences.

"Southern Californians should be reminded that the size of the quake anticipated by Whitcomb isn't unusual for the southwestern United States and northern Mexico," he said. "About 90 earthquakes with magnitudes greater than 5.5 have taken place in southern California and northern Baja California since 1933. There have been 29 quakes with magnitudes greater than 6.0. On the average, earthquakes — with magnitudes in the range of the one being predicted — occur more than twice a year in southern California and northern Mexico."

But Whitcomb noted in his presentation to the American Geophysical Union that only one non-aftershock earthquake with a magnitude greater than 5.5 has occurred within the test area since 1932. "The next few years will be hard ones for both earthquake researchers and the public," he said, "because earthquake prediction will involve several false alarms along with the successes. But because of the social importance of this research, the public must be kept fully informed of our progress."

Three faculty members given Guggenheims

Three Caltech faculty members have received fellowship awards from the John Simon Guggenheim Memorial Foundation on the basis of demonstrated accomplishment and strong future promise.

The recipients are Jesse L. Beauchamp, professor of chemistry, for experimental studies in physical chemistry; Aron Kuppermann, professor of chemical physics, for experimental and theoretical studies in chemical dynamics; and L. Gary Leal, associate professor of chemical engineering, for theoretical studies in fluid dynamics and transport phenomena.

Swimming and tennis programs open to alumni

Caltech alumni and their families are invited to participate in the summer recreation program at Caltech, June 21 through September 12. The program includes use of the pool and classes in swimming and tennis for both children and adults.

Alumni who have not received information through the mail about the recreation program can pick it up at the Caltech Athletic Department office from 8 a.m. to 5 p.m., Monday-Friday. Registration for classes will begin on June 21 at 9 a.m. for previous participants and June 22 for families new to the program. Classes will begin Wednesday, June 23.

Glee Club concert

A concert by the Caltech Glee Club, including a production of the Alec Wilder-Arnold Sundgaart folk opera, "The Lowland Sea," (shown above), concluded this year's Alumni Seminar Day activities. The men's section, directed by Olaf Frodsham, and the women's section, directed by Monica Roegler, joined in a program of sacred, contemporary, and folk music of America. Adding their talents to the evening's performance were the Chamber Singers, including members of both men's and women's Glee Club sections; the Apollo Singers, a men's group directed by R. Kent Russell; and the Varsity Quartet, specializing in barber shop harmony.

Two faculty, four alumni among new NAE members

Two Caltech faculty members, one of them an alumnus, and four other Caltech alumni have been elected to membership in the National Academy of Engineering.

The faculty members are Clarence R. Allen, MS '51, PhD '54, professor of geology and geophysics; and Amnon Yariv, professor of electrical engineering and applied physics.

Allen was honored for his work in evaluating seismicity and fault movements — contributions that have led to sound engineering practices and codes in earthquake-prone regions. Yariv was elected for his contributions to the invention, analysis, and development of devices for integrated optics and optical communications.

Other alumni elected were Julian D. Cole, MS '46, Eng '46, PhD '49, professor and chairman of the department of mathematics, UCLA, for contributions to education, literature of engineering and applied science, and creative application of mathematics to fluid mechanics; and Fernando J. Corbato, BS '50, professor of electrical engineering, MIT.

Gordon E. Moore, PhD '54, president and chief executive officer, the INTEL Corporation, for contributions to semiconductor devices from transistors to microprocessors; and Reinhardt Schuhmann, Jr., Ex '33, Ross Professor of Engineering, School of Material Science and Metallurgical Engineering, Purdue University, for contributions to the science of extractive metallurgy and applications to process analysis and design.

Election to the National Academy of Engineering is considered the highest professional distinction that can be conferred upon an American engineer. Membership honors those who have made important contributions to engineering theory and practice or who have demonstrated unusual accomplishments in the pioneering of new and developing fields of technology. There are 23 Caltech trustees, faculty, administrators, or JPL staff persons who are members of the NAE, in addition to 57 alumni who have been elected.

James Olds shares Kittay Foundation research prize

James Olds, Bing Professor of Behavioral Biology at Caltech, and Hans Selye, internationally known authority on stress, share the third annual $25,000 prize offered by the Kittay Scientific Foundation for outstanding work in their fields.

Olds has made major contributions toward understanding how the brain functions. Some of his contributions include an expansion of our knowledge of the brain's memory centers, and the location of the pleasure centers of the brain.

His current research concerns the mechanisms of reward and learning. Olds has developed precise techniques for monitoring various parts tech's seismological laboratory, probes, using small animals whose brains are structurally and neurophysiologically similar to those of humans.

In these studies, he is tracking nerve pathways from taste receptors to brain centers involved in controlling feeding behavior. He also is tracing connections from food "regulatory centers" to mechanisms that help to control purposeful behavior.

