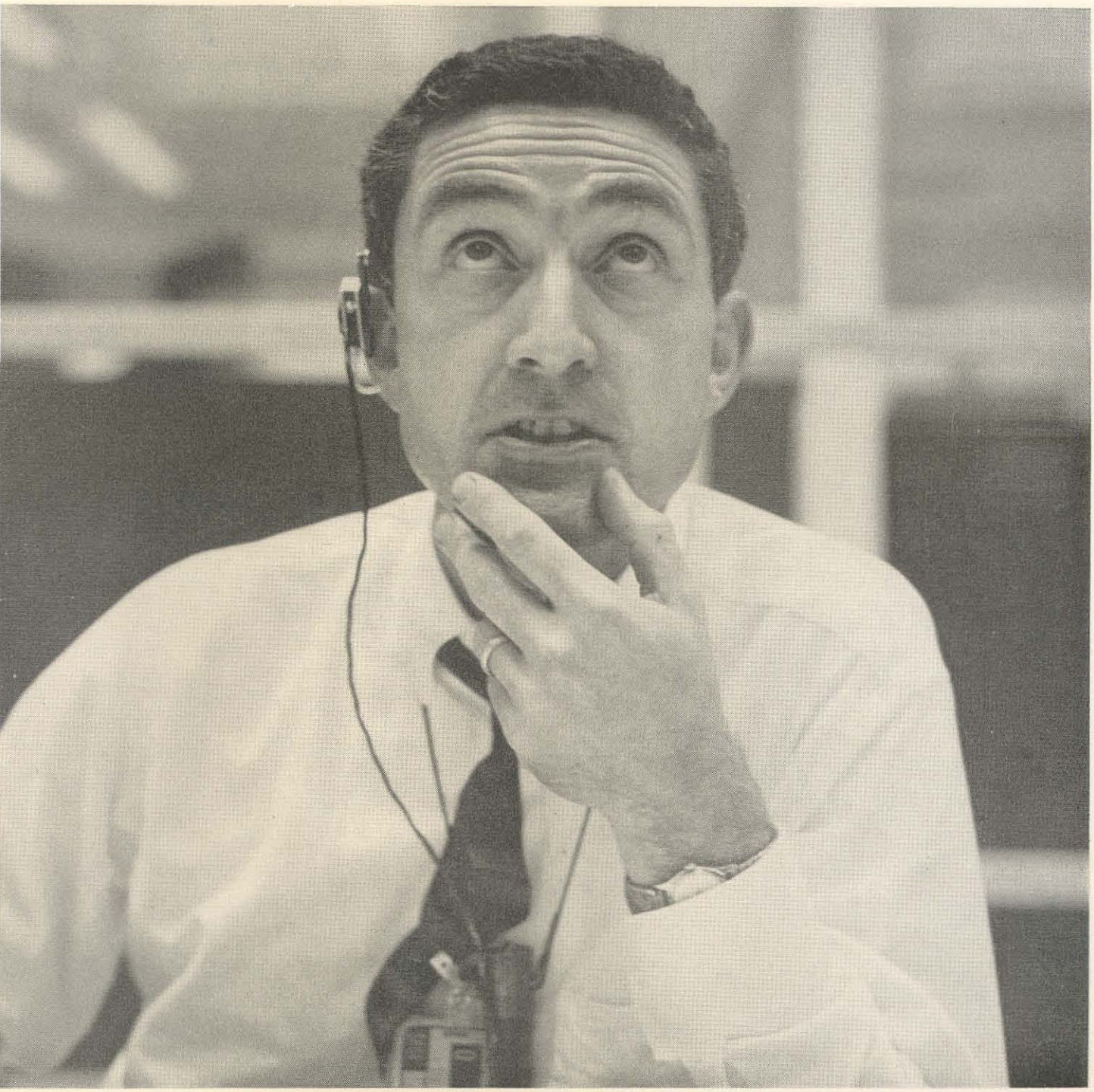
JUNE 1966

ENGINEERING AND SCIENCE



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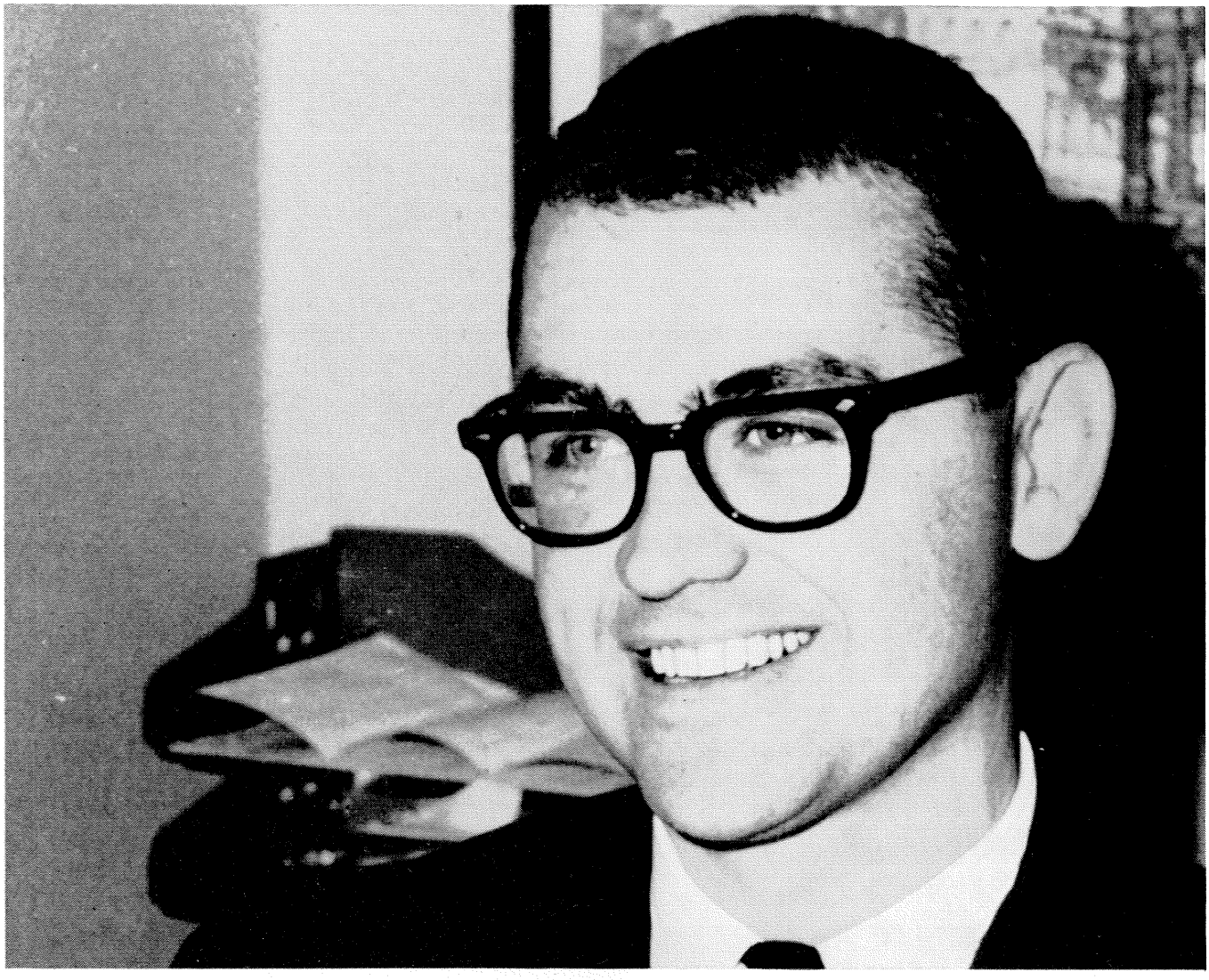
says Hal Gatewood, Jr., C.L.U., Ohio State '55



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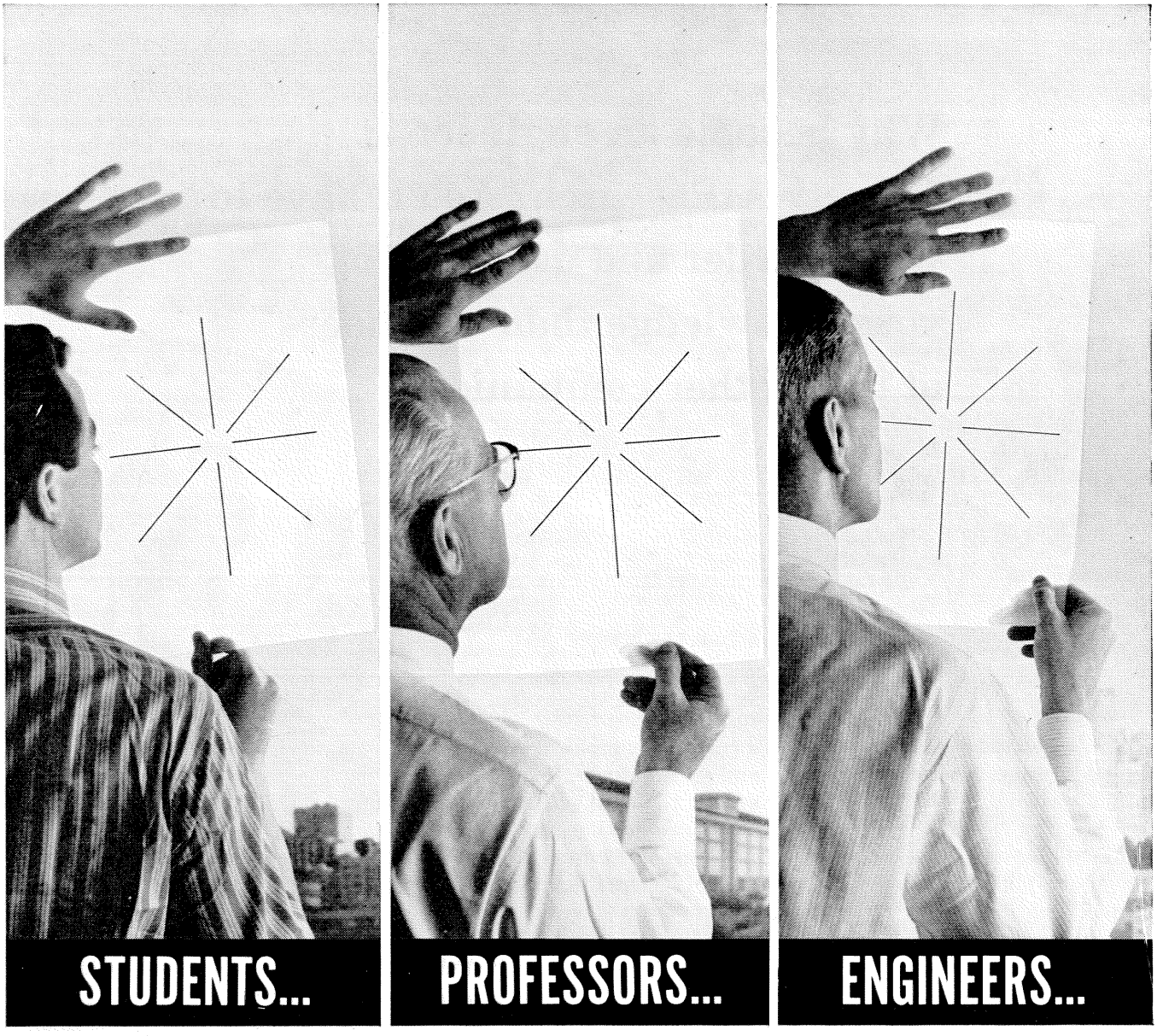

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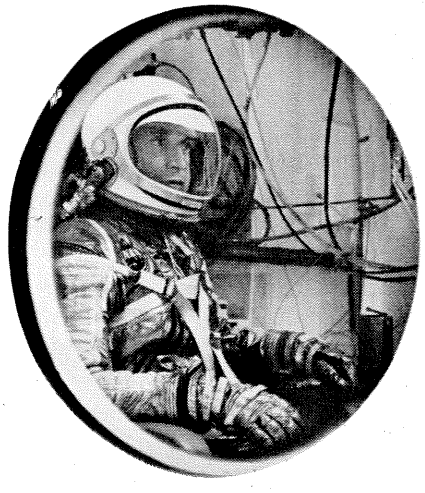

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ENGINEERING AND SCIENCE

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On Our Cover

Albert R. Hibbs, at Caltech's Jet Propulsion Laboratory during the final critical hours of the Surveyor flight on June 1, follows the progress of the spacecraft as it heads for the moon. Dr. Hibbs, lecturer in government at Caltech and senior staff scientist at JPL, served as commentator on the Surveyor flight for the workers, reporters, and officials who assembled at the Lab to see whether Surveyor would make the first successful soft landing on the moon. The story of the mission, some initial results, and some spectacular photographs are in "Surveyor to the Moon" on page 7.

Peter W. Fay,

associate professor of history at Caltech, left the Institute in June 1964 to spend two years teaching and helping to develop curricula at the new Indian Institute of Technology in Kanpur. Dr. Fay is one of a growing number of Caltech men who are participating in the U.S. Government program to help develop the institute for advanced science and technology at Kanpur. As he leaves India this month to return to his teaching position at Caltech, Dr. Fay sums up his experience and the Indian project in general in a "Report from Kanpur" on page 11.

Books

Explorer of the Universe: A Biography of George Ellery Hale

by Helen Wright
E. P. Dutton and Co. $10.00

Reviewed by Allan Sandage, staff member, Mount Wilson and Palomar Observatories.

"George Ellery Hale probably did more than any other one man to awaken interest and find support for a sound and effective development of science in this country." These words by Dr. I. S. Bowen, former director of the Mount Wilson and Palomar Observatories, introduce Helen Wright's outstanding biography of this most remarkable man.

