ENGINEERING | AND | SCIENCE

January 1959

Admissions at Caltech . . . page 20

Published at the California Institute of Technology

Want to see a pinhead—47 feet wide?

The head of a pin would appear about 47 feet wide if examined under this instrument. It's an electron probe microanalyzer—the first to be used industrially in this country. U. S. Steel research teams use it to get a better look at the microstructure of new types of steel. In this way, they gather more information about the factors affecting steel quality and performance.

Research like this is typical of U. S. Steel's leadership in the production of better steels for the wonder products of tomorrow.

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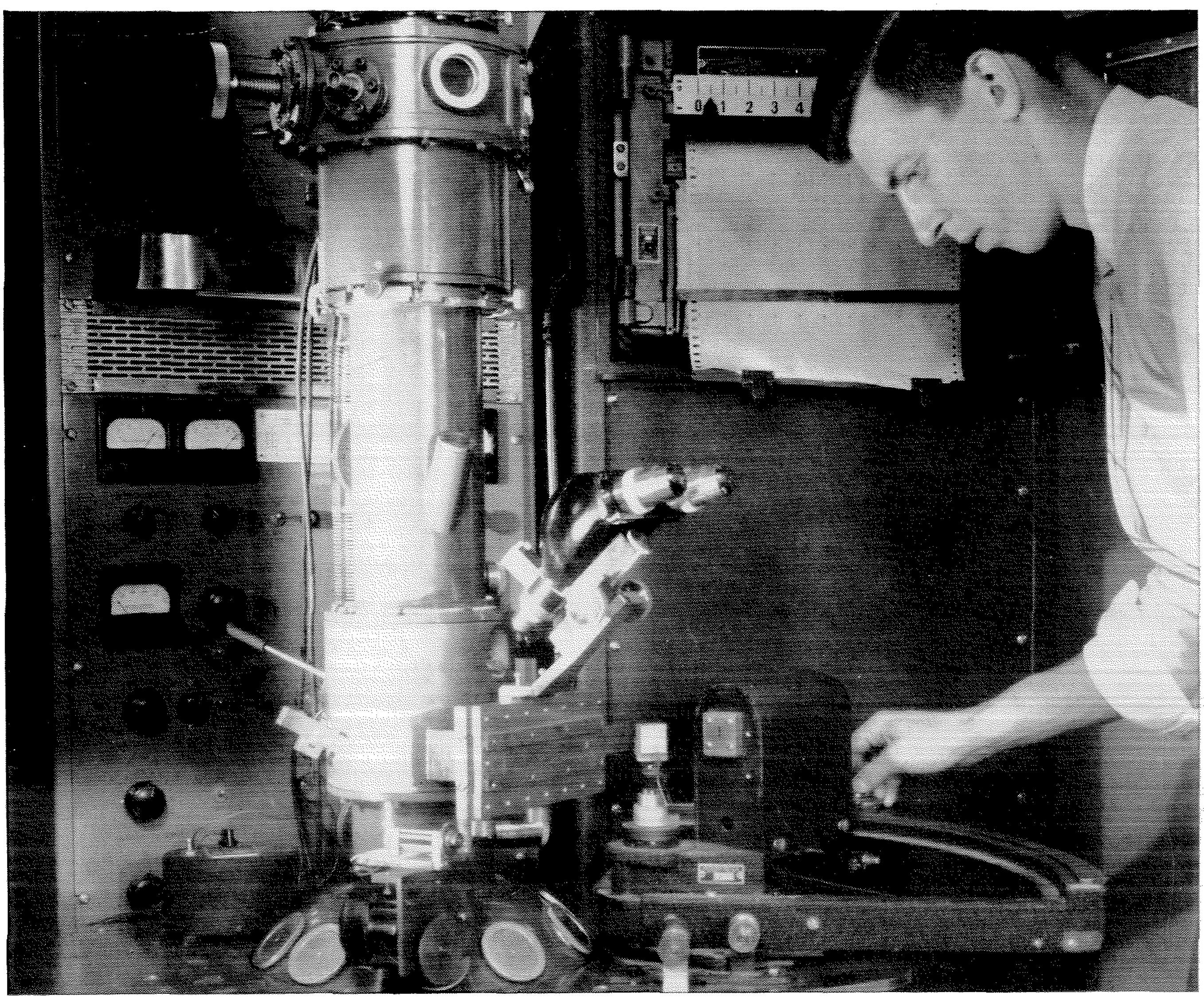
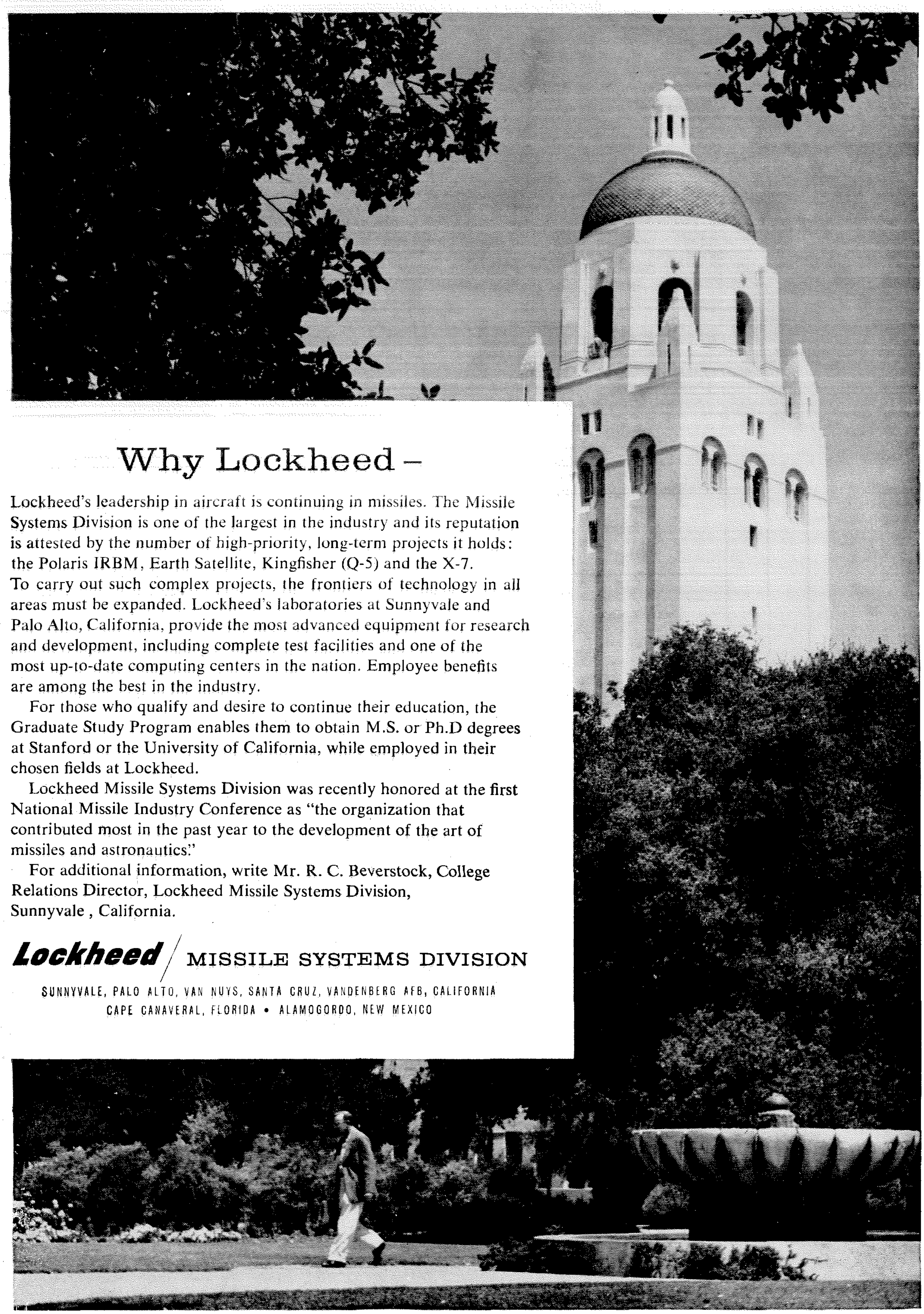


USS United States Steel



ENGINEERING | AND | SCIENCE

JANUARY 1959 *VOLUME XXII* *NUMBER 4*

On Our Cover

Paul C. Eaton, Caltech's dean of students, and a member of the Admissions Committee, interviews some prospective Caltech freshmen.

(Directly below, for the benefit of *other* prospective freshmen, we present evidence to show that, though Dean Eaton most certainly has a serious side, it is rarely as serious as it appears on our cover.)

On page 20, an illuminating account of how Caltech selects its freshmen – and what it takes to get into Caltech today – by Peter M. Miller, assistant director of admissions and undergraduate scholarships.

Adventures in Science

On page 11, has been adapted from an address given by President Du-

continued on page 6

P. C. Eaton – a second look

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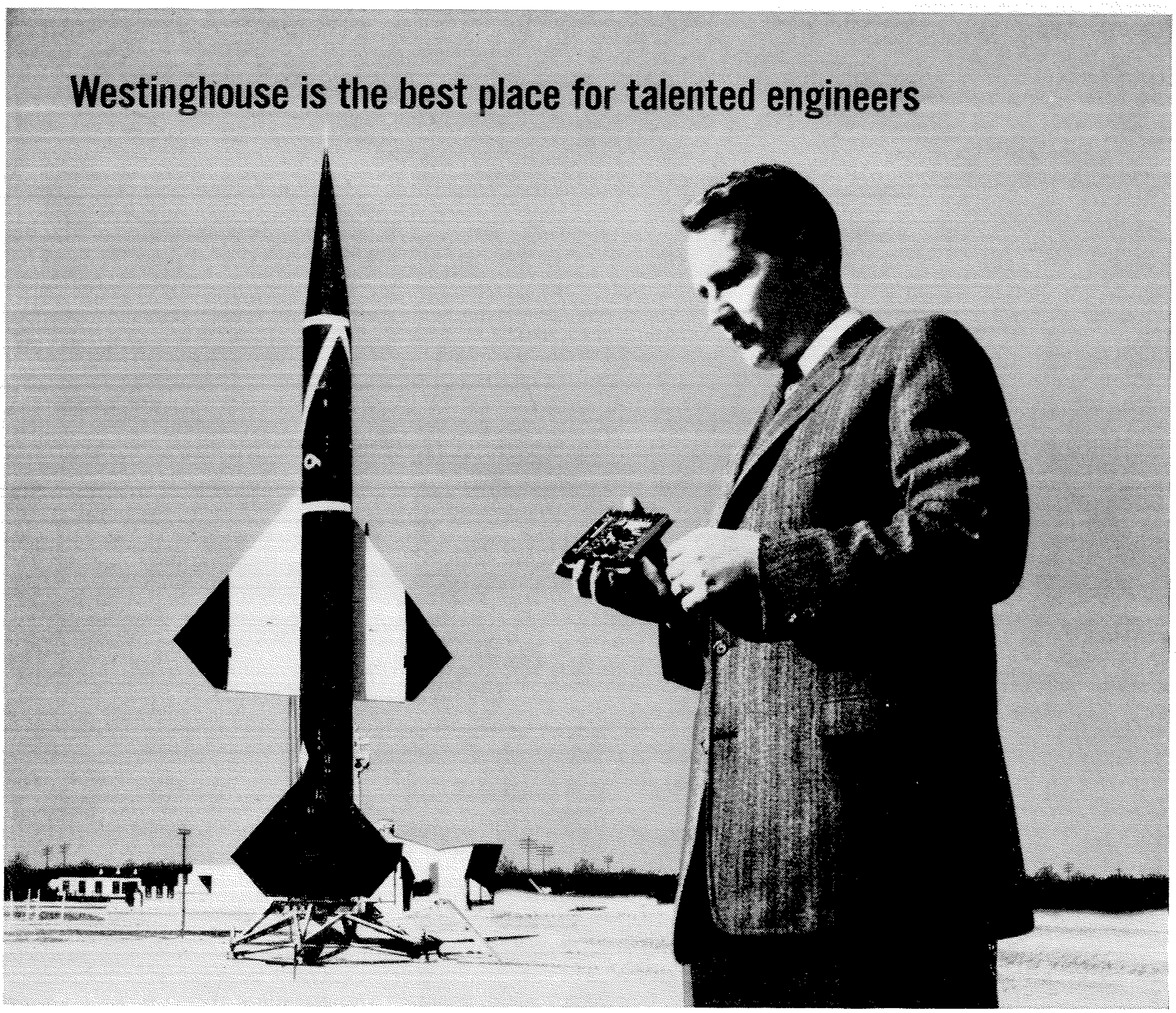