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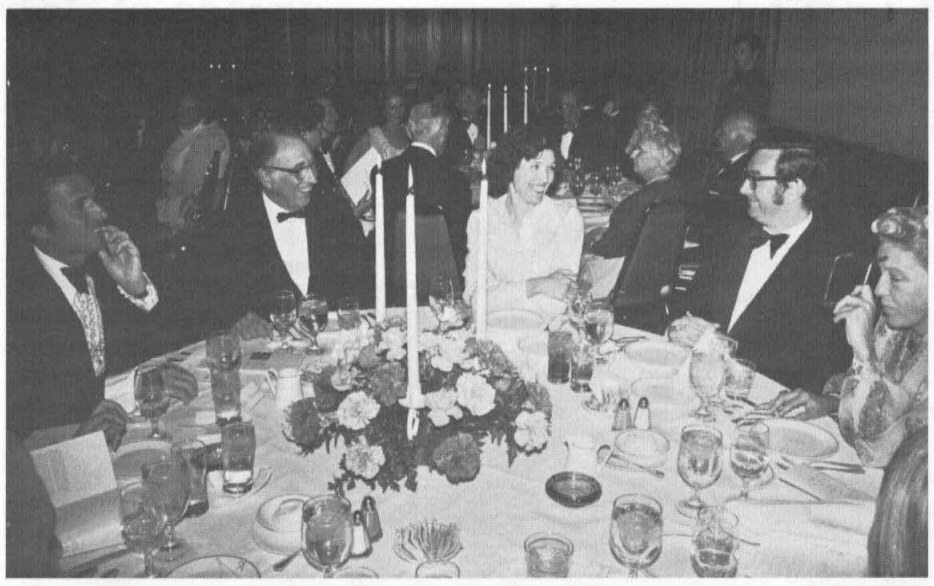
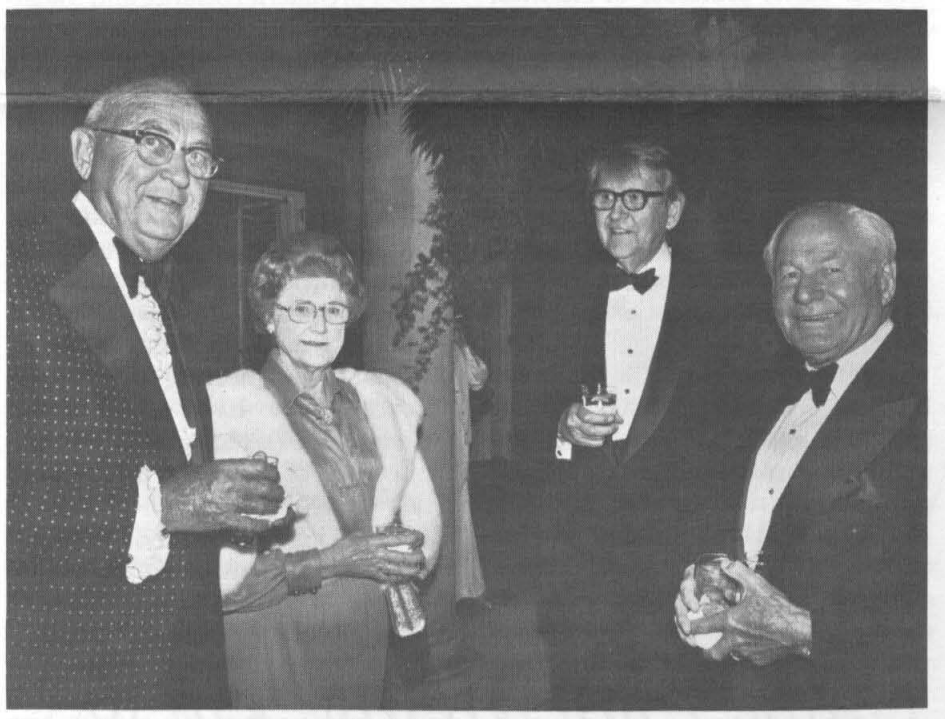
The Associates celebrate their fiftieth anniversary



Among those attending the Associates' 50th anniversary dinner: left to right – Joseph Wambaugh, Richard Webb, Mrs. Harry B. Gray, Harry B. Gray, and Mrs. George Jagels.

Mr. and Mrs. Clifford Burton, Mrs. Roland R. Smoot.



Mr. and Mrs. Stuart L. Seymour, Frederick C. Lindvall, Louis E. Nohl.

Mrs. Vernon Barrett, Mr. and Mrs. Robert J. Barry, Vernon Barrett.

Fifty years ago The Associates of Caltech — 100 of the most influential people in southern California — met for the first time in the large drawing room at the home of Henry Huntington, now the world-famous Huntington Library and Art Gallery. There they pledged themselves to "aid and advance the welfare of the California Institute of Technology." Caltech, in turn, pledged to serve as an intellectual and cultural center for the dynamic new support group.

During the ensuing 50 years, both pledges have been richly fulfilled. Caltech and The Associates have grown beyond the dreams of their founders. The Associates have contributed $7 million through their memberships to the general support of the Institute, and they have made many other gifts for research and educational projects. In all, 33 buildings on the campus bear the names of Associate donors.

Last month, The Associates met for a black-tie dinner to celebrate the 50th anniversary of the founding of this partnership between southern California educational and industrial leaders. They used the occasion to reflect on the history of this unique association — one that has become a model for others throughout the country. Their meeting place was the Athenaeum, a clubhouse constructed in 1930 through a gift from Mr. and Mrs. Allan C. Balch, founding members of The Associates.

Some 375 members and guests attended the dinner, filling the Hall of The Associates, the Athenaeum dining room, and the Athenaeum lounge. Hosts for the three areas were, respectively, Howard G. Smits, president of The Associates; Joseph B. Earl, first vice president; and George D. Jagels, second vice president.

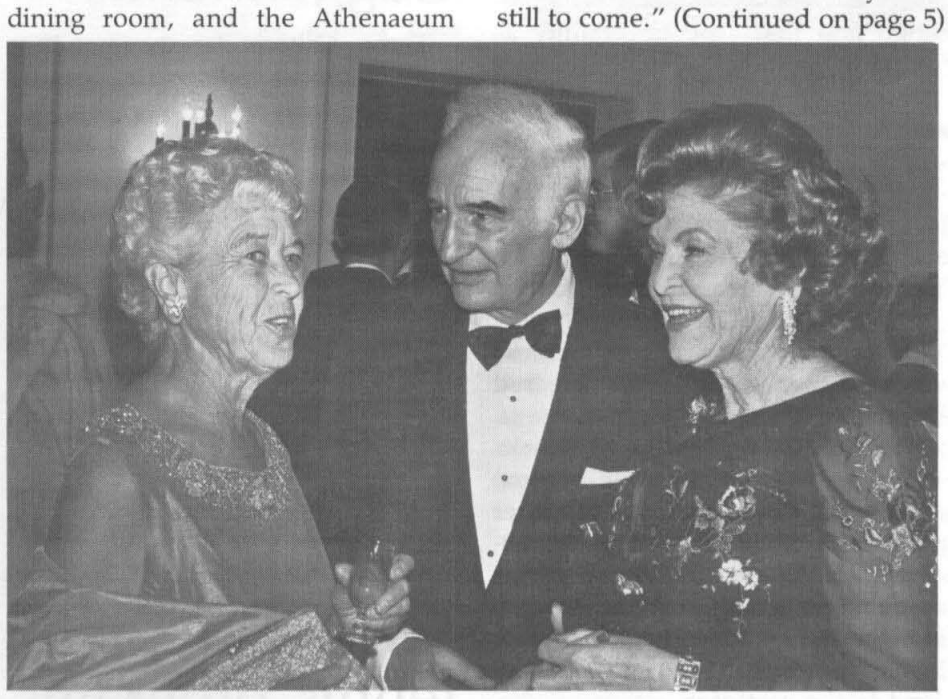
After dinner the Caltech Glee Club, under the direction of Olaf M. Frodsham, sang several numbers as guests enjoyed cordials on the Athenaeum patio and an adjoining canopied cocktail area. Then the guests reassembled for the evening's program.

