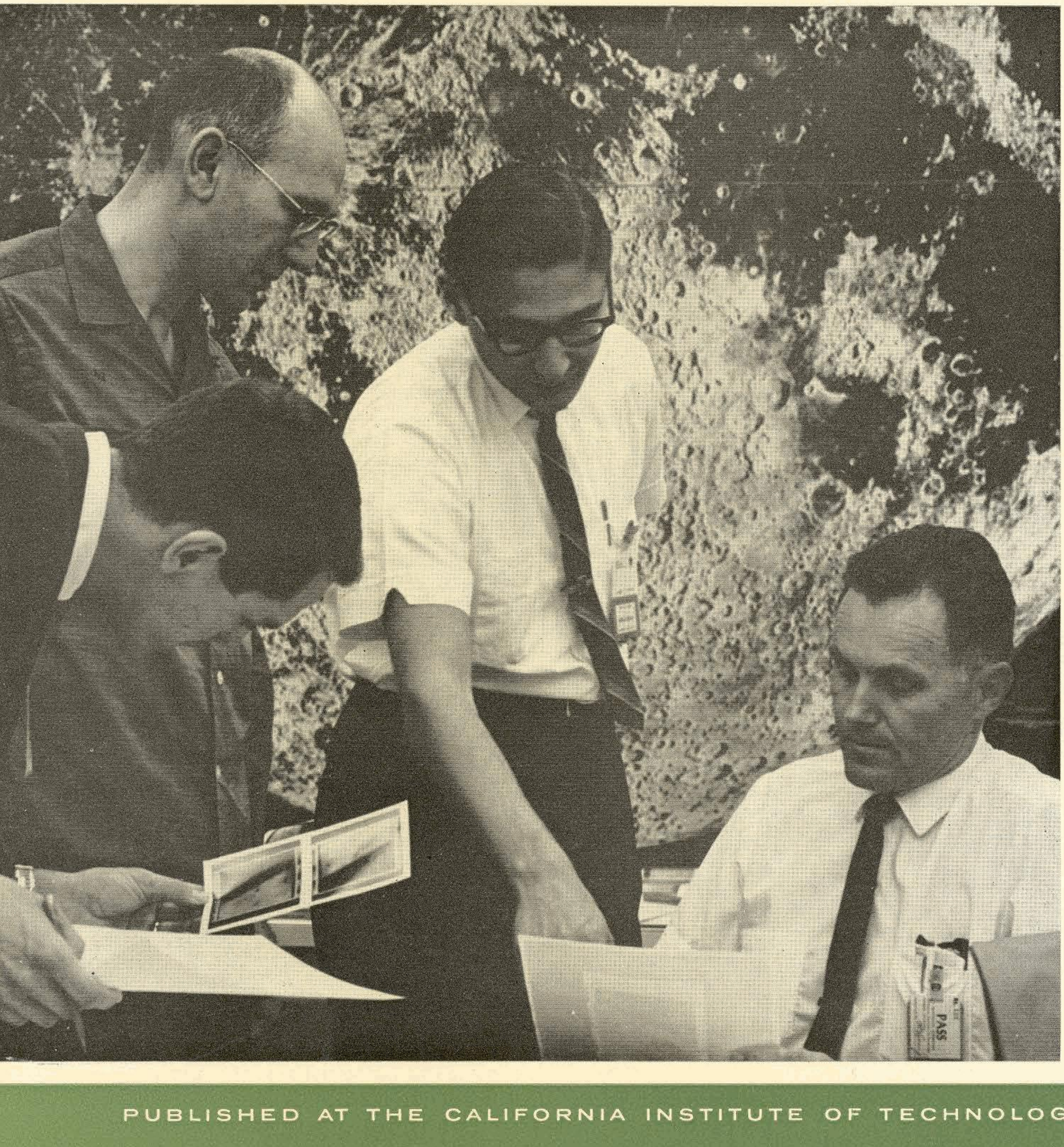
OCTOBER 1965

ENGINEERING AND SCIENCE



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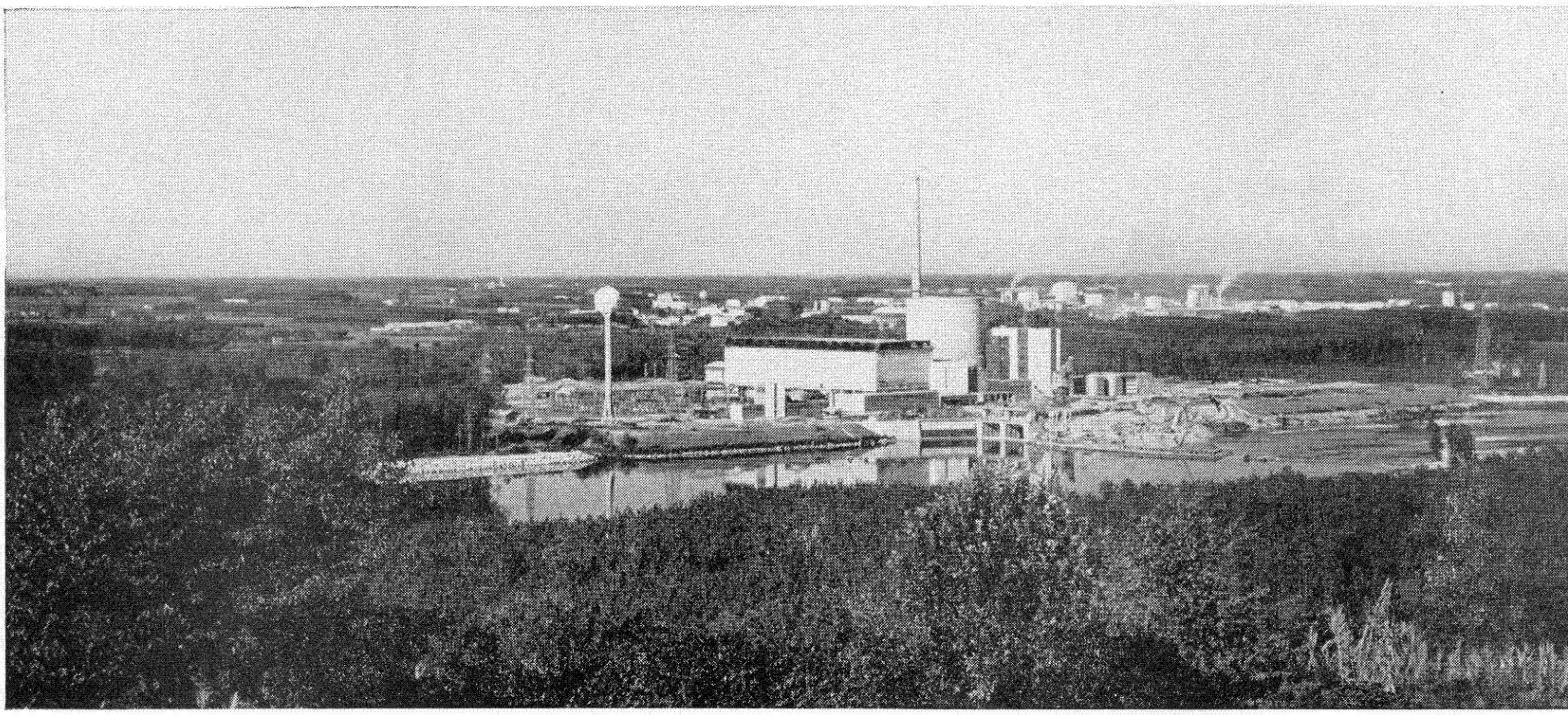

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Located at Trino, near Milan, this plant makes Italy the third largest nuclear producer of electricity in the world and the biggest in continental Europe.

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Through advanced electronic switching gear in the GM Communications' network, virtually any GM location in the world may contact any other GM location, regardless of the type or speed of equipment at the other end, whether by magnetic tape, punched paper tape, punched cards or printed copy. Speeds vary from 60 words per minute to 3,000 and more!

Approximately 23,000 messages of all kinds flow through Central Office in Detroit on an average day. This system puts the facts, figures, orders and ideas of GM people within brief minutes of other GM people reached through 72 regional communication centers in the U.S. and Canada, plus overseas locations as widely removed as Sweden and South Africa.

Interplay within the GM team is vital to its progress. Thus, the "Communicator" fills a keystone position.

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making better things for you

ENGINEERING AND SCIENCE

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On Our Cover

At Caltech's Jet Propulsion Laboratory, Robert Leighton (right), professor of physics at Caltech and principal investigator for the Mariner IV television experiment, studies the first pictures sent from Mars, with other Mariner scientists and engineers. The time – July 15, 1965, almost eight months from the day Mariner IV started its historic flight. On pages 9-13 of this issue – some of the spectacular scientific results of this record-breaking mission, about which the Caltech Board of Trustees has said:

"Whereas, the flight of Mariner IV was an engineering triumph, being practically perfect over a trajectory of 325 million miles to Mars and beyond, and

"Whereas, the scientific data returned by Mariner IV . . . have given scientists many startling new scientific facts that will profoundly affect theories about the origin of the solar system and the evolution of the planets . . .

"Now, Therefore, Be It Resolved:

"That Dr. William H. Pickering and the entire staff of the Jet Propulsion Laboratory be sincerely congratulated and commended on the supreme team effort which resulted in the magnificent engineering and scientific achievement of Mariner IV, and that National Aeronautics and Space Administration be congratulated for its fine cooperation."

Books

Where Science and Politics Meet

by Jerome B. Wiesner

McGraw-Hill *$6.95*

Reviewed by Joel N. Franklin, professor of applied science

Since 1964 Dr. Jerome B. Wiesner has been Dean of the School of Science at MIT, where some years previously he had been the director of the Research Laboratory of Electronics. In 1958 Wiesner was staff director of the American delegation to the Geneva Conference for the Prevention of Surprise Attack. In 1961 President Kennedy appointed him Special Assistant for Science and Technology. From 1962 until 1964 Wiesner was director of the Office of Science and Technology.

Where Science and Politics Meet is a collection of papers written and addresses given by the author from 1960 to 1965. The book has three parts: I, "Where Science and Politics Meet"; II, "Education for Modern Life"; and III, "Learning About Disarmament."

Part I begins with a remembrance of President Kennedy. Wiesner, who gave Kennedy advice about science from the time he was in the Senate, notes Kennedy's broad general knowledge of science and his appreciation of the leading role of technology in the present and in the future.

"Technology and Society" presents several important examples of contributions of computer technology: the simulation, directed by Wiesner, of the economy of Pakistan; and the computer determination of the structure of molecules by Watson and Crick. Wiesner suggests areas of future technological development and estimates reasonable increments in current expenditures for them.

Computers

Wiesner lays great stress on computers, as in this quote: "The introduction of computer courses and the use of computational methods in teaching physical sciences, engineering, economics and social sciences would so enhance the professional competence of the students involved that extraordinary measures should be taken to assist the colleges in this effort. Possibly, computers should be included in the category of academic facilities that the federal government will help to finance under the College Aid Bill."

The chapters "Living with Science" and "Science and the Affluent Society" present a history of science in our government and give recommendations for scientific policy. Like Kenneth Galbraith, Wiesner believes in government support of worthy projects which private industry would find unprofitable to support. In Wiesner's view, developmental projects should be kept under strict surveillance, but basic research should be given much greater freedom. Considering government support of university research, Wiesner perceives the conflict between the policy of supporting the centers of excellence and the policy of building the competence of underdeveloped universities. Part I ends with essays on "Federal Research and Development" and "Water Resources Research."

Education for modern life

Part II, "Education for Modern Life," discusses federal support for primary and secondary schools, the problem of meeting our technological manpower needs, and education for scientific productivity. In the important essay, "Science and Education for Developing Nations," Wiesner states that ". . . modern technology and agriculture cannot be transferred intact from one environment to another," and "I do not believe a nation can produce the manpower necessary for a complex society without a good university system."

"The Role of Science and Technology in Industrial Development" shows how a university, like Caltech in the Los Angeles area, creates new industry. "What to Do about Scientific Information" is concerned with government classification and distribution of newly-appearing scientific results.

Part III, "Learning About Disarmament," is highly technical. In "The Relationship of Military Technology, Strategy, and Arms Control," Wiesner shows how limitations in our knowledge of seismology hampered some disarmament negotiations. There are discussions of surprise attack; of comprehensive arms-limitation systems; and of inspection for disarmament, including a theoretical, mathematical analysis.

The book ends with a brilliant, incisive essay — "National Security and the Nuclear Test Ban" — by Wiesner and Dr. Herbert F. York, chancellor of the University of California at San Diego and a member of the President's Science Advisory Committee. The main contention is that the task of technical defense against thermonuclear-missile systems is hopeless. Defense in the Battle of Britain in World War II is contrasted with defense against a modern missile attack. In the Battle of Britain, "interception of no more than 10 percent of the attacking force gave victory to the defending force . . . Yet the delivery of only one (thermonuclear) warhead would result in . . . an effective attack." Although Wiesner and York conclude that there can be no adequate technical defense, they confidently believe that there is a non-technical solution whose first important step is the partial nuclear test ban.

In the opinion of this reviewer, Dr. Wiesner's book is an important contribution to our philosophies of science, government, education, and disarmament. The book is not easy to read, and it suffers the lack of coherence common to all collections of previously-written papers. But the best of Wiesner's essays are self-sufficient and outstanding in their originality, their balance of judgment, their perceptiveness, and their constructive practicality.

Letters

St. Georges, Delaware

EDITOR:

The man I work for is by way of being an amateur philologist. His friends frequently send him new words for his collection, and not long ago one of them phoned to see whether he had ever heard of a millifung, which was used for scorekeeping in Caltech's First Annual Eucalyptus Decimation Contest (*E&S*—June 1965).