Hale was born in 1868 and died at the age of 70 in 1938. His influence has been so pronounced that astronomy as we know it today would not exist, nor would the climate of scientific research in this country be the same, if Hale had not lived. Four different times in his career Hale conceived, organized, secured funding, and directed the construction of the largest telescope in the world—the Yerkes 40-inch refractor in 1897, the Mount Wilson 60-inch reflector in 1908, the 100-inch reflector in 1917, and the 200-inch reflector beginning in 1929. Hale virtually created astrophysics, as practiced in this country, and left a legacy of instruments which are still among the most powerful in the world.

Helen Wright has done a superb job of tracing Hale's development not only of new and powerful instruments and of his important discoveries of sunspot magnetic fields and the law of reversing polarities, but also of the embryonic state of American science in the early days of this century. Of particular interest to astronomers is the description of the early days at Yerkes and Mount Wilson and of the fervor of work with the unique and powerful new telescopes. The difficulties of working on an isolated mountain site are described with authority. The excitement of this great adventure, with the consequent flood of new astronomical results, comes through with clarity. There is a nostalgic quality to these chapters, and many astronomers of this present generation will wish that they had been there.

Yet, for all his influence on astronomy, Hale's stake was broader. His unceasing activity in the organization of scientific and intellectual endeavors was phenomenal. He played a major role in the formation of Caltech—persuading first Scherer and then Millikan to become its presidents. By his great personal charm and strength of logic, Hale then persuaded other prominent men, such as Alfred Noyes and T. H. Morgan, to join the faculty.

Hale founded the National Research Council, and was instrumental in obtaining the building for the National Academy of Sciences. He had strong ideas of international cooperation and was heavily involved in the establishment of the International Solar Union which grew into the International Astronomical Union. He served on numerous international committees to bring worldwide science closer together.

Nearer to home Hale conceived a master plan for the coordinated development of Pasadena. This resulted in the unified civic buildings centered about the auditorium, the city hall, and library. And, with Hale's persuasion, the nearby Huntington Library was founded as a great research library in literature and history.

Helen Wright describes all this and much more, giving for the first time an authoritative biography of one of the most influential men of science this country has produced. The book will bring to contemporary scientists and historians the story of this unique astronomer whose life is of such special interest to the Caltech community.

The Life of the Mind in America from the Revolution to the Civil War

by Perry Miller
Harcourt, Brace and World $7.50

Reviewed by Daniel J. Kevles, assistant professor of history.

For this book Perry Miller was awarded, posthumously, the 1966 Pulitzer Prize in history. Written in graceful and compelling prose, this work is distinguished by its penetration to the roots of American thought in the early years of our nationhood. It bears the marks of Miller's earlier work—the command of a wide-ranging literature, the imagination and insight, the eloquence of presentation—that made him perhaps the most respected historian of American ideas of his generation.

Miller's untimely death in 1963 occurred in the midst of the writing, so that the book is only a fragment of his original intention. But his treatment of the American mind was designed as a mosaic, and the pieces that survive are no less interesting as fragments. Religious evangelism, the legal mind—these are the wholly completed portions of the over-all design. Miller never completed his discussion of the American attitude towards science, theoretical and applied, but what he did write is illuminating and provocative.

Running through the design of the work, binding it together, is the motif of interpretation: the theme is nationalism. For all the while that Americans thrust westward across the Alleghenies, streamed into the Ohio Valley and out onto the plains, all the while that they united East to West with iron rails and bonds of commerce, they sensed the centrifugal forces of sectional antagonism, of social and economic tension. In response, often subconsciously, they sought to develop a cast of mind unique to America, superseding the forces of division. *The Life of the Mind in America* eloquently describes the nationalist impulse that colored the thought of this country as it struggled for genuine nationhood.

Alumni Books

Adventures in Living Plants

by Edwin B. Kurtz, Jr., PhD '52, and Chris Allen
University of Arizona Press $4.95

Edwin Kurtz, professor of botany at the University of Arizona, and Chris Allen, teacher in the Tucson elementary schools, designed this book for use in teaching botany at the elementary level. It is amply illustrated and has pages that serve as "notebooks" for experiments the reader can perform. Subjects include cells, photosynthesis, respiration, nutrition, circulation, growth, reproduction, heredity, plant kingdom, and ecology.

Introduction to Matrix Methods of Structural Analysis

by Harold C. Martin, PhD '50
McGraw-Hill $11.50

A textbook for students or structural engineers. Dr. Martin is now professor of aeronautics and astronautics at the University of Washington and consultant to the aerospace group of the Boeing Co. in Seattle.

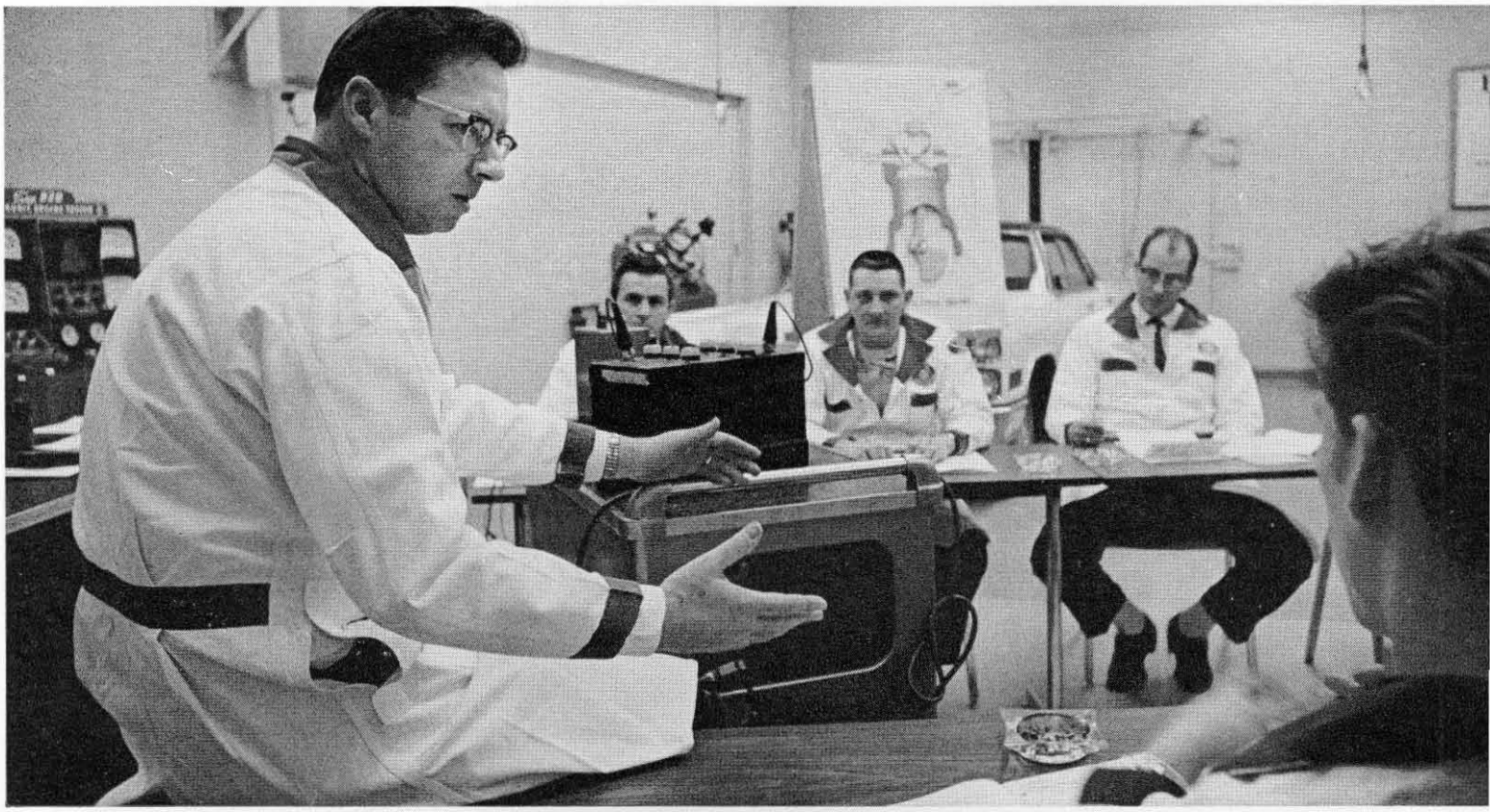
Flight

by H. Guyford Stever, PhD '41, James J. Haggerty, and the Editors of Life Time-Life Books $3.95

This picture-and-text history of

continued on page 24

Art Mayer–self-taught mechanic now teaches at a GM Training Center



He was the happiest boy in town when he landed a part-time job at the corner gas station. He wanted to be a mechanic for as long as he could remember. He wanted to learn all he could about cars and engines. And this was his big chance. He turned his part-time job into a full-time ambition. He never lost the desire to work on engines . . . or to learn more.

After serving as a helicopter mechanic during the war, Art joined one of the General Motors car divisions as a mechanic and soon worked his way up to Master Mechanic. Today, Arthur E. Mayer, Jr., is an instructor at one of 30 GM Training Centers across the nation, with a total annual enrollment of some 125,000 automotive mechanics drawn from GM retail dealerships. The "refresher" courses taught at these centers keep local dealer mechanics constantly abreast of new advances in technology and service methods.

Art Mayer is happy working with his students, helping to advance their knowledge and skills. He's a fine example of the kind of people that make GM go.

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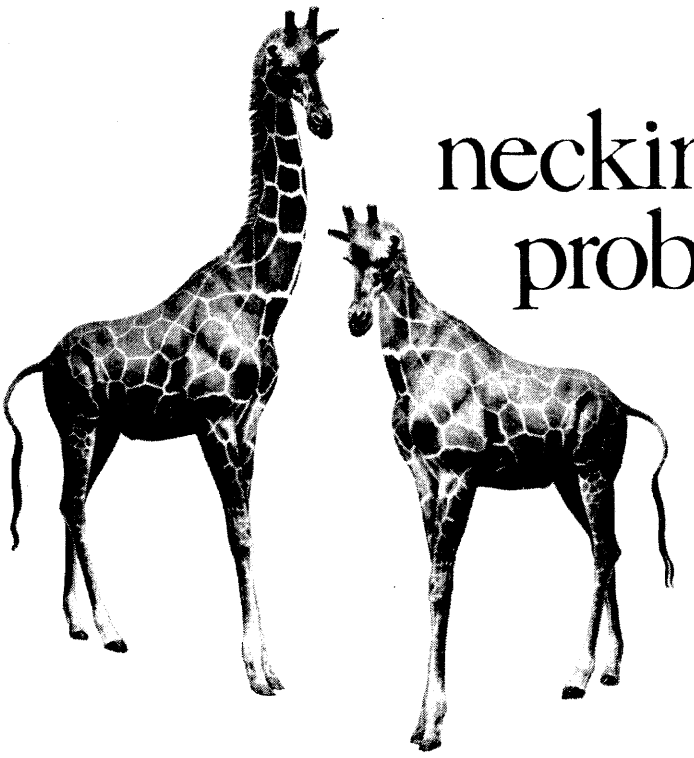


necking problem

To build a rectangular color TV tube with more of a picture than the earlier round tube type, and then squeeze it into a dimensionally attractive cabinet—you face almost insurmountable challenges.

Just to build a conventional color tube, you must . . .

1.—with absolute precision, lay more than a million red, blue, and green phosphor dots in a perfect triad pattern over the entire surface of the picture screen. Why so tough?—because the light source for the dots is a single ray coming through a pinhole. And it must be bent by a correction lens with precise mathematical calculation (different for each dot) to pass through over a third-of-a-million pinholes and fall exactly at a given spot on the screen.

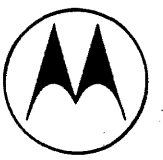
2.—Once you've figured out the phosphor dots, you must then bend the electron beam broadcast by the TV station so that it too passes through the third-of-a-million pinholes.

These are just some of the feats you must perform. But after going through all this, you wind up with a tube with a neck so long it requires a cabinet nearly a yard deep to hold it. To shorten the neck requires mathematical calculations and engineering techniques so demanding they fall beyond any brief description.

The complexity of the 23-inch rectangular color tube development is considered by some of our consumer products engineers even more of a technological challenge than designing some of the sophisticated command systems required for space flights.

Motorola military engineers tend to disagree.

But now that we've brought it up, Motorola has accomplished both.