Samuel Zimmerman joined Westinghouse in 1955 – now developing missile guidance system

At 27, Samuel E. Zimmerman, a 1955 BSEE graduate of the University of North Dakota, is already well on his way in an exciting career in defense electronics. Now at work in the Electronics Division in Baltimore on the ground guidance and control system for the advanced BOMARC missile, he's principally concerned with the development of special purpose computers and helped to design the error detection and logic systems for a new transistorized computer-tracker.

Most important, *Samuel Zimmerman is doing exactly what he wants to be doing.* Since completion of the Westinghouse Student Training Course, he has submitted four patent disclosures, one of which resulted in a cash award; and he's now preparing two more. In addition, he has completed a year of graduate work on wave theory and analog computers toward a Master of Science degree at the University of Maryland under the Westinghouse Graduate Study Program.

Samuel Zimmerman is one of many talented young engineers who are finding rewarding careers with Westinghouse. You can, too, if you've got ambition and you're a man of exceptional ability. Our broad product line and decentralized operations provide a diversity of challenging opportunities for talented engineers. Guided missile controls, atomic power, automation, radar, semiconductors, and large power equipment are only a few of the fascinating career fields to be found at Westinghouse.

Why not find out now about the opportunities for *you* at Westinghouse? Write to Mr. L. H. Noggle, Westinghouse Educational Center, Ardmore & Brinton Roads, Pittsburgh 21, Pennsylvania.

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In This Issue . . . *continued*

Bridge at the annual meeting of the American Petroleum Institute in Chicago, November 1958.

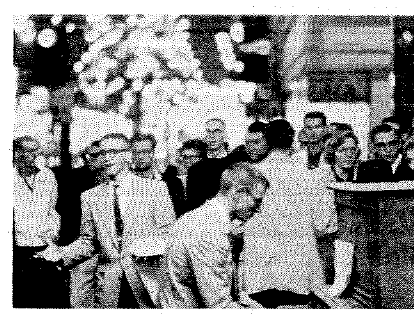
How to Get Rid of a Piano

In our Student Life article on page 18, Brad Efron, in discussing how students while away the days before final exams, blithely states that "time is found to destroy pianos on Hollywood Boulevard."

In fuller explanation of this obscure reference, we might briefly explain that, on December 5, a steamy group of undergraduates, suddenly finding themselves with a superannuated piano on their hands, trucked the thing over to Hollywood Boulevard and Las Palmas Avenue, set it up on the sidewalk, and launched a revival meeting. The group thereupon indulged in an orgy of carolling, exhorting, shouting and passing out religious literature. Shortly, however, *another* Caltech group, dressed as hoods, swarmed in and vigorously attacked the evangelists, the piano, and – most viciously – the pianist, who had been going to a good deal of trouble all evening pretending to be crippled.

At this point the police moved in. Somehow the students talked their way out of the whole fracas and started happily back to the campus. To top off the evening, they dumped the piano in the Oxy swimming pool – which they just happened to be passing on their way home.

So that's the story – which is of interest if only to show that undergraduate ingenuity is still a fearful thing. Somebody may find out how to harness it someday. Then watch out.



Caltech revival meeting

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A darning needle or grain of sand?

E/C^2?

A singularity in a field?

A ratio of accelerations?

How is it held together?

Is there a region of anti-matter extant in the cosmos?

The nature of matter is important to Allison because energy conversion is our business and matter is convertible to energy. Thus, we have a deep and continuing interest in matter in all its forms.

Basic to our business is an intimate knowledge of every form of matter — solid, liquid, gaseous. We search for this knowledge to increase the effectiveness with which we accomplish our mission — exploring the needs of advanced propulsion and weapons systems.

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Energy conversion is our business

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STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

The "Space Age" isn't going to become a fact by itself. We engineers have to make it happen. Here's what Douglas is doing about it:

We've formed a top level engineering council to bring all our knowledge and experience to bear on the new problems relating to extreme high speeds and altitudes and to outer space.

This council is composed of the heads of our six major engineering divisions and is chairmanned by our senior engineering vice president. It will map out the most important goals in aviation and mobilize the scientific and engineering resources required to achieve them.

If you would like to become a part of our stimulating future, we'll welcome hearing from you.

Write to Mr. C. C. LaVene
Douglas Aircraft Company, Box 600-E
Santa Monica, California.

Adventures in Science

An imaginary tour of some of the laboratories where great adventures are taking place today.

by L. A. DuBridge

With manmade satellites whizzing around the earth, with pot shots being taken at the moon every month or so, and with lots of talk about shooting next for Venus or Mars, no one has any doubt any more that great adventures are to be found in the field of science.

Science and technology have indeed suddenly burst open a new geographic frontier—the frontier of space. Just as the 15th- and 16th-century adventurers opened new frontiers by sailing the seven seas; and just as the early aviation pioneers opened new frontiers by flying through the air, so today we are about to see new adventures on the great frontiers of space. So far, we have taken only the first steps in this new exploration, but the essential tools are at hand. And though it will be slow, expensive and dangerous, we shall in the next 50 years see many a space vehicle launched to bring back new knowledge of our solar system, millions of miles away from our tiny earth.

But geographic exploration is not the only field of adventure that human beings have enjoyed. In fact, only a fraction of the exciting adventures which have taken place in the last 300 years have anything to do with geography at all. The great adventures of mankind today are at the frontiers of the mind – the frontiers of knowledge.

The entire world was thrilled when Sputnik I sailed successfully into orbit. But 300 years ago a man in Italy was getting a great thrill out of watching marbles roll down an inclined plane, timing them and discovering for the first time the "law of motion." That man was Galileo and he, too, startled the world of his day by showing that a heavy stone and a light stone, when dropped from the leaning tower in Pisa, hit the earth at nearly the same instant. The stone twice as heavy did not fall twice as fast – as everyone had thought for many centuries.

At almost the same moment, way up in Denmark, another man named Tycho Brahe was patiently making an extensive series of accurate observations on the position of the planets in the sky. He plotted the course of Venus and Mars and Saturn more accurately than anyone had ever done. And his measurements enabled another man in Prague – Johannes Kepler – to prove that the earth and the other planets traveled in elliptical orbits about the sun, with the sun at one focus. And the exact laws of planetary motion which he deduced – together with the law of motion which Galileo found for his marbles – enabled Isaac Newton to evolve the laws of the relation between force and motion and deduce the law of gravity. And it was Newton who pointed out that, knowing the way the moon stayed in orbit about the earth, a man could put an artificial moon into another orbit about the earth – provided he could get away from the atmosphere and provided he could hurl his little moon with an unimaginable speed of 5 miles per second, or over 18,000 miles per hour.

Three hundred years later men, in fact, learned how to do just that. But the intellectual adventure which paved the way for that achievement took place in the 17th century in the minds of Galileo, Tycho Brahe, Kepler and Newton.

But adventures like that – great discoveries at the frontiers of our ignorance – have been taking place in the laboratories and work rooms, the field stations and observatories of scientists every since. Some have had less sweeping and less astonishing consequences than those of Newton. But still others have rivaled Newton's in their depth and their world-shaking results.

It would require a recital of the whole history of science to tell about these great discoveries – and many of you are already thoroughly familiar with the discoveries in chemistry, atomic physics, electricity and mechanics which converted the world of the Middle Ages into the world of 1958. From the conquest of space to the conquest of disease, these discoveries have led to adventure after adventure in improving man's knowledge and adding to his comfort.

But these adventures are not just matters of history; they are taking place today in the laboratories of universities, of industry, and of governments. All over the world scientists, engineers and doctors are penetrating new frontiers, laying the basis for the new things of the 21st century.

I am going to ask you to take a little imaginary tour of some of these laboratories in order to inquire what frontiers of knowledge are being attacked today.

In attacking a frontier of knowledge — a frontier of the mind — one begins, not by taking a far journey, but by staying home and asking questions. What are some questions being asked today in the laboratories of science throughout the world? There are thousands of them, of course, so the problem is where to start. I'll have to start in some laboratories with which I am familiar — namely, those at Caltech. But I'll start with one of the laboratories with which I personally am least familiar — the laboratories of biology.

The question biologists ask

I am not a biologist, but the general theme of the questions the biologists ask is one which we can all understand: What is Life?

That, of course, is a question which scientists of all kinds have been asking for hundreds of years. In the old days an approach to the answer was attempted solely by the process of cataloging and describing all the different kinds of life which could be found on the earth. That was a necessary start, and it told us what different forms of life exist — but it hardly answered the question. Then for many generations scientists argued about how life began. Only a few hundred years ago it was commonly believed that certain kinds of life — rats, bugs, spiders — would be spontaneously generated wherever dirt or spoiled food was found. It took long and careful experiments to show that such forms of life did not generate in such places, but simply migrated to them in search of food or shelter.

Later on, when the microscope was invented and microorganisms, such as bacteria, were discovered, it was thought for a long time that *they* were generated spontaneously in decaying matter. It was Pasteur who showed that bacteria caused decay and not vice versa; that even bacteria did not spontaneously generate themselves.