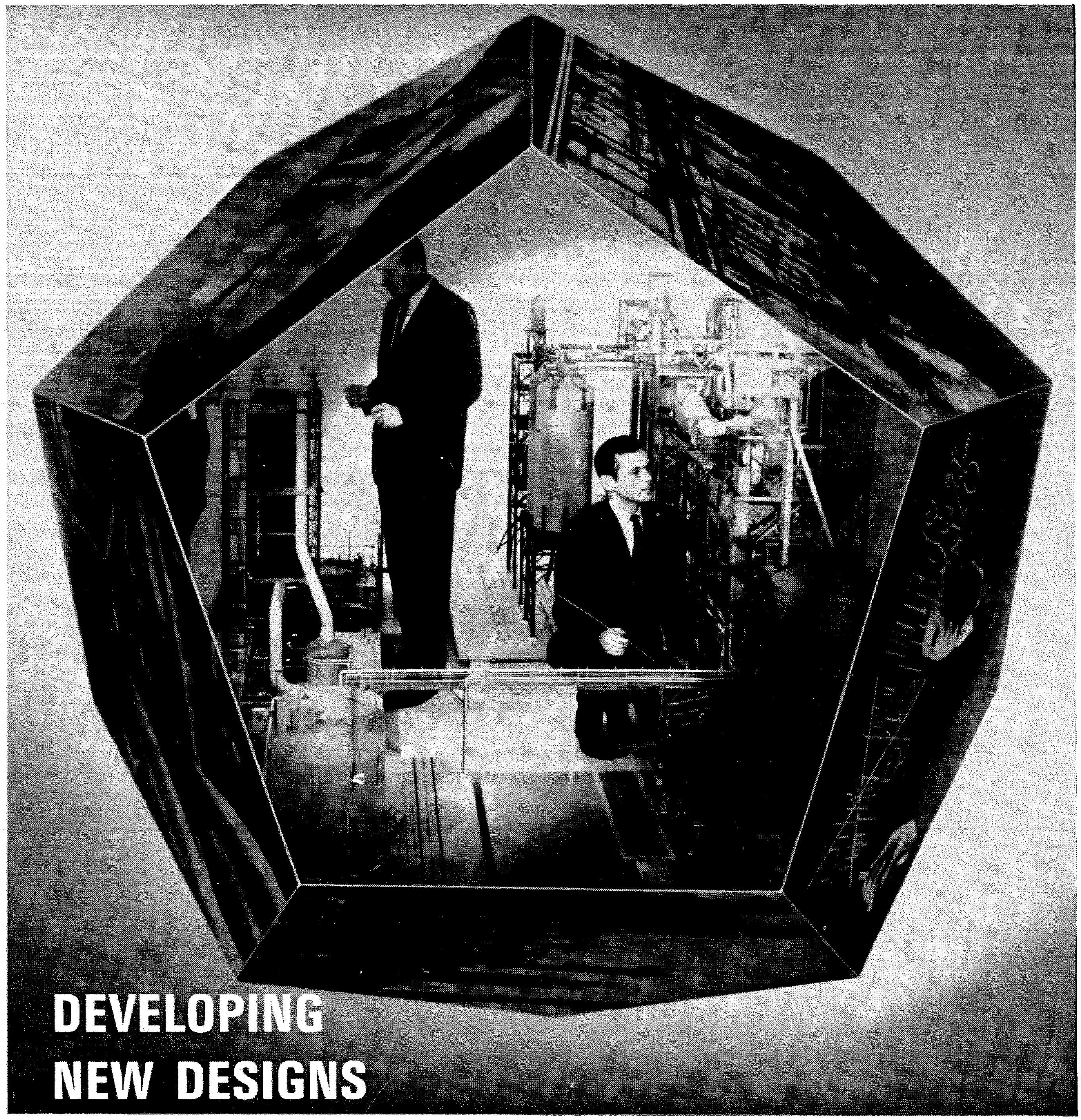
He hadn't. Neither had I. Neither had Webster nor several other reasonably good authorities. We give up. Please let us know what a millifung is.

MRS. CHARLES J. ZENCEY

From the inventor of the millifung, Tim Hendrickson '67, comes this official definition:

The fung (a millifung is 10^{-3} fung) is now standardized as an English unit of normalized tree-felling time.

For those of you who wish to use the fung for tree decimation contests of your own, its derivation is: Let T be a tree of circumference c (inches) with cross-sectional area a (square inches) felled in time t (seconds). Then the fung rating, F, is given by $F = t/c^2$ (sec/in²).



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responsibility

Stephen Jaeger
B.B.A., Univ. of Pittsburgh

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Stephen Jaeger, of the Ford Division's Milwaukee District Sales Office, is a good example of how it works. His first assignment, in January, 1963, was in the Administrative Department where he had the opportunity to become familiar with procedures and communications between dealerships and the District Office. In four months he moved ahead to the Sales Planning and Analysis Department as an analyst. He studied dealerships in terms of sales history, market penetration and potentials, and model mix. This information was then incorporated into master plans for the District. In March, 1964, he was promoted to Zone Manager—working directly with 19 dealers as a consultant on all phases of their complex operations. This involves such areas as sales, finance, advertising, customer relations and business management. Responsible job? You bet it is—especially for a man not yet 25 years old. Over one million dollars in retail sales, annually, are involved in just one dealership Steve contacts.

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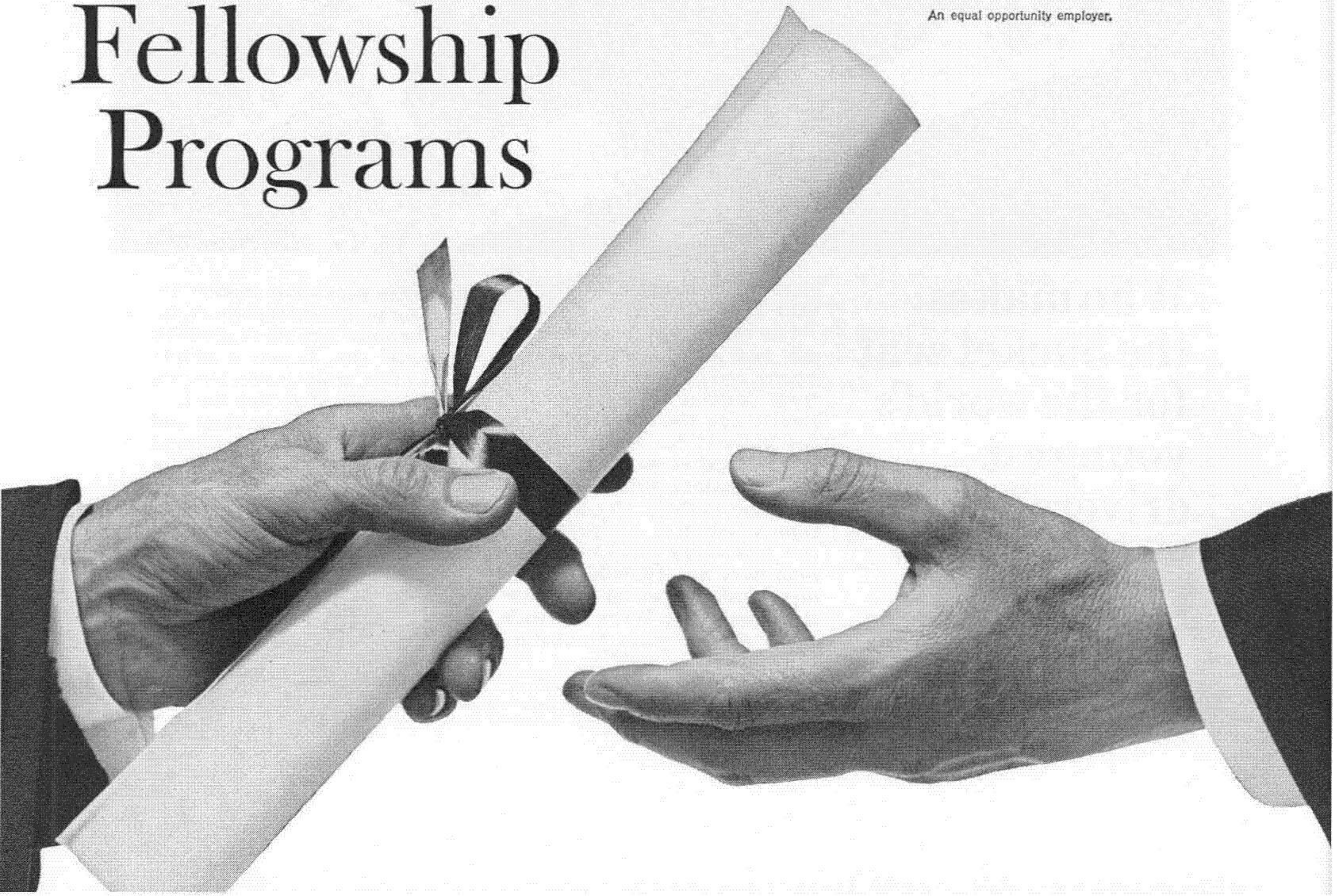

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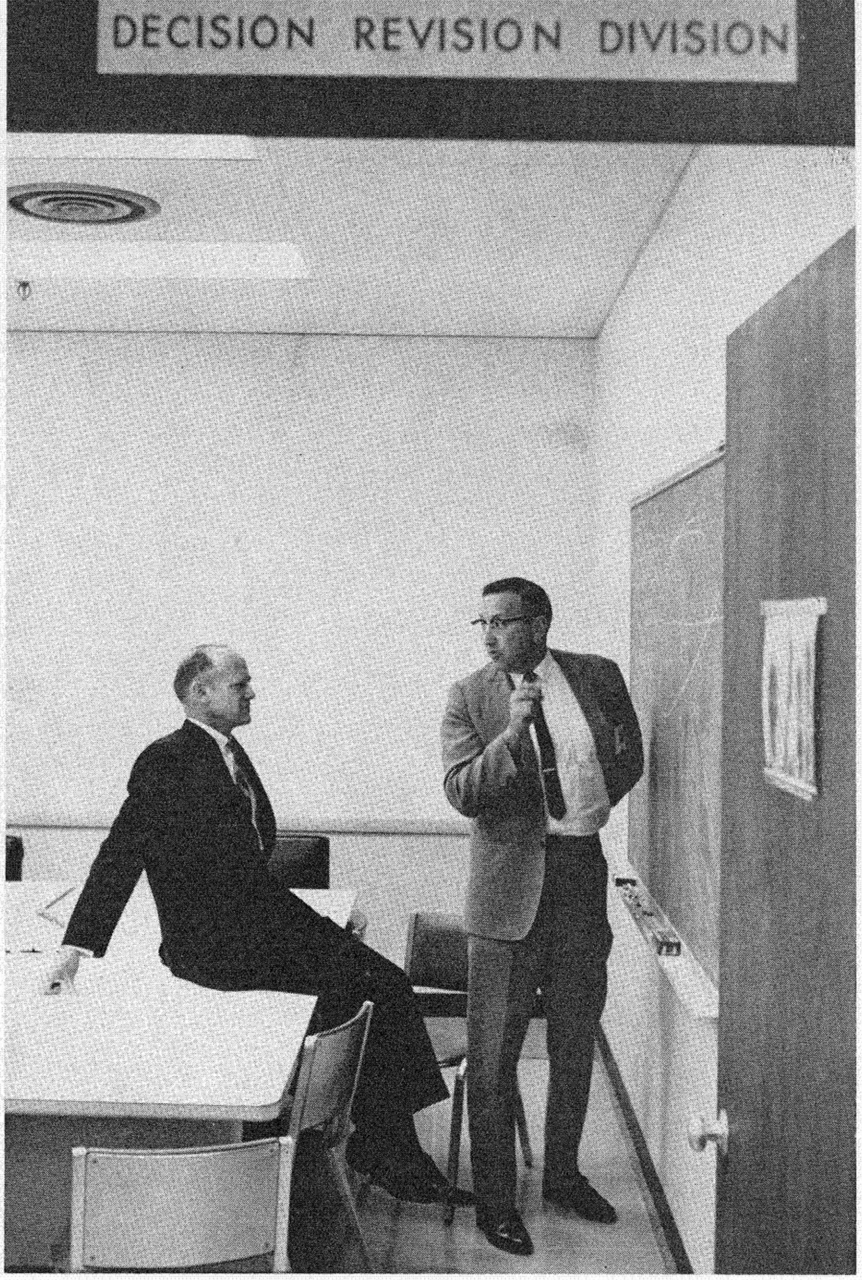
MARINER TO MARS

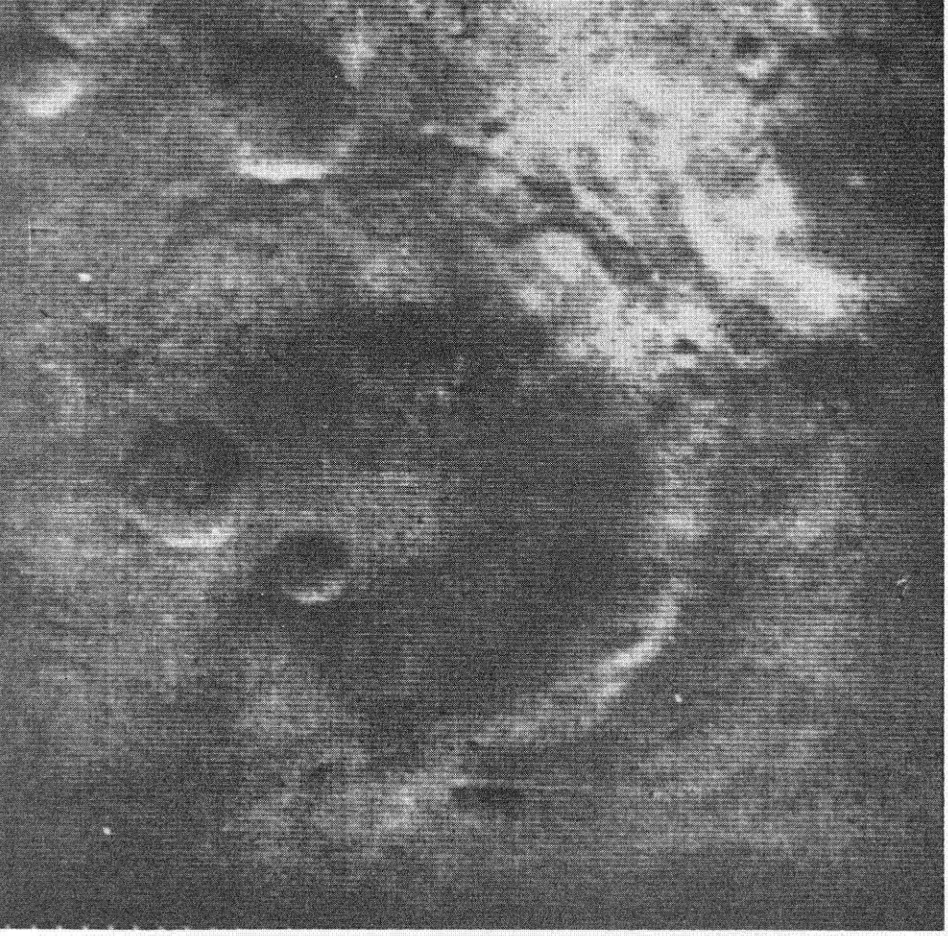


William H. Pickering, director of Caltech's Jet Propulsion Laboratory, and Dan Schneiderman, Mariner Project manager, in the room where they spent many tense hours during the eight-month mission.