TRUST THIS EMSIGNIA  WHEREVER YOU FIND IT

MOTOROLA

ENGINEERING
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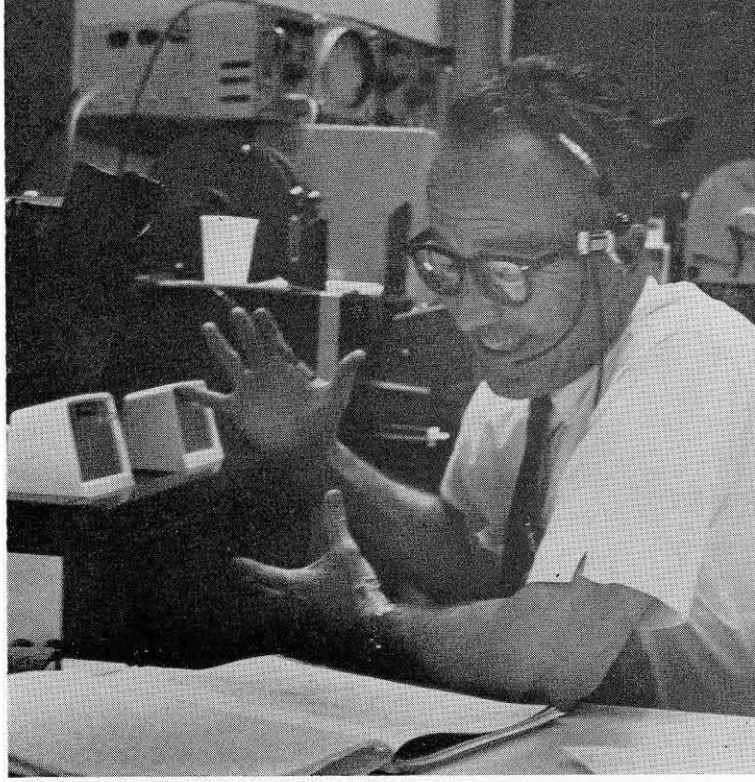
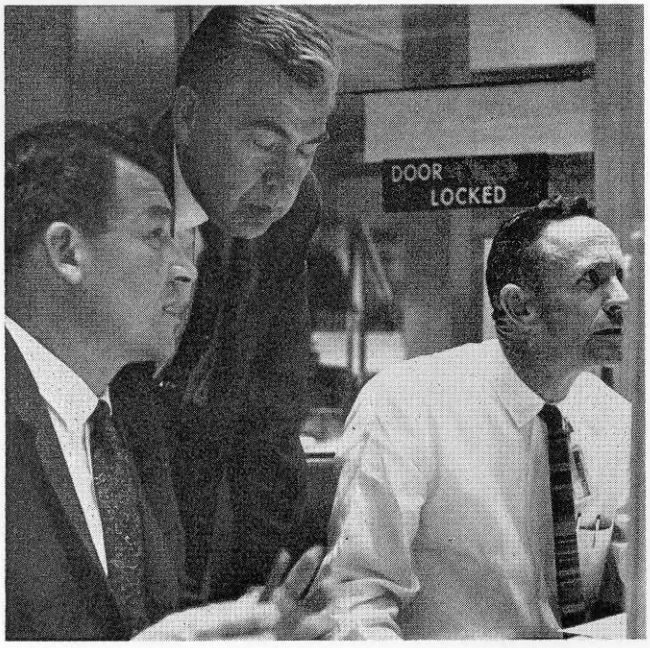
June 1966, Vol. XXIX, No. 9

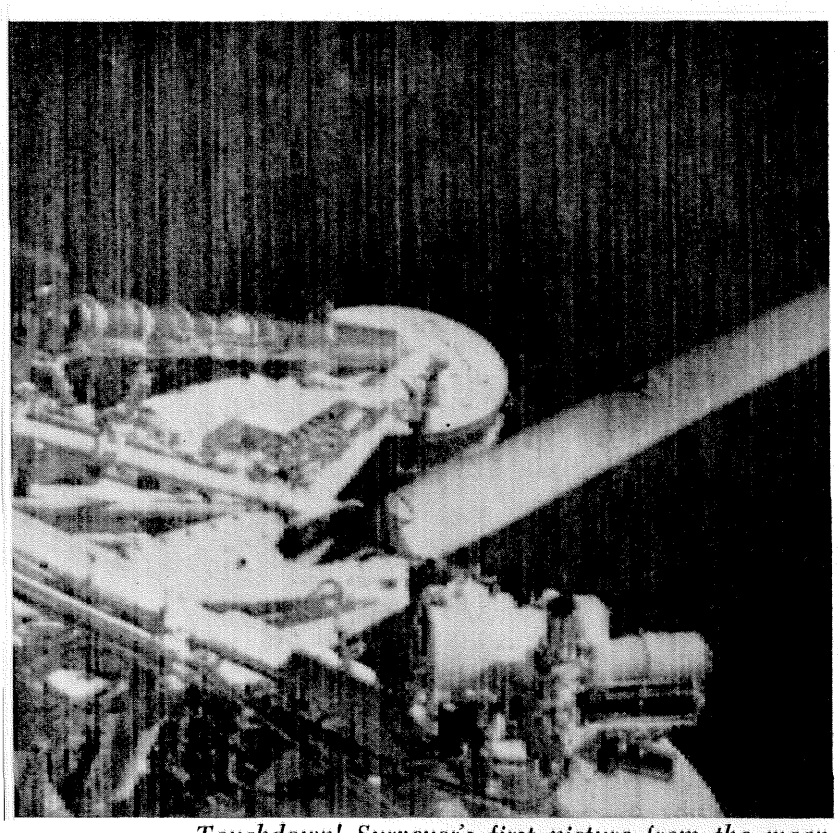
SURVEYOR TO THE MOON



On June 1, 1966, a 596-pound package of space hardware gently bumped down on the surface of the moon and proceeded to send 10,338 excellent pictures of the lunar landscape back to Caltech's Jet Propulsion Laboratory. The flawless performance of Surveyor I came as a surprise to the people who had worked so long on the project. They had frankly expected to have several unsuccessful—or only partly successful—flights before the system worked perfectly. As a result of the model mission of the spacecraft, JPL and NASA officials now say that the Surveyor program is about one year ahead of where it was expected to be at this time.

A long, tense wait at Caltech's Jet Propulsion Laboratory—then jubilation as Surveyor I makes a perfect soft landing on the moon.





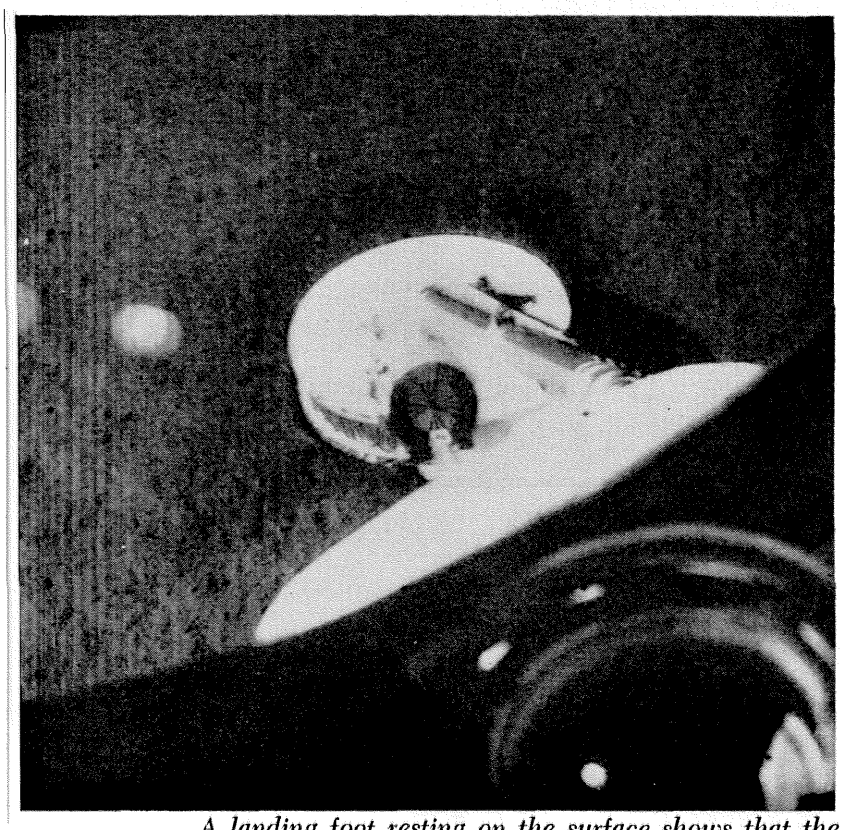
Touchdown! Surveyor's first picture from the moon, received at 11:52 p.m. PDT June 1, was immediately flashed on home television screens. It shows one of the spacecraft's landing legs, its foot pad, an antenna boom, and the top of a helium container.

Surveyor is the most complex unmanned space program yet attempted by the United States. Its bull's-eye soft landing on the moon (the first ever) has given a big boost to the Apollo program, which will use essentially the same technique to land men on the moon. Even more important, the photographs that Surveyor has sent back show that the ground in the region of the landing site, at least, is strong enough to support the weight of an Apollo landing craft—and that of a man walking on the surface as well.

JPL and NASA scientists are now working with other moon experts to evaluate the data received from Surveyor. Since there are more than 10,000 pictures, the job will take some time, but even after a first brief look at the pictures, the scientists have been able to draw some tentative conclusions about the lunar environment.

Preliminary results

The lunar surface around the landing site is a debris-strewn field, with particles ranging in size from 1/50 of an inch to large clods of "soil" and hard boulders many feet across. Some of these larger particles may have been ejected when craters were formed long ago and far



A landing foot resting on the surface shows that the landing site—on the floor of the crater Flamsteed in the Ocean of Storms—is strong enough to support the weight of an Apollo landing craft.

This view shows a large rock, several smaller rocks, and a crater about a yard deep in the surface layer. The grid of black dots is part of the television tube; the bright spots are reflections of the sun.

away from the landing site, perhaps even on the other side of the moon.

According to one scientist, the scene on earth most resembling Surveyor's landing site is the area around the Sudan nuclear crater in Yucca Flats, Nevada, which is believed to closely resemble a typical impact crater on the moon.

Although the actual ground surface is quite flat at the landing site, the numerous large boulders nearby are large enough to have spoiled the soft-landing if the spacecraft had come down a few hundreds yards away.

Pictures from the Soviet Union's Luna 9 (*Engineering and Science,* February 1966) gave the impression that the smaller objects on the surface were all rocks, but Surveyor indicates that at least some of them are lumps of soil.

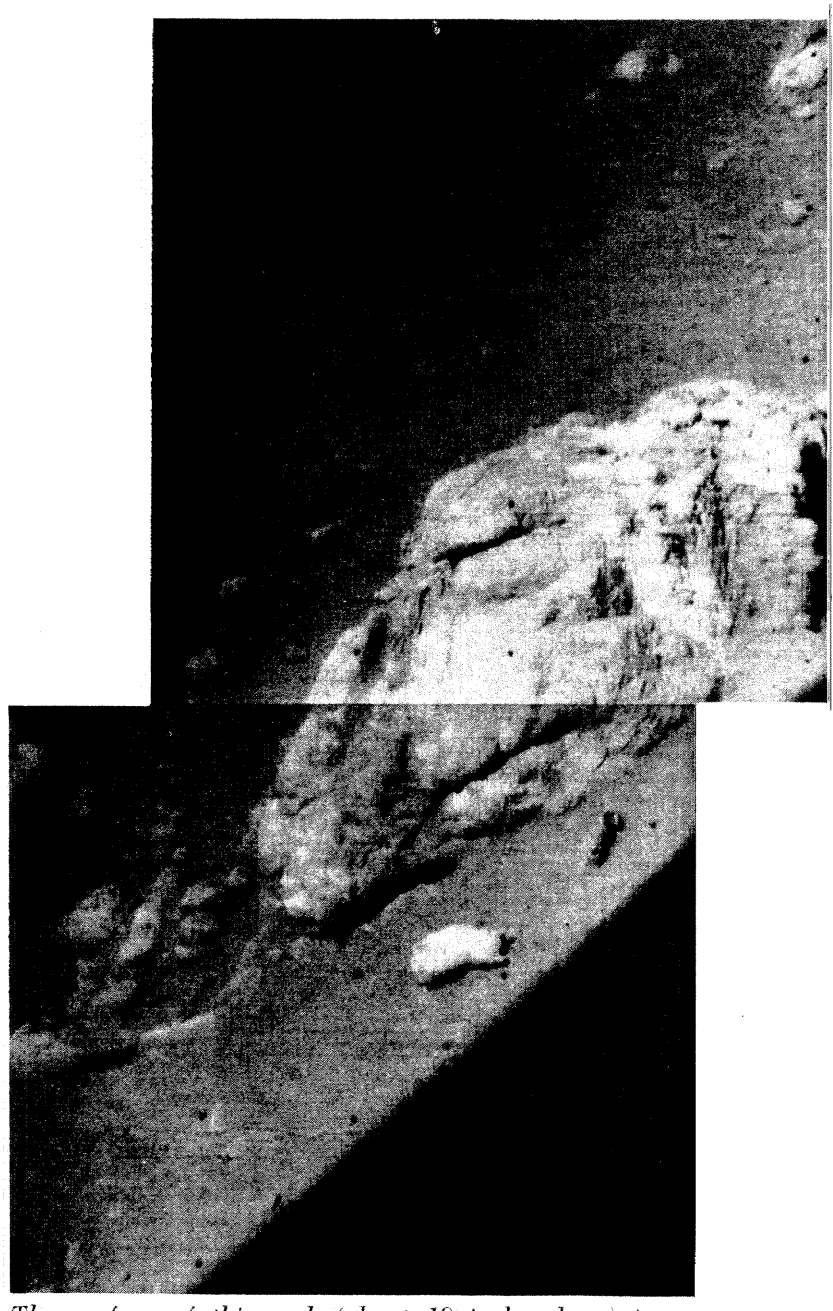
The actual surface on which Surveyor landed is definitely smoother than that on which Luna 9 came down.

In a post-landing experiment, the attitude control thrusters near the base of the spacecraft's legs were fired at the ground while the camera was trained on the ground underneath. Apparently the jets of nitrogen gas (less than one-pound thrust) produced no movement of material on the ground.

Surveyor's feet sank only a little way into the material on the moon's surface, indicating that if there is a dust layer, it is either relatively hard or fairly shallow.