"We are a part of the Caltech family and this family is headed by Harold Brown," Howard Smits told The Associates as he introduced the Institute president.

Expressing his appreciation to the members, Brown said, "Since the Institute first set out on its course as an outstanding institution of teaching and research, the partnership between Caltech and The Associates has paid many dividends. The Associates have become an integral part of the fabric of Caltech's eminence in scientific achievements — achievements that have had far-reaching implications for our society."

Brown then introduced Caltech President Emeritus Lee A. DuBridge and Harry B. Gray, William R. Kenan, Jr. Professor of Chemistry, for an unrehearsed, anecdote-filled dialogue about Caltech and the people who are a part of its heritage.

"The pessimists among us insist that *these* are the good old days," Brown remarked in his introduction, "but I believe the best old days are still to come." (Continued on page 5)

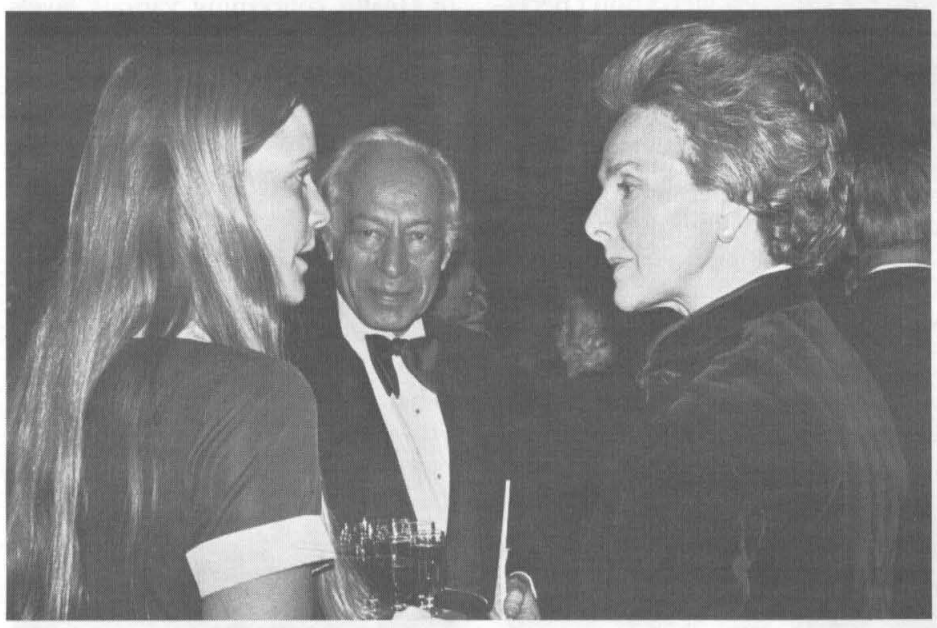


Mrs. Theodore C. Combs, Dr. and Mrs. Simon Ramo.

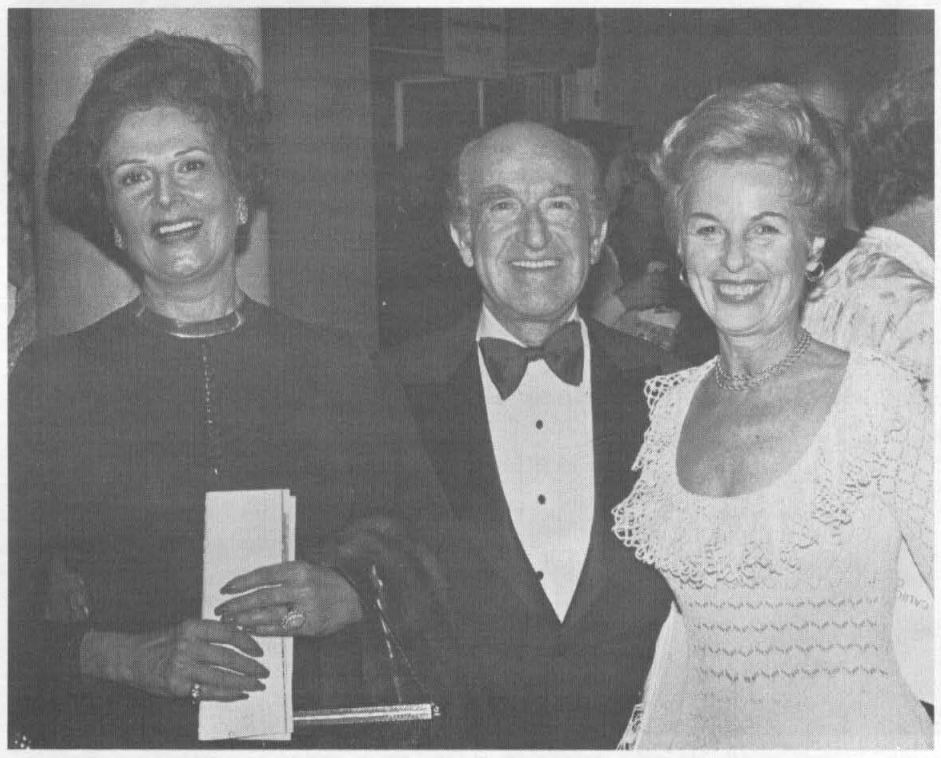
Mr. and Mrs. William F. Arndt, Mrs. Frank W. Bireley, Mrs. Richard Oliver.

Mr. and Mrs. Gerald Lynch, Mrs. Nick T. Ugrin, Mrs. Charles M. Kase, Dr. Grace L. Smith, Alfredo Rodriguez, William H. Corcoran, Mrs. Edna Gordon, and Mrs. Virginia Curry.

Mrs. William L. Hoyt, Mrs. Nathaniel Paschall, Mr. and Mrs. William Lang.



Mr. and Mrs. Eric Lidow are served by Miss Margo Robe, a Caltech engineering student who works part-time at the Athenaeum.



Mrs. Alwyn Freeman, Mark Taper, Mrs. David Loew.

DuBridge and Gray trade memories at festive dinner

In his opening comments, Gray reminisced about his first meeting with DuBridge. "I was here to give some lectures as a member of the faculty of Columbia University," he said. "I was in shock when I was told that the president of Caltech wanted to see me, for at Columbia I had only seen the president two or three times — and from a distance.

"You asked me how you could persuade me to come here permanently," he said to DuBridge. "At Columbia a new physics building had just been built on the tennis courts between my apartment and my lab and we chemists had agreed that one good set of tennis was worth a dozen physicists. So I said, 'Promise you'll never build a physics building on the Athenaeum tennis courts,' And, although you were a physicist, you kept on smiling.