Finally it was concluded that no known form of life ever generated itself spontaneously, but that every living thing was a direct descendant from another living thing. And then the stage was set for Darwin to evolve the theory of evolution which proposed that, while all living things were born from similar parents, there were from time to time small variations or "mutations" among the offspring and that these mutated forms — if they were properly adapted to their environment — would multiply their kind and then eventually another mutation would occur. Thus, in the course of time, new species would arise and old ones, less adapted to the struggle for existence, would die out. The theory of evolution, hotly contested only a few years ago, is now the basic concept of all biology.

But all of this only pushes the question back a few more stages — whence arose the *original* living thing?

The clue to the answer

The clue to the answer to this comes from a study of the simplest forms of life — first, the bacteria and other single cells, then the parts of the cells, then a particle called a virus and, finally, a particular part of the virus called a nucleic acid. Certain nucleic acid molecules, it is found, possess the ability under proper conditions to multiply — to reproduce their kind. That is the first requirement of life. But also, in reproducing themselves it is found that these molecules occasionally make mistakes; the daughter molecule is not quite like the mother. Maybe the daughter will die — will not be able to reproduce itself. Maybe, however, it will reproduce other daughters which will contain the same mistake. Maybe, in short, a mutation will take place. Reproduction and mutation — these are the essential features of life — and if once, millions of years ago, a single nucleic acid molecule was formed in the soupy substance of some primordial sea, then all of earth's living things might have descended from that one molecule.

Scientists are learning a great deal about nucleic acid molecules and about the protein molecules which are the raw materials from which living things are built. Certain types of protein molecules — the hemoglobin protein in blood, for instance — have recently been synthesized in the laboratory in Pasadena. Possibly some day a nucleic acid molecule can be synthesized — one which can reproduce itself — and a new chain of living things can be begun.

And so the pursuit of mystery goes on, and in the process more is learned about bacteria and viruses, about genes — the element of heredity — and about enzymes — the proteins which help in the manufacture of the material from which living things are built. Thus, in asking questions about the origin and nature of life, scientists learn answers to questions about the nature of the living material of which we ourselves are made — and help us understand the problems of human suffering and disease.

But life did not always exist on the earth. This planet probably whirled in its orbit around the sun for two or three billion years before that first speck of life — that first nucleic acid molecule — appeared. What was the earth like during those eons? How, in fact, did the earth itself come into being? These are questions that the geologist wrestles with. So let's walk across the campus and talk to some geologists.

Here is one who traces the history of oceans and mountains; another examines the structure of the interior of the earth by observing how earthquake waves travel through it. This geologist examines the structure and history of rocks and asks why some contain minerals and others contain oil. And, since oil itself is a product of living material, the geologist joins the biologist in examining the history of the various forms of life whose remains can be traced in ancient rocks.

How old are these rocks themselves? Here the geologist joins with the physicist. The physicist points out that the element called uranium exists on earth and that uranium atoms are unstable – i.e., they die off just as living things do. Only they live much longer. The average uranium atom lives, not threescore and ten years, but for 4½ billion years. Now, if the earth were *infinitely* old, then all the uranium atoms would be long since dead – would have been converted, in fact, into lead. There would be no atomic bomb – no Atomic Energy Commission – no atomic power! But by measuring how much uranium and how much lead actually do exist in a particular rock, the age of that rock can be accurately determined. It is not really as easy as it sounds, and it has taken long and exhaustive measurements to arrive at an acceptable figure for the age of the earth itself – but 4½ billion years is the current figure. By coincidence the earth is of just such an age that just about half of all the uranium that originally existed has now decayed into lead.

A talk with the astronomers

A few years ago a figure of 4½ billion years for the age of the earth would have brought howls of anguish from the astronomers. Maybe we should walk over and talk with *them*. They, too, are interested in the age of things. They worry about the age of the earth, the sun, the stars, the galaxies – of the universe itself. They, too, know that the universe is not infinitely old – because they discovered some 30 years ago that the universe is expanding. Now a universe which is known to be expanding could hardly be infinitely old – else all the rest of the universe would have been expanded out of sight and our poor earth would be all alone in an empty void. As a matter of fact, we can actually measure the speed of expansion – and from that we can figure back to how long ago it was that the expansion began.

Such measurements, however, are not easy; it is difficult to make them exactly, and it is difficult even to know how large the errors of measurement might be. And so it happened that, only 20 years ago, it was confidently believed from expansion measurements that the universe was just about 2 or 3 billion years old.

You can see why it was embarrassing to have the earth 4½ billion years old! The universe can't be younger than its parts – younger than the earth itself. So, as the geophysicists began talking about an earth that was over 4 billion years old, the astronomers began checking their measurements of the distances to the faraway galaxies which were receding from us so rapidly. They found some errors in previous measurements – some pretty big errors, in fact. And now the astronomers are sure that the universe is not a mere 4 billion years old, but probably between 10 and 15 billion years old. We can see some distant galaxies so far away and moving at such a speed that they must have been on their way for 10 billion years or more to get where they are now.

But this only leads to another puzzle. If the earth is only 4½ billion years old, while the universe is 10 or 15 billion years old, was the universe itself not all created at once? The answer is *no*. The universe is a living thing; new stars are being born all the time, and old stars are dying, too. The story of how the first stars were condensed out of clouds of hydrogen; how some of them after a strenuous life of a billion years or more, blew up into vast clouds of dust and debris; and then how new stars, of which our sun is one, were condensed out of that cosmic dust – these are the stories being pieced together by astronomers, astrophysicists and nuclear physicists.

Thermonuclear reactions

We pride ourselves as scientists on having discovered rather recently how to make a thermonuclear explosion. But in the universe thermonuclear explosions have been going on for billions of years. Indeed, all the energy of the whole universe itself comes from thermonuclear reactions – the fusion of hydrogen into helium and heavier elements. And since the universe is still composed of 90 percent hydrogen, these reactions have a good chance of continuing for another 10 or possibly 100 billion years. Our own sun will be burned up long before then, however – in fact, it may have only a measly 4 or 5 billion years more to live. Always there is *something* to worry about!

And so it is that night after night the great 200-inch Hale telescope on Palomar Mountain peers out into the vast reaches of space, trying to put together these mighty secrets of how the universe was born, how it evolved into its present state, and what its future might be. Just recently the colossal radio telescopes – which pick up radio waves from space as the optical telescope picks up light waves – have joined in the search and are adding valuable bits and pieces to the solution of the cosmic mystery story.

Speaking of space brings us back to the fact that within recent months men have decided that they will not be content forever to sit at the receiving end of telescopes to *watch* what goes on in space; they want to get out there – or at least send instruments out there – to get a better look at what is going on.

The exploration of space has, of course, long been a dream of men everywhere. Most people thought, however, that it was a dream only to be realized in the next century and not in this one — until Sputnik I woke us up to the fact that the age of space is at hand.

Possibly a word of caution is appropriate here — to remind us that "space" to the astronomer may mean a different thing from what it means to the rocket and satellite expert. The astronomer is accustomed to dealing with objects so far away that it takes *light*, traveling at 186,000 miles per second, millions or even billions of years to reach us. Even the very nearest star to our sun — the nearest object outside our solar system — is 4 light years away. An earth satellite, however — like the Sputniks or Explorers — travels, not 186,000 miles per second, but only 5 miles per second. Hence, even if a satellite could get away from the gravitational field of the earth, and then get away from the very much stronger field of the sun, and if it could even then continue with a speed of 5 miles per second, *it would still take over 150,000 years to reach* that nearest star.

In other words, space travelers are likely to stay relatively close to home — astronomically speaking — for the next few years at least.

Travel within the solar system

But travel within the solar system will offer some exciting adventures. Travel to the moon will take only a couple of days, to Venus or Mars a few weeks, and to the outer planets — Uranus and Pluto — a few years. On the way there will be exciting things to examine, too. Already the Explorer satellites have uncovered a new and unsuspected cloud of high energy charged particles high above the earth. Trapped in the earth's magnetic field, these particles orbit down to within 500 to 600 miles of the earth's surface and then swing out to 5,000 or 10,000 miles into space. At 5,000 miles up they form an exceedingly dense cloud — one that can produce X-rays intense enough to kill a man in a few hours. From there on out they gradually get weaker, and at 30,000 or 40,000 miles out they may be down to negligible intensities. However, their discovery was a great surprise both to the scientist who puzzles about where the particles come from and to the engineer who is puzzled about how to get photographic film and other sensitive instruments — to say nothing of men themselves — to function in such an environment.

When I speak of "travel" to these distant places, I am thinking primarily of travel by unmanned instrumented vehicles. As our rocket techniques improve we will be able to send larger and more complex instrument packages into space, and we will be able to equip them with energy supplies large enough to broadcast their findings to earth for a longer time. And all the measurements we wish to make — of cosmic rays, magnetic fields, radiations in space, weather observations — can be made with such automatic instruments.

What, then, is all the talk about a man in space?

This is a topic to which we should give careful attention. Clearly, there are some operations and some observations which it will be very difficult to achieve with automatic instruments. Navigating an accurate course close to or around a distant planet may be an example. Keeping a telescope pointed at a particular star in order to get a good photograph may be another. Also, men want to *see*.

Clearly, however, sending up a man is going to add enormously to the expense of the venture. Men are not yet "miniaturized"— they are heavy and bulky. They need a lot of fuel — oxygen, water and food — to keep them going, and they can't stand very high or low temperatures. Furthermore, they insist on coming back alive.