Mariner IV, launched on November 28, 1964, was man's most ambitious and, perhaps, most rewarding effort at space exploration to date. It provided the scientific community with exciting new information about Mars, and confirmed and refined earlier measurements made from Earth; it also demonstrated that modern engineering was able to design and build a complex system capable of operating with high precision at truly astronomical distances. The results of the scientific experiments will be studied for many years, and the engineering lessons will be used in future space probes.

Mariner's task was to perform eight experiments – six of them continuously during the flight, and two (television and occultation) at the time of encounter. That six (including the two at encounter) were successful more than 130 million miles from Earth is indeed remarkable and gratifying. The most spectacular was, of course, the television experiment, which returned 22 pictures that covered Mars from limb to terminator. Other experiments provided measurements of the atmospheric conditions, magnetic field phenomena, and cosmic dust.

In addition to providing scientific data, Mariner set deep-space endurance and long-distance communication records. Caltech's Jet Propulsion Laboratory continued to receive telemetry data until October 1, 1965, when the Earth left the range of Mariner's high-gain antenna; the last command given switched Mariner's broadcast to an omnidirectional antenna which will permit the Earth to receive the carrier signal through the 210-foot antenna currently under construction at the Goldstone Tracking Station. Tracking data received will permit corrections to basic measurements of the relative positions of Earth and the other planets, to the benefit of future space navigation. The Earth will be within range of Mariner's high-gain antenna again in September of 1967, at which time an attempt will be made to re-establish contact with the spacecraft.



Picture Number 11 – "one of the truly great scientific photographs of our age, maybe of all time," according to Robert P. Sharp, chairman of Caltech's Division of Geological Sciences and one of the television investigators on the Mariner Project. This shows the largest (120 kilometers) and smallest (6 kilometers) craters seen on any of the photographs, as well as some curious dome-like bulges near the center of the picture. The area covered here is 170 miles wide and 150 miles high. The picture was taken from a slant distance of 7800 miles.

TELEVISION EXPERIMENT

Mars, more amenable to telescope observation than Venus, with its constant cloud cover, has been the planet that most excited man's imagination since the time of Galileo. As a penalty for its popularity, however, it has suffered from a wide divergence of descriptions and observations. Even in the scientific community there has been considerable disagreement as to what the first explorer might find. According to Robert Leighton, professor of physics at Caltech and principal investigator for the television experiment, "The total range of opinion on the nature of the surface of Mars was so broad that it didn't really help much to know that the truth might lie hidden somewhere within it."

The initial surprise expressed by the Mariner scientists when the television pictures were finally seen may have been due to the extent of the destruction of the Mars surface by meteorites, or it may have been unspoken disappointment at the prospects for finding life there similar to that on Earth. While no signs of life were detected, it should be pointed out that it was never intended for the pictures of Mars to reveal life, but rather to show the terrain and topographic features. Essentially, the pictures removed certain matters from the realm of controversy and focused attention on new opportunities and new problems.

As an indication of how hard it is to detect life in such pictures, at the Caltech-JPL Lunar and Planetary Conference held on the Caltech campus in September, Carl Sagan, professor of astronomy at Harvard, showed a picture of the northern Atlantic seaboard, taken from a Nimbus satellite. This picture was comparable in detail to a Mars picture; it showed familiar topographic features, such as Cape Cod and Long Island; but Sagan defied anyone to detect signs of life. No identifiable objects, no highways, no railways were visible at this resolution. In fact, out of a thousand such pictures of Earth, only two showed any signs of life, and even these signs would not have been seen if certain contrasts had not been brought out by an overnight snowfall. So, obviously, the pictures of Mars can neither confirm nor deny the existence of life there. The experiment of detecting life on Mars still remains to be done.

What can be said with certainty is that at least part of the Mars surface is covered with large craters. If the Mariner pictures, which constitute, after all, only one percent of the whole surface, are representative, then future explorers can expect to find more than 10,000 craters of the size seen. Mars may, indeed, resemble the Moon more than it does the Earth.

The present surface is probably very old, and may not have changed appreciably (except for meteorite impact) for a billion years or more because of an almost complete lack of erosion; the little ero-

Members of the television experiment team wait out the arrival of the first pictures from Mars—Robert Nathan (PhD '56), JPL; Bruce Murray, associate professor of planetary science at Caltech; Robert P. Sharp; Robert Leighton; and Clayton La Baw, JPL. Television data were transmitted at a very low rate—eight hours to complete one picture—to preserve intelligibility over the 130-million-mile distance.

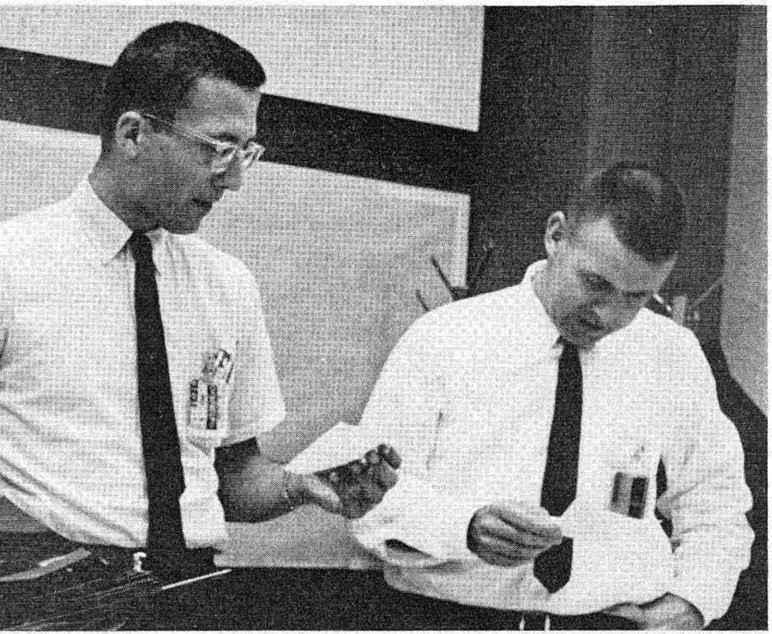
sion that can be seen can probably be attributed to dust and sand storms. Significantly, no signs were seen that water had ever flowed over the present surface. This, together with the very low erosion rate, argues against the possibility that any great bodies of water have existed on Mars since the present surface was formed, for the presence of so much water *anywhere* on Mars would have resulted in severe erosion *everywhere* on the planet, as it does on Earth. The lack of evidence of large bodies of water has prompted some people to conclude that there is little or no likelihood of life on Mars; without water, which serves as a kind of external circulatory system for primitive organisms, it would seem to be very difficult, if not impossible, for life to evolve.

The other striking observation of Mars was the lack of surface features (such as mountain chains and volcanoes) of the kind that are associated on Earth with internal dynamism. Indeed, this simple observation strongly agrees with what Mariner's magnetic measurements also indicated — that Mars has a solid center and, hence, no magnetic field to speak of.

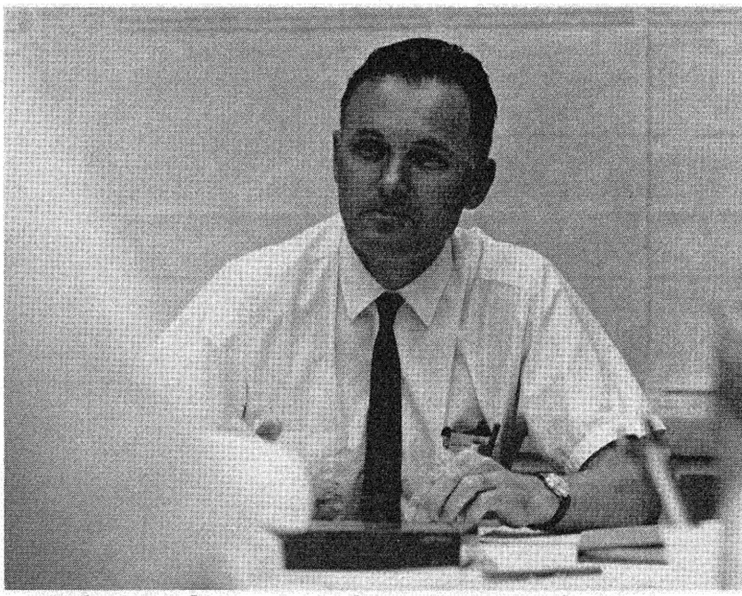
View of Earth, taken from a Nimbus satellite, comparable in resolution to Mariner's pictures of Mars. In addition to Cape Cod, Long Island, and Chesapeake Bay, it shows water and clouds—good signs that life could exist. Actual proof of life on Earth? None.

MARINER MEN

Bill Collier, assistant Mariner Project manager; Dan Schneiderman; John Casani, spacecraft system manager; and W. H. Pickering.



Television experiment investigators — Dick Sloan (MS '56, PhD '64), senior scientist at JPL; and Bruce Murray.



Robert Leighton, principal investigator for the Mariner television experiment.

Leverett Davis, professor of theoretical physics at Caltech, and an investigator for the planetary and interplanatary magnetic fields experiment; and Herbert Bridge, research physicist at MIT, and principal investigator for the solar plasma probe experiment.

Television investigators Denton Allen, JPL engineering group supervisor; and Robert P. Sharp.

OCCULTATION EXPERIMENT

As the path of the radio signal from Mariner intersected with the Martian atmosphere (just before disappearing behind Mars for 54 minutes), the signal's frequency, phase, and amplitude changed. Comparison of the changes with the precisely known parameters of the signal in free space permitted determination of some properties of the atmosphere through which the signal was passing.

Previous observations from Earth suggested that Mars had a low atmospheric surface pressure, somewhere in the range from 20 to 75 millibars (as opposed to about 1000 millibars at the surface of the Earth). Mariner showed that the pressure was about 5 millibars, equivalent to the Earth's atmosphere at about 150,000 feet.

The other important fact gleaned from this experiment was that the atmosphere of Mars probably consists almost entirely of carbon dioxide, based on a combination of Earth and Mariner measurements.

The obvious implication of the thin atmosphere in terms of future exploration is to make it difficult to achieve a soft landing on the surface without using braking rockets (which could alter the very surface features that the vehicle is being sent to investigate). The air, because it is so thin, is quite cold (about -100°C), which explains the extreme dryness of the Martian atmosphere as previously measured from Earth.

MAGNETIC PARTICLE EXPERIMENTS

Trapped electrons and a magnetic moment

Just as high-energy charged particles are trapped in the Earth's upper atmosphere by action of the magnetic field, it was reasoned that a Martian magnetic field would have a similar effect. The trajectory of Mariner passed through regions that would have exhibited three types of characteristic radiation caused by charged particles: bow shock (characteristic of the interaction of the solar wind and the planetary magnetosphere), a transition region, and a magnetospheric boundary — all of which could trap particles for a wide range of Martian magnetic moments. No particles were detected in any of the regions. If it is assumed that the same physical processes leading to acceleration and trapping of electrons in the Earth's magnetic field would be found in a Martian magnetic field, then an upper limit on the magnetic moment of Mars can be set at 10^{-3} that of the Earth.

Search for radiation belts

While there is no quantitative theory of the origin of a planet's radiation belts, it is believed that if the planet is magnetized strongly enough and exposed to the solar wind, belts will exist. Therefore, the failure to detect a radiation belt around Mars would seem to indicate a negligible magnetic field; from this experiment it was concluded that the magnetic field of Mars is less than 10^{-3} that of the Earth.

Magnetic field measurements

It was assumed that the interaction of the solar wind and a Martian magnetic field would produce effects geometrically similar to those observed near the Earth, but with a scale determined by the magnitude of the dipole moment of Mars. Failure to detect a magnetic field implies an upper limit on the value of the Martian magnetic field of between 3×10^{-4} and 10^{-4} that of the Earth.

On the basis of the most widely accepted theory of planetary magnetism, which says that a planet must be endowed with both rotation and a liquid, electrically conducting core, it appears that Mars must lack the fluid core. This may be a reflection of Mars' mass, which is only about 11 percent that of the Earth.

The absence of a magnetic field allows the solar wind to have a direct interaction with the Martian atmosphere, which very likely has an effect on its physical state. The energy and momentum fluxes are large enough that if they interact with moderate efficiency with the Martian atmosphere at the level where ion pressure balances the stagnation pressure of the solar wind, they will remove atmosphere at a rate that is significant in any treatment of its evolution. It is not clear if the present Martian atmosphere has a lifetime comparable to the age of the planet. The absence of high-altitude charged particles means that cosmic radiation and solar-flare protons will reach the top of the Martian atmosphere with their full intensity. Because the atmosphere is so thin, the particles interact with the ground surface, and the entire secondary production of particles from high-energy interactions takes place below the Martian surface.

The success of the Mariner project paves the way for future, perhaps even more spectacular, lunar and planetary exploration. Surveyor, an unmanned but very active outpost to be landed on the Moon, is near completion under JPL's direction, and may have its first test flight late this year. Another project, whose debt to Mariner is incalculable, is JPL's Voyager, which will land an instrument package on Mars sometime near the end of this decade. Voyager will be designed to answer the big question: Does life in some form exist on Mars?

LEAD – DANGEROUS POLLUTION

Clair Patterson, senior research fellow in geochemistry, has been studying trace occurrences of lead in the earth and the ocean. In the course of this work, he has found that there is a profound quantitative influence of industrial lead contamination in the oceans and atmosphere of the Northern Hemisphere. Moreover, Dr. Patterson challenges two commonly held beliefs: (1) that industrial and natural sources contribute more or less equal amounts of lead to the body burdens of the general population, and (2) that the current average ranges of lead concentrations in the blood are essentially "natural" levels, and, hence, safe. Actually, current lead blood levels suggest that the average American is being subjected to severe, chronic lead "insult."

A danger of lead poisoning is that it can attack the central nervous system. The classical symptoms are increased irritability and decreased ability of the brain to function properly. It is possible that similar impairments on a lesser, but still significant, scale might occur in persons subjected to severe, chronic lead insult. While much more must be learned about the metabolism of lead in the human body, it is known that absorbed lead accumulates in the body, and may be stored in the skeleton.