"This meeting with you, and my other experiences on the campus, convinced me that Caltech was a special place where many exciting things were happening, and where a lot of interaction was taking place among everyone here — those at the bottom, the top, and in between."

Gray reminded DuBridge of a few memorable but unpublicized moments in his career as Caltech president, including the time the students decided they didn't like the food in the cafeteria and protested by depositing their half-eaten lunches outside his office door, and the time he discovered, before a dinner at the White House, that he had packed two right shoes.

Then DuBridge, who first came to the Institute in 1926 as a Fellow of the National Research Council, recalled that he was attracted to Caltech because of the opportunity to work with Robert Millikan on cosmic ray research. "There were only 23 full professors here in 1926," he said, "among them, some of the finest minds in the world. They would sit around a long table and talk about chemistry, physics, and philosophy — and many other topics. I was amazed at how much these men knew about history and current affairs. The spirit of Caltech has been one of blending the humanities with science and engineering — a spirit that continues today."

Reminiscing about the enthusiasm for scientific matters that pervaded the Caltech campus, DuBridge recalled the time when Millikan and Einstein, then a visitor to the campus, were discussing the future of seismology as they strolled outside Throop Hall. So deeply were they absorbed in their conversation that they were unaware that a mild earthquake had just jostled the campus until a student called it to their attention.

"I left Caltech in 1928," DuBridge told the audience, "and the place was steaming. Already I could feel the pulse of many changes. In the 1930's, Caltech ceased to be a good private university and became an internationally famous institution. Now it has become a dynamic center of growth for the whole world."

"Those were exciting times," Gray agreed, "but the times have never been more exciting than now. And with the help of the research of people like James Bonner (Caltech professor of biology) we'll both be back for the 100th anniversary of The Associates in 2026."

Mrs. Virginia Curry, Dr. and Mrs. William H. Corcoran, Mrs. Don Hayden Rose, Dr. Henry L. Lee, Jr.

Harry B. Gray and Lee A. DuBridge trade anecdotes about their experiences at Caltech.

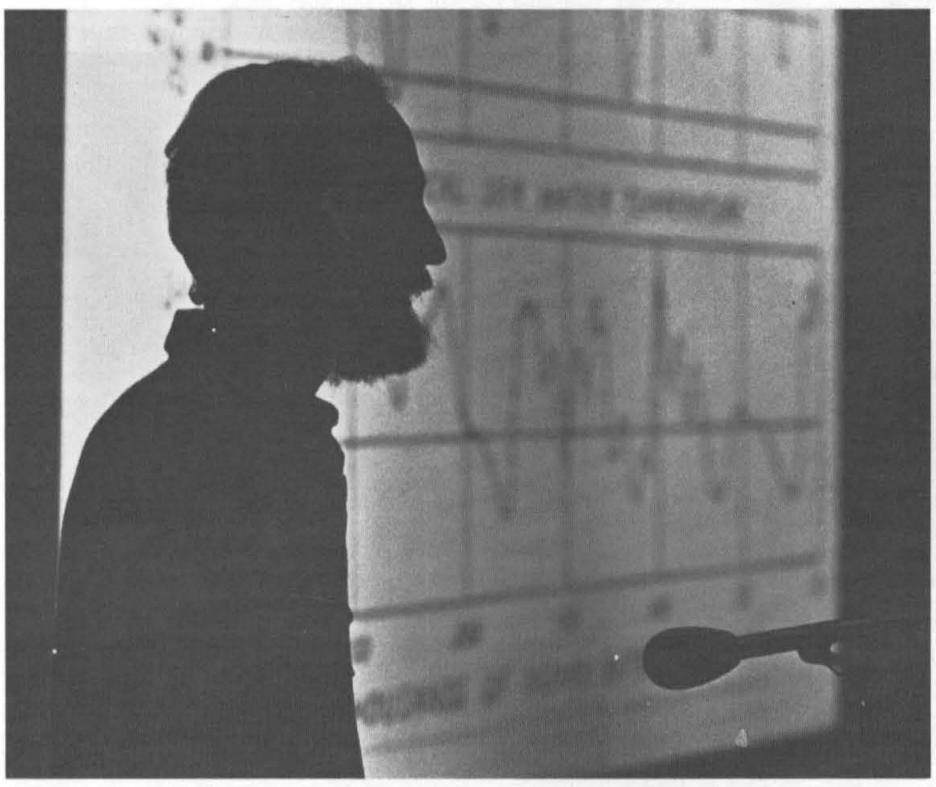
Eels to energy:

Seminars packed with research news

Planetary atmospheres

Part of the process of understanding the earth is to learn more about other planets, Andrew P. Ingersoll, associate professor of planetary science, told alumni.

"In particular, the factors that control the earth's climate and cause it to change are not well understood," Ingersoll said. "Most evidence suggests that small external changes, such as a one percent decrease in the amount of sunlight deposited in the polar regions each year, can have a large effect, as with the ice age that reached its peak 18,000 years ago. Studying the planets helps us to understand why the earth's climate is so sensitive to the external parameters."



Andrew P. Ingersoll talks about the atmospheres of Mars, Venus, and Jupiter, and how we can better understand the earth's climate through a knowledge of other planets.

Mars and Venus are basically rocky planets like the earth, but they receive, respectively, about one-half and two times as much sunlight. Ingersoll argued that the resulting phase (solid, liquid, or vapor) of water and carbon dioxide explains the great differences between the three planets.

On Mars, the dominant phase is solid, and the heat balance of the polar caps controls the atmosphere and climate. On the earth the dominant phase of water is liquid, and the oceans play the major role. On Venus the dominant phase is vapor, and the massive atmosphere controls the climate. "Seeing the dramatic importance of phase changes from one planet to another helps us to understand the smaller changes that occur on earth," Ingersoll said.

"With Jupiter, the interesting meteorological questions concern the cloud patterns. We can ask whether, if the earth were ten times larger, the weather patterns would be larger or more numerous or both. With this perspective we can separate the effects of a planet's size from other effects, and better understand how weather patterns might change during a changing climate."

Testing earth dams

If an engineer wants to know how well his analyses of a steel or concrete structure describe its behavior in an earthquake, a technique is available for him to use. He builds a precise scale model and then subjects it to a scale-model earthquake. But the problem is much more complex if the structure is made of soil, because soil changes its properties when it is subjected to intense pressures. The mechanical properties of soil in a large dam are much different from those of soil in a scale model of the dam, because the soil in the dam is under much greater stress.