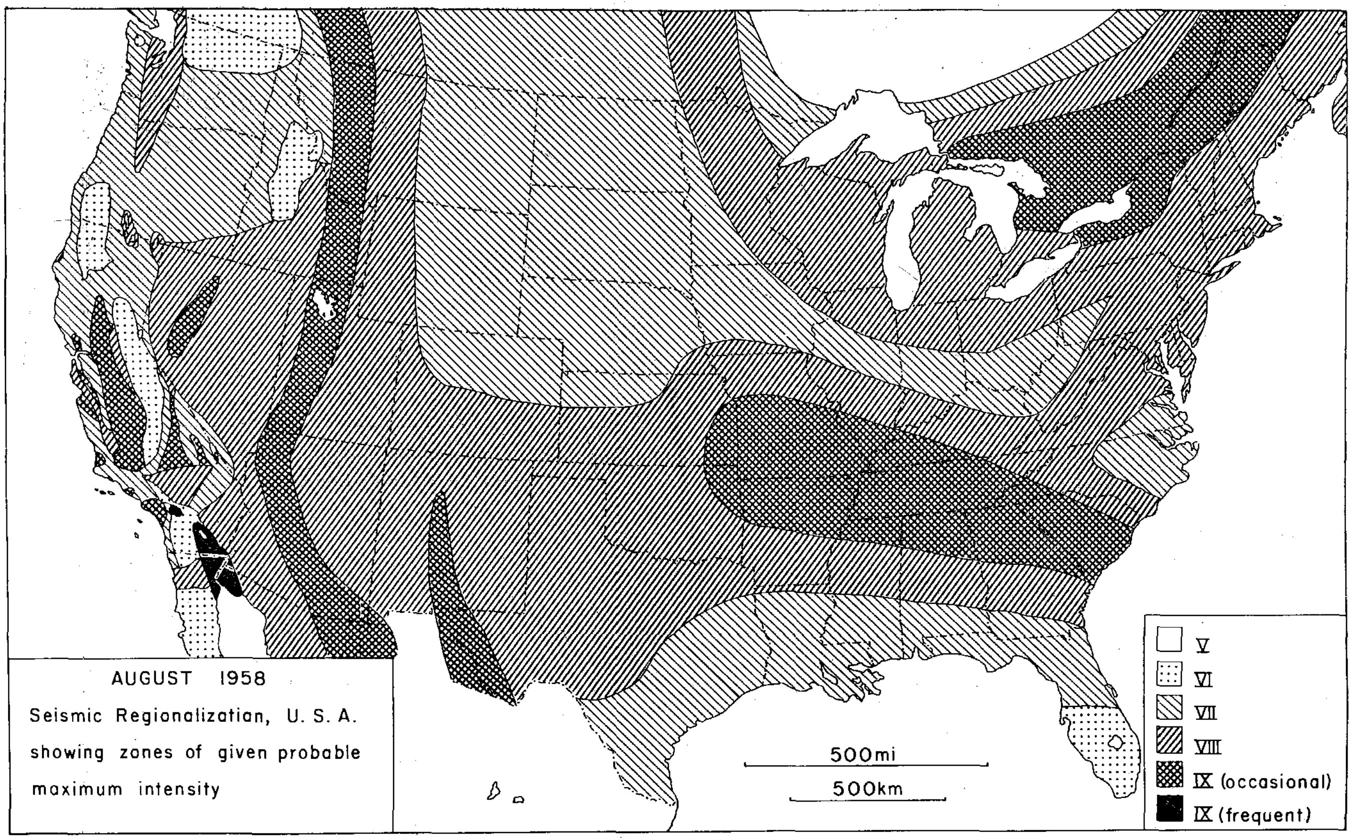
This is a most difficult requirement indeed, for it means carrying along fuel (to fire retro-rockets to slow down on re-entry), wings and other flying equipment to come in to a safe landing — preferably not in the middle of the ocean. All of this stuff must be included in the initial payload at takeoff. So, when we recall that every pound of payload requires about 100 pounds of fuel to get it into orbit, we see that getting a man and all his auxiliary equipment into space and back again may require rockets of effective thrusts of a million pounds or so, just to get into an orbit around the earth.

Human space travel

They had better be pretty reliable rockets, too. We won't like it if very many men come plunging to earth as a result of rocket failures. When we recall that the U.S. agencies have succeeded in getting only 4 objects into orbit after some 15 tries, we see that human space travel may have to wait for more reliable equipment.

But reliability will come — slowly perhaps. Airplanes and even automobiles still sometimes fail — and we won't expect ever to get 100 percent safety. However, since automatic instruments alone can do so much for us in the meantime, we can afford to wait before risking a man. We need to do research on man in space, of course, but do not be disappointed if it takes a few years for the research to pay off.

These, then, are just a few of the adventures in science that scientists and engineers are engaging in these days. And exciting adventures they are — full of promise for the future, and full of mystery. These adventures will change the lives of our children and grandchildren in ways we cannot possibly predict. We cannot predict because every day the adventures uncover new knowledge, and often the new discovery knocks all previous predictions into a cocked hat. The only prediction that we can be absolutely sure of is this: The world of tomorrow will not be the same as the world of today.



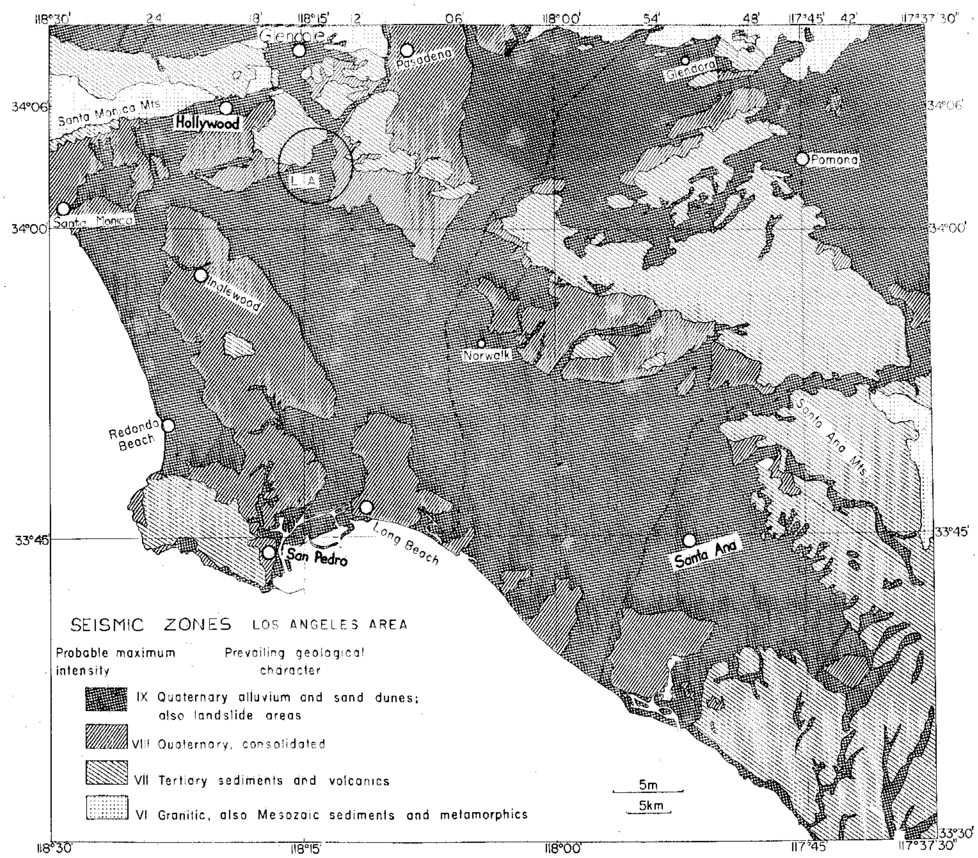
Regionalization map of the United States showing the maximum intensity of earthquake shock that can be expected in any one area. Areas assigned higher intensities do not necessarily represent the location of earthquake epicenters, but merely the probability of strong shaking from sources possibly at considerable distance.

Mapping Earthquake Risk Areas

A Caltech seismologist outlines the areas where damaging earthquakes are likely to occur

Seismologists have always known that about 80 percent of all small earthquakes in the United States occur in California. Now, after making a comprehensive national survey, Charles Richter, professor of seismology at Caltech, has found that the risk of *damaging* earthquakes is just as great in many other states. Among the high risk areas, in fact, are northwestern New England and New York near the St. Lawrence rift; a belt extending east from the central Mississippi Valley through South Carolina and part of Georgia, the Rio Grande Valley in New Mexico and southwest Texas; and a narrow belt extending through Montana, Idaho, Utah and Arizona.

Dr. Richter has mapped the United States into regions showing the probable maximum intensity of earth shocks that can be expected in any region. He uses the Mercalli intensity scale, which differs from



A map of the Los Angeles area showing the maximum intensity of earthquake shock that can be expected in any one section. The Mercalli scale is used, giving the intensity of a shock as felt in any particular locality. Intensities below VI are usually too weak to cause structural damage; those over IX rarely occur.

the Richter magnitude scale in that it measures the amount of shaking at any one point, while the Richter scale is related to the amount of energy released by an earthquake at its origin.

In this mapping project Dr. Richter has laid out the United States in earthquake risk areas ranging in intensity from VI through IX on the Mercalli scale. (Intensities below VI are too weak to be considered, and those above IX are too rare). Intensity VI can cause slight damage to weak buildings; VII, considerable damage to weak buildings and negligible damage to strong ones; VIII, heavy damage to poor construction and slight damage to well-built structures; IX, considerable damage to good construction.

In these earthquake risk maps, Dr. Richter has not attempted to predict when and where earthquakes will occur, but where *damaging* ones are *likely* to occur — based on local geology, proximity to active faults, and the history of temblors in the area. The estimates do not represent the probability of average-sized quakes, but the maximum shock that could be anticipated over the years.

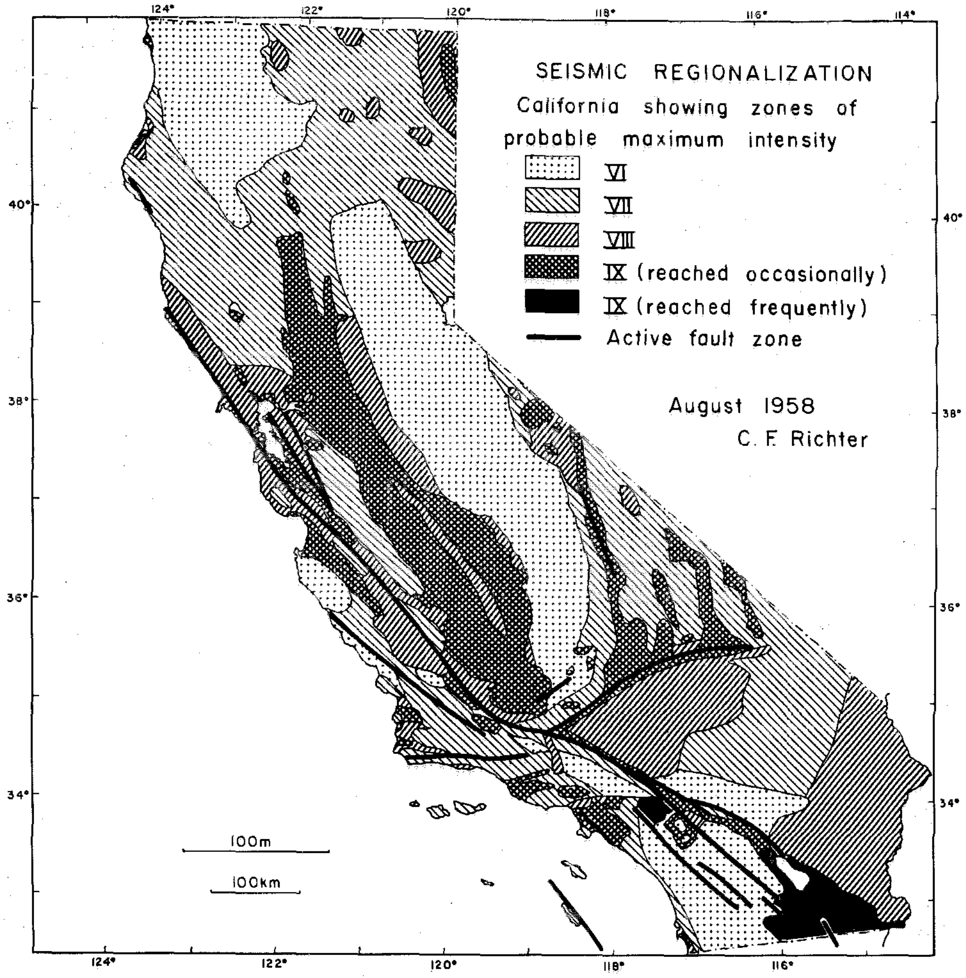
The maps are part of a paper on seismic regionalization soon to be published by Dr. Richter in the *Bulletin of the Seismological Society of America*. The paper, which presents and discusses maps for the Los Angeles basin and vicinity, for California, and for the United States, parallels work done in Russia on seismic regionalization. According to Dr. Richter, the Russians have already mapped risk zones in southern and eastern perimeters of their country, and have incorporated the findings in their building codes.