Dr. Patterson points out that it would be tragic if it were recognized many decades from now that large segments of our population had suffered needlessly because the early warning signs now being seen went unheeded. He emphasizes that current average lead concentration in the blood (0.25 ppm) is approaching the recognized threshold level (0.5 to 0.8 ppm) of lead poisoning, and may be 100 times the level that humans had at the time the physiological responses to lead were being developed.

Evidence that lead pollutants are not from natural sources is found in samples taken by Dr. Patterson and colleagues Dr. Tsaihwa J. Chow at the University of California's Scripps Institute of Oceanography, and Dr. M. Tatsumoto of the U.S. Geological Survey in Denver. The samples show that the lead collected from three diverse sources (air in Los Angeles; gasoline in San Diego; and snow on a high, isolated slope of Mount Lassen) is identical isotopically, but different from samples of lead deposited on the ocean floor near California in prehistoric times.

In work sponsored by the U.S. Public Health Service and the Atomic Energy Commission, Dr. Patterson and his colleagues have found that the industrial production of lead today is 100 times greater than the natural flow of dissolved lead salts into all the oceans of the earth, and that the atmosphere now contains thousands of times more lead than it did in pre-industrial periods. Evidence has been found recently in samples taken from various levels in the Greenland ice sheet, of a substantial increase in lead in the snow for the last several decades. Further samples taken at a more remote location in Greenland are currently being analyzed, and Dr. Patterson will take samples in the place most remote from civilization – Antarctica – in the near future.

The difference between *natural* and *typical* levels of lead concentrations and absorptions is the difference between pre- and post-industrial production of lead in large quantities. Typical levels of

Clair Patterson, senior research fellow in geochemistry

Comparison of Lead Absorption in Humans in Natural and Typical Environments

Source	Uncontaminated Man (micrograms/day)	Contaminated Man (micrograms/day)
Food	1	20
Water	0.05	1
Air	0.004	10 (urban) 1 (rural)
Tobacco (1½ packs/day)	....	10

lead in man and his environment may, therefore, be greatly different from natural levels. While actual measurements of natural levels may be available in the future from such things as frozen mammoth tissues, dated mammalian teeth and bones preserved in arid cairns, and tree rings, they can only be estimated reliably by geochemical means now.

As shown above, man today absorbs 20 times as much lead in food and water as he did in an inferred natural environment, and he absorbs over 2000 times as much lead from the air he breathes if he lives in an urban area. As shown below, discussions of absorption are more significant than those of ingestion because the system disposes of lead taken into the body with different efficiencies. Thus, lead in food is more easily passed out of the body than is lead in air, which has to pass into the bloodstream before elimination.

Ingestion and Absorption of Lead for a Typical Human

Substance	Lead Ingested (micrograms/day)	Fraction Absorbed	Lead Absorbed (micrograms/day)
Food	400	0.05	20
Water	10	0.1	1
Urban air	26	0.4	10
Rural air	1	0.4	0.4
Tobacco smoke (1½ packs/day)	24	0.4	10

Dr. Patterson has used gradational relations of chemical properties and observed abundances among the metals mercury, thallium, bismuth, germanium, tin, calcium, strontium, and barium in man and his environment to infer natural levels of lead.

Some striking differences between inferred natural and existing conditions of lead contamination are that:

(1) Existing average body burdens of lead are about 100 times larger than natural burdens.

(2) Existing rates of average lead absorption are about 30 times higher than natural rates.

(3) Existing atmospheric sources of lead make highly significant contributions to absorbed lead, while such sources make insignificant contributions under natural conditions.

Sources of Contamination

Air. The principal sources of lead in the atmosphere are lead alkyls (the result of burning leaded gasolines in automobiles), coal flyash, and lead paint dust. Of these, lead alkyls contribute about 100 times as much absorbable lead as the other two.

Although not actually an atmospheric constituent, lead in tobaccos (present from insect-spraying with lead arsenate) is also ingested through the respiratory system. The amount of lead absorbed into the body by smoke inhalation (for 1½ packs of cigarettes a day) is equivalent to the absorption of lead from all other sources in the urban air.

Food. Although most food is grown in rural areas, it doesn't escape considerable fallout of decomposed lead alkyls. In fact, the amount of fallout is over 1000 times the amount of lead actually ingested in food, so that contamination by only 0.1% of the fallout on crop lands may be significant. Studies made of strontium-90 retention in plants indicate, by analogy, that lead may be retained against rainfall runoff to the extent of about 10% on foliage, about 1% on fruits and pruned leafy vegetables, and 0.1% on edible parts of grains. This may yield about 1 ppm for foliage, 0.04 ppm for fruits and vegetables, and 0.01 ppm for grains.

Additional lead comes from solder used in canned food, and it appears quite possible that the amount of lead dissolved in the food in a medium-sized can could be as much as an entire day's intake from other sources.

Contamination from lead arsenate insecticides is not as significant as it was a few years ago because of the increasing use of organic insecticides. However, wherever it is used, concentrations of lead on the order of several ppm can be expected.

Additional contamination may come from lead used in ceramics and the production of tableware, glass, china glazes, and porcelain enamels for food processing equipment and kitchenware.

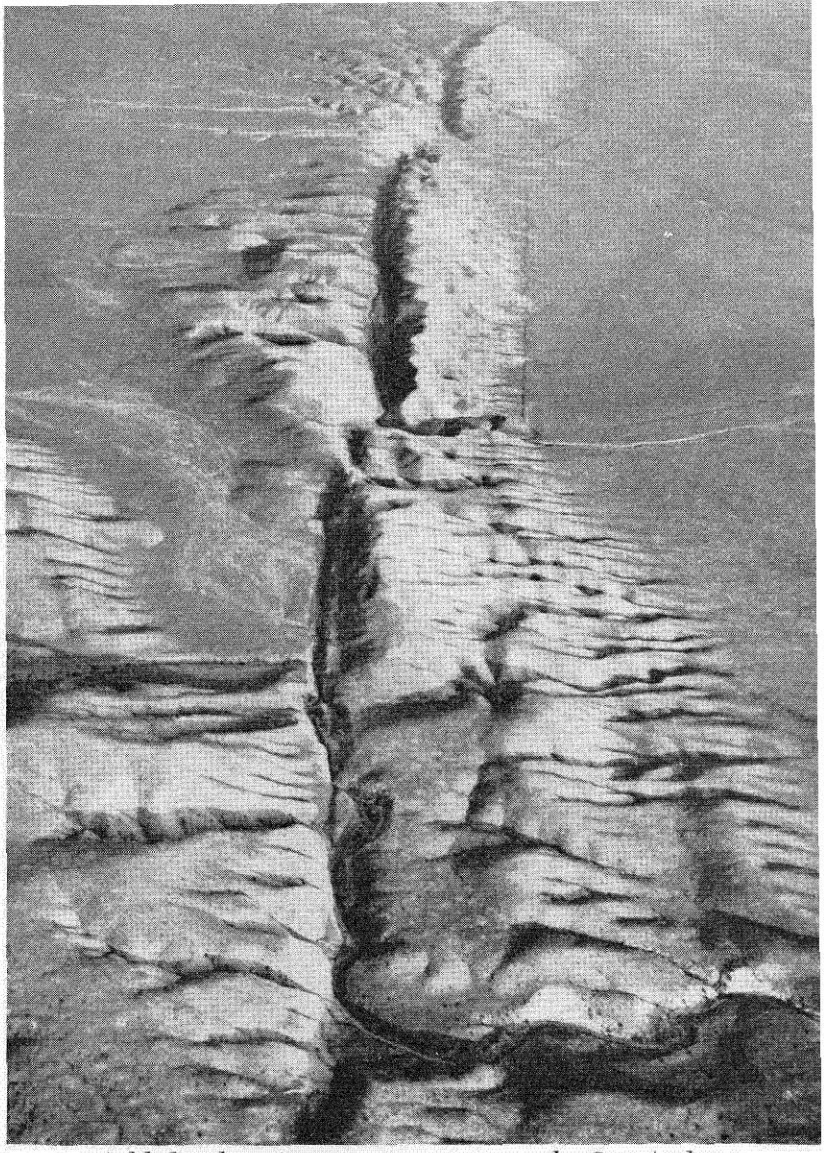
Water. It appears that concentrations of about 10 micrograms per liter in water result from a multitude of sources, including lead derived from atmospheric washout of lead alkyls and from lead service pipes in water systems.

Conclusions

With the exception of tobacco smoke, a large part of the lead ingested today can be traced to leaded gasolines used in automobiles. The remainder commonly originates from such sources as solder, lead arsenate, lead piping, and leaded glazes.

EARTHQUAKE PATTERNS

New conclusions based on a study of Caltech records



A likely place for seismic activity — the San Andreas fault trace in the Carrizo Plains area, west of Taft, in California's Central Coast Range.

A 29-year history of southern California earthquakes has been collected, studied, processed in a computer, and analyzed by a group of Caltech seismologists, who have drawn some new guidelines for evaluating earthquakes and their hazards. The conclusions reached by the team are of particular interest to southern Californians, and may affect some commonly held beliefs about seismic activity. The work was done by Dr. Clarence Allen, interim director of Caltech's Seismological Laboratory; Dr. Charles Richter, professor of seismology; John Nordquist, senior research assistant in seismology; and Dr. Pierre St. Amand, a Caltech graduate who is now head of the Earth and Planetary Sciences Division of the Naval Ordnance Test Station in China Lake, California.

Records from more than 10,000 earthquakes, dating back to the beginning of formal publication of records at the Caltech Seismological Laboratory (1934), were the primary source of data for the study, which was undertaken to gain a better understanding of current tectonic processes in an area of present-day mountain building. The general method of study was comparison of seismic activity with geologic structure — both of which are relatively well known in the southern California region. The region of study was roughly bounded by Mono Lake, California; Ensenada, Mexico; Yuma, Arizona; and the offshore Channel Islands.

Among the conclusions that resulted from this survey and analysis:

Faults that have been most active in the recent geological past (within the last million years) are the most likely candidates for future activity.

This is suggested by the over-all historical record, as well as the abundant geologic evidence for recurrent displacements along such major fault systems as the San Andreas. Also included are the Salton Sea trough; the Agua Blanca-San Miguel fault region in Baja California; most of the Santa Ynez, Santa Monica, San Gabriel, and San Bernardino mountains; the central Mojave Desert; and most of Owens Valley.

Gradual slippage along faults may be a more important factor in relieving strain than was previously thought.

It has been demonstrated that land masses on either side of portions of the San Andreas fault move in opposite directions, building up strain along the fault until the friction of rock against rock is finally overcome, causing an earthquake. While this is still believed to occur, measurements have shown that in some areas there is a corresponding movement along the fault plane — a gradual slipping that produces no shock, but which relieves part of the regional strain. Evidence of such slippage is found in Hollister, where the concrete floor of a winery built across the fault is cracked, with one side moving about an inch a year relative to the other side. However, the concrete lining of the Elizabeth Lake water tunnel of the Owens Valley aqueduct passes right through the fault and has not cracked at the fault in the 52 years it has been there, so it must be concluded that this slippage does not occur on all sections of the fault, if on very many at all.

Occurrence of small earthquakes is not a valid prediction of large earthquakes, at least on a time scale comparable to the one used in the study.

Smaller shocks may actually relieve strain as it builds up, making a large earthquake less likely. This may be the case in the Imperial Valley, which has high seismic activity, but no record of recent great earthquakes.

Temporary quiescence in a seismically active zone may be more a cause for apprehension than for comfort.

Sudden, violent earthquakes in quiet areas have provided illustrations of this several times in the last few years. The great 1960 Chilean earthquake occurred in an area that had been identified as one of low seismicity back to 1904 (the advent of earthquake records for the area), but in a region that had great earthquakes in 1575 and 1835. Before the earthquake, some residents had never felt as much as a slight tremor. Similar examples were 1964 earthquakes in Niigata, Japan, and Prince William Sound, Alaska, and a 1962 earthquake in Iran. While that portion of the San Andreas fault zone northwest of San Bernardino is one of the most seismically quiescent in southern California (with the last major earthquake along it in 1857 at Fort Tejon), it is possible that some strain release does occur through gradual slippage. The current intensive study of the San Andreas fault being conducted by a team of Caltech geologists and geophysicists (*E&S — November 1964*) should provide new data on such strain release. Other quiet areas with active histories include the central Owens Valley and the Banning-Mission Creek fault zone between the Imperial and Coachella Valleys along the east side of the Salton Sea.

Proximity to active faults is by no means the only criterion of seismic hazard.

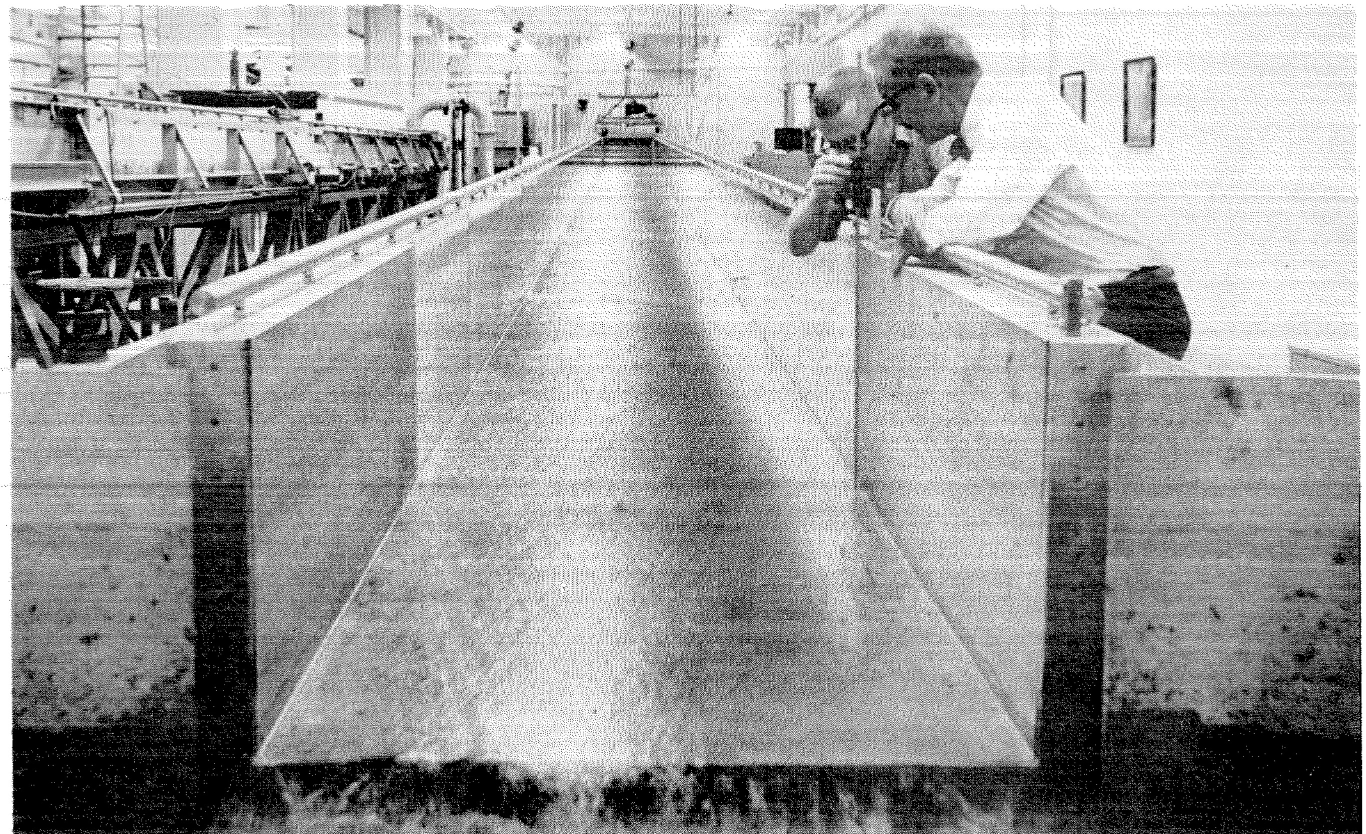
No part of southern California is very far removed from one or more faults that have a demonstrable history of recent displacements. Another significant factor is related to ground conditions, which may play a greater role than location in determining hazard (within certain limits). The 1964 Alaskan earthquake demonstrated this point; ground seemed to lose its strength and fail at great distances from the center of the shock under prolonged shaking, causing extensive damage. In addition, it has been suggested that shaking during a great earthquake may be more intense at some distance from a fault than very close to it.