The solution to this dilemma is found through the centrifuge, R. F. Scott, professor of civil engineering, explained to alumni on Seminar Day. Scott told alumni that a model of an earth dam can be rotated within a centrifuge where the force of gravity is multiplied hundreds of times in relation to the size of the model. For example, in a centrifuge, a model one hundredth the size of the earth dam can be subjected to gravity intensified 100 times. If it is then vibrated by a simulated earthquake, the results tell engineers how the full-sized dam would react to a real event.

Scott showed videotapes of experiments at Caltech in which the centrifuge on the roof of Thomas Laboratory was used. The videotapes focused on the moments when the models failed under the stresses to which they were subjected.

The role of agendas

"Committee procedures play an overwhelmingly important role in the shaping of committee decisions," Charles R. Plott, professor of economics, told alumni on Seminar Day. "Even when groups use direct majority rule, the procedures can induce decisions that no one wants. Furthermore, some people can instinctively use the influence of agendas to their own advantage."

The first evidence of systematical, mathematical thinking about committee processes is found in the work of 18th century mathematicians, Plott said. And much current research in this area is motivated by paradoxes unearthed in those early studies.

"We can provide some generalizations about certain kinds of committees and the way they function," Plott said. "These generalizations are at odds with some common theories about committees. The kind of committee that we can say the most about now has three properties: there is little or no new information generated during the meeting, all committee members care a lot about the outcome, and the committee uses majority rule.

"Contrary to common belief, in these kinds of committees the people with the strongest views don't necessarily pull the decision toward themselves, nor does the committee decision always turn out to be the one the members most prefer.

"An implication of this type of research is that you can influence or even determine the decision at a committee meeting if you know how to manipulate the agenda. The key variables are the way the issues are worded and their sequence."

Future energy resources

"Although great difficulties can be anticipated, it now appears humanity need never suffer from a shortage of available energy," Harrison S. Brown, professor of geochemistry and of science and government, told alumni. "We will be faced with considerably higher costs than we experienced during the Golden Age of petroleum and natural gas. We will be confronted with environmental problems far more difficult to solve. But to compensate for these difficulties we will have available far more energy than we can use even in the foreseeable long-range future when our energy needs will be greater than today.

"The difficulty is time: time to intensify exploration, to undertake the necessary research and development, to build new plants and relocate industries, to change ways of life. For the next decade, at least, the oil importing countries are destined to remain in the political and economic trap that they helped to build for themselves."

The potential alternative energy resources available to mankind are vast, Brown said. Among these, he mentioned reserves of oil shale, tar sands, and coal; hydropower, geothermal energy (including the potential for tapping the heat content of the earth's crust), solar power, and nuclear fuels.

Genetic engineering

When benign, malign, and possibly even accidentally cataclysmic results are involved in a given field of research, what limits to scientific inquiry should be imposed?

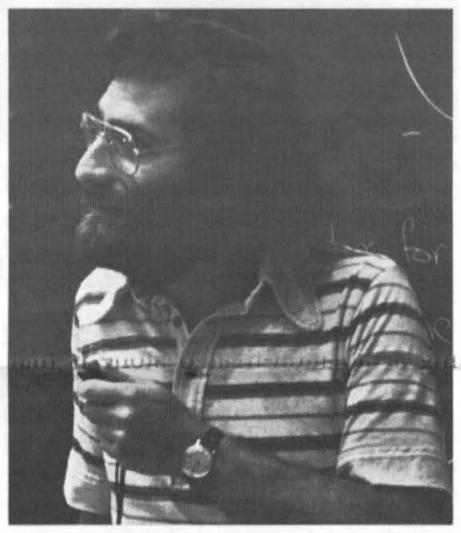
Discussing the controversial field of genetic engineering, Robert L. Sinsheimer, professor of biophysics and chairman of the Division of Biology, told alumni he feels scientists should place responsible restrictions on their work. Sinsheimer discussed recent advances in biology that have brought genetic engineering — on the level of microorganisms — to imminent reality.

"The role of science in our society has changed profoundly in the last half of the 20th century," he said. "The development of synthetic biology has the potential for making major changes in life on this planet. With this power, science can no longer eschew contact with the world of values. We need to find a way to be doubly responsible, both to mankind and to science. This will not be easy."

In response to questions, he discussed guidelines now under consideration before the National Institutes of Health concerning various levels of physical and biological containment that might be imposed on research in genetic engineering.

The eel's nervous system

The electric eel puzzled Darwin who was unable to account for its natural history. But modern science is gaining many new insights into the evolution and functioning of its nervous system, Henry A. Lester, assistant professor of biology, told alumni.



Henry A. Lester describes the electric eel and its nervous system.

"The eel uses his electrical organs to detect, navigate, and signal," Lester said. "To have a navigational and protective system capable of these functions, he must also have electrical receptors. Many species of fish, including all sharks and rays, are equipped with these receptors." It is believed that the electrosensory systems evolved first and then the electrical organs evolved from the muscles, he explained.

Lester noted that two electric fish whose signals interfere with each other are able to detect and circumvent the jam by shifting the frequencies of their signals. Faced with the need to handle such sophisticated electrosensory problems as this one, the electric fish have evolved cerebellar neuronal circuits that rival those of mammals, he pointed out. Thus research concerning electric fish is telling us more about how the central nervous system governs behavior — an important problem in neurobiology, he said.

Lester explained how the electrical discharge arises in the membrane of individual cells in the electrical organs. These membranes contain the same sort of "ion channels" that govern the electrical activity of all nerves and muscles. By studying the cells of electric eels, Lester and his colleagues are beginning to understand the mechanisms that allow these channels to open and close on a time scale of thousandths of a second.

Faculty reports attract alumni

Gems or gyps?

When is a gem a colorful gyp? It's becoming more and more difficult to tell, George R. Rossman, assistant professor of mineralogy, told alumni on Seminar Day, because methods for artificially altering the color of gemstones are becoming increasingly sophisticated. He illustrated his talk with slides showing the techniques used to cause and to detect artificial coloration.

Rossman said that even jewelers may not be able to tell when a piece of jade or turquoise has been treated to enhance its color. But a mineralogist, by means of optical and infrared spectroscopy, can study the gem's basic atomic structure and make a determination. And often he finds that a dye has been added to the stone's natural color-causing impurities.