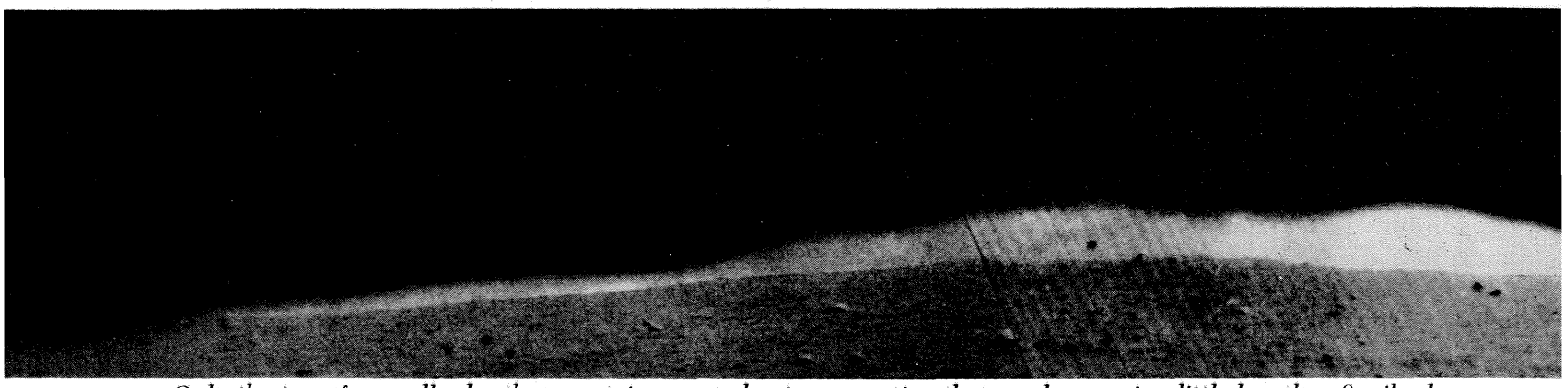
Had there been a lot of loose dust on the lunar surface, it would have adhered to the surfaces of the spacecraft. The normally shiny, heat-reflecting surfaces would then have begun to heat abnormally in the sunlight. Temperature sensors on the spacecraft have not detected any abnormal temperature rise, indicating that the surfaces are still clean.

Although the gas jet produced no apparent movement, the surface material is nevertheless probably not as cohesive as had been expected by some people, because "rays" of soil were thrown out by the relatively gentle impact of Surveyor's feet. These rays are similar to the long rays that can be seen stretching out from large craters on the moon, except that they are darker than the surface material on which they lie; this is just the opposite of the older rays, which are lighter. The significance of this difference in color is not known.



The surface of this rock (about 18 inches long) is eroded or abraded, probably by bombardment of fine particles. The rock also shows evidence, in its slaty cleavage, of having undergone plastic flow of the type produced by conditions of strong shock.

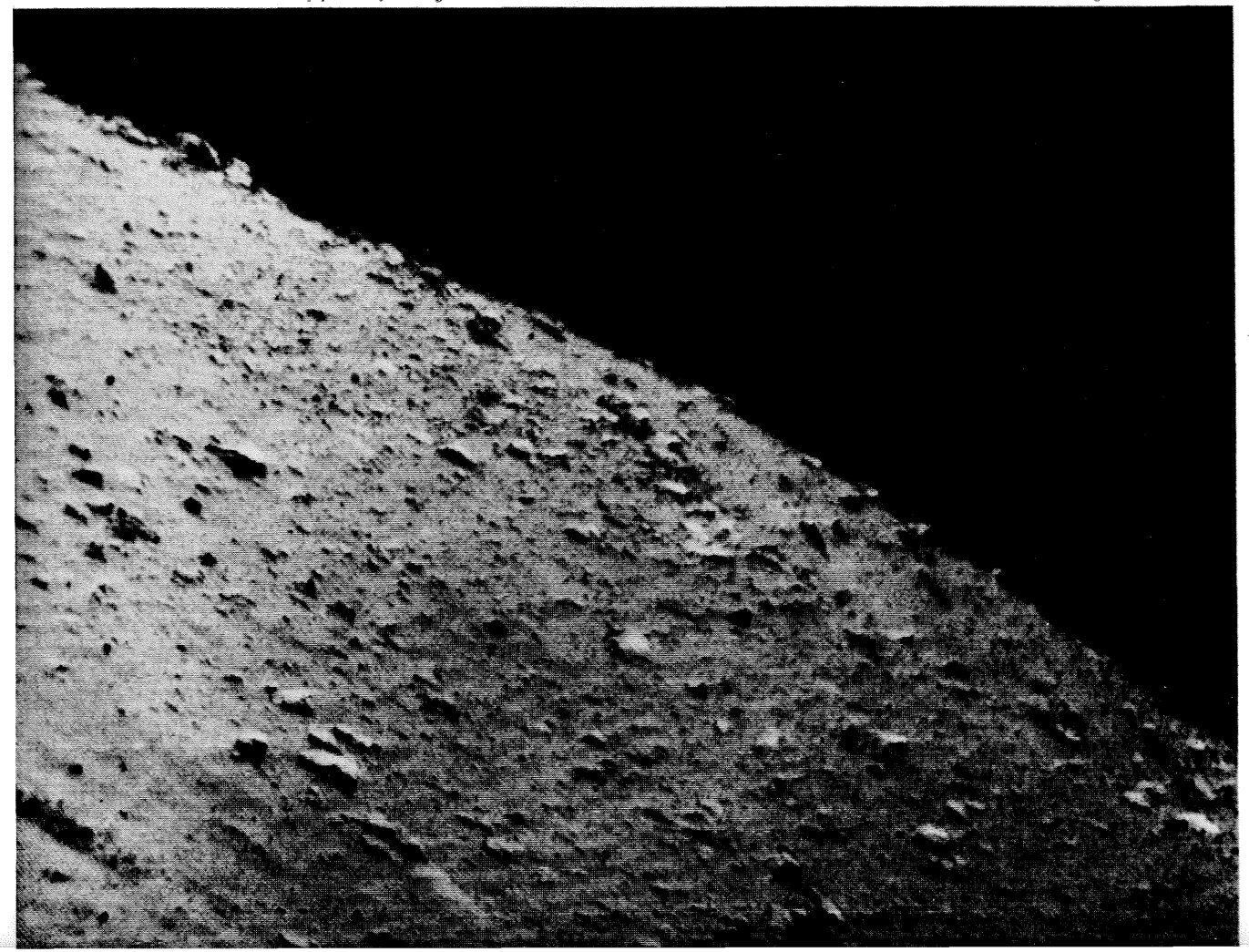
One rock on the lunar surface is speckled with dark spots, which are actually cavities. These indicate that it was once molten; the holes are the remnants of bubbles. Either lunar vulcanism or shock melting (from impact) could have produced the features.



Only the top of a small, ghostly mountain range about 12 miles from the spacecraft shows above the lunar horizon, which is probably less than a mile away. The portion that can be seen is a little less than 8 miles long and rises 500 feet above the near horizon. It is part of the nearly buried crater in which Surveyor landed.

As the two-week lunar day ended on June 14, Surveyor took pictures of its own lengthened shadow, the corona of the sun, and of one of the spacecraft's landing feet illuminated by sunlight reflected from the earth. Finally, before it was shut down for the duration of the two-week night, Surveyor was commanded to move its solar panel and high-gain antenna to a horizontal position. If the batteries have frozen and the spacecraft cannot be reactivated when sunlight again appears, the panel and antenna will be in position to cast a long shadow. This summer another U.S. spacecraft, the Lunar Orbiter, is scheduled to make a photographic survey as it flies around the moon. When it passes over the crater Flamsteed, it may be able to spot Surveyor by its shadow, permitting a valuable correlation of the findings of the two explorers that are paving the way for man's eventual landing on the moon.

The boulders strewn over this field probably came from the crater whose outer rim can be seen along the horizon. Those boulders in the upper left may be one or two yards across. Had the spacecraft hit one of them during landing, it could have tipped or even broken apart. The distance to the horizon is several hundred yards.



REPORT FROM KANPUR

A Caltech professor of history sums up his experiences and impressions after two years on the faculty of the Indian Institute of Technology at Kanpur.

by Peter W. Fay

The Indian Institute of Technology at Kanpur, the old Cawnpore on the Ganges in the state of Uttar Pradesh, received its first 100 undergraduates in July, 1960, and graduated 66 of them in May, 1965. It is therefore the youngest of the Indian Institutes of Technology, following IIT/Kharagpur (near Calcutta) by almost ten years, and IIT's/ Bombay, Madras, even Delhi (newer in name only), by several. Kanpur also differs considerably from the older four, though the difference is limited in some directions by the uniform framework imposed on all five by Acts of Parliament and by the necessity of admitting students on the basis of an examination common to all. The difference is nevertheless substantial. It has been made possible by, though it certainly is not simply the work of, nine American universities, which in 1962 began to send some of their faculty and a great deal of Uncle Sam's money to Kanpur.

The nine are MIT, Ohio State, Purdue, the University of California (which has meant Berkeley), Princeton, Case, Carnegie Tech, the University of Michigan, and Caltech. I do not know how Caltech happened to join. Perhaps it was in a fit of absentmindedness. Only a few of our people—notably Donald Hudson, our first representative on the steering committee of the consortium (since succeeded by Marc-Aurele Nicolet)—seemed to take an interest in the Kanpur Indo-American Program (KIAP) during its first two years. Victor Neher, Robert Huttenback, and perhaps one or two others, made brief visits to Kanpur. But no one came for long; and had you stopped almost anyone along the Olive Walk and asked where Kanpur was, you would have drawn a blank.

Then in 1964 six Caltech people were encouraged to join KIAP. The six were Jon Mathews of physics, David Welch and Peter Mason of engineering, Mason's graduate student John Trenholme, Mason's technician Richard Carrouche, and myself from humanities. The Institute eyed us, blessed us with reservations, and off we went. That was almost two years ago. At this writing only I remain of the six. But Taras Kiceniuk of engineering has just arrived, and Ernest Hugg of Physical Plant soon will. So the ice is broken, and Caltech is as involved as any of the nine institutions in the work of assisting IIT/Kanpur.

That assistance takes a number of forms. Money for the program comes from the Agency for International Development, which early in 1962 contracted with the nine universities through their agent, Educational Services Incorporated, to finance the operation. This arrangement has made all of us at Kanpur AID people. We get our flour and sugar and Scotch from the Commissary in New Delhi. Our mail moves by APO if we wish it to. Our children ride to school and we to work or to the Cawnpore Club in green AID jeeps supplemented by decrepit black AID Ramblers and a few locally rented Indian Ambassadors with transmission trouble. We travel on AID vouchers, take paid leave within AID limits (26 days a year), bring our cars in duty-free under AID diplomatic privilege, receive our furniture and air-conditioners from the Delhi AID warehouse, and live in houses which are rented for us by the

Dr. S. Radhakrishnan, President of India, reviews the cadet corps at the first convocation of the Indian Institute of Technology at Kanpur.

program according to the AID housing allowances.

But at the same time we remain members on detached service of the nine universities from which we come. They pay us our normal salaries in dollars (to which AID adds certain increments in dollars and rupees), and Washington reimburses them so that they may engage people to take our places while we are gone. We are contract, not direct-hire, AID personnel. And though the program is in almost daily contact with AID-Delhi, and though Program Leader Robert Green, a civil engineer from Ohio State and one of the founders of the program, works closely with John Lewis, the economist who heads AID in India, KIAP remains essentially the organ of the nine American universities. It is the steering committee, composed of representatives from each of the nine and chaired by Paul Chenea of Purdue, and Bob Green and the program members actually at Kanpur, who decide what to do and how to do it—not Dr. Lewis. And since the doing of it often requires more PL 480 rupees than Lewis, with his many other commitments, is anxious to argue for, the program manages to be both the brightest jewel in AID's Indian crown (the metaphor is Lewis's) and the greatest thorn in its side (mine).

This condition of belonging and yet not belonging to the foreign aid program is repeated within IIT/Kanpur itself with respect to our belonging and yet not belonging to the faculty. At the other IIT's the foreigners either run the show or do not. The Russians at Bombay and the Germans at Madras do not. They are for the most part simply members of the faculty, on a par with their Indian colleagues. In the normal Indian academic setting this means that they do as they are told by the director and by the departmental chairmen. No doubt they have good ideas. No doubt they have influence too, particularly when the school has just begun and the power of the purse still makes itself felt. But neither carries them very far, though they probably do not realize it for a while. For they are treated with such tact, such politeness and such indirection, that they perceive nothing until the day they discover that they have been bemused and beguiled and that the path to fundamental change lies blocked and shrouded by the gentle impenetrability of Indian manners and Indian English. Then, I think, they either withdraw into their teaching and their labs, or are content simply to enjoy India.

At Delhi the Britishers, as English people are usually called, do things quite differently. They do not have difficulty with departmental chairmen because they themselves fill the chairs. Few in number, coming to India for terms of at least five years, recruited from the ranks of what might be called the professional overseas educational services, they take charge of a department and build it up as they think best. But if this spares them the frustrations of insufficient authority, it probably also spares IIT/Delhi the services of many able Indian faculty. For in proportion as the English call the tune, the Indians are likely to find the situation unbearable.

Neither servants nor masters

What is attempted at Kanpur is something in between. Thirty in number at our peak a year ago, twenty now and still declining, we are neither servants nor masters, but associates. We bring to the Institute professional ability, experience, and dollars for equipment and books. We advise and assist. Usually connected to particular departments, we are in, but not of them. We may teach, but we do not have to. Indeed, it is generally understood among us, though not among all our Indian colleagues, that we ought not to teach unless doing so will have a larger consequence—introducing a new technique or a new subject—than simply filling a teaching slot. We sit on departmental and Institute committees, and cast our votes on those rare occasions when matters are forced to so shockingly emphatic and final a thing for India as a vote. We are all by courtesy members of the Senate, that organ of Institute government which we have tried to make into something resembling a normal American faculty meeting—with only partial success, since our Indian colleagues have insisted that, except for us, no one below the rank of associate professor shall attend.

In rented hoods we paraded with our Indian col-

leagues in the first convocation, as commencement is called here. In short, we are encouraged to feel like full members of the Institute.

But though we sit on the selection committees which make faculty appointments, on these, significantly, we do not have the vote. In matters of promotion, a thing of the greatest importance for the future growth of the school, we are often not even consulted. Except in cases where no Indian faculty as yet exists (for example in aeronautical engineering when it began under an MIT man two years ago), we are never ourselves heads of departments, not even if age and experience would naturally make us so.

There are people, it is true, who suppose that we pull the strings from backstage. Chowkidars (watchmen) and peons salute us (awful habit) more earnestly, perhaps, than they do our Indian colleagues. A first-year student from Delhi explained to me once that he came to Kanpur instead of to the sister IIT near home because "you Americans run this one." I said I sometimes wished we did. For the fact is we have influence; we do not have power.