On maps such as these, the effect of variations of ground from point to point can be shown only on a large scale. This is known as microregionalization, which takes into account sharp and marked changes in the earth's formation, such as a sudden shift from sandy alluvium (where an earth shock is apt to be of higher intensity) to solid granite (where the risk is low). Dr. Richter's map of the Los Angeles Basin, above, is an example of microregionalization. Small-scale maps like those of California (page 17) and the United States (page 15) require considerable generalization. Dr. Richter describes his mapping for the Los Angeles Basin area as "reasonably definite." That for California is "fairly reliable, but less so in desert and mountain areas." And that for the United States is "in part highly speculative and subject to substantial change."

Regionalization, and especially microregionalization, can be used in construction and planning (as they are now being used in Russia) as indicating the maximum effects to be considered in designing permanent structures. Insurance companies and structural engineers are showing considerable interest in the Richter project.

Envisioning the possibility of zoning a city for earthquake protection, Dr. Richter notes that, generally speaking, buildings constructed on mountains or solid rock are likely to suffer the least damage from earthquakes. Those on foothills are a little more susceptible. Structures on lower hilly and terrace areas

Map of California showing the maximum intensity of earthquake shock that can be expected in any one area. Unlike the detailed Los Angeles map on the opposite page, this map covers areas in broad blocks. The active fault zones mapped as narrow belts are where damage and risk are of exceptional character.



are higher quake risks. And buildings on valley alluvium and sandy areas near the coast are the highest risk areas.

Usually residential areas are on higher ground, where the earthquake risk is generally less. Industrial areas — and of course harbor developments — are likely to be on low ground, which may be sandy, alluvial or even marshy, and subject to higher risk.

In California, the principal high risk areas are lowland parts of the Los Angeles basin, the San Joaquin Valley, the southern Sacramento Valley, the San Francisco Bay area, and two other areas (the San Bernardino-Riverside district, and the Imperial Valley) where there is also a frequency risk for damaging shocks. These two areas are associated with fault complexes — fractures in the earth's crust along which the earth on one side is moving with respect to that on the other — which are areas of special risk.

Although California is high in earthquake risks, it has some of the lowest risk areas in the nation. It is a state of great contrasts, geologically, and in many areas the lowest and highest risk districts adjoin each other.

Areas of lowest risk in the United States include parts of southern California, the Sierra Nevada mountains, the Klamath and Siskiyou mountains in northern California and southern Oregon, mountains in the north of Washington State and Idaho, and southern Florida.

Dr. Richter has a rough rule for estimating the likelihood of a damaging shock: Where an average of 500 small quakes occur each year, one great temblor may be expected once every 40 years; but in areas where 50 small quakes occur yearly, one great one may be expected about once every 400 years.

Southern California has an average of 200 small earthquakes a year, so that best evidence indicates that great earthquakes may be expected here on an average of about once per century.

"In large measure, the effects of four principal past earthquakes govern the estimates of damage possibilities in California," Dr. Richter explains. "The four are the great temblors of southern California in 1857, in Owens Valley in 1872, San Francisco in 1906 and Kern County in 1952. Earthquake risk in this state depends primarily on the character of local ground and only secondarily on geographic position. Most of the points are near enough to one of the principal faults to justify an estimate of Intensity IX on the Mercalli scale on poorly consolidated ground."

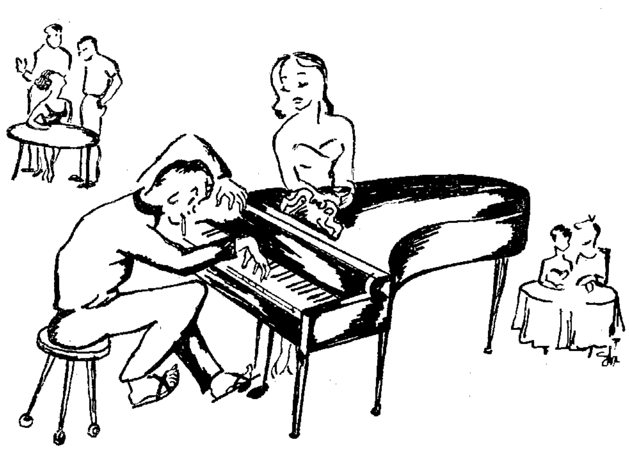
Dr. Richter hopes that his study will introduce a relatively new principle of investigation to American seismologists and will lead to more and better work of the same kind.

Facing Up to Finals

— or how to end a carefree life

The weekend before the weekend before — that's when finals begin to exert their influence on Joe Tech's previously carefree life. Many a two-date-per-weekend man settles happily for one. Some one-date men just buy their own copy of *Playboy*. Even if the weather is warm and the mountains visible, very few undergrads are likely to be found at the beaches (traditionally, the weather here is most tempting just when time is least abundant). Repentance is in the air — for the lectures slept through, the classes missed, the homework undone, the books unread. Knowledge becomes much more desirable merchandise, a valuable asset to be gathered quickly against the mortgage payment soon due. One word is on everyone's lips: "Help."

Working against this feeling of impending doom, however, is a phenomenon known technically as the "retroactive martyr effect." Sample mental conversation of sample simple student: "Gads, think how hard I'm going to be working next weekend. Think how little fun I'll be having. I deserve a rest right now. Really care about Physics 2." ("Really care" is delivered properly with absolutely no emphasis on any syllable. It means "really don't care.") Hence, time is found to destroy pianos on Hollywood Boulevard, and to attend bad science-fiction double features. Also hence, there is negligible increase in studying the weekend before the weekend before. However, there *is* a significant increase in worry.



Retroactive martyr effect

Enter the Monday before the Monday of. Exit the retroactive martyr effect, leaving only ignorance behind. Sample Monday mental conversation: "Let's see — if I go out every day this week I can pass PE, but what about my other 49 units? Perhaps I'd best study a little." So pencils are sharpened, desk lamps adjusted, and little signs posted outside of rooms:

PLEASE CLOSE DOOR BEFORE ENTERING **SNAKING**

There are two main species of studying: basic research and equation-copying. Basic research involves actually learning the subject matter of a course, and seeing how it fits in with what has been learned before. It's heady stuff in that it gives a (well-deserved) feeling of accomplishment when done properly. Equation-copying is just that, accompanied by little prayers that the final won't use Greek symbols instead of Roman. Unfortunately, as the week before finals passes and the panic grows, equation-copying more and more wins the day.

The strain begins to tell. Shaving becomes a less frequent native custom. Freshmen wander about muttering, "$F=dP/dT$ . . . integral of tangent is logarithm of cosine . . ." Sophomores mutter, "Right hand screw rule . . . granidiorite, schist, grabbo . . . divergence of curl is zero . . . " Juniors and seniors just mutter. Suddenly the despised little technical joke gains sharply in popularity. Ordinary English: "Get the hell out of here. You bother me." Pre-finals English: Proceed

Conscience overcomes mypoia

by induction to a closed neighborhood not including the identity element."

One would think that the week before finals would be a quiet one in the student houses. Experimental evidence does not bear this out. One year it's pluto-platters, another it's court basketball (played with a volleyball). Most recently the prime time-usurpers have been hula hoops, spun and jumped through, not twirled, and those most uncooperative of all toys, the Eskimo yo-yos. Whatever it is, it gets noisier as finals get closer. People are desperate for any brief diversion from the steady grind. Conscience soon overcomes myopia, and the wayward student returns to his books. Neverthless the games continue, surviving the high turnover of personnel. To state a general theorem: In any one term, mental entropy is always increasing.

Suddenly, it's the Friday before Waterloo. "Where goes the rose of yesterday?" Schedule for day: buy bluebooks, pick up take-home tests, study, study, study. That's a grim weekend if there ever was one. Mealtime at the student houses looks like the class reunion of a TB ward. True, there are always those indomitable gamesmen who have one or even two dates just for propaganda purposes. Often they don't laugh last.

A typical Saturday conversation revolves about the completed take-home tests. Question: "Did you catch the trick in problem 7?" (Actual meaning: I *did* catch it. Bet you didn't.") Answer (panicky): "What trick? It looked perfectly straightforward to me . . . OOOoooohhhh . . ." (moan of horrible realization.)

That Sunday is the worst of all. There's an unlimited amount of material to study, no possible excuse not to study it, and yet nothing can be finished completely. Any sense of accomplishment must wait for examination time. Until then the only companion is an overwhelming feeling of being turned down on a lathe.

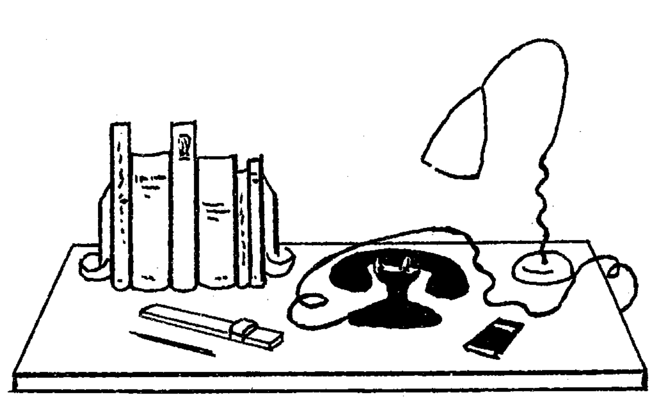
One hundred watts of *Die Walküre* in your ear! It's seven o'clock Monday morning and the moment of truth is one hour away. Breakfast is well attended but not overly enjoyed. Most of the people are scared, some so much that they're physically sick. The next three hours and the next three days can be among the most important of a lifetime. To the 2.0 (C) student it can mean the difference between graduating and flunking out, between Electrodata and selling cars for the next 40 years. The 3.4 (B+) student may be making his choice between a good grad school and North Dakota Normal. First term freshmen, as yet unclassified by grade point average, will soon acquire such GPA tags as almost part of their names. And four years of mediocrity is no fun, even at a topflight school. Perhaps that's why some of the 4.0 (A) boys sweat it most of all. Quickly, breakfasts are finished and the Olive Walk stampede begins. (Wild Russian music in background.) Sit down, rip open the mimeographed sheets: Sure enough — finals!