Dyeing stones — with food coloring or by highly sophisticated methods — is one way to achieve a more desirable color, Rossman noted. Another and more dramatic method is to use cobalt 60 gamma rays or X rays. This method is used to enhance the color of zircons, fluorite, aquamarines, quartz, and even diamonds. It can also be used to change the color of kunzite, an inexpensive form of spodumene, to that of hiddenite, a rare variety of spodumene that is much desired for its brilliant green color.

For the buyer, the hazard in buying a radiation-treated stone is that the color change may not be permanent. A dramatic example, Rossman said, is radiation-treated kunzite, which loses its brilliant green color in a few weeks. Other stones may keep their new color or they may lose it slowly, especially if they are exposed to heat or to the ultraviolet rays in sunlight.

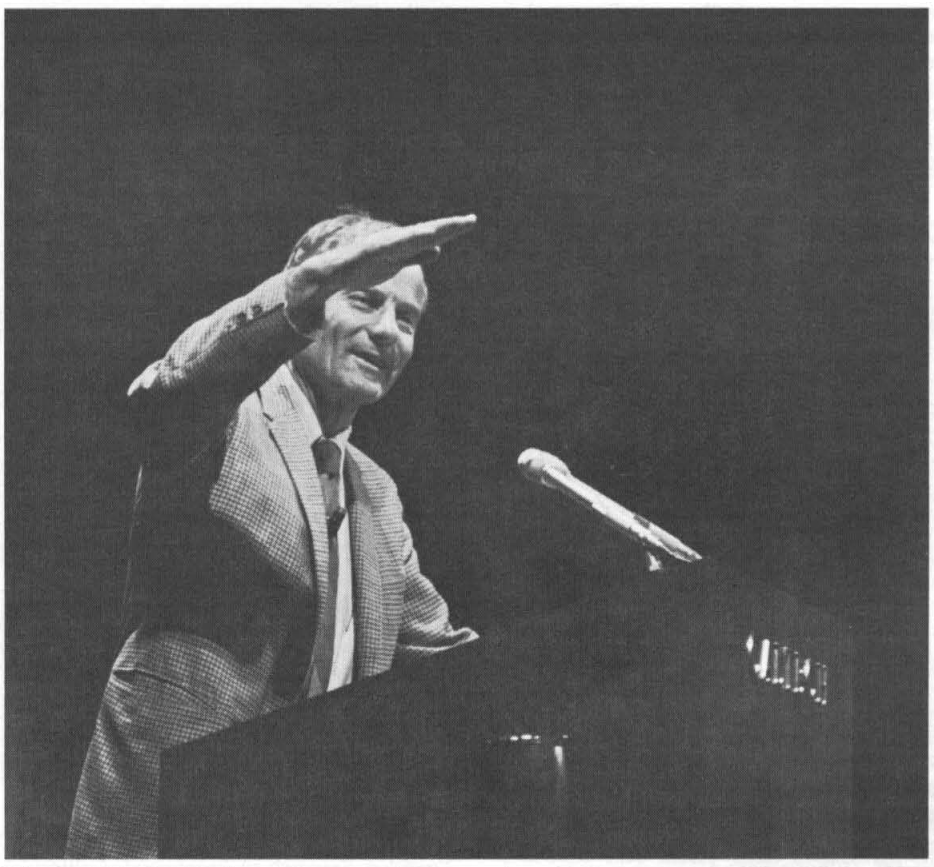
Kelp as an energy source

A progress report on growing kelp as an energy source was given alumni by Wheeler J. North, professor of environmental science. North told of attempts to grow harvestable crops of kelp in the ocean for the first time. Color slides of underwater scenes at the kelp beds illustrated his talk.

"About 70 percent of the earth's surface is open sea, most of it a watery waste," North said. "But if we are successful in our attempts to grow kelp there as a source of food and energy, then we hope that in a few decades a major portion of our sea can be used in this manner."

North explained that one problem facing researchers is that the open sea is nutrient-poor near the surface, but rich in nutrients at depths too great for photosynthesis to occur. He showed slides of an ice-cream-cone-shaped support that had been built in an attempt to meet this problem. With the help of the Navy, the cone was anchored off Corona del Mar. Two hundred gallons per minute of nutrient-rich water were pumped through it for 11 days. The scientists were able to demonstrate, through their results, that the deep water stimulated the plants' growth.

North mentioned that future experiments are planned, including the eventual development of a 1,000-acre kelp farm. "At some future time," he concluded, "we'll all be working on a 100,000-acre kelp farm."



Wheeler J. North tells alumni of progress in the growing of kelp as an energy source.

Indian revolutionaries

The drama of the Indian movement for independence expressed through the lives of a young Indian couple during World War II was described by Peter W. Fay, professor of history, on Alumni Seminar Day.

Fay is editing the reminiscences of the couple whose adventures he described, and whom he knows personally: Prem Sahgal, a young captain with the 10th Baluch Regiment of the Indian Army, and Lakshmi Swaminathan, a young woman who practiced medicine in Singapore before the beginning of the conflict. Malaya's fall threw them together and into intense political activity in support of the Japanese.

Prem joined the force that became the military arm of free India's provisional government and served as principal military secretary to its leader, Subhas Chandra Bose. Lakshmi became the only woman on Bose's cabinet, organized a regiment of Indian women to fight against the British, and — toward the end — took to the Burmese jungle. Both were captured by the British; Prem was tried for treason, convicted, but released. Then they married and retired to Kanpur where politics passed them by.

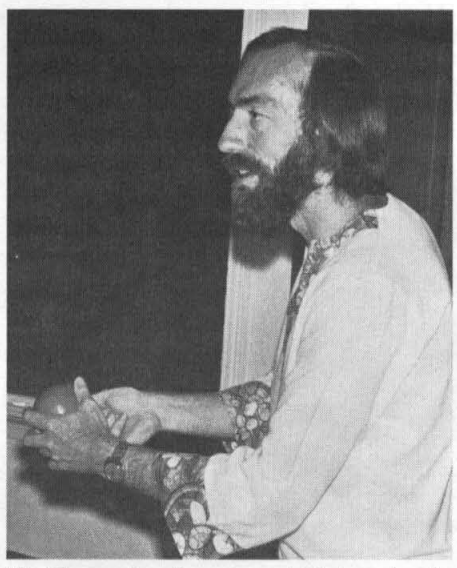
Alternative automotive engines

Is there an alternative to the conventional internal combustion engine, and, if so, what is that alternative? R. Rhoads Stephenson, systems analysis section manager at JPL, told alumni about the efforts of a team of engineers and scientists from JPL and the Environmental Quality Laboratory to find answers to this question. Their research was funded by a $500,000 grant from the Ford Motor Company.