Aftershocks may cause more damage than the initial shock.

The shallow aftershocks are distributed over a much larger area than is generally realized, and may do more damage in a local area than the main shock itself. In the 1952 Kern County earthquake, an aftershock caused more damage in Bakersfield than did the main shock. Following the Chilean earthquake in 1964, an aftershock of magnitude 7.1 occurred more than 500 miles from the epicenter of the initial shock, and presumably not on the same fault. (For comparison, the 1933 Long Beach earthquake had a magnitude of 6.3.)

Geologic history covers time periods so much longer than man's actual observations of the earth that the data used in this or any similar study could be anomalous, which is why any conclusions drawn for particular areas must be accepted with the numerous constraints imposed by a limited frame of reference. In this vein, the investigators pointed out four areas (the Oceanside-San Diego region, the easternmost and westernmost portions of the Mojave desert, and the central San Joaquin Valley) in southern California that are probably truly stable, because they have a combination of (1) low earthquake activity during the period of study and (2) relative lack of faults showing movements during the last million years.

The study was sponsored by Caltech, the Navy, the Air Force Office of Scientific Research, and the National Science Foundation.



Vito Vanoni and Richard Brock measure heights of waves in the 130-foot flume in the hydraulics laboratory.

Simulated Waves and Flood Control

Using a 130-foot-long flume, Caltech engineers are simulating waves that develop in Los Angeles County's flood control channels during light and moderate rain, to determine whether the waves will build up to dangerous heights during the infrequent periods of concentrated, heavy rainfall. Many of the new concrete channels have never been tested in such rain, and if the waves are present, flooding could result, even though the channels have been designed to accommodate the amount of water being fed into them.

The research, being conducted by Vito A. Vanoni, professor of hydraulics, and graduate student Richard Brock, is sponsored by the Los Angeles County Flood Control District, which operates the world's most extensive metropolitan flood control system. It includes 14 major dams, 12 debris dams, 51 debris basins, over 500 miles of open concrete flood control channels, and 642 miles of enclosed storm drains.

Waves are manufactured in the flume, and the engineers observe how they propagate and what shapes they take, and measure their velocities and heights. There are no detailed field data available on these factors.

The waves have been observed when the channels are carrying from only a few inches to about two feet of water. The problem is to determine what kinds of waves there will be, if any, when the flood channels are at capacity. The channel walls are designed to be about 2½ feet higher than the high water mark during maximum flow.

Apparently the waves require some time and distance to form. They first appear a mile or more below the channel inlet in a small flow of water traveling at about seven miles an hour. The waves always travel faster than the water. The greater the volume of water in a channel, the faster the water will move. When channels are running at capacity, the water in them may be traveling as fast as 40 miles an hour. This velocity may not give the waves enough time to form. One of the goals of the study is to learn whether time or channel length is more important.

The channels are designed to move water more rapidly than did the original stream beds which they have replaced. The beds had many boulders and turns which slowed the flow. The channels are designed to move as much water as possible in the shortest time. The resulting rapid flow means that more water can be handled in a smaller channel.

The Month at Caltech

75th Anniversary

Caltech, which dates from the 1891 founding of Throop University, will be 75 years old next fall. Plans for the anniversary celebration are now under way and center around a week-long program of meetings, lectures, and special events. The celebration will bring to the campus distinguished persons and representatives of institutions of higher learning, foundations, industries, and businesses from all over the world.

David Elliot, Caltech professor of history, has been named chairman of the 75th Anniversary Convocation, and is working with a faculty committee to explore and expand preliminary ideas for the commemoration celebration. The central theme will concern the operations and significance of science in our changing civilization.

Lunar and Planetary Conference

Caltech was host to more than 130 international space scientists at a six-day Lunar and Planetary Conference held on campus September 13-18. Participants from eight countries and the United States gathered to pool information, deliver papers, advance and argue theories, and survey the results of our most recent knowledge of the moon and planets.

Meetings of the first five days were attended only by the invited scientists and engineers; on the final day, sessions were open to representatives of Caltech's Industrial Associates and other guests of the conference sponsors – Caltech, JPL, and NASA.

Monday and Tuesday conference sessions were devoted to lunar astronomy; Wednesday to the planet Jupiter; Thursday, Venus; and Friday, Mars. Highlights of the final day, attended by some 750 persons, were an up-to-date report on Mariner IV's fly-by, and a surprise slide-showing of eight previously unreleased Russian pictures of the backside of the moon.

Honors and Awards

President L. A. DuBridge received an honorary doctor of science degree from The Rockefeller Institute in New York City, at their Annual Convocation for Conferring Degrees in June.

William A. Fowler, Caltech professor of physics, was awarded the Columbia University 1965 Barnard Medal for Meritorious Service to Science, and was cited for his pioneering work in the nuclear reactions of the lighter elements and its widespread influence on nuclear physics, astrophysics, and related fields.

Jesse L. Greenstein, Caltech professsor of astrophysics and staff member of the Mt. Wilson and Palomar Observatories, has been elected to the board of overseers of Harvard University. Dr. Greenstein received his BA, MA, and PhD degrees from Harvard.

Charles Lauritsen, Caltech professor of physics, emeritus, was awarded an honorary doctor of law degree from the University of California at Los Angeles at the June commencement exercises.

Theodore C. Sorenson

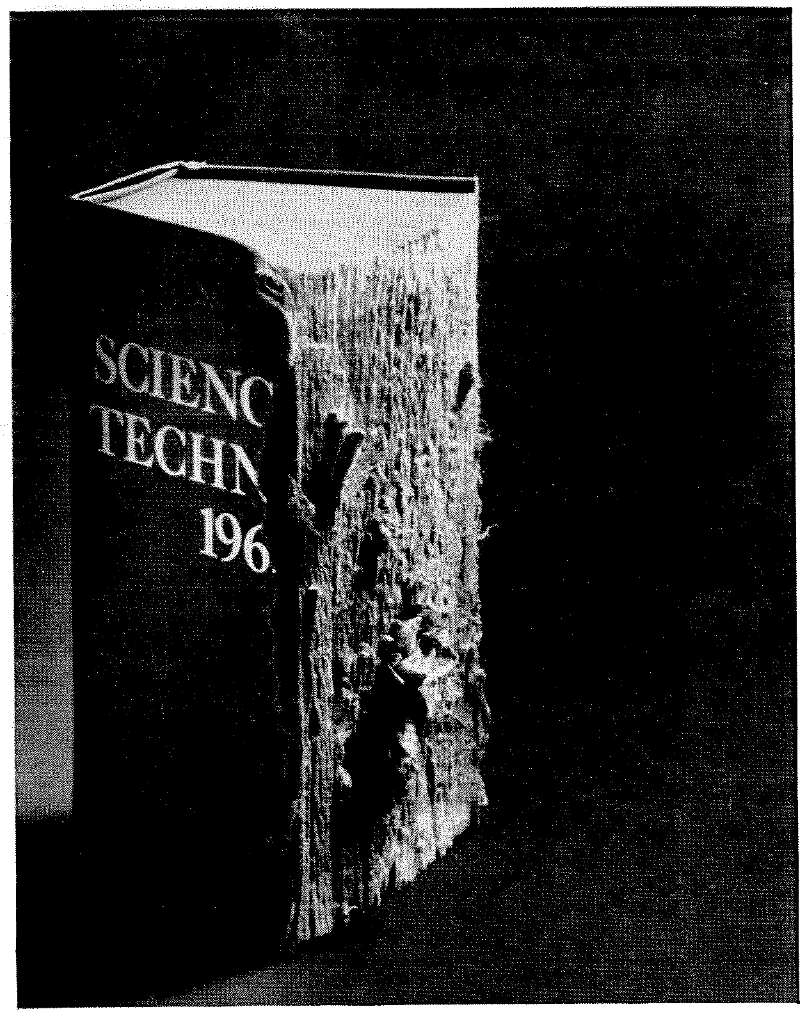
Theodore C. Sorenson, writer, lecturer, and former special counsel to President Kennedy, will be on campus November 17 and 18 as a guest of the Caltech YMCA under their Leaders of America program.

Sorenson, whose book, *Kennedy,* has just been published, will give a public address in Beckman Auditorium on November 17, and will meet informally with student and faculty groups during the two-day visit.

Sorenson is the first of the 1965-66 "Leaders". The program, sponsored annually by the Caltech Y since it was established in 1954, brings distinguished persons to the campus to lecture and to discuss subjects of political and social significance.

James N. Ewart

James N. Ewart, secretary of the Caltech board of trustees, has been elected assistant secretary and assistant treasurer of the California Institute Associates, the organization of industrial and professional leaders dedicated to advancing Caltech's welfare. Mr. Ewart, who came to Caltech in 1946 to set up the personnel department, succeeds Herbert G. Nash, who has retired after 43 years at the Institute.



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Faculty Changes 1965-1966

PROMOTIONS

To Professor:

JAMES K. KNOWLES — *Applied Mechanics*
JOEL N. FRANKLIN — *Applied Science*
JEROME VINOGRAD — *Chemistry and Biology*
ROBERT D. MIDDLEBROOK — *Electrical Engineering*
LEON T. SILVER — *Geology*
ADRIANO M. GARSIA — *Mathematics*

To Associate Professor:

MARC A. NICOLET — *Electrical Engineering*
PETER L. CRAWLEY — *Mathematics*
RALPH W. KAVANAGH — *Physics*
GERRY NEUGEBAUER — *Physics*
FOSTER STRONG — *Physics*
ROCHUS E. VOGT — *Physics*

To Senior Research Fellow:

PETER H. LOWY — *Biology*
MICHAEL F. MOODY — *Biology*
LAJOS PIKO — *Biology*
MARIUS W. VAN HOF — *Biology*
RAOUL KOPELMAN — *Chemistry*
DUEN-PAO WANG — *Engineering*
CLEMENS A. HEUSCH — *Physics*

To Assistant Professor:

WOLFGANG G. KNAUSS — *Aeronautics*
MORRIS BROWN — *Organic Chemistry*
RUSSELL A. WESTMANN — *Civil Engineering*
HENRY A. KREIGER — *Mathematics*
DONALD S. BURNETT — *Nuclear Geochemistry*
CHARLES W. PECK — *Physics*
THOMAS A. TOMBRELLO — *Physics*
JOHN N. BAHCALL — *Theoretical Physics*
ROGER F. DASHEN — *Theoretical Physics*

NEW FACULTY MEMBERS

Professors:

ROBERT E. IRELAND — *Organic Chemistry* — from the University of Michigan, where he was associate professor of organic chemistry.

RICHARD T. SHIELD — *Applied Mechanics* — from Brown University, where he was professor of applied mathematics.

FREDERICK B. THOMPSON — *Applied Science and Philosophy* — from the General Electric Corporation in Santa Barbara, where he was a member of the technical staff.

Research Associates:

JAMES E. MERCEREAU — *Physics* — from the Ford Motor Company in Dearborn, Michigan, where he was staff member of the engineering research department.

Associate Professors:

JAMES N. BRUNE — *Geophysics* — from Columbia University, where he was adjunct associate professor of geology.

JAMES J. MORGAN — *Environmental Health Engineering* — from the University of Florida, where he was associate professor of water chemistry and research associate professor of civil engineering.

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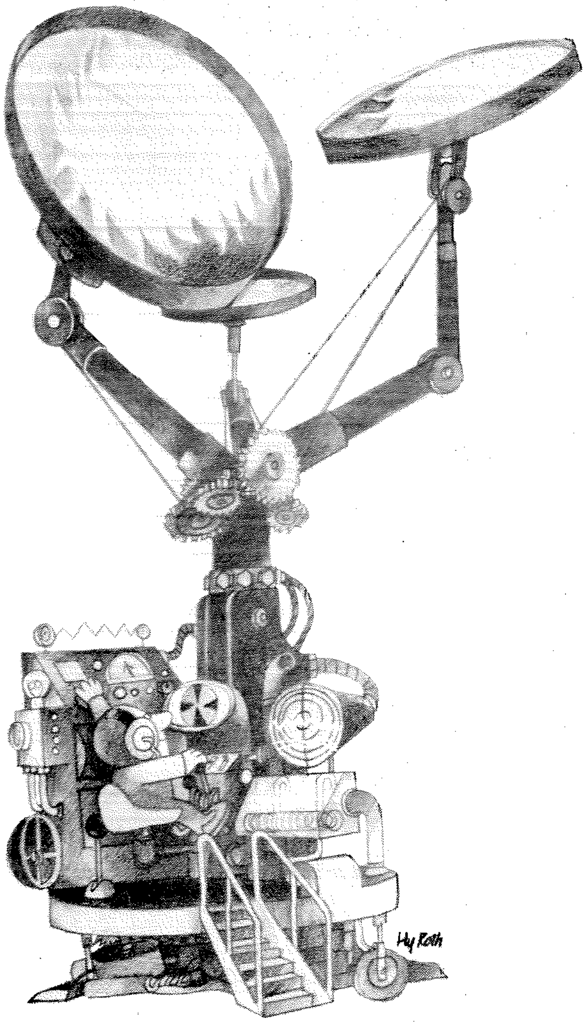
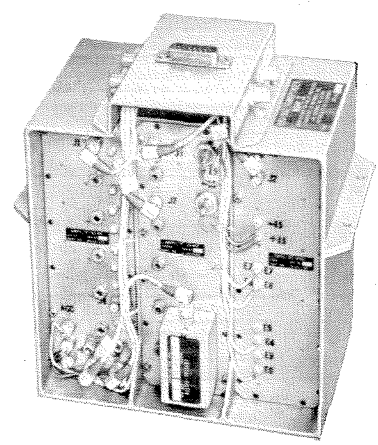


Flash it with a sun mirror . . .