They're over. Some people have cooled some finals, some finals have cooled some people, but anyway they're over. Luckily for Athenaeum members and other local residents, everyone doesn't finish at once. Nevertheless, the spontaneous Thank-God-I'm-Done parties achieve impressive proportions. Usually the loudest celebrators are those who've done most poorly in the previous few days. At the other end of the scale are those who commemorate the occasion with a good night's sleep.

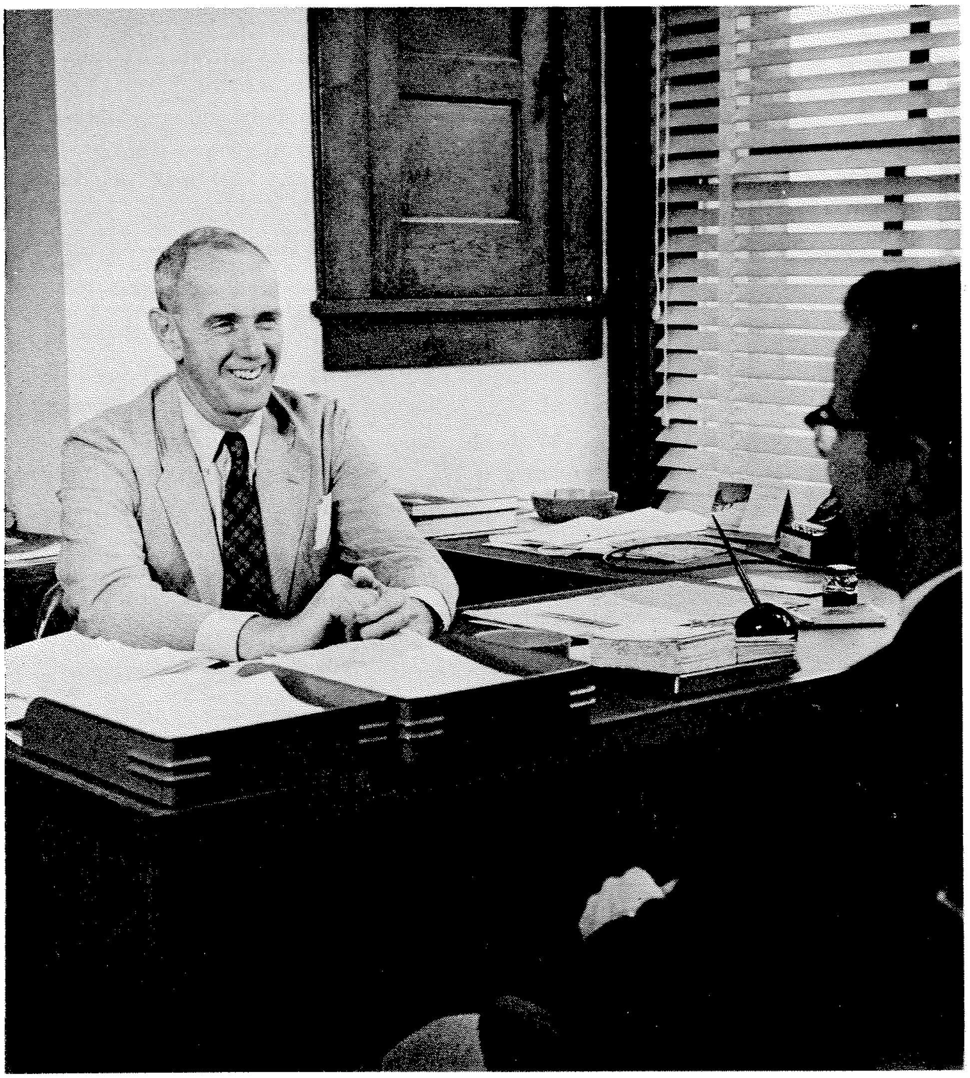
Soon the student houses are quiet and nearly empty. Home — that comfortable haven which demands no performance, only attendance — has called. There are friends, family, girls, and good food to be met all over again. The freshmen go most eagerly, as yet unaware of the difficulties absence can cause. Most of the upperclassmen go, too, but traveling lighter of many illusions. Then there are those who lack money or reason to leave. They spend their days working and pestering instructors for graded exams. And often they have people to welcome *back* from school. It's more fun that way.

The first date after finals can be a wonderful one. A soft voice to hear, a soft hand to hold — soothing medicine for writer's cramp and slide-rule burn. Soon Tech life will resume in full hectic glory, but right then there's time just to relax, and perhaps even be in love.

— *Brad Efron '60*



The first date can be wonderful



Peter M. Miller, assistant director of admissions and undergraduate scholarships, interviews a prospective Caltech freshman.

Admissions at Caltech

by Peter M. Miller

Like a good many other institutions of higher learning, the California Institute has more qualified applicants for admission these days than it can handily make use of — and this is an understatement. The result is, of course, that many good boys are refused admission. Since the great majority of these boys will be offered admission by the other schools they apply to, a genuine curiosity arises as to what it takes to get into Caltech, and rumors containing only the required modicum of truth begin to circulate.

Is it true that a straight A average in high school is necessary before a candidate will be seriously considered at CIT? (Answer, no). Is it true that at least one 800 on the College Board tests is a prerequisite to admission at Caltech? (Answer, no). Is it true that a prize-winning project at a city, county, or state Science Fair will insure admission over boys whose entrance examinations are higher? (Answer, no). Is it true that the boy from North Dakota or the upper peninsula of Michigan, because of the geographical outpost (from the southern California point of view) he represents, will be accepted ahead of a better-qualified applicant from San Diego? (Answer, again no).

There is, of course, *some* basis for these rumors or they would probably never have got started. It is true that boys with straight A averages will probably do better on their College Boards and will also probably get stronger recommendations from their schools than boys with lower grades. And it is true that as the number of our applications increases, so also does the geographical representation of our student body broaden. But a candidate, to be successful, is neither required to demonstrate genius in high school nor to live in an igloo in a geographical fringe area.

It is the purpose of this article to explain what the requirements are for admission to Caltech, and to describe in some detail the operations of the Freshman Admissions Committee, which result in the choosing of the best freshman class it can find.

In the first place, the applicants must be male. This requirement is under constant attack, but so far there has been no weakening. The restriction seems to have little or no deleterious effect on the social blooming of the Caltech undergraduate.

In the second place, our candidates must have taken certain courses and received certain credits in high school. Four years of high school math are required; so are three years of English and one year each of chemistry, physics, and United States history. Beyond these specific courses there must be five other credits made up of courses that are primarily academic: languages, more English, more history, and more science are welcomed; so are no more than one credit for shop or engineering drawing. Coeducational cooking and driver education do not qualify.

Necessary prerequisites

These requirements are not arbitrary hurdles set up to see whether a candidate can successfully get himself off the ground in various areas. They are real prerequisites without which a student would be at a serious disadvantage if he ever found himself admitted to Caltech. Take the mathematics, for example. Four years of high-school mathematics will get a boy through trigonometry at least; and without trigonometry a boy is not prepared for the freshman course in analytic geometry and differential and integral calculus which he must begin as soon as he arrives at Caltech.

The same kind of thing can be said about the other requirements. Freshman physics and chemistry presuppose a year's study at the high-school level and waste no time getting into more advanced matters. And the humanities program a new freshman faces would (with the exception of a few boys of well-developed natural capabilities) be quite beyond the reach of anyone without the prerequisite English and history.

There are no specific grade requirements for these prerequisite courses, but a boy who has not done well in them in high school — particularly if they are the math and science courses — stands little chance of being admitted. Poor performance in these areas probably results from one of two things: Either a boy has not been interested enough in the courses to do much work (and this will show up in the College Board scores, and in the recommendation of the school, which is made out conscientiously by high school teachers and administrators); or he has found the work in high school too hard (and this, too, will be reflected in the test scores and recommendations). In neither of these cases would admission to Caltech be a good thing either for the boy or for the Institute. When I say that a boy must have done well, I mean that he should have done work of B+ quality or better. We ask no more; and we can accept less if there is valid reason for a lower grade. But without extenuating circumstances, it is safe to say that work of at least B+ quality is expected.

A point that often surprises questioners is that we have no requirement that a boy have a high school diploma in his hand before he comes here. Most boys do, of course. But as long as the proper prerequisite courses have been taken, and as long as a school is ready to agree that a boy is ready for college work, we will consider him regardless of when he would normally graduate from high school.

Occasionally, a high school student comes along who has covered by his junior year all that the school has to offer in mathematics and science, the areas of his major interest. To insist that such a boy stay around another year just for the sake of a piece of paper seems poorly advised, nor do we advise it. We do, though, scrutinize such candidates more strenuously for signs of immaturity which might cause difficulty in freshman year, no matter how high the boy's intellectual potential. We have had only middling success here with boys who enter a year or so ahead of the normal chronological age; and the Admissions Committee tries to make sure with the younger high school applicants whether we would be acquiring an intellectual asset to the Caltech community or merely another problem for the Dean's Office.

Entrance examinations

If a college received applicants from no more than 15 or 20 schools, which over the years it would learn to know and trust (or distrust), there would be little need of entrance examinations. The school record would indicate clearly what the boy had done up to the present, and school faculty and counselors, who had recommended many boys to us in the past and had come to know the type of student who could make the grade here, would be able to interpret where the record was somewhat smudged or cloudy. But we receive applications from students at well over 1000 schools each year, and we cannot even begin to know the standards at more than a quarter of them. In order, then, to measure accurately a boy from Boise, Idaho, against a boy from Natchitoches, Louisiana, we have to use entrance examinations. The examinations used to be of our own manufacture, but for various compelling reasons it is not necessary to go into here, we now use the examinations of the College Entrance Examination Board.

I hasten to say that this does not mean that the College Board is dictating to us whom we will admit. The College Board is a service organization consisting of more than 200 member colleges and associations. Its primary aim is to simplify the procedures of college admission, for the applicant and the college. In nationwide — to be accurate, worldwide — administrations, the Board offers the three-hour Scholastic Aptitude test (SAT) six times a year; and about ten (of which a student may take three at a time) one-hour achievement tests four times a year.

Colleges may require what tests they choose of their applicants. Since most applicants to college at present apply to at least three colleges to be sure of gaining admission to one, it is customary for a college to allow some leeway in choice of examination. The Caltech requirement is as specific as any: we require of every candidate for admission the Scholastic Aptitude test, the Advanced Mathematics test, and two of the three tests: Physics, Chemistry, English. Many colleges require only the SAT. Others are likely to ask for the SAT and three achievement tests, including the English test.