A year or so ago a visiting mathematician from Berkeley, appalled by a department whose chief glory was the churning out of papers appropriate to 19th century British applied mathematics, tried to introduce a little modern analysis and algebra into the system by arranging the appointment of some able young Indians with those interests. By every standard except, as it turned out, the prevailing one, the visitor outranked the departmental chairman. But the chairman outmaneuvered the visitor. At the crucial meeting of the selection committee he managed to get his own applied mathematics people appointed or promoted in place of the Berkeley man's pure mathematicians. Today the math department remains as comparatively innocent of pure mathematics as it ever was.

There is another side to the coin, however. When our man from Berkeley saw he had been beaten, he cleared out his desk, retired to his house, and spent the rest of his stay in India writing a book. To this the departmental chairman could say nothing. For our responsibility lies to the program leader, not to the Institute.

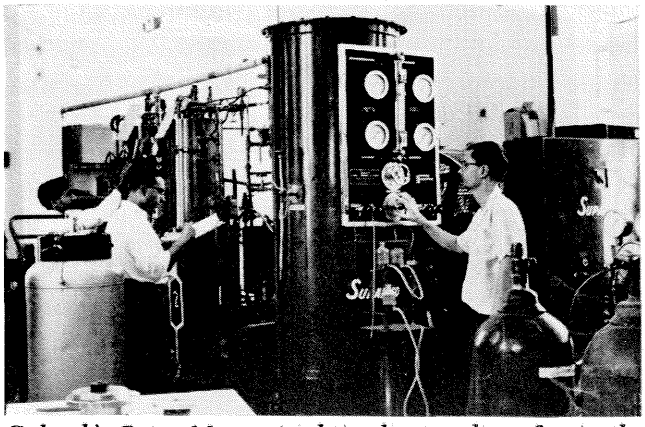
We have our own administrative offices. We hold periodic morning meetings to which our Indian colleagues are not invited. Passing by on the open-air walk outside, they can glance through the windows and observe us seated around the long oval table, looking in our whites like a bunch of barbers, and they sometimes wonder (one said to me once) what we are plotting. Not much, I told him. Maybe what to do about equipment lying in the rain at Delhi airport waiting for customs. Or maybe how to get out of Kanpur in a hurry—this during the fighting last September, when the city was blacked out and Americans in the Punjab were all ordered to Delhi—without abandoning (in my case) a four-foot Benares brass tray. If at the worst we do not accomplish what we want to accomplish, at least we can curse in privacy.

The Institute of the future

If the Institute becomes what it has set out to become, it will be a a residential university with a strong engineering bias, a fair amount of science and mathematics, and enough humanities and social sciences (the Institute has preceded Caltech in naming both barrels) to be quite startling for India. It will confer five-year Bachelor of Technology degrees (five years because entering students are a year or two younger than they are in the U.S.) in aeronautical, chemical, civil, electrical, mechanical, and metallurgical engineering. It may also give, in fewer years as befits the lower importance attached to them in India, BS degrees in mathematics, physics, and chemistry. There will be MS and PhD degrees in all these fields, plus philosophy, sociology, English, and perhaps psychology and economics. There will be no astronomy or geology or biology; probably no Hindi because of the language problem; probably no history because it came at the end of the line; and no leather or glass or textile technology, which is quite a relief in a country abounding in "institutes" for such things.

Fifteen hundred undergraduates living in five hostels will take in their first three years a common "core" including English, some social science, rather more math and physics and chemistry, a considerable amount of engineering science (such as mechanics of solids, rate processes, electrical science), and a nearly equal quantity of "technical arts" (graphics, measurements, shop). The last two years will be devoted to professional training in the branch of engineering—or science, if it is included—which the boy or the boy's father has chosen, with a little compulsory humanities and social science still thrown in. Candidates for MS and PhD degrees will have to take courses, pass comprehensive exams, and satisfy a residence requirement, besides doing their research and writing their theses.

A faculty of about 250, distributed among the ranks familiar to Americans, will teach, do research, consult, and to a large extent administer the Institute. Instruction will be by courses, progress judged by the accumulation of course grades based



Caltech's Peter Mason (right) adjusts a liquefier in the low temperature lab he set up at Kanpur.

in part on quizzes and midterms. Soon there will be a structures lab, a low temperature lab, a magnetic resonance lab, and a number of other central labs. There will be several small wind tunnels and a flight-test facility with gliders and light power planes operating off a 2,900-foot asphalt runway. There will be a 40-booth language lab and a television studio broadcasting films and live shows by closed circuit; there will be an air-conditioned IBM 1620 for instructional and other ancillary purposes, an air-conditioned IBM 7044 for research (Phase 1 has just arrived), and a library, also air-conditioned, of roughly 130,000 books and periodicals—about the number Caltech had four years ago. And there will be a faculty building, an administration building, an auditorium, lecture halls, teaching and research labs, and workshops.

The 1,100 acres of flat, arable, and waste land which the Institute occupies six miles northwest of Kanpur on the Grand Trunk Road will contain a community of about 4,000 people exclusive of students, each household in the Institute house or apartment to which its rank exactly entitles it. There will be a guest house, a post office, a bank, a telephone exchange, a shopping center, an infirmary, two schools, miles of paved roads and thousands of young trees protected by wire or low circular brick walls against nonexistent cattle. There will be shops selling pan (betel nut and other spices wrapped in a leaf and chewed), watchmen with short spears, barefooted gardeners flooding parched lawns from heavy rubber hoses, and dozens and dozens of ragged attendants called peons making tea and reading cheap paperback Hindi novels behind the almira (storage cabinet) in the corner of every lab and office.

It will be quite a place. But how American will it be?

To resemble an American school—that is of course the idea entertained openly by the visiting Americans, more discreetly and with reservations by many of the Indians. The five IIT's were set up in the first place because the government of India did not think it could develop adequate engineering schools out of what it already had in the established universities. If, for example, it tried to do something with the engineering departments at an established university, it would encounter an old and entrenched faculty teaching engineering exactly as it had taught it 40 years ago, and hardly interested in research. Moreover it would find that any extra money it gave to the university it would also have to give, by the logic of democratic politics, to dozens of other places. By creating new schools, Delhi made possible a new approach with younger and better faculty at a much higher level of expenditure. And it chose to do this with foreign assistance. To expect, then, that American-aided IIT/Kanpur would not grow to resemble an American school would have been silly.

There are certainly some very American things about the Institute. Having humanities and social sciences through all five undergraduate years is American. Postponing professional training until after a common core is American. Proceeding by courses, each an end in itself with a grade to itself, instead of preparing for distant "papers," is American. Giving letter grades is trivial American, and basing them in part on quizzes and midterms is important American. Problem-solving is American, at least if the end in view is that the student acquire, not a stock of solutions, but a habit of mind. Fewer hours in class, more spent on homework, is American. Having lots of equipment and books is American. Putting air-conditioning into the library is American—but so far we have only the ducts. The computers and the language lab are American, and the television system is way-out American. Requiring course work, preliminary exams, and a minimum residence of PhD candidates is American. So is the system of having several full professors in each department, and the habit of using senior faculty to administer the school.

The caliber of the faculty is also, if not American, at least due in part to the Americans. Of the 75 or so who at this moment are assistant professors or better, all but four are under 40 years of age. All have PhD's or equivalent degrees—a dozen from the United Kingdom or elsewhere in Europe, over half from the U.S. and Canada, the rest from India. No other IIT has anything like this concentration of higher degrees. In the mechanical engineering department at Delhi only one man out of fifteen, I am told, has a PhD. In our same department only four out of twelve do not. And ours is the only IIT whose

director is an academic and not a civil service engineer.

There are respects, however, in which the Institute does not really live up to its American appearance. Humanities and social science courses for undergraduates are indeed there, but many of my Indian colleagues are so little interested in them, and so much more interested in the status graduate work confers, that they will begin a PhD program with as little in their discipline as three faculty and fifty feet of books. Most departments do, in fact, have a number of full or associate professors instead of a single professor presiding over readers and lecturers like an oak among the saplings or a guru in the middle of his flock. But though these senior men are theoretically equals, like Orwell's pigs, some are more equal than others. After months of effort the Institute has, at last, two deans drawn from the senior faculty. Yet it needs to create and fill half a dozen administrative posts. And the people at the top have yet to acquire the habit of delegating responsibility and of then refusing to listen when, as so often happens, someone comes running to appeal a decision or to ask for a pencil sharpener. On paper, PhD standards are high. But that paper has only just been written, six years after the Institute's birth and several years after the first candidates for higher degrees appeared; and when you set the number of candidates already enrolled ad hoc (math and physics each have over 50) against the faculty members themselves sufficiently involved in research to be in a position to supervise any, you begin to wonder how much some of these candidates are really doing.

And there is one area in which the Institute's American appearance is downright deceptive. That is the area of language. Like the four other IIT's and all other central schools, IIT/Kanpur operates in the English language. Lectures are given, labs conducted, reading assigned, memoranda written, and most books bought in English. It is a great convenience for us visiting Americans. We have no language problem—but that does not mean the Institute escapes one.

English is a language in which only a fraction of the students feel thoroughly comfortable. It is included in the common entrance exam, but the passing mark is set deliberately low for fear of excluding promising engineers on the grounds of English alone, a thing politically and morally indefensible. As a consequence, most entering students have difficulty with English, and some are literally cripples in it. The first-year course has therefore been made into what is predominantly an English language course; and it was to improve it that some of us requisitioned—on too large a scale and without sufficient preparation, it is turning out—a language lab.

But the first-year course does not cure, it does not even substantially relieve, the language deficiencies of many students. It probably never will. And so the Institute will continue to operate in what is, for a part of the student body, a semi-foreign language. This may be tolerable for engineers and scientists, for they have math and the blackboard. It is intolerable in the humanities and most of the social sciences, where language is central to thought. As for the supporting staff, clerks, and foremen, their English runs from poor to nonexistent. Entangled in it like flies in a web, they move slowly and sometimes with a seeming stupidity.

But what is the Institute to do? National politics prevents shifting into Hindi, which contains no respectable technical literature anyway. And if the shift should even so occur, that half of the faculty from Bengal, Gujerat, and the south, including eight of ten departmental chairmen, would, in time, probably leave.

The little things add up

To continue with the Institute's shortcomings and problems—there are so many little things wrong. The washroom I use has soap dispensers, but in 20 months I have yet to see any soap. Broken windows are rarely mended and sound windows almost never washed. An internal mail service does not exist. Examination arrangements are extremely complicated, regularly require the personal attention of the deputy director, yet often break down. Senate meetings have been going on for several years, but the seating arrangements are such that when the overhead fans are turning, as they must during the hot weather, one end of the table is reduced to lip reading what the other end says.

It is not easy to lay your finger on why these things are as they are, and it is dangerous to draw large conclusions. Do soap containers without soap reflect a national inclination to promise more than can be performed, or does someone pinch the stuff? A few general observations are, however, possible. The windows are dirty, not because the work force is too small, but because it is fragmented, unenterprising, almost totally unsupervised, and much too big. There are plenty of peons (the term is Indian and in daily use; it is not an American wisecrack) and plenty of sweepers. But peons make tea, carry messages (hence no internal mail service), and read cheap Hindi novels. Sweepers just sweep. Neither washes windows. Faculty do not wash windows

either. They do not worry about dirty windows. I am not even sure they *see* the dirt. As for the building superintendent, if there is such a person, he has achieved the dignity of a desk somewhere, with perhaps an almira and a phone and, of course, his own peon. He is not about to leave them for more windows.

Fire some to encourage the others, you may say. But that is impossible! By law or by custom they have tenure and cannot be dismissed unless there is obvious dereliction of duty, as in the case of the chowkidar found sleeping on my desk one morning. (When I arrived, I discovered that the door was bolted from the inside, got suspicious, and used my shoulder to break in.)

And tenure, while we are on the subject, also threatens the future quality of the faculty. It is normal at the IIT's for an associate lecturer, lowest in the faculty ranks, to receive tenure after one year. So do research and teaching assistants, unless specifically appointed on a recurring temporary basis; and since many graduate students hold these positions they often have tenure too. It is also usual, one might say only decent, for a man to look out for his community and his friends. The consequence of premature tenure may bring about the gradual replacement of the present first-rate staff, recruited at American insistence on the basis of ability only, by persons of the second or third rank, who will gradually be pushed up the ladder by the inertia, kindheartedness, and the good offices of the senior men who brought them to the Institute. Though the new deans are trying to check this development by seeing that graduate students at least do not get tenure, it will be difficult to stop it altogether; and indeed some of it has already occurred.

Meanwhile windows do not get washed, and much else of more importance is done sloppily or not at all. There are exceptions, of course. Convocation last October (it was held then because May, when the academic year ends, is too hot) was brilliantly done. There were lots of flowers in pots, policemen in immaculate whites, bagpipes; the student cadet corps looked very smart for its inspection by the President of India. The ceremony itself was held inside a multicolored tent the size of half a football field, and the gowns worn by the VIP's were of black velvet set off by absolute rivers of gold braid. But for the rest of the year there is no braid at all. Because good technicians are hard to find at the pay the Institute can offer, equipment is often wretchedly maintained. Stockrooms tend to be disorderly and their contents incomplete. If you want a particular screw, it will have to be turned for you; if a particular test tube, it will probably be blown. And almost nowhere do you find at the middle support level the kind of competence and energy we take for granted at home. What the Institute needs most, perhaps, is people like Tom Harvey and Gerry Fling, like Frances Humphries and Ruth Toy and Virginia Kotkin; and it does not have them.

Not all the defects are Indian

Not all the defects of IIT/Kanpur are Indian, however, and not all its virtues ours. Some of the features that we are trying to introduce we do not practice ourselves. Looking back at Pasadena from this side of the world, I am occasionally startled and a little pleased by how Indian Caltech seems. Some problems at this Institute, moreover, are compounded by our presence. Its tendency to compose itself into autonomous parts, each tugging against the others—something that characterizes, I am told, Kanpur industry, and certainly is true of political India—is perhaps encouraged by the presence of the program, autonomous certainly and tugging too. And we have undoubtedly created a special problem by bringing to the Institute so much so quickly.