Stephenson said the team technically analyzed the leading generic types of automobile engines and considered the possibility of their introduction during the 1980's. Engines including the stratified-charge Otto, Diesel, Rankine (steam), Brayton (gas-turbine), Stirling, electric, and hybrid engines were evaluated as alternatives to the conventional engine. The team considered these in terms of vehicle use patterns, energy consumption, consumer costs, materials availability, urban air quality, and industrial impact.

Stephenson said the results showed that goals for emission reduction and energy conservation, set for the automobile over the next ten years, can be met by improvements in the conventional (Otto-cycle) engine and in other parts of the vehicle.

"The ten-year period will provide time for the necessary development work on the Brayton and Stirling engines," Stephenson said. "After development, we expect that these engines will greatly reduce automobile fuel consumption and that their higher initial cost will be offset by a reduction in operating costs."



Kip Thorne describes a new technique for detecting gravity waves from outer space.

Gravitational waves

If gravitational waves from outer space could be detected and studied, they would reveal — for the first time — details of what is happening inside quasars, black holes, and the cores of galaxies. But until now, these elusive waves, which were predicted by Einstein, have defied detection.

Kip S. Thorne, professor of theoretical physics, described a new technique for detecting these waves when he spoke on Alumni Seminar Day. Thorne developed the idea for this new experiment in collaboration with a Russian physicist, Vladimir B. Braginsky of Moscow State University, and JPL scientists Richard Davies, Frank B. Estabrook, and Hugo D. Wahlquist.

The technique would involve a dragnet of radio signals between the earth and interplanetary spacecraft. For ultimate success it may also require extremely accurate clocks that are still being developed and might not be ready for another five years. For this reason, the search for gravity waves may not succeed for another five to ten years, Thorne said.

Thorne explained that once gravitational waves are detected, they can be used as the light from the stars has been used — to tell what's going on in the universe. "These waves are to the gravitational force what light waves are to the electrical force," he said. "The disadvantage of light is that it only reveals the surface of objects. But gravitational waves come from the interior of objects and so they can be powerful tools in revealing cosmic activity that we've never seen before."

Proteins and evolution

Proteins that are found in a great many living organisms can be used to study the evolutionary relationships between those organisms, Richard E. Dickerson, professor of physical chemistry, told alumni on Seminar Day. One relatively small protein with a molecular weight of 12,400, cytochrome *c*, is an essential part of the respiratory machinery of all organisms that extract energy from their foods by oxidizing them, or combining them chemically with substances such as O_2.

"Cytochrome *c* is present in all plants and animals, and in all aerobic bacteria," Dickerson said. "The amino acid sequences of these cytochromes have been studied for more than 70 species, and their three-dimensional structures have been solved for horse, tuna, and three kinds of respiring bacteria. The folding of the protein chain in all of these cytochromes is essentially the same; thus we know that horse, tuna, and bacteria share a common ancestry.

"All serious theories about the origins of life on earth assume that life evolved at a time when the earth's atmosphere was reducing in character — with H_2, CH_4, NH_3, H_2O and H_2S, but with no free O_2," he explained. "The gradual change to our oxygen-rich atmosphere is believed to have come about from the emission of O_2 during green plant photosynthesis. Respiration would not have evolved until significant amounts of O_2 were present in the atmosphere.

"The comparison of cytochrome *c* structures suggests that respiration developed by making use of metabolic machinery that had originally been a part of photosynthesis. Present-day purple non-sulfur photosynthetic bacteria are probably similar to the bacteria that were capable of both photosynthesis and respiration, and that lost their photosynthetic capabilities to become our metabolic ancestors."

PERSONALS

1925
HAROLD C. SHEFFIELD has been elected to a three-year term on the vestry, St. James Episcopal Church, South Pasadena, California.

1936
RICHARD L. HAYMAN, Ex '36, president and chairman of the board, Haskel Engineering & Supply Company, Burbank, returned to work in June from a successful convalescence following open heart surgery after a heart attack.

1938
EDWARD N. FRISIUS retired from the headquarters of the U.S. Postal Service where he was in charge of the economic analysis of capital investments.

1939
PAUL L. SMITH, vice president for marketing at McDonnell Douglas Astronautics Company, is gaining a different kind of fame — as a hobbyist in the magical arts — according to a feature about him in the February issue of *Fortune* magazine.

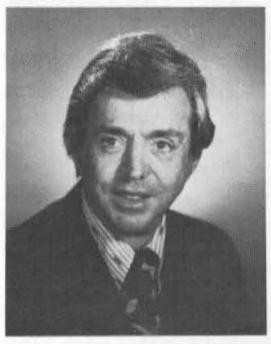
1940
DAVID J. VARNES, a geologist with the U.S. Geological Survey, received a distinguished service award from the U.S. Department of the Interior in December 1975.

1943
STANLEY G. WOOD, MS, was elected vice president of Stone & Webster Management Consultants, Inc., of New York, one of the nation's large consulting firms.

1944
PHILLIP L. ADAMS, after 16 years as a senior development economist with Stanford Research Institute in Menlo Park, California, is setting up his own firm to do economic analyses, development planning, and selected realty and investment work in the San Diego area.

1946
ARTHUR E. MARSHBURN, MS, was named dean of mathematics and science at Santa Monica College where he had been serving as chairman of the department of physical science.

1948
HAROLD A. ROSEN, MS, PhD '51, has been awarded the first L. M. Ericsson International Prize for "proposing the introduction of geostationary communications satellites and for his scientific and technological contributions to their development, design and operation." Rosen, a vice president of Hughes Aircraft Company, accepted the $25,000 prize from King Carl XVI Gustav in ceremonies in Stockholm, Sweden, in May.



Harold A. Rosen

1952
RICHARD R. DICKINSON has been transferred to Westville, New Jersey, as plant manager of Texaco's Eagle Point Refinery.

1953
BERT E. BROWN, MS, is professor and chairman of the department of physics at the University of Puget Sound.

1955
FRANCESCO G. BEUF writes, "In December 1975 I completed work on my MD degree at Temple University Medical School. For the next six months I'll be doing research on pancreatic enzyme replacement in Temple's department of medicine on a fellowship from the General Clinical Research unit. In July I'll start a pediatric residency. My wife, Ann, is teaching at Penn, and our three children are growing up at a horrendous rate."