Mathematical materials

Supposedly, the SAT does not depend much on what a boy has done in the classroom; it tests, rather, his verbal fluency and his facility in quantitative thinking. If he has gone through freshman mathematics in high school, he can take the math part of the test without being out of his depth. It measures, not the amount of math he has studied, but his quickness, his accuracy, and his general reasoning ability with mathematical materials. A couple of sample questions should show the type.

i. Which of the following fractions is closest in value to 1/3?

   A– $\frac{1}{4}$ *B–* $\frac{3}{8}$ *C–* $\frac{3}{16}$ *D–* $\frac{5}{16}$ *E–* $\frac{7}{16}$

ii. In 1943, the United States imported 30 million dollars' worth of tea from Ceylon and India. If the total cost of the tea from India was 50% more than the total cost of the tea from Ceylon, how many million dollars' worth of tea came from India?

   A– 7.5 B– 12 C– 18 D– 20 E– 22.5

The achievement tests, on the other hand, measure primarily what has been learned in class. Two examples from the Advanced Mathematics test follow.

iii. If h, k, m, and n are positive numbers, k is greater than m, and n is greater than h, which of the following is (are) true?

   I—$n+h$ may equal $k+m$
   II—$k+h$ may equal $n+m$
   III—$k+n$ may equal $m+h$

   A– Only I B– Only I and II C– Only I and III D– I, II, and III E– None

iv. What is the smallest acute angle x which satfies the equation
   $\sin(2x + 45°) = \cos(30° - x)$?

   A– 5° B– 15° C– 25° D– 30° E– 45°

There is a big advantage in having both aptitude and achievement scores on all applicants. In seven cases out of ten, there will be a high correlation between them. But occasionally a boy will come along with high aptitude scores and low achievement scores, and we will know that here is a bright boy who has neglected his work, or hasn't had the opportunity to take a good course in one or more important subjects. Whatever the reason, the state of his preparation is not such that we feel he can negotiate the difficult work of freshman year successfully. He does not get to try.

Or we may find a boy who scores well on the achievement tests and not on the SAT. This, in all probability, is a boy who has had material drilled into his head by good teachers who have spent considerable time with him. This speaks well for a boy's determination and a teacher's coaching, but it does not augur well for advanced courses in math or science where there will be no eager mentor at each boy's elbow. This boy, too, will probably be rejected.

I have been speaking as though the Admissions Committee examined each set of College Board scores and reached some kind of conclusion on them. It does not follow so painful a procedure. On the basis of several years' use of the Board tests, we have learned which among the required tests correlate highest with academic performance during our freshman year. A formula has been devised to give each test score the appropriate weight, and the test scores are fed into the formula as soon as they arrive. It is a matter of a short computing time only and the figures have produced a predicted grade point average (PGPA) for freshman year. The weights allotted to each score in the formula vary with correlation studies that are done. It is a good bet, however, that the Advanced Math test will continue to have the greatest weight.

Delayed data

So far in this article, we have seen a large number of applicants taking four College Board tests apiece and deluging the Admissions Office with data. If all the data came in nicely at an early point in the year and there were a month or two to work on them, Admissions Officers would be a happier lot. As it is, the final College Board scores are in our hands, at the most, two weeks before we hope to make our final decisions. This is much too late to let things go without doing any preliminary assessing and weeding.

What Caltech is now requiring is that all applicants take the SAT by February at the latest (they are advised to hold off on the achievement tests until March). The aptitude scores, available to us by mid-March, provide us with the early data we need.

On the basis of the aptitude scores alone, we make a preliminary rank-order list of all the boys who have applied. No final decision can be made on the basis of this list, because there is always the chance that the achievement test scores will throw a few boys up from the depths and drop a few from the heights. But the preliminary list can be very useful in giving an indication of many boys who are likely to be admitted and many who have little chance. Much time is saved by concentrating on the former and slighting the latter, until such time as later information moves a few of the applicants to significantly different positions.

At this point in the discussion, with a preliminary rank list in our hands based on the SAT, it is appropriate to shift attention to the Freshman Admissions Committee, which now assumes great importance in the picture. This is a regular faculty committee, which has been given complete autonomy by the Institute in the field of freshman admissions. No campus office does anything more than pass on information to the committee, regardless of the prowess – intellectual, athletic, or financial – of an applicant the office would hope to see admitted. It is also as hard-working a committee as any among the faculty. Demands on its time are heavy throughout the year, but especially during the months of March, April, and May. The importance of what the committee does is such, however, that the demands are met ungrudgingly and by men who have given their time over a great many years – and understandably so, for essentially what the Freshman Admissions Committee does determines what Caltech is.

Caltech's committee

The committee consists at present of 15 faculty members, all but five of whom are full-time teaching faculty. There is the Dean of Admissions, the Dean of Students, the Dean of Freshmen, the Master of the Student Houses, and the Assistant Director of Admissions (all of whom teach in addition to their administrative work); and there are faculty members from the areas of math and science, engineering, and the humanities. Some of them are full professors, some associates, some assistants; some have been at Caltech for upwards of 20 years, some less than five.

What I am getting at is that there is no single rank group or age level that dominates admission to Caltech. The committee represents different points of view, different degrees of experience, and different academic backgrounds. What it is agreed in, however, is that its work is of the greatest importance, and that the considerable time spent on the perplexing problems of freshman admission deserves spending.

Each member of the Admissions Committee is made responsible for a certain number of applicants. They are assigned on a geographical basis, with, for example, one member getting the candidates from New England, one those from the Pacific Northwest, one those from San Francisco and central and northern California. Southern California, which still produces the largest single segment of applications, is split among several committee members. Once each member gets his respective allotment of candidates, the problem is to decide which ones among them all are worth an interview.

The interview is used differently by Caltech than it is by most other colleges. We do not interview all candidates for admission (few colleges do) but we attempt to interview as many boys who look as though they might qualify for admission as we feasibly can. And we interview at a point in the whole admissions procedure where the result of the interview carries considerable weight – the point where the first reports from the entrance examinations indicate that the boy being considered stands some chance of being admitted.

Scattered possibilities

The economics of traveling to certain parts of the country for a small number of interviews makes it impossible, at least at present, to do much in the South. We could not justify the expenditure of sending someone to Alabama to see six scattered applicants, only two of whom look like possibilities for admission. The same holds true of Idaho, and Kansas, and South Dakota. There are enough applicants, however, and enough good ones, to make an interviewing trip in New England distinctly worthwhile. So is one along the Eastern seaboard from New York to Washington, and one around Chicago, and one to Washington and Oregon.

The determination of who should be interviewed (among those for whom geography does not act as a determinant) is something that has received much pondering. The interview is important to us, but it is time-consuming and expensive. We want to talk personally to as many as possible of the boys who will be considered seriously; but we want to avoid, and avoid gracefully without hurt feelings, the boys whose chance of being accepted is one or two in a thousand. And since interviewing, for the most part, goes on before all College Board scores are in, the decision is a delicate one.

The best solution the Admissions Committee has found so far—and this was used in the spring of 1958 for the first time – is to take the preliminary rank list based on the SAT scores alone, and go down to a point where it seems logical that all the boys who will eventually be admitted have been included. This point is down around number 700. All the boys above this point are considered for an interview, then, and all of them who are geographically within reach get one. Since we do not offer admission to anything like 700 applicants, this means that a number of boys whose chances of admission are slim are neverthless given an interview. But the big advantage of this procedure is that we miss very few boys who rise to the readily acceptable area when complete information is in.

This is perhaps a good place to note that last year

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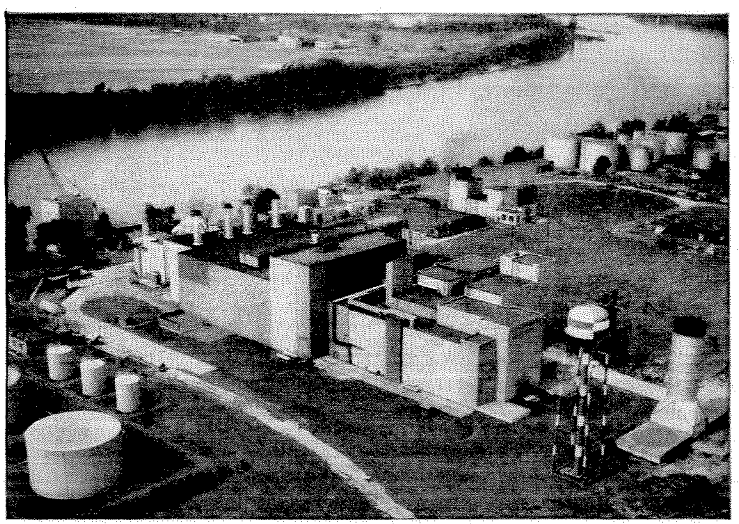
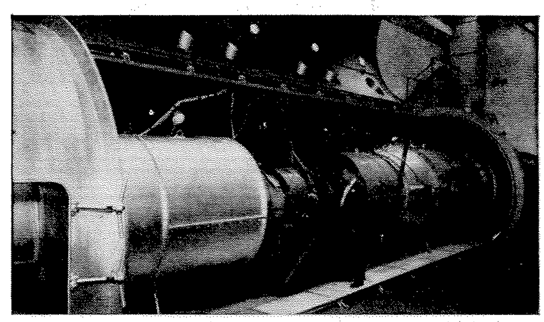
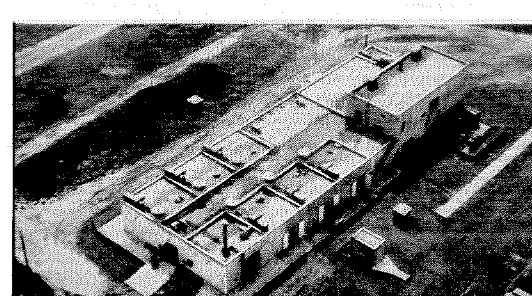


The Willgoos Turbine Engine Test Facility is the world's most extensive privately owned turbine development laboratory. Designed and built specifically to test full-scale experimental engines and components in environments simulating conditions at extreme altitudes and speeds, it is currently undergoing expansions that will greatly increase its capacity for development testing of the most advanced forms of air breathing systems.



In chambers like this at the Willgoos Turbine Engine Test Facility full-scale engines may be tested in environments which simulate conditions from sea level to 100,000 feet. Mach 3 conditions can also be simulated here.



In the new Fuel Systems Laboratory engineers can minutely analyze the effects of extreme environmental conditions on components of fuel systems – conditions such as those encountered in advanced types of flight vehicles operating at high Mach numbers and high altitudes. Fuel for these tests can be supplied at any temperature from −65°F to +500°F.

was the first time that alumni interviewers were used to any real extent. Certain spots in the past (like Buffalo, New York, and Tulsa, Oklahoma) have had alumni who took over interviewing for the Admissions Committee; but there have been few such places and no more than two or three men involved. In 1958, the great majority of the interviews in the New York City and Long Island areas were handled by alumni — who did, incidentally, a thoroughly workmanlike and commendable job.