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Faculty Changes . . . *continued*

RANGASAMI SRIDHAR – *Electrical Engineering* – from Purdue University, where he was associate professor of electrical engineering.

NICHOLAS W. TSCHOEGL – *Materials Science* – from the Stanford Research Institute, where he was a senior physical chemist.

Assistant Professors:

JOHN F. BENTON – *History* – from the University of Pennsylvania, where he was assistant professor of history.

DONALD S. COHEN – *Mathematics* – from Rensselaer Polytechnic Institute, where he was assistant professor of mathematics.

WILLIAM R. COZART – *English* – from Free University, Berlin, Germany, English Seminar.

JOHN A. HOLBROOK – *Mathematics* – He received his PhD degree from Caltech in June, 1965.

KEITH L. PHILLIPS – *Mathematics* – from the University of Washington, where he was instructor in mathematics.

GALEN L. SEEVER – *Mathematics* – from the University of California at Los Angeles, where he was acting assistant professor of mathematics.

FREDERICK H. SHAIR – *Chemical Engineering* – from the General Electric Company's Space Sciences Laboratory in Santa Barbara, where he was a research engineer.

WILLIAM B. WOOD – *Biochemistry* – from the University of Geneva, where he was a postdoctoral fellow in the department of biophysics.

Instructors:

JOHN F. CRAWFORD – *English* – from Newark College of Engineering, where he was instructor of English.

ROGER G. NOLL – *Economics* – from Harvard, where he was a teaching fellow. He received his BS degree from Caltech in mathematics in 1962.

ON LEAVE OF ABSENCE, 1965-1966

FELIX H. BOEHM, professor of physics, to study at the Bohr Institute in Copenhagen.

ROBERT D. MIDDLEBROOK, professor of electrical engineering, to write, and to give lectures and observe work in solid state electronics at universities and in industries in Europe and the United States.

DAVID BRAVERMAN, associate professor of electrical engineering, to the Hughes Aircraft Company in Los Angeles, the Space Systems Division, to help in defining the role of the synchronous satellite in worldwide communications.

DAVID R. SMITH, assistant professor of English, to do research and to write a book on the developing art of Joseph Conrad.

BRADFORD STURTEVANT, assistant professor of aeronautics, to Harvard to teach fluid mechanics and to do experimentation in non-linear dispersive water waves.

RESIGNATIONS

ANTON LANG, professor of biology, to Michigan State University.

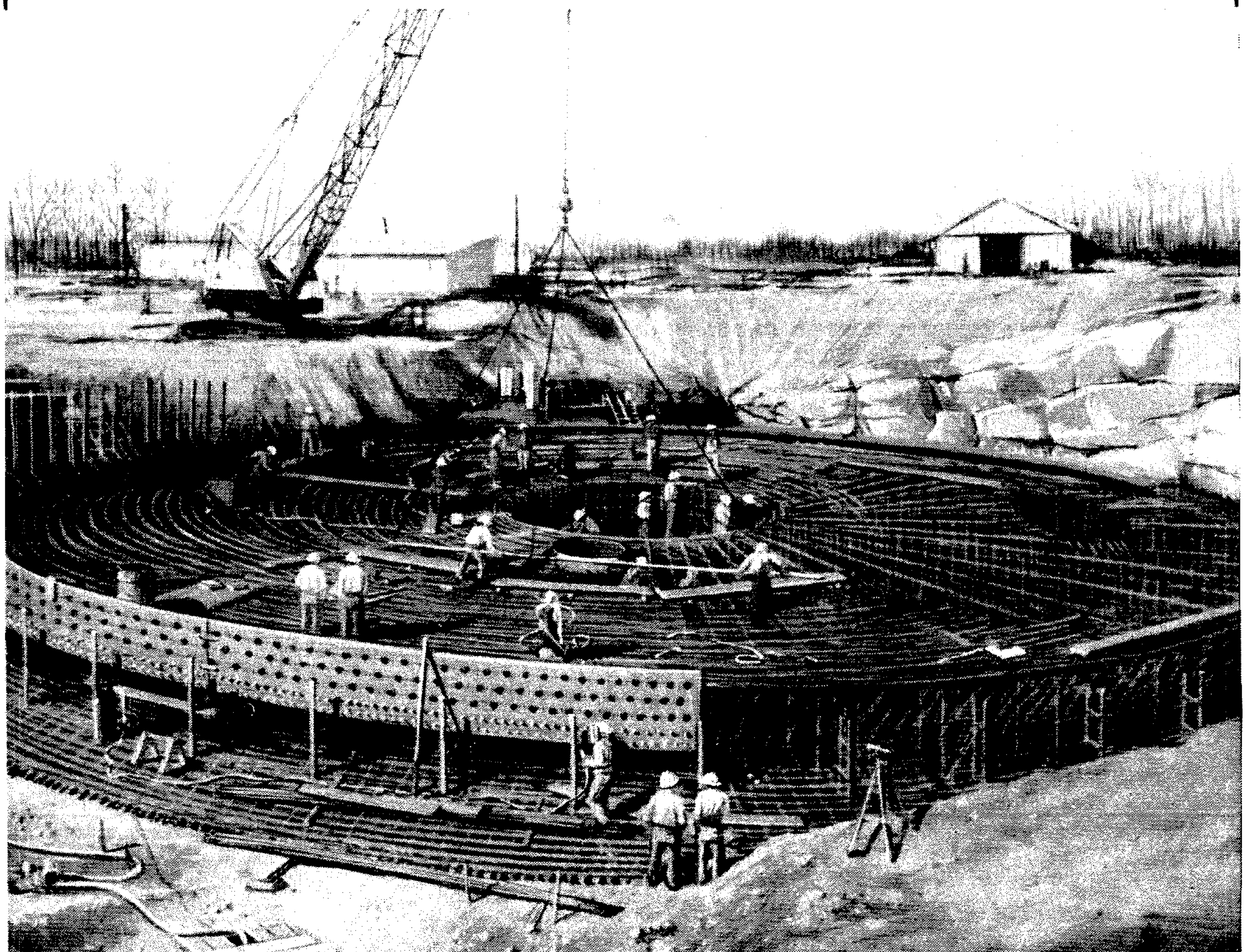
FRANK PRESS, professor of geophysics, director, Seismological Laboratory, to MIT.

MILTON LEES, associate professor in mathematics, to Case Institute of Technology.

ROBERT L. KOVACH, assistant professor of planetary science, to Stanford University.

JAMES D. HALPERN, instructor in mathematics, to the Institute for Advanced Studies, Princeton.

COLIN W. CRYER, instructor in mathematics, to the University of Wisconsin.



Personals

1922

LINNE C. LARSON has retired as executive officer of the Los Angeles Regional Water Pollution Control Board, State of California, after 15 years of service. He and his wife, Ruth, live in Glendale, and plan to do some traveling.

CLYDE R. KEITH has resigned after four and a half years as assistant director of audiovisuals for the Presbyterian Board of National Missions. This is Keith's second retirement. In 1961 he left the Bell System after 38 years with Bell Telephone Laboratories and Western Electric. He plans to do consulting work in sound recording, particularly for Recording for the Blind in New York City.

1924

MAURICE B. ROSS retired last spring after nearly 40 years of service with the San Diego city schools. During that period he served at various times as teacher, research assistant, secretary of the board of education, and, for the past 21 years, as principal of the Sherman Elementary School.

1927

THOMAS S. SOUTHWICK, MS '29, is in Bangkok working with the Meteorological Department of Thailand for the United Nations – World Meteorological Organization, according to news from CHAROEN CHAROEN-RAJAPARK '47 (see Personals under 1947).

1928

FRANCIS NOEL and his wife have been traveling in Europe since May, visiting England, France, Germany, Switzerland, Austria, Czechoslovakia, Denmark, Sweden, Norway, and Holland. They expect to tour the Mediterranean before winter, and possibly to be in Australasia for Christmas.

CARL F. RENZ, MS, has moved to San Marcos, Calif., after retiring in April from The Ohio River Division Laboratories in Cincinnati, where he was a structural engineer.

1929

CHARLES A. BOSSERMAN is working on the 707 design project for the Boeing Company in Renton, Washington. Active in political, interracial, and anti-poverty work, he is also consultant for the Central Area Business Enterprises (CABE) of Seattle, an organization which helps provide jobs for residents of the city.

1931

ABRAHAM J. GRAFMAN has returned to Los Angeles after nine years in Israel as technical advisor with the engineering department of the Israeli Air Force. On the homecoming trip Grafman and his wife visited Iran, India, Nepal, Thailand, and Japan. Their two sons, who married Israeli girls, remained in the Middle East.

1936

CURTIS G. CORTELYOU has recently moved to New York City to become air and water conservation coordinator for the Socony Mobil Oil Company, Inc. He has been with Mobil since 1938, most recently as general manager of operations at the Torrance refinery.

1939

CHARLES H. TOWNES, PhD, provost and professor of physics at MIT and co-winner of the 1964 Nobel Prize for physics, has been named to the board of trustees of The Rand Corporation. KENNETH S. PITZER, '35, president of Rice University, is also a member of the Rand board.

HERMAN S. ENGLANDER is a project scientist at the Naval Electronics Lab in San Diego, a job he describes as "teaching-factotum." He reports he has a daughter in high school and a married son.

1940

DOUGLAS B. NICKERSON has opened an office in Pasadena as a consultant and product designer in cryogenics and fluid flow. He was formerly at the Von Karman Center of Aerojet General Corp. in Azusa.

DONALD E. LOEFFLER, technologist at the Martinez refinery of the Shell Oil Company, writes that 1965 is the "Year of the Boy Scout" for him. With a daughter in junior Girl Scouts, and two sons in Scouting, he joined them as Scoutmaster.

LLOYD T. GOODMANSON, MS '41, is a project engineer with the Boeing Company in Seattle. His son, Mike, is a junior at Caltech, and his daughter is a sophomore at Central Washington State College in Ellensburg.

HENRY G. HOHWIESNER, JR., writes from Salem, Oregon, that his daughter is a freshman at Scripps College in Claremont, and his son will graduate from the Air Force Academy in June 1966.

DUMONT S. STAATZ, MD., FACS., is a practing orthopaedic surgeon in Tacoma, Washington, and has five children, ages 21, 20, 18, 15, and 13.

KEITH E. ANDERSON, consultant in engineering and geology in Boise, Idaho, recently returned from a 30-day assignment in Turkey, accompanied by his wife. On the return trip the Andersons visited their son Elliott in France, where he was spending his college junior year. The Anderson children at home are Stuart, 17, Paula, 12, and Holly, 8.

WILLIAM W. STONE, JR., MS '41, Colonel in the U.S. Army, is the commanding officer at Dugway Proving Ground in Utah.

JACK TIELROOY is a consulting chemical engineer with an office in Fullerton, Calif., although he says it is more often "aboard American Airlines or KLM." The Tielrooys celebrated their 25th anniversary this year. They have a married daughter, a one-year-old granddaughter, and three sons still in school .

DONALD H. KUPFER is associate professor of structural geology at Louisiana State University in Baton Rouge. He and his wife have a 12-year-old daughter and a 10-year-old son.

LUDWIG IVAN EPSTEIN is back in graduate school, working on his PhD degree at Ohio State University in Columbus. He recently taught at Marietta College in Ohio, and before that time at the Lowell Technological Institute in Massachusetts.

WILLIAM R. CLEVELAND, JR., MS '42, has completed his 19th year of teaching geology at the College of Sequoias in Visalia, Calif. His son graduated from Sequoias in June.

JULES F. MAYER, MS '41, is superintendent of the chemical division of the Standard Oil Company's Richmond, Calif., refinery. His oldest son is 21, and "the others range down to nine years for a total of four." On a recent trip to the Mother Lode country he visited H. JACK WHITE '40, in Placerville.

WILLIAM R. V. MARRIOTT, MS '42, Colonel in the U.S. Air Force, is Commander of the hospital at Hamilton Air Force Base in California. He was assigned there in April after 14 months in Saigon, where he managed the Air Force medical activities in Viet Nam, Thailand, Laos, and Cambodia. He succeeded in getting medical facilities out of tents and into fixed structures at six bases and he reorganized the medical staffing, supply, and administrative procedures of facilities in Viet Nam and in Thailand.