As of last November more than $4,000,000 worth of equipment and books had been requisitioned from the U.S. A great deal of it has reached Kanpur, often late, sometimes battered, but nevertheless in such quantities that the Institute is already the best equipped engineering and science school in India. And that has had a lot to do with its success in attracting able faculty.

In theory all of it was asked for by Indians, and in practice most of it has been. Part of an American's job is to make his colleagues justify requisitions before he signs them and passes them on to the program leader. But some of the stuff, though ordered with the concurrence of the Indians, began as an idea in an American's head. The 1620 computer, operating since the summer of 1963 and a very great success, falls in this category. So do the low temperature lab, the television system, and in a sense the entire library. For we have always been in a hurry. The program is to run for only ten years, and individuals never stay for more than two. We come, we look around, we see what we think is needed, and we induce an Indian colleague to order it. This has often seemed to us not only the best use of our experience but also the only way to make sure that we leave something concrete behind us.

This requisitioning exuberance has had, however, two unfortunate consequences. It has encouraged a natural inclination not to improvise or even to maintain equipment; and because, until recently,

the supply of dollars and of rupees seemed inexhaustible, it was easier and even quicker to order than to build. And if something broke down, you could usually cannibalize from the extras. Ordering on American initiative, while it has endowed the Institute with a number of things of great use, has also left it with some of very little. The supersonic wind tunnel has yet to be installed, the smoke tunnels are toys operated to please visiting firemen, and the electrolytic plotting tank sits idle, because the four Indian aeronautical engineers do not happen to be interested in the things the Americans who founded the department two years ago thought they should be interested in. Question marks hang over optical spectroscopy, an image processing lab, the television studio (Indian participation is adequate on the technical side, but who is to do the programming?), and the language lab.

It is a pity, though in the circumstances not an easily avoidable one, that this sort of thing should occur at IIT/Kanpur. The first thing the Indian faculty members—I am tempted to say Indians in general—need is advice. This they rarely ask for and as rarely accept. Equipment they need less, and we deluge them with it.

Some Caltech accomplishments

What have the six of us from Caltech accomplished? Peter Mason brought over the low temperature lab. It has survived him and will continue, because at least one Indian physicist is determined it shall. Dick Carrouche, surely Old Sceptic himself, has been gone eight months now. But the nitrogen liquefier he nursed into action still fills dewars for the labs that ask for them, and the helium liquefier will be used when a piping system is complete. John Trenholme never did get down to his own research (the idea was for him and Mason to provide a working example of graduate student-supervisor relations), and he developed reservations about the ability of the Indian PhD candidates to do independent work. But he taught undergraduates, came to know a number well, and departed last August quite encouraged by their competence and attitude. Dave Welch worked very hard to improve several of the technical arts courses, with encouraging results, I believe. Both the first-year physics course and that department's graduate programs are the better for Jon Mathews. The language lab is at a standstill, and there is no more history now outside of books than when I came. The first-year English course, in which I spent most of my time, is still inadequate, but the department has more books and more of an interest in the library than it would have if I had not come. So one has some effect.

In April, as I write, a hot wind from the west has begun to blow; the overhead fans are turning, and paperweights litter every desk. In the TV studio an electrical engineer from MIT watches with an expression of intense pain as a sweeper, swinging his cloth in the classic Indian manner, slaps dust all over delicate equipment. Our children go to school very early, come home at noon, and cannot be allowed out of doors until almost sundown. The winter crop is in, and the fields are bare. Over the vast Ganges plain on which this overgrown village of 1,000,000 sits, with its 19th century factories, there is, except for the trees, no color but the sun-tan color of the parched earth.

In May, when anyone who can afford it goes south or to the hills, the thermometer will pass 100 by noon. Blowing dust will deaden the sky and at times obscure the sun. June will be simply more so, with temperatures as high as 115 and occasional wind and lightning storms that bring a little relief. The rains do not come until July. So now is the most trying season of the year in what is by common consent the poorest, laziest, most God-forsaken part of India; and now is the time when Americans, including myself, are likely to be a little testy.

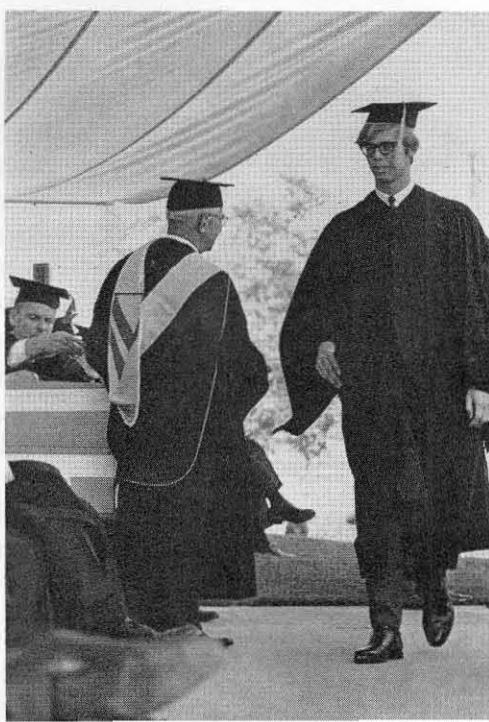
Yet we know that we do not have to live for long with the Institute's blemishes and with Kanpur's squalor and heat, because we will all go home. What is really surprising is that the Indians on the faculty do not grow discouraged. It is true that this is their country; and that the things I know I shall miss are presumably the things which brought them back to India or kept them here. But Kanpur is not India, it is only a piece of India—probably the worst piece. Except for the few who "belong to" the town, as the phrase goes, there is hardly a man on the faculty who would not prefer to live somewhere else. So why do they stay, living on salaries one-fourth what they would receive if they took jobs in the U.S. (as quite a number could), on a half-built campus with very poor schools and almost no amenities? If you go back to the labs in the evening, you will find a number still there, working at something or other— a thing I am told you will not see at other schools in India.

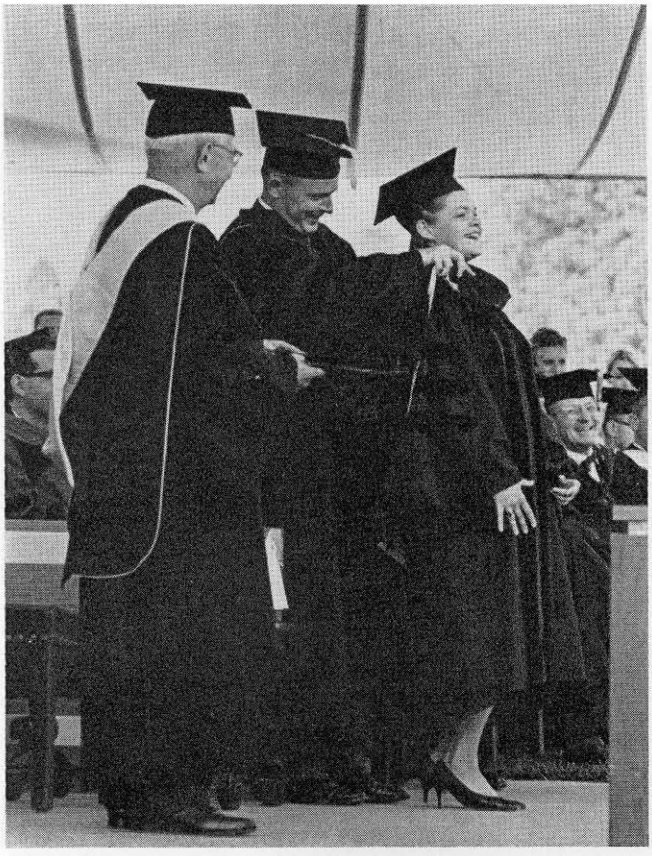
It is because of them that I think IIT/Kanpur is a success. I do not suppose it can become an institute of the very first rank in ten years, and it may not become one in fifty. But I think it will achieve international standing. And in India it is already at the top among the schools of engineering and science. Coming as I do from an institution with so long and proud a tradition of immodesty as Caltech, I can hardly claim less.

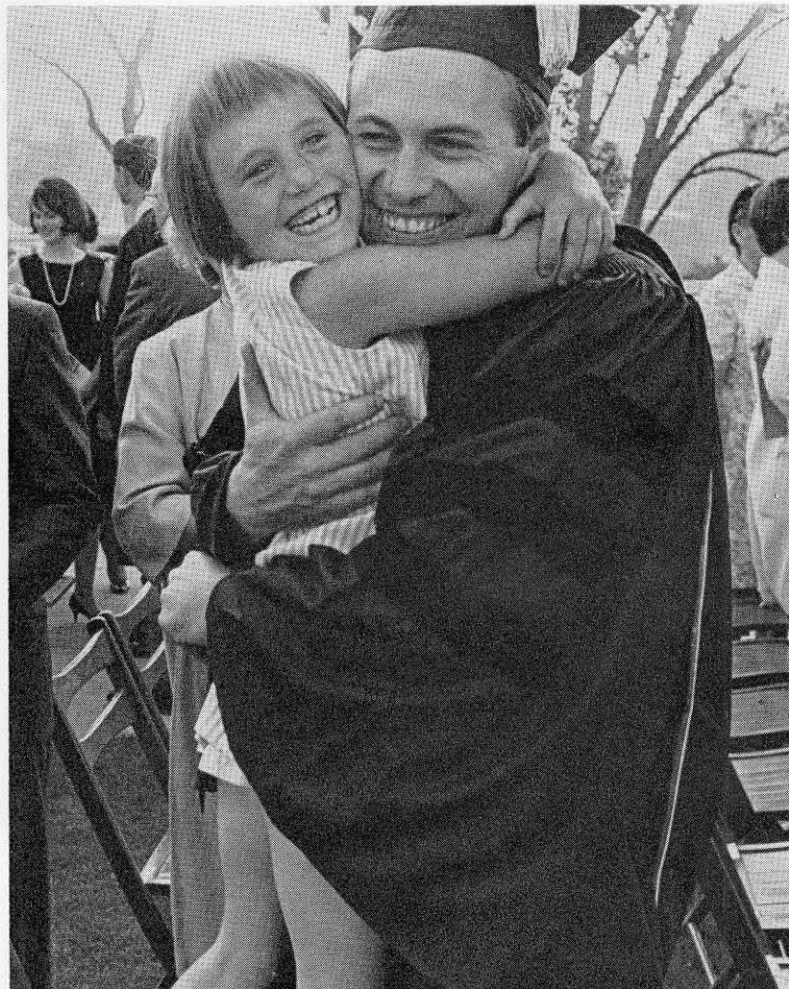
COMMENCEMENT 1966

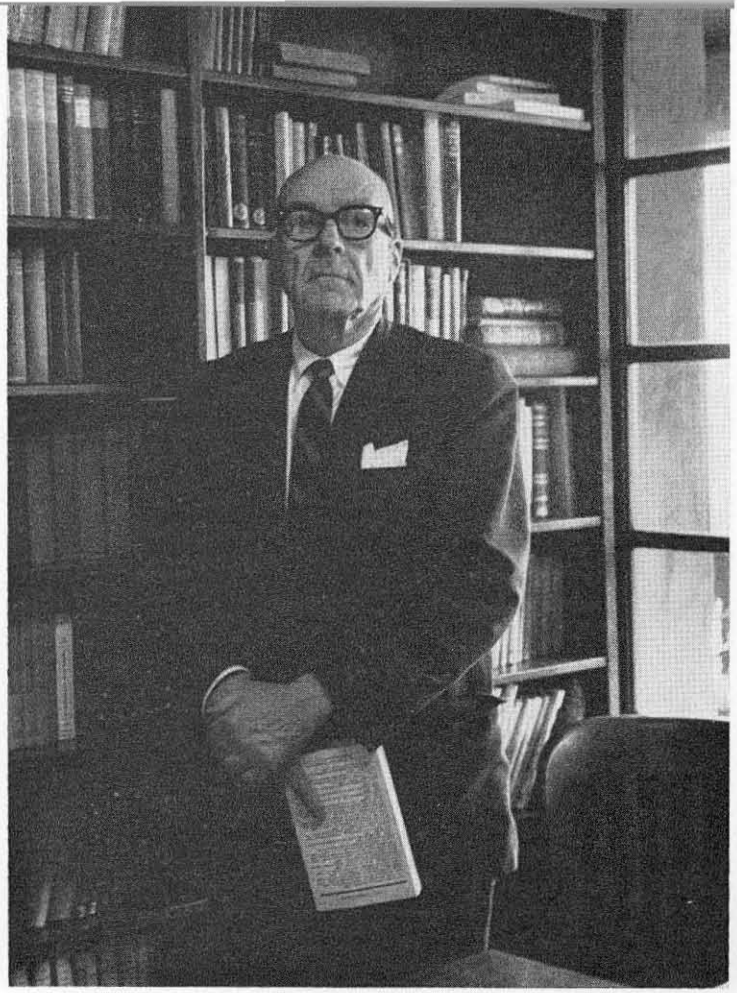
At Caltech's 72nd annual commencement on June 10, a total of 374 students received degrees—135 bachelors of science, 127 masters of science, 8 engineers, and 104 doctors of philosophy. One-third of the seniors were honor students who maintained a B-plus average throughout their four years at Caltech.

Theodore O. Yntema, retired vice president and director of the Ford Motor Company, gave the commencement address, "The Role of the Scientist in Society."