1960
ROBERT L. NORTON, a senior engineer at JPL, received his doctorate in civil engineering from USC in June 1975.

1961
HENRY I. ABRASH, PhD, professor of chemistry at Cal State University, Northridge, is on sabbatical leave at Carlsberg Laboratories in Copenhagen, Denmark.

CHARLES J. SIEGEL is an operations officer for the 492nd Tactical Fighter Squadron of the Royal Air Force in Lakenheath, England.

1964
VOLKER M. VOGT is assistant professor in the section of biochemistry, molecular and cell biology at Cornell University.

1965
JON K. EVANS is a self-employed real estate broker and also serves as AAU International Karate representative to the World Union of Karatedo Organizations.

1968
CHARLES E. DEAN is consulting actuary for the Tulsa office of A. S. Hansen, a national employee benefit consulting firm.

1969
DENNY R. S. KO, PhD, is executive vice president of Physical Dynamics, Inc., of Santa Monica, California.

1970
JEAN-PIERRE DOLAIT, MS, Eng '72, is chairman of the department of operations management in the business school at Leval University in Quebec, P. Q. Canada.

1972
DAVID D. MANTROM, MS, has joined Poseidon Research of Brentwood, California, as a research engineer and is working on experimental fluid mechanics.

FRANK D. UHLIG, PhD, is professor of matrix mathematics at Wurzburg University in West Germany.

1973
JEFFREY A. FRELINGER, PhD, assistant professor of microbiology at USC, received a two-year grant from the American Cancer Society to continue his research in immunobiology.

PETER MIASEK, PhD, and his wife, Donna, have a son, Philip Lloyd, born on February 3.

RAYMOND T. SPEARS is a technical writer for Intermetrics Inc. of Cambridge, Massachusetts.

1974
LAWRENCE C. FORD, PhD, and his wife have a son, Michael L., born September 9, 1975.

RHONDA L. MacDONALD completed the requirements for her master's degree in civil engineering at MIT and is employed as an engineer at C F Braun & Company in Alhambra, California.

BRUCE G. MONTGOMERY writes, "I've worked for the past two years at JPL, being responsible for the design of a portion of the primary structure and the weight and C. G. operations for Mariner-Jupiter-Saturn 1977. On the side I've worked on a master's in civil engineering (structures) which will be finished this spring. But this fall will be time to move on. I will be attending the graduate school of industrial administration at Carnegie-Mellon University in Pittsburgh. With that education and my engineering background, I will have a good foundation for doing work I will enjoy."

OBITUARIES

1926
JAMES W. HASTINGS in January. He was a retired manager of operations for the Western Division of Union Oil Company and a former superintendent of a refinery in Edmonds, Washington. Surviving are his wife, Winona, two sons, and two daughters.

1927
HARRY T. McCOMB on November 19, 1975. He is survived by his wife.

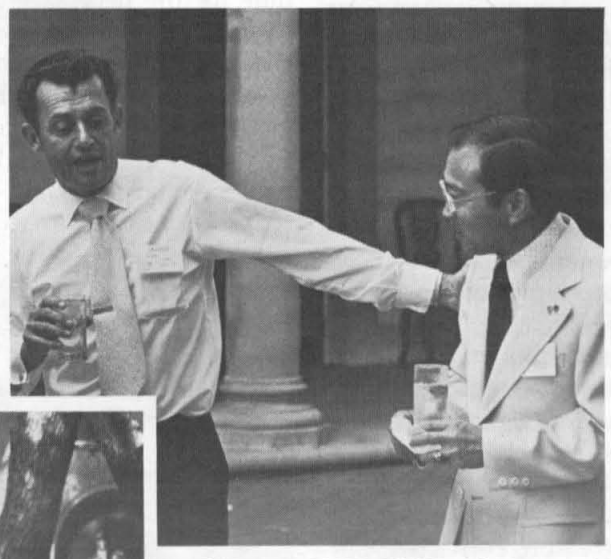
1939
SIMON PASTERNACK, PhD, in his home in Blue Point, New York, on January 26. A theoretical physicist, he was editor of *Physical Review*. Surviving are his wife, Ruth, a son, and two daughters.

1941
JEREMY A. JONES on December 2, 1975. He had worked for Lockheed for 33 years before illness forced him to retire. He remained active, however, in community affairs, and was involved in scouting throughout his life. Surviving are his wife, France, two daughters, and a son.

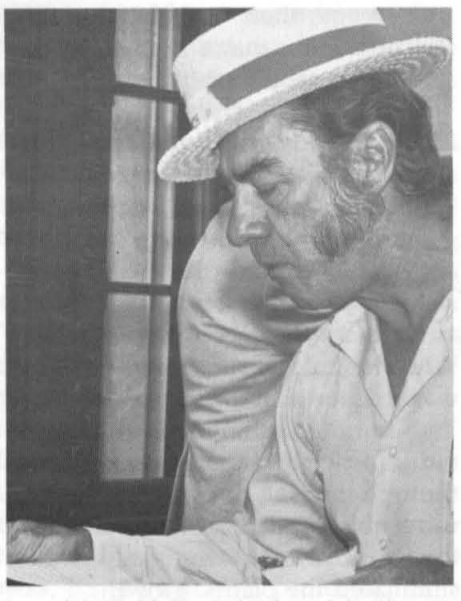
1953
ALEXANDER M. RODRIGUEZ, MS, PhD '56, in December 1975. He was a visiting associate in engineering at the Institute.

Class of '51 reunion

To the theme of "nostalgia isn't what it used to be," 100 members of the class of 1951 and their guests converged on the Caltech campus during Seminar Day weekend for their 25th reunion. A campus tour, cocktail party and dinner, and dancing to the music of the Tommy Vig Band kept the visitors busy on Friday. Seminar Day lectures, a luncheon in Dabney Gardens, a cocktail party in Millikan Board Room, and the Caltech Glee Club concert packed the schedule for Saturday. John R. Fee, BS '51, chairman, had predicted that this would be "Tech's most boisterous reunion ever." Caltech students apparently agreed; after Friday night's dinner dance they posted a banner, "Welcome Back, Rowdies."



Hiroshi Kamei, BS '51, MS '52, right, is greeted by a former classmate, above left. Above right: Frank C. Bumb, BS '51, MS '52, and John R. Fee, BS '51, reflect on student life in 1949.



Members of the class of 1951 recall their college days via vintage editions of the California Tech, above left. Oliver H. Gardner, BS '51 and Cornelius J. Pings, BS '51, MS '52, PhD '55, exchange reminiscences, above center. Above right: Walter F. Pfeifer, BS '51, reviews a schedule of reunion activities.