1941

ELDRED W. HOUGH, MS, PhD '43, is now assistant dean of the School of Tech-

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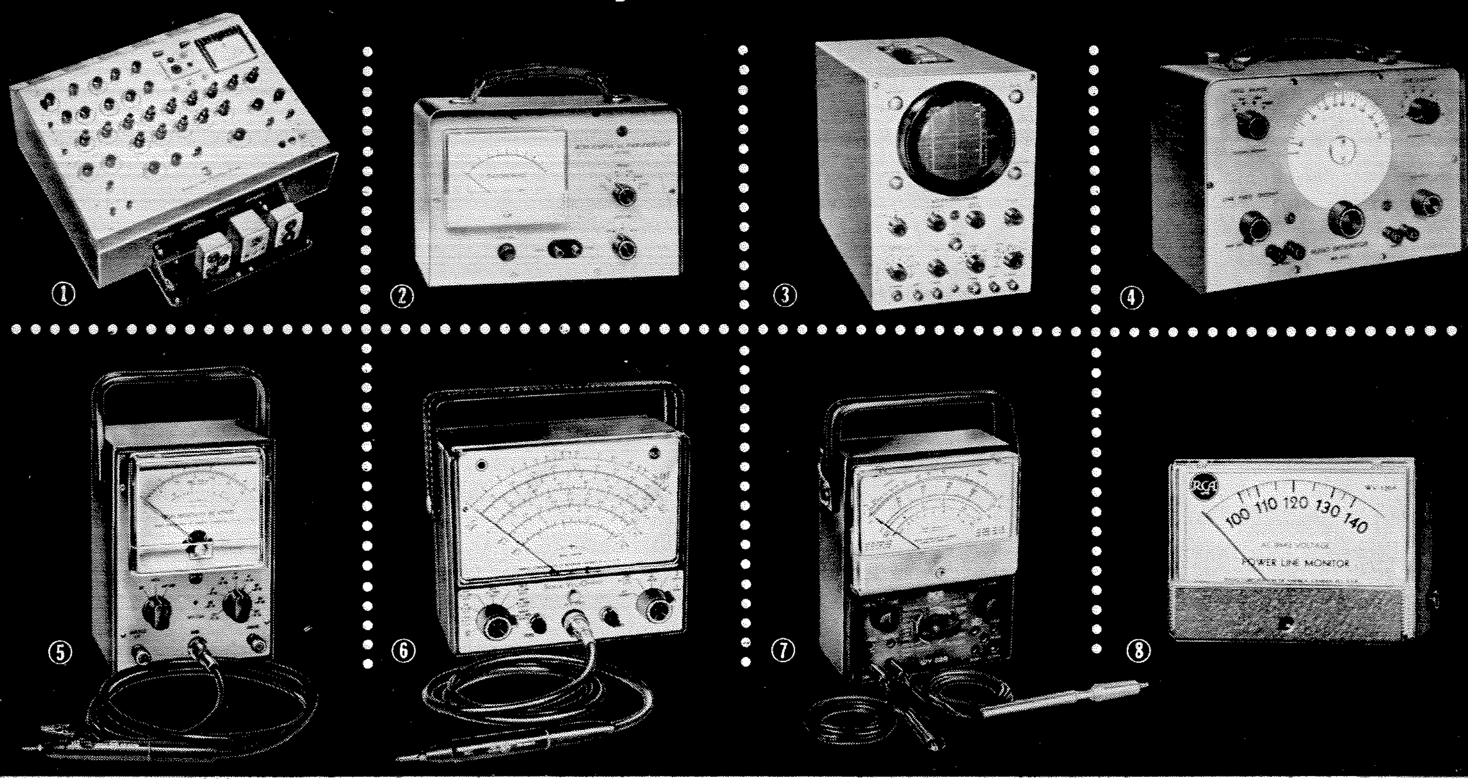
Equipment maintenance...Product quality checks...
Laboratory measurements...



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❸ **WO-91B RCA 5-INCH OSCILLOSCOPE** A high-performance, wide-band 'scope—serves as a display-type VTVM. Choice of wide band (4.5 Mc—0.053-volt rms/inch sensitivity) or narrow high-sensitivity band (1.5 Mc—0.018-volt rms/inch sensitivity). New 2-stage sync separator provides solid lock-in on composite TV signals. **$249.50***

*Optional Distributor Resale Price

❹ **WA-44C RCA AUDIO GENERATOR** Generates sine-wave and square-wave signals over range of 20 to 200,000 cps to test audio systems. Can be used to measure intermodulation distortion, frequency response, input and output impedances, speaker resonance, transient response, and phase shifts. Less than 0.25% total harmonic distortion over range of 30 to 15,000 cps. **$98.50***

❺ **RCA WV-76A HIGH-SENSITIVITY AC VTVM.** A combination voltmeter and preamplifier for audio applications. For signal tracing, audio-level and power-level measurements, gain measurements, amplifier balancing applications, and audio voltage measurements. Frequency response from 10 cps to 1.5 Mc with "direct" probe, 10 cps to 500 kc with "low-cap" probe. Measures decibels from —40 to +40 db in 9 overlapping ranges (up to 56 db with probe switch in "low-cap" position). As a pre-amplifier, provides up to 38 db maximum gain. **$79.95***

❻ **WV-98C NEW RCA SENIOR VOLTOHMYST®** For direct reading of peak-to-peak voltages of complex waveforms, rms values of sine waves, DC voltages, and resistance. Accuracy: 3% full scale on both AC and DC, with less than 1% tracking error. Color-coded scales differentiate peak-to-peak from rms readings. New 0.5 volt full scale DC range for use in low-voltage transistor circuits. 6½" meter. **$79.50***

❼ **RCA WV-38A VOLT-OHM-MILLIAMMETER** One of the most versatile electronic test instruments. 0.25-volt and 1.0-volt DC ranges. Big easy-to-read 5½" meter. Non-breakable sealed plastic case. Jacks located below switches to keep leads out of the way. Spring clips on handle to hold leads. Attractive, scuff-resistant, rugged carrying case, only $4.95* extra. **$47.95***

❽ **RCA WV-120A POWER LINE MONITOR.** Provides a constant check on incoming line voltage. Responds to voltage fluctuations. Highly accurate (± 2% at 120 volts). Gives true rms reading. 5" wide meter. **$14.95***

SEE THEM ALL AT YOUR AUTHORIZED RCA TEST EQUIPMENT DISTRIBUTOR.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

The Most Trusted Name in Electronics

announcing the

Donald S. Clark Alumni Award

Donald S. Clark has now been associated with Caltech for 40 years; as a student, a professor, a distinguished researcher, and a tireless member of the Alumni Association.

The *Donald S. Clark Alumni Award* will honor Don for a lifetime devoted to Caltech and its alumni.

The award will be given to undergraduates in their junior year in recognition of demonstrated leadership potential and superior academic performance without regard to other financial aid.

Alumni have set a goal for 1965-66 of $25,000, income from which will provide the award beginning next year. All gifts will be credited through the current Alumni Fund.

Make checks payable to California Institute of Technology.

Personals . . . *continued*

nology of Southern Illinois University, in Carbondale. He was formerly head of the department of petroleum engineering at Mississippi State University.

JOSEPH W. LEWIS, JR., was recently elected president of the Board of Education of the San Marino, Calif. Unified School District. LEROY SANDERS, JR., '44, was elected vice president.

1942

JOHN K. DIXON is in Cleveland Clinic Hospital in Cleveland, Ohio, recovering from a kidney transplant operation. He is in continuing need of replacement blood, and friends wishing to help can contact their local Red Cross Blood Bank for donor information.

1944

THOMAS W. NORSWORTHY, president of Norsworthy-Mercer, Inc., advertising agency in Dallas, was crusade chairman of the 1965 American Cancer Society drive in Dallas county.

1945

DUDLEY B. SMITH has joined the international licensing department of the Celanese Corporation of America in New York City, after 10 years with Cluett, Peabody & Company, and Clupak, Inc. The Dudleys have four children.

HUGH S. WEST, director of training and research for the sales operation of Connecticut Life Insurance Company in Hartford, confided to his Caltech class secretary that "the last 20 years must have worn on me more like 40. My wife, on appearance at court recently for nonregistration of her car, was asked by the judge whether she was my daughter."

1947

JOHN L. MASON, MS '48, PhD '50, announces the birth of John Edward, his fourth child, third son, on July 13.

ELLIS H. BEYMER has been named manager of the Raytheon Company's Oxnard, Calif., facility, operated by the firm's missile systems division. In his 14 years with Raytheon, Beymer has been assistant manager of the NATO Hawk Support organization, manager of the flight test facility at the White Sands Missile Range, and missile system section head of the Oxnard laboratory. From 1962-64 he was an industry member of the U.S. team of national experts on NATO air defense in Paris.

CHAROEN CHAROEN-RAJAPARK, MS '48, writes from Bangkok that he has been appointed deputy director-general for technical services of the meteorological department of Thailand. He and his wife,

Personals . . . *continued*

Somsri, have three sons, 12, 4½ and 3½ years old.

ROBERT B. DAY, MS, PhD '51, died August 15 in a mountain climbing accident in southern Colorado. A physicist with the Los Alamos Scientific Laboratory, Day and three fellow climbers were descending 14,000-foot South Maroon Peak, when apparently one slipped and all were pulled by the safety rope down a boulder-strewn snow field for nearly 1,000 feet One of the men survived to summon rescuers. Day leaves his wife, Jean, and five children: Deborah, 16; Margaret, 14; Robert, 10; Stephen, 9; and Charles, 7. His associates have established a memorial fund for his children's education.

1948

ALLEN T. PUDER, MS '49, vice president of research and development of the Hughes Electronics Company of Los Angeles, recently presented a paper to the Society of Motion Picture and Television Engineers on an illuminator system, designated XTL (Xenon Twin Light), which he developed. The new system supplies up to 25 percent more usable light than equivalent wattage systems for projection of 35mm and 70mm motion pictures.

PATRICK N. GLOVER has been transferred by the Shell Oil Company to the exploration economics department in New York City, after eight years in Denver. The Glovers live in Westport, Conn., with their three sons: John, 15; Michael, 14; and David, 7.

KEITH W. HENDERSON has joined the Stanford Linear Accelerator Center as an electronics engineer, and lives with his wife, Verneice, in Mountain View.

1949

JESSE C. DENTON, MS, is chairman of the mechanical engineering department of Southern Methodist University in Dallas. He also is principal investigator for the NASA multi-disciplinary institutional grant for $200,000.

1950

WILLIAM B. HIGGINS, Lieut. Col. in the U.S. Marine Corps, writes that he has been selected for "bird colonel" and is now at El Toro Marine Corps Base in Santa Ana, Calif. Higgins just returned from South Vietnam where he was executive officer of an aircraft attack group operating in support of Marine forces.

1952

WILLIAM W. IRWIN, secretary-treasurer of Induflux, Inc., and of Irwin Laboratories, Inc., both of Los Angeles, recently was elected to a top post in Toastmasters International. He will serve as administrative lieutenant governor for Founder's District of the international organization.

1955

THOMAS W. NOONAN, PhD '61, professor of astronomy at the University of North Carolina at Chapel Hill, has been selected by the National Science Foundation to write a textbook on relativity from the research of his faculty advisor at Caltech, H. P. Robertson, professor of mathematical physics, who was killed in an automobile accident in 1961. The book, requested by the Air Force, will be a memorial to Robertson. Noonan, the last student to earn a PhD under Dr. Robertson, will use papers and notes from a course taught by his professor.

1956

DONALD J. SELDEEN is supervisor of the wedding rings division of J. R. Wood & Sons, Inc. He and his wife, Darlene Jacqueline, live in Corona, N.Y.

1958

HALLAN C. NOLTIMIER is senior demonstrator in physics at the University of Newcastle in England, where he recently received his PhD. He and his wife have a two-year-old son and are expecting a second child this month. Mrs. Noltimier received her MBBS last year and is now a registered Doctor of Medicine.

GORDON DAVID LANGE received his PhD in biophysics from the Rockefeller Institute in New York in June and will be a research associate there for the 1965-66 academic year. He and his wife, (Nadine Goodstein, PCC '57, honorary member of Dabney House '58), have two sons: three-year-old Douglas, and Ronald, born April 7 .

1960

MARTIN A. KAPLAN, class secretary, helped plan the June 9th reunion in Los Angeles, and urged all class members who couldn't attend to let him know what they were doing. Here are some replies:

DONALD W. ANDERSON plans to teach at MIT this year. After receiving his PhD at the University of California in Berkeley in 1964, he was at Oxford, England, on a National Science Foundation aerospace fellowship, and at Harvard, doing research and study.

L. CAMERON MOSHER plans to be in Europe this year continuing work on his PhD, which he began at the University of Wisconsin in Madison. He plans to "compare my work in the Triassic of the Great Basin with the type sections of the Triassic system in Europe." Mosher is married and has a 1½-year-old daughter.

DOUGLAS R. McLANE is with the Dole Company in Honolulu, having completed his master's program in industrial management at MIT in June. He and his wife, the former Cecelia Palmer, have a 10-month-old son, Sean Robert.

GORDON D. LONG writes that he has been with Tektronix, Inc., in Beaverton, Oregon, since 1960 and has designed everything from sampling 'scopes to spectrum analyzers.

ROBERT G. CHAMBERLAIN, MS '61, is a research engineer at Caltech's JPL in the systems analysis section. He married Elene Roen, "a girl I met at the ASCIT dance class." The Chamberlains have sons 3½ and 2½ years old, and a daughter 7 months.

NORMAN E. MACLEAN, JR., MS '61, is working at TRW Systems in Redondo Beach, Calif.

KEITH A. TAYLOR, MS '61, is at Tektronix, Inc. in Oregon, designing fast vertical amplifiers. He writes, "The 50mc-547, in case anybody is familiar with it, is my fault." Taylor keeps busy skiing, backpacking in the Cascades, keeping a sports car running, photographing, beer drinking and "enriching Merrill Lynch." He hears that BOB LUSHENE '61, is doing graduate work in psychometrics at the University of North Carolina in Durham, and LEE RENGER, MS '61, has been tracking missiles in Eniwetok for two years, but returned to the U.S. in August.

WILLIAM B. ARVESON, who was acting assistant professor in mathematics at UCLA this past year, is now at Harvard on a Benjamin Pierce Instructorship in Mathematics. Bill is married and has a year-old son. He was with the U.S. Naval Ordnance Testing Station in Pasadena before getting his MA and PhD degrees at UCLA (1961-64).

RONALD G. LAWLER is assistant professor of chemistry at Brown University in Providence, Rhode Island. After receiving his PhD from the University of California at Berkeley, he did two years of postdoctoral work in electron spin resonance at Columbia University in New York. The Lawlers have a 2½-year-old daughter, Jennifer.

FLETCHER I. GROSS is assistant professor of mathematics at the University of Alberta in Edmonton, Alberta, Canada.

1961

WILLIAM L. DOWD was killed on June 13 by severe blows on the head, attacked by a burglar he discovered ransacking his apartment in San Diego. He was working on his PhD at the University of California at San Diego, and was on a fellowship at the Scripps Institute of Oceanography. "He was one of the most brilliant in his field," according to Harmon Craig, as-

Personals . . . *continued*

sociate professor of geochemistry at the school.

BENT HULD, graduate student in physics working on his PhD at Harvard, was seriously injured in an atomic laboratory explosion in Cambridge, Mass., on July 5. He was recently released from the hospital and is now back on campus.