HARVEY EAGLESON,
professor of English

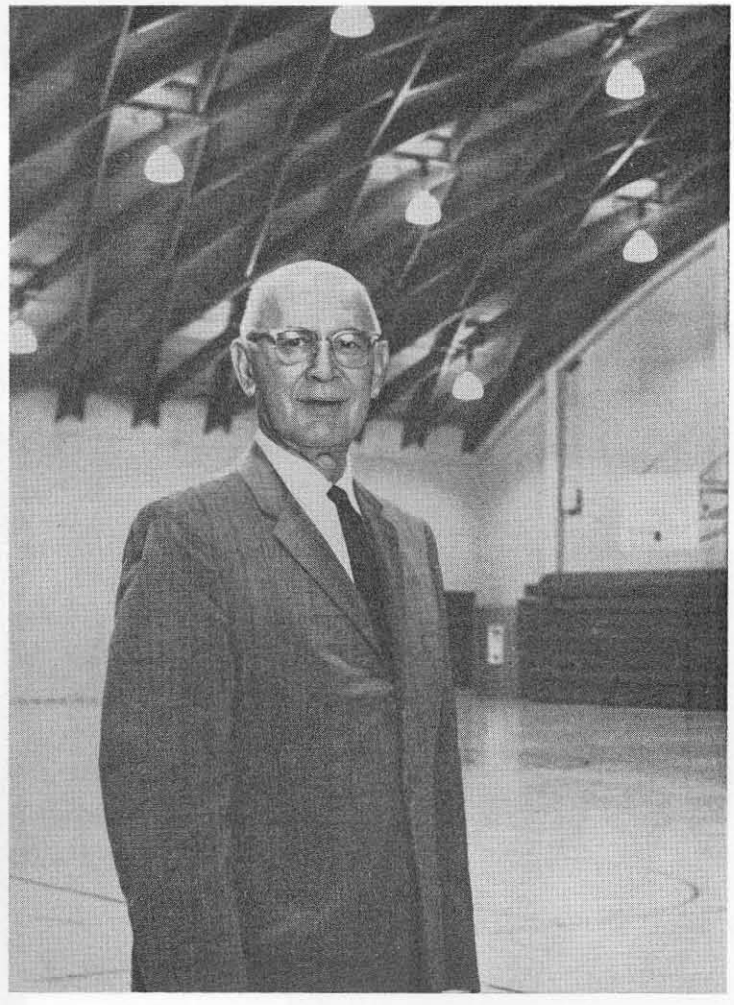
Dr. Eagleson will become professor emeritus when he retires from the Institute next month. He has been at Caltech 38 years. His popularity as a teacher of English and his close association with the undergraduates, especially as resident associate of Blacker House and later as master of student houses, have earned him a unique position in his relationship with students. He has taken part in student affairs also as chairman of the student relations committee, the student house committee, and the student social affairs and lectures and assemblies committees. Dr. Eagleson's English classes have been consistently popular over the years, and he has probably "humanized" as many scientists and engineers as anyone at Caltech. Former students living in the Los Angeles area even organized once-a-week evening meetings with him years after their graduation. Dr. Eagleson received his BA from Reed College in Oregon in 1920, his MA from Stanford, and his PhD from Princeton. He taught at the University of Texas for four years before coming to Caltech.

RETIRING THIS YEAR

HAROLD Z. MUSSELMAN,
administrative advisor in physical education and athletics

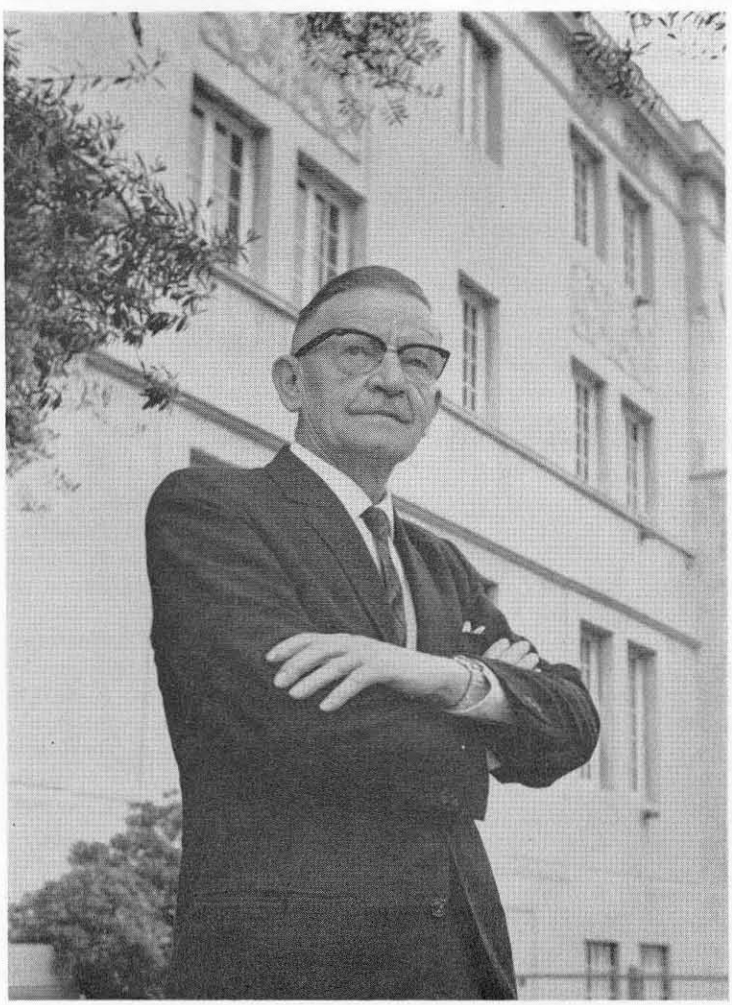
Mr. Musselman, who has served Caltech for 45 years as coach, athletic director, and administrative advisor, will become director of physical education and athletics, emeritus, on his retirement next month. He came to Caltech in 1921 as a coach and YMCA secretary, became coach and manager of athletics three years later, and director of athletics in 1947. He was varsity baseball coach for 26 years, and also served as varsity basketball and assistant football coach. He maintained an athletic program designed to include all who wanted to participate in intercollegiate competition, and he has provided Caltech students with opportunities in such specialized sports as karate, soccer, rugby, cricket, and fencing.

Mr. Musselman was president of the Southern California Intercollegiate Athletic Conference Coaches and Managers Association for 11 years. He has been a member of the Tournament of Roses Association for 19 years, and in 1932 managed the Olympic cycling races at the Rose Bowl. He was recently honored by alumni, faculty, and friends with the presentation of two round-trip tickets to Hawaii, which he and Mrs. Musselman will use this month.



RICHARD McLEAN BADGER,
professor of chemistry

Dr. Badger will become professor emeritus next month after nearly 50 years on the Caltech campus —first as a student and then as a faculty member. He came as an undergraduate in 1919, received his BS and PhD degrees, and stayed on as a research fellow for four years. After a year in Germany as an International Research Fellow, he returned to Caltech in 1929 as assistant professor of chemistry and has taught for the 37 years since. In 1952 he was honored by election to the National Academy of Sciences; in 1960 he spent a year visiting laboratories in the East and in Canada and doing research at Caltech on the structure of molecules by infrared spectroscopy on a Guggenheim Fellowship Award. In 1961 he was elected a fellow of the American Academy of Arts and Sciences. Dr. Badger's research has been mainly in the field of investigation by spectroscopic methods. He has also been a mainstay of undergraduate physical chemistry classes at Caltech. In 1961 he received the Manufacturing Chemists' Association Medal and Citation for his superior work as a chemistry teacher. Dr. Badger plans to complete work on his book, *Experiments in Physical Chemistry,* and on several scientific projects.



ALEXANDER GOETZ,
associate professor of physics

Dr. Goetz, who will retire from Caltech on July 1, has been a member of the Institute faculty since 1930. He was born in Germany, where he received a PhD in physics and a PhD in physical chemistry from the University of Goettingen. He continued there as a research assistant, a lecturer, and then as an a.o. professor. Although he came to Caltech in 1927 as a Rockefeller Fellow and joined the Institute faculty in 1930, he remained on the University of Goettingen faculty until 1941. At Caltech Dr. Goetz's research has been centered on molecular physics, particularly of the colloidal states. His studies of aerosols, under the sponsorship of the U.S. Public Health Service and the California Department of Health, led to his appointment in 1961 as advisory director of the science division of the Institute of Aerobiology in West Germany. He is a fellow in the American Physical Society and the United German Physical Societies, and a member of the American Geophysical Union. Dr. Goetz plans to divide his time between acting as senior staff advisor at the National Center for Atmospheric Research in Boulder, Colorado, and as a senior scientist for the Atmospheric Research Group of the Meteorological Research Institute in Altadena.

Personals

1924

HAROLD E. GRAHAM died on February 14 at the Huntington Memorial Hospital in Pasadena, after a long illness. He was 62. A design engineer and owner of Harold Graham—Displays, he had lived in Claremont, Calif., since 1938. He was born in Texas in 1904 and came to California in 1912. Graham attended Caltech and the Chouinard Art Institute in Los Angeles and studied in Berlin in 1930-31. In 1936 he went into business for himself. He taught in the art department of Scripps College in Claremont from 1935-39, and during World War II he served in the Army Air Corps. He is survived by his wife, Doris.

1925

NEWTON H. TEMPLIN died suddenly of a heart attack on May 8. He had been road commissioner for the Los Angeles County road department since 1959 and had been with the county for 41 years. Templin was active in engineering and public works organizations throughout his career. He was president of the Southern California chapter of the American Public Works Association, vice president of the County Engineers Association of California, chairman of the Metropolitan Transportation Engineering Board; and chairman of the highway advisory committee of the County Supervisors Association of California. Templin is survived by his wife, Laura; his daughter, Mrs. R.O.M. Phillips of Woodland Hills; his son, Charles of Alhambra; and four grandchildren.

1929

J. CLARK SUTHERLAND, MS '30, who is president of the Robinson Clay Product Co. of Akron, Ohio, president of Keystone Clay Product, Inc., of Philadelphia, and president of the Robinson Clay Product Co. of Canada, writes that he has an unmarried son, a married daughter, and four grandchildren. His wife, Dot, passed away last spring (1965).

1932

JAMES R. BRADBURN has been named division vice president and general manager of electronic data processing of the Radio Corp. of America, in Camden, N.J., responsible for the over-all direction of RCA's computer activities. Bradburn, who joined RCA last year, was formerly a vice president and director of the Burroughs Corp. in Detroit, Mich.

1936

HUGO A. MENEGHELLI, manager of tire development operations for the General Tire and Rubber Co. of Akron, Ohio, writes that his son Lance, 24, a lieutenant in the Air Force, will graduate as a fighter pilot in July, and his son Leonard, 21, is scheduled to ship to Japan in July from the Marine Corps Air Station at El Toro, Calif., where he is now stationed.

1942

SHELDON W. BROWN, AE, has been appointed the Washington, D.C. representative for Naess & Thomas, New York investment counselors. He will continue part-time on the general planning staff of the Aerojet-General Corporation.

1943

CHARLES D. WAGNER, PhD, a supervisor of radiochemistry research at the Shell Development Company's Emeryville, Calif., research center, attended the 7th Japan Conference on Radioisotopes in Tokyo last month and presented a paper on "Skeletal Isomerization of Olefins by Radiation." He also conducted a seminar at the Takasaki Atomic Energy Research Institute. Earlier in the month Wagner presented another paper at the Conference on Radiation Chemistry in Organic Systems held in Hawaii.

1947

TING-YI LI, AE, PhD '50, professor of aeronautical and astronautical engineering at Ohio State University in Columbus, writes that he will be in Los Angeles in June to take part in the American Institute of Aeronautics and Astronautics' fourth aerospace sciences meeting, and to do consulting for The RAND Corporation.

PAUL T. HUTCHISON, MS, has been appointed head of the microwave radio design department at the Bell Telephone Laboratories in Holmdel, N.J., and will be responsible for the design and development of a new microwave radio system used to transmit telephone messages or TV signals up to 1000-mile distances. Hutchison, who joined Bell in 1960, has been a supervisor in the department since last year.

1949

EMMETT P. MONROE, MS, MD, who is in general practice in Cuyahoga Falls, Ohio, writes that he has five children who all want to visit California, but "things are too busy here to allow frequent returns to Pasadena."

1950

WALTER L. MUDGETT has joined The MITRE Corporation of Bedford, Mass., as a member of the technical staff. He has been with the Radio Corporation of America in Burlington, Mass., since 1957. Before that time he was an engineer at the laboratory for electronics in Boston.

JAMES C. CONLY, PhD, has been named manager of chemical development by the Mobil Chemical Company of New York. He will be responsible for coordinating development activities in connection with new industrial chemicals and chemical intermediates. Conly, who lives in Scarsdale, N.Y., was with the Stauffer Chemical Co. and ICI, Inc., prior to joining Mobil.

1951

THORNE J. BUTLER, MD, a major in the U.S. Air Force and chief of the laboratory division at the Air Force Hospital at Sheppard AFB in Texas, has been awarded the Legion of Merit, one of the nation's highest peacetime decorations. He was cited for his leadership and significant contributions to educational medicine and to Japanese-American relations while he was assigned to the Intern Education Committee of the USAF hospital in Tachikawa AB in Japan.

1952

ROBERT W. ZWANZIG, PhD, research chemist with the National Bureau of Standards in Washington, D.C., has a dual appointment to the faculty of the University of Maryland as research professor in both the Institute for Molecular Physics and the Institute for Fluid Dynamics and Applied Mathematics, in the colleges of arts and sciences and engineering.

1952

FRANCIS R. KRAMER is senior supervisor at the E. I. du Pont de Nemours & Co.'s dacron plant technical group in Kinston, N.C.

1953

THOMAS L. CURKENDALL, MS, who is a systems program staff officer at Travis AFB in Calif. and a member of the Military Airlift Command, has been promoted to lieutenant colonel in the U.S. Air Force. He was commissioned in 1944 through the aviation cadet program.

1954

ROBERT H. SHENNUM, PhD, has been promoted to director of the mathematical analysis and apparatus design laboratory at the Bell Telephone Laboratories in Winston-Salem, N.C., where he will be responsible for the design of transmission, microwave and power apparatus and for mathematical analysis work related to military systems. Shennum joined Bell in 1954 and has been head of the microwave radio design department of the laboratories in Murray Hill, N.J., since last year.