ELI I. CHERNOW is now associated with the Los Angeles law firm of Tuttle & Taylor, after a year at Harvard as a Frederick Sheldon Traveling Fellow

JOEL A. MICHAEL has been awarded a research fellowship by the Carnegie Corporation of New York. The grant provides for a year at the National Physical Laboratory, Teddington, England, where he will investigate the brain processes involved in vision. Since leaving Caltech, Michael has received an MS from McGill University, Montreal, Canada, and a PhD from MIT.

1962

MARC L. RENARD, AE, is in Delft, Holland, with the European Space Technology Centre of the European Space Research Organization. He reports other Caltech alumni on the staff are: JEAN A. VANDENKERCKHOVE, MS, '54; JEAN B. LAGARDE, MS '60; and RENE C. COLLETTE '63.

1963

JAMES E. McCOY writes that he is working as a physicist and also on optics at the National Space Center in Houston, and is attending Rice University on a fellowship. McCoy and his wife have a 2½-year-old daughter and are expecting a second child this fall.

1964

CHARLES F. LEONARD is studying medicine at the College of Physicians and Surgeons of Columbia University, and reports that last year he directed the school's first-year class show — a satire on the college in which 60 students participated. He is writing a book for the Denny George School in New York City — "The Applications of Land Value Taxation."

DAVID L. COLTON has begun his studies for a PhD at the University of Edinburgh. He will be working under Professor A. Erdélyi, former professor of mathematics at Caltech.

1965

RONALD REMMEL received a research assistantship at Princeton during the summer, and began work on his PhD in physics at Princeton this fall.

ALUMNI ASSOCIATION
CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California

BALANCE SHEET
June 30, 1965

ASSETS

Cash in Bank			$ 2,952.50
Investments:			
Share in C.I.T. Consolidated Portfolio		$101,146.18	
Deposits in Savings Accounts		20,929.79	122,075.97
Investment Income Receivable			5,506.41
Postage Deposit, etc.			383.68
Furniture and Fixtures, at nominal value			1.00
Total Assets			$130,919.56

LIABILITIES, RESERVES AND SURPLUS

Accounts Payable			$ 1,339.11
Deferred Income:			
Membership Dues for 1965-66 paid in advance		$ 11,225.25	
Investment Income for 1965-66 from C.I.T. Consolidated Portfolio (earned during 1964-65)		5,300.06	16,525.31
Life Membership Reserve			66,800.00
Reserve for Directory:			
Balance, July 1, 1964	$ 2,677.39		
1964-65 Appropriation	2,500.00	$ 5,177.39	
1964-65 Directory Expense		133.25	5,044.14
Surplus:			
Balance, July 1, 1964		$ 33,896.68	
Share of Profit on Disposal of Investments of C.I.T. Consolidated Portfolio for 1964-65		7,104.89	
Excess of Income over Expenses for 1964-65		209.43	41,211.00
Total Liabilities, Reserves and Surplus			$130,919.56

STATEMENT OF INCOME AND EXPENSES
For the Year Ended June 30, 1965

INCOME

Dues of Annual Members		$ 18,822.50
Investment Income:		
Share from C.I.T. Consolidated Portfolio	$ 4,752.76	
Interest on Deposits in Savings Accounts	1,090.96	5,843.72
Annual Seminar		5,461.45
Program and Social Functions		3,286.95
Miscellaneous		35.00
Total Income		$ 33,449.62

EXPENSES

Subscriptions to Engineering & Science Magazine:		
Annual Members	$ 13,170.50	
Life Members	3,188.50	$ 16,359.00
Annual Seminar		4,895.26
Program and Social Functions		3,667.74
Directory Appropriation		2,500.00
Administration (Directors' Expenses, Postage, Supplies, etc.)		2,294.05
Fund Solicitation		1,655.91
Membership Committee		1,068.23
ASCIT Assistance		800.00
Total Expenses		$ 33,240.19
Excess of Income over Expenses		$ 209.43

AUDITOR'S REPORT

Board of Directors, Alumni Association, California Institute of Technology
Pasadena, California

I have examined the Balance Sheet of the Alumni Association, California Institute of Technology, as of June 30, 1965, and the related Statement of Income and Expenses for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as I considered necessary in the circumstances.

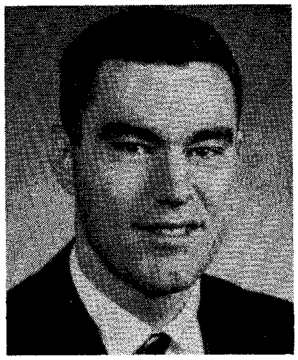
In my opinion, the accompanying Balance Sheet and Statement of Income and Expenses present fairly the financial position of the Alumni Association, California Institute of Technology, at June 30, 1965, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

CALVIN A. AMES, Certified Public Accountant
1602 West Thelborn St., West Covina, California

September 28, 1965

Alumni News

Matthew Couch Memorial Fund



The family and friends of Matthew M. Couch '62, who died of a heart attack on May 6, have established a memorial fund in his name at Caltech. At the time of his death, Matt, who had received his MS in chemistry from Yale in 1963, was working at Caltech with Dr. Alexander Goetz's group in physics. He was looking forward to continuing his graduate studies in chemistry this fall.

Matt was a fellow of the British Chemical Society, and a member of the American Chemical Society. As an undergraduate at Caltech, he was treasurer of Page House, and a member of the staff of the *California Tech*.

Contributions may be sent to the Matthew Couch Memorial Fund, in care of the Alumni Office.

ALUMNI EVENTS

November 20	Interhouse Dinner-Dance
May 7	Annual Alumni Seminar
June 8	Annual Meeting

PLACEMENT ASSISTANCE TO CALTECH ALUMNI

There are two ways in which the Placement Service may be of assistance to you:

(1) To help you seek new employment or a change of employment.

(2) To inform you when outstanding opportunities arise.

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 Alumni Placement Service
California Institute of Technology
Pasadena, California 91109

Please send me:

☐ An Application for Placement Assistance

☐ A form to report my field and operation so that I may be notified of any outstanding opportunities.

Name .... Degree (s) ....

Address .... Year (s) ....

....

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VICE PRESIDENT
Sidney K. Gally, '41

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Theodore C. Combs, '27
Robert W. Lynam, '54
John L. Mason, '47

John T. McGraw, '38
Paul D. Saltman, '49
Frederic T. Selleck, '49
Patrick J. Fazio, '53

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Vice-President — Willis A. Bussard, '44
Appleby Drive, RFD 1, Box 78B, Bedford, N.Y. 10506

Secretary-Treasurer — Harry J. Moore, Jr., '48
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Blueberry Hill Rd., Sudbury, Mass.

Secretary-Treasurer — Thomas C. Stockebrand, '53
55 Summer St., West Acton, Mass. 01780

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Chairman — Willard H. Hanger, '43
4720 Sedgwick St., N.W., Washington, D.C.

CHICAGO CHAPTER

President — Laurence H. Nobles, '49
Dept. of Geology, Northwestern Univ., Evanston, Ill.

Vice-President — Philip E. Smith, '39
Eastman Kodak Co., 1712 Prairie Ave., Chicago, Ill.

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G.E. Vallecitos Atomic Lab., Pleasanton, Calif.

Vice-President — Dallas L. Peck, '51
U.S. Geological Survey, Menlo Park, Calif.

Secretary-Treasurer — Thomas G. Taussig, '55
Lawrence Radiation Lab., Univ. of Calif., Berkeley, Calif.

Meetings: 15th Floor, Engineers' Club, 206 Sansome St., San Francisco
Informal luncheons every Thursday at 11:45 A.M.
Contact Mr. Farrar, EX 9-5277, on Thursday morning for reservations.

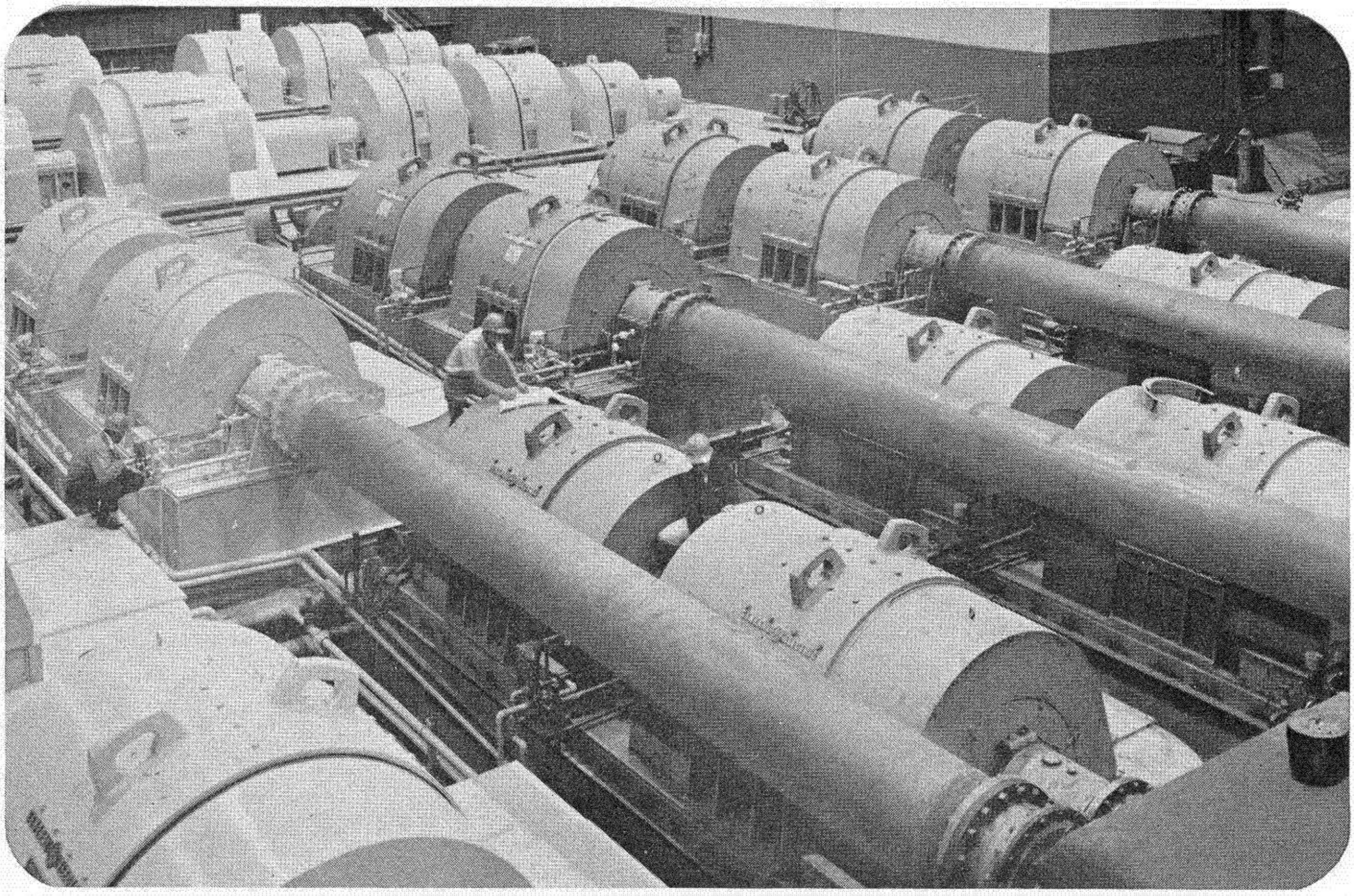
SACRAMENTO CHAPTER

President — Harris K. Mauzy, '30
2551 Carson Way, Sacramento, Calif. 95821

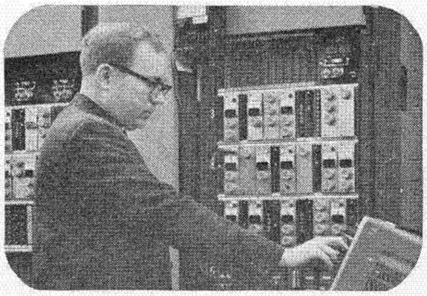
Vice-President — Frederick J. Groat, '24
877 - 53rd St., Sacramento, Calif. 95819

Secretary-Treasurer — William D. Pyle, '49
3920 Dunster Way, Sacramento, Calif. 95825

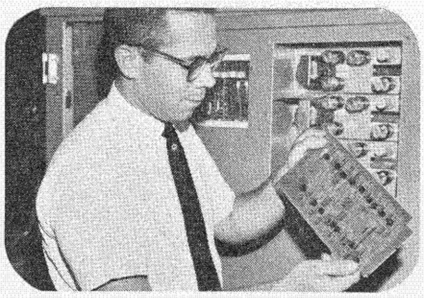
Meetings: University Club, 1319 "K" St.
Luncheon first Friday of each month at noon.
Visiting alumni cordially invited—no reservation.



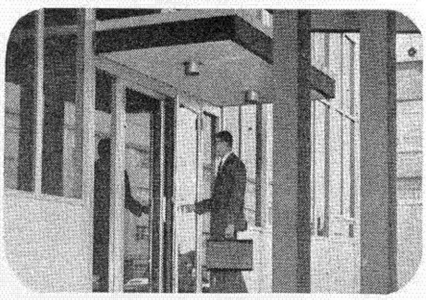
DRIVE POWER by General Electric: one section of Bethlehem Steel Corporation's new mill at Burns Harbor, Indiana.



INDUSTRY CONTROL engineer Bob Vaughn, Virginia Polytechnic Inst., worked on drives, control and the new SCR armature regulator, from design through installation.



PRINTED CIRCUIT PROCESS heart of automatic control, was checked by Glenn Keller, Lehigh U., on the Manufacturing Program at Specialty Control Department.



CUSTOMER REQUIREMENTS for d-c motors were met by Jim Johnson, U. of Cincinnati, on a Technical Marketing Program assignment at Large Generator & Motor Department.

A PREVIEW OF YOUR CAREER AT GENERAL ELECTRIC:

Automating a Complete Steel Mill

The automation of Bethlehem Steel Corporation's new Burns Harbor, Indiana, cold rolled and plate mills is another giant step toward meeting the demands for stepped-up steel production. General Electric is uniquely equipped to supply all the bits and pieces of automation, and to call on and integrate the skills of more than 120 business departments —skills that run the gamut of specialized and systems engineering, manufacturing and technical marketing. Whatever the projects at General Electric, and they are legion, a small-company atmosphere is maintained, so that individual contributions are quickly recognized. And, these become starting points to new discoveries and opportunities. Write us now—or talk with your placement officer—to define your career interest with General Electric. Section 699-14, Schenectady, N. Y. (An Equal Opportunity Employer)

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GENERAL ELECTRIC