RALPH D. HANDEN JR. is teaching assistant in the department of history at Ohio State University in Columbus. He recently spent five years in the parish ministry. Handen and his wife have two sons and a daughter.

1956

JOSEPH P. GIBBS has been appointed manufacturing manager of the instrumentation division of Microdot Inc. of South Pasadena. He has been chief engineer for transducer products.

CHARLES E. HELSLEY, MS. '57, assistant professor of geology at Western Reserve University in Cleveland, Ohio, has accepted an appointment as associate professor of geology at Indiana University in Bloomington. He and his wife, Joann, have two sons: Mark, 2½, and Paul, 4 months. They spent last summer touring northwestern Europe and collecting for his research work.

1957

DOUGLAS G. RITCHIE has been named chief engineer for transducer products of Microdot Inc., of South Pasadena. He has been a section head for special engineering projects for Electro-Optical Systems in Pasadena.

1959

MICHAEL T. GRAY, MS, has joined the Edex Corp. of Mountain View, Calif., as chief engineer in charge of administering the general engineering programs and directing the development of integrated programmed learning systems embracing computer controls and communications. He lives in Sunnyvale with his wife and four children.

THOMAS F. CLANCY, MS, has been appointed an advisory engineer in systems mathematical analysis at the IBM Corporation's space guidance center in Owego, N.Y. He has been with IBM as a staff engineer since 1962. He and his wife, Lynda, have one daughter, Karen.

1960

STEPHEN G. SAWOCHKA, MS, is in San Jose, Calif., with the General Electric Company's atomic power and equipment department. He received his PhD from the University of Cincinnati last year.

1961

MARTIN H. SCHULTZ is an assistant professor at Case Institute of Technology in Cleveland, Ohio. He received his PhD in mathematics from Harvard University last year.

DOUGLAS W. SHAKEL, a navigator-bombardier assigned to the Air Force plant representative officer at the Boeing Company in Wichita, Kansas, has been promoted to captain. He is a member of the Air Force Systems Command. Shakel entered the Air Force in 1961.

CHARLES J. SIEGEL, a captain in the U.S. Air Force, has entered the Air University's Squadron Officer School at Maxwell AFB in Alabama. He has been serving as an instructor pilot at Reese AFB in Texas. Siegel was commissioned in 1961 and is married to the former Donna Nelson of Brownfield, Texas.

JOHN C. CASEY, MS, AE '62, who is an assistant professor at the U.S. Air Force Academy in Colorado, has been promoted to lieutenant colonel in the Air Force.

1962

THOMAS EDWIN CREIGHTON, one of the 15 young scientists to be awarded a grant for a year's postdoctoral research by the Air Force Office of Scientific Research, will go to Cambridge University in England to work in biophysics. His topic is the structure of globular proteins by x-ray diffraction analysis. Creighton has been working toward his PhD in biology at Stanford.

BRUCE R. ABELL and his wife, the former Nancy Matthews, have a new daughter, their first child, born on May 24. Bruce has been associate editor of *Engineering and Science* magazine since September 1965, when he came from The Bunker-Ramo Corporation in Canoga Park, where he was a technical editor.

1963

RALPH T. SHUEY, a physicist at the General Electric research laboratory in Schenectady, N.Y., has been selected to participate in the postdoctoral program supported by the Air Force Office of Scientific Research. He plans to work at the Swiss Federal Institute of Technology in Zurich in solid state physics. His research topic is the theory of dielectrics.

KARVEL K. THORNBER, MS '64, has been selected to participate in the postdoctoral research program sponsored by the Air Force Office of Scientific Research. The national research council of the National Academy of Sciences administers the program. Thornber will do his research at the Electronics Laboratory at Stanford, in the field of applied solid state physics. His research topic is semiconductor band structure in and above the conduction band.

C. ROBERT KLOTZ, MS, is a systems engineer in the power equipment division of Lear Siegler, Inc., in Cleveland, Ohio.

RONALD K. COUNSELL writes that he has enrolled in a program leading to a PhD in international studies at Johns Hopkins University in Baltimore. He has been doing graduate work in the chemistry department there.

Books . . . *continued*

manned flight is the 12th volume in the Life Science Library. Dr. Stever, now president of the Carnegie Institute of Technology, was Chief Scientist for the Air Force in 1955-56 and later served as consultant for the National Aeronautics and Space Administration and the Congressional Committee on Science and Astronautics.

The Molecules of Nature: A Survey of the Biosynthesis and Chemistry of Natural Products

by James B. Hendrickson '50
W. A. Benjamin $3.95

A short (189 pages) monograph intended as a supplement to a first-year text in organic chemistry. "Natural products," in this case, are compounds primarily of chemical interest rather than biological significance. Dr. Hendrickson is associate professor of chemistry at Brandeis University.

Faculty Books

The Analysis of Stress and Deformation

by George W. Housner and Thad Vreeland Jr.
Macmillan $11.95

A text prepared for a Caltech course in the mechanics of deformable bodies by Dr. Housner, professor of civil engineering and applied mechanics, and Dr. Vreeland, associate professor of materials science, for advanced undergraduate or first-year graduate students.

Elements of Abstract Algebra

by Richard A. Dean
John Wiley & Sons $7.95

A text which is the outgrowth of the introductory algebra course given at Caltech by Dr. Dean, professor of mathematics, covering the "topics and techniques of abstract algebra that are finding ever wider applications in mathematics and the applied sciences."

Basic Chemical Thermodynamics

by Jurg Waser
W. A. Benjamin .....$8.00 cloth
$3.95 paper

A text derived from the notes prepared by Dr. Waser, Caltech professor of chemistry, for use in his freshman chemistry course.

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The thesis

Treasured recipes yield enviably fine photographic films. Nonetheless we must not underrate science. It has served us well ever since the smart move we made in 1912 in hiring brash C. E. K. Mees, aged 30, to take a new kind of job, "director of research."

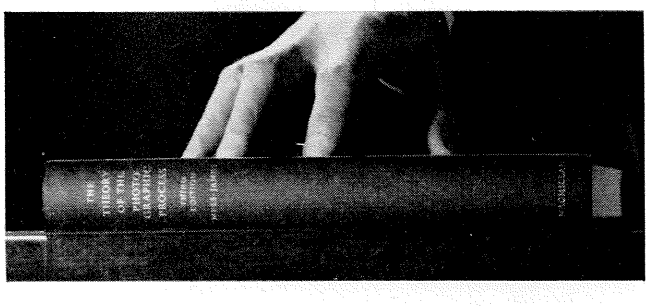
He and a friend had done a joint doctoral dissertation, *Investigations on the Theory of the Photographic Process*, at University College, London, under Sir William Ramsay, co-discoverer of the noble gases and of the principle that industry need not necessarily be beneath the dignity of science. The young men had met the challenge of convincing a demanding faculty that the physical and chemical basis of the technique employed by artists who limn with light was not unduly light in academic weight. Not long after we hired Mees, he sent for his collaborator. The two of them and a growing corps of others set to deepening, elaborating, refining, correcting, and expanding the content of their thesis.

This work still goes on every working day of the year, though the two who started it are no longer living. Apart from the fallout that has had the intended effect—in combination with other talents—of making us exceedingly prosperous, the great endeavor has brought forth merciless revisions and enlargements of the frame of reference from the 1907 dissertation, first in 1942, then in 1954, and now in 1966.

The new third edition of *The Theory of the Photographic Process* has been published by The Macmillan Company, 60 Fifth Avenue, New York 10011, and priced at $25. From the 1907 rootstock it carries over the name Mees and the creed that the workings of the silver halide process merit the attention of serious contemporary scientists entirely aside from any usefulness in teaching others how to invent treasured recipes of their own.

The 1966 edition was written by Kodak physicists and chemists in time stolen from their daily research tasks at Rochester, Harrow (England), and Vincennes (France). It was really no sacrifice, not even on the part of the shareowners. A book like this is at least as beneficial to the writers to write as for the readers to read. No assumption is made that the reader has eaten and slept the subject since graduate school. When the book needs to refer to excitons, nucleotides, or nucleosides, it stoops to define them.

Amiability is necessary but insufficient



Here is that book advertised above. Its sheer physical presence cannot help but elevate the tone of an office bookshelf. A substantial book with hard covers represents long-term worth, work, wisdom. You can't go wrong symbolizing good taste with a book. Bookish souls rarely recall that the book itself appeared relatively recently in recorded history as a piece of newfangled technology in competition against the far more venerable scroll. It did offer some advantages in random access and in the protection of literary content from wear and weather by covers of animal and (more recently) vegetable origin.

"Better yet, mineral," pipes up a nice young man whose acquaintance you can readily make if your business has anything to do with book manufacturing (printed or blank) and you signify as much to Eastman Chemical Products, Inc., Kingsport, Tenn. 37662 (Subsidiary of Eastman Kodak Company). The young man is pursuing a career in marketing, a word that has a new meaning which makes some bookish people slightly fretful. They fail to understand that a young man who ranked high in his class at a high-ranking center of scientific scholarship can strain his intellectual endowment to capacity at the work of best fitting the demands of civilized society to supplies of gas issuing from holes in the ground.

A very special way of co-polymerizing the gases ethylene and propylene to make TENITE Polyallomer, the young man can explain, results in a most unnaturally tough, semi-stiff sheeting which when machine-scored develops an inbuilt hinge good for a hundred thousand flexings. The thesis advocated and defended by the young marketer holds that when deciding whether to make a book animal-or-vegetable hardcover, paperback, or polyallomer there is no question which gives the most wear for the least cost and furthermore feels as soft as a two-year-old's cheek.

So much for books. Now about meat, another basic need. Along comes a marketer of ours who sees how the gas from the ground can serve a good purpose by being turned into transparent little trays so that the shopper can inspect the down side of the steak before assuming financial obligation. Our kind doesn't shatter when cold. The importance of that point has to be discovered and conveyed, not least of all, to the fraternity brother who decided marketing was for the merely sociable and now says, "I can make a zillion better pounds of polyallomer. Where shall I ship it?"

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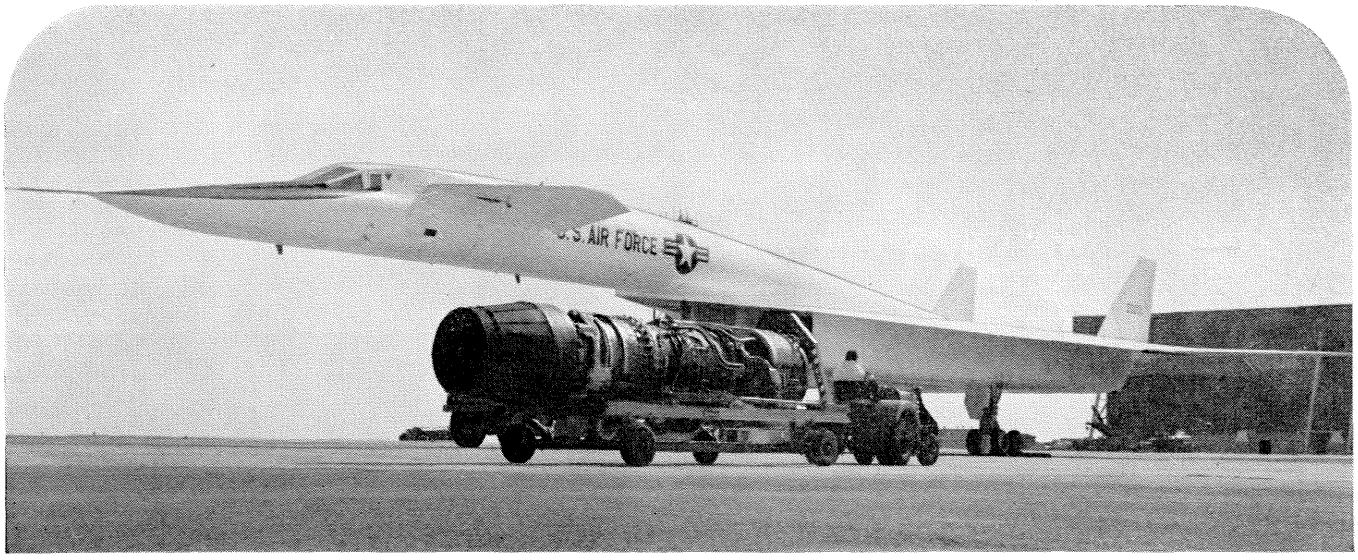

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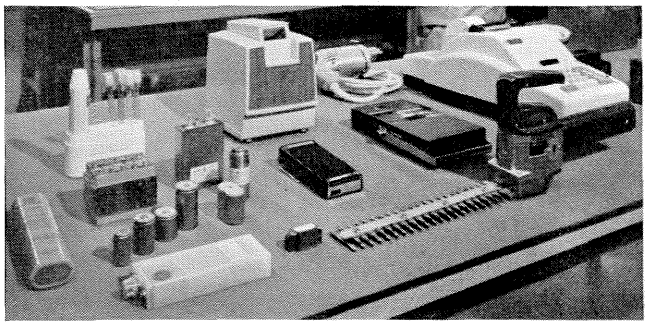

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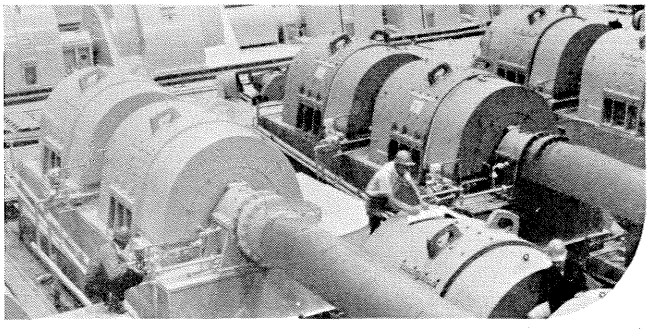

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