It may well be asked what the purpose of the interview is so late in the game. We already know from his school record and his first College Board scores that the boy is a likely prospect. And we already know from the fact that he has filed application that he is interested in Caltech. The purpose of the interview is not to sell the boy on Caltech. Its purpose is, rather, to try to find out from information other than test scores and high school grades *why* he wants to come to Caltech, and whether he would be a good risk if accepted.

Admittedly, this is a difficult area in which to deal, but it is a most important one. Too many boys come here for the wrong reasons — the size, the location, the difficulty of gaining admission — and too many others come here without knowing what they are getting into. The result is a number of unhappy boys, and an attrition rate that is higher than we like to see.*

Teachers know best

An important point to be made at the outset is that the key part of the interview (what gives it real effectiveness from our point of view) is the talk with a boy's teachers that accompanies it. Almost all interviews are scheduled for the school a boy is attending, at a time when the school is in session. A half-hour or so is spent with the boy. But he is often uncomfortable and nervous, and he rarely gives the best impression he is capable of. As a matter of fact, a fair part of the interview with the boy consists in putting him enough at ease so that he can talk intelligently in the few minutes that are left about his hopes and aims. What really pays off is the chance the interviewer has to talk with a boy's recent teachers. These men and women have known him for at least a year, and usually longer, and they know what his aptitudes and capabilities and prospects are in the areas he will be working in at Caltech. Many times, five minutes with a clear-sighted teacher will make the whole school visit worthwhile.

Essentially, what the interviewer tries to find out is whether a boy has a real desire to work hard in the area of engineering or science, together with a knowledge of what hard work in these areas really entails. This means that the interview is more than the assessing of social traits in a friendly chat with teacher or boy; it is more than the giving of information about what Caltech has to offer — though both of these elements are present in the purpose of the interview.

The interview is really an attempt to get at motives, to measure their strength, and to weigh their validity. The boys who are being seen have already demonstrated their ability to do good work in school; the interviewer does his best to find out whether, granted admission, the boy will continue to want to do this good work in the particular program and the special environment Caltech offers.

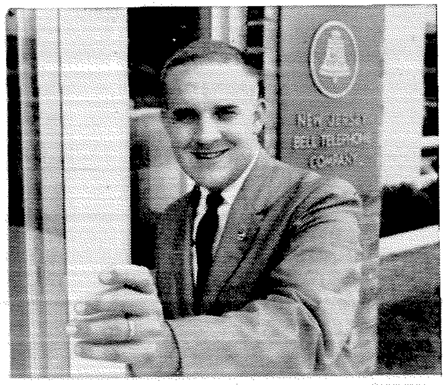
Detective work

There is no sure-fire way of getting this information from the boy or his teachers, just as there is no guaranteed way in an employment interview to find out how a man will really do on the job he is being considered for. Sometimes some prying into a student's leisure-time activities, into his hobbies, will give a hint. Sometimes it will come from his attitudes about his school work or about his teachers. Sometimes it can be gained from actions his teachers will tell about, special investigations he has pursued in math, or physics, or chemistry. Sometimes it won't come at all, and in such cases the interviewer may be thought to have failed. But in general, the interviewer is likely to come away from a school with increased knowledge of how much a student wants to study science or engineering, and with some feeling of how he is going to react when the going gets rough, as 99 out of 100 of our freshmen find that it does.

It is true, of course, that an interviewer likes to find among his candidates a president of the student body, a football star, an editor of the school paper. Boys who will add something to the Caltech student body are naturally hoped for above those whose doors open only to send them forth to class and close on them again as soon as classes are over. Regardless of this hope of the interviewer to find a civilized human being in the budding scientist, however, the boy who is going to be admitted must show more than the signs of being a good fellow and a prospective big man on campus. He must demonstrate, or at least suggest, that the proper area for him is either engineering or science, and that he is willing to work at it for better or worse from this day forward.

By the time the interviews are over, it is nearly time for the final admissions decisions to be made. The interviewers hurry back from the corners of the world they have been exploring to find out what changes on the rank list the College Board achievement tests have

**Of the 165 boys who entered in the fall of 1954, for example, only 99 graduated in 1958. There are ten or so more who will probably graduate one or two years later, having been delayed for a variety of reasons. But this still means an attrition rate of right around 33 percent.*



WILLIAM F. BLOOMFIELD, B.S.I.E., LEHIGH, '53, SAYS:

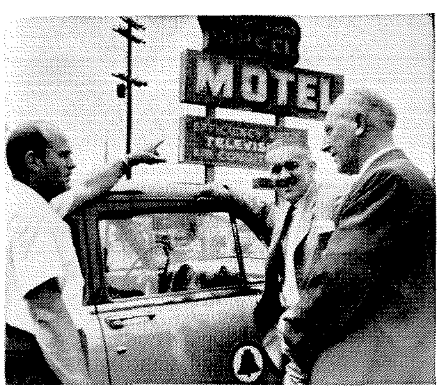
"Join me for a day at work?"

Bill is Plant Service Supervisor for New Jersey Bell Telephone Company at Dover. He joined the telephone company after graduation, has held many jobs to gain valuable experience. Now he has three foremen and 32 craft people working for him. "It's a challenging job and keeps me hopping," says Bill. "See for yourself."

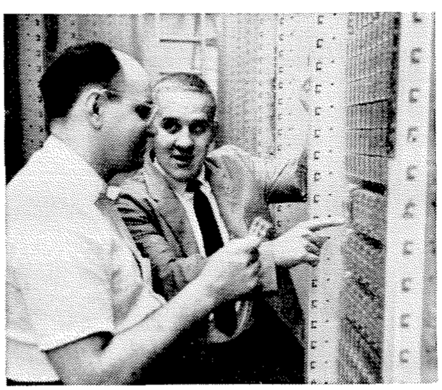
"8:30 a.m. With my test bureau foreman, I plan work schedules for the coming week. Maintaining equitable schedules and being ready for emergencies is imperative for good morale and service."

"9:10 a.m. The State Police at Andover have reported trouble with a mobile radio telephone. I discuss it with the test deskman. Naturally, we send a repairman out pronto to take care of it."

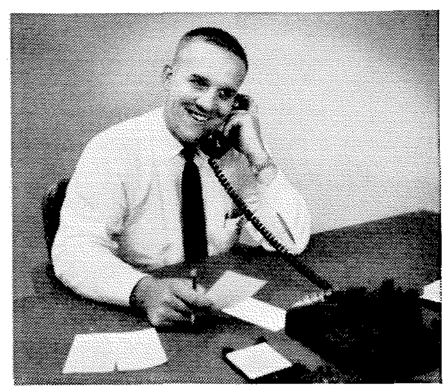
"11:00 a.m. As soon as things are lined up at the office, I drive out to check on the mobile radio repair job. The repairman has found the trouble—and together we run a test on the equipment."



"1:30 p.m. After lunch, I look in on a PBX and room-phone installation at an out-of-town motel. The installation supervisor, foreman and I discuss plans for running cable in from the highway."



"2:45 p.m. Next, I drive over to the central office at Denville, which is cutting over 7000 local telephones to dial service tomorrow night. I go over final arrangements with the supervisor."



"4:00 p.m. When I get back to my office, I find there are several phone messages to answer. As soon as I get them out of the way, I'll check over tomorrow's work schedule—then call it a day."

"Well, that's my job. You can see there's nothing monotonous about it. I'm responsible for keeping 50,000 subscriber lines over a 260-square-mile area in A-1 operating order. It's a big responsibility—but I love it."

Bill Bloomfield is moving ahead, like many young engineers in supervisory positions in the Bell Telephone Companies. There may be opportunities for *you*, too. Talk with the Bell interviewer when he visits your campus and get the whole story.

BELL TELEPHONE COMPANIES

made. Many who have been interviewed will now have fallen too low for serious consideration, but only a few totally unexpected candidates will have risen from below rank 700 to the point where they can be seriously considered.

There are, of course, a certain number of boys living in noncentral areas who will not receive an interview no matter how high they stand. These boys are in a curious position: there is little chance that a hidden spark will be transmitted through the papers that accumulate in a boy's folder; on the other hand, there is no chance for the interviewer to unmask the phony, or to steer the genuinely perplexed student away from the shoals of math and science, which an interviewer might have labeled as not for him.

The best thing to say about a boy who receives no interview because of physical inaccessibility is that he has just as good a chance of gaining admission as an interviewed boy; but if he is an unusual case – a boy with real potential whose record looks mediocre, or a boy with a splendid record about whom we should be suspicious – either he or the Institute may suffer because there has been no interview.

Final roundup

Everything is now ready for the committee meetings, which take up the better part of a week. Each member of the Admissions Committee has a number of boys he is responsible for. On each he has five College Board scores (the SAT yields two, the achievement tests three) a predicted grade point average, a 3½-year high school record, and a school recommendation. On most he also has the notes he made when he interviewed the boy and his teachers. There are 180 places in the freshman class to be filled. In order to get this many freshmen we send out roughly 300 offers of admission. Those who have received bigger scholarships elsewhere, or whose mothers won't let them travel 3,000 miles to college, or whose apparent interest in coming to Caltech has given way to the desire for another college, will drop by the way, and approximately 180 students will remain for the next freshman class. But this is premature. The problem now facing the Admissions Committee is which 300 to pick.

Here the final rank list based on complete College Board scores comes into use. Boys who are near the top of this list and have their school and interviewer firmly behind them are almost automatically accepted. There are, however, among these top boys some whose school is lukewarm in recommendation, and others about whom the interviewer has particular reservations. These cases are brought up, thrashed out, and voted on, and the committee is then ready for the "fight" cases.

A "fight" case, technically, *can* involve a high-ranking applicant whom an interviewer does not wish to see admitted; more often it concerns a boy whose College Board scores have put him farther down the list, but who has, the interviewer is prepared to swear (and often does), exactly the qualities Caltech is looking for. If the interviewer can convince the rest of the committee that this is so, and that the lower ranking on the entrance examinations does not indicate that the work here will be too much of a struggle, the boy is in. In cases of this sort, the Admissions Committee is glad to be convinced; it is not, however, quick to be so.

Three case studies

It might be informative to close this discussion with three case studies, giving insofar as possible the pertinent information the Admissions Committee had to work with and the decision it reached.

Case #1 attended a large high school in the Northwest, where he ranked 18 out of 475. His College Board scores were: SAT-Verbal 718, SAT-Math 746, Advanced Math 800, Chemistry 794, English 695, giving him a PGPA of 3.376 and a rank on our list of 15.*

The school was eager to have the boy admitted to Caltech, but the interviewer detected something a little odd in the recommendation. The counselor who was urging him on us so strongly was doing so because Caltech would be so good for the ***boy***. It would get him away from home, where he was overprotected, and start him off fresh in an area where he could try to achieve something.

This suggested that there had been something wrong with the pattern of his achievement in school, which proved to be true. The boy was not accepted by his classmates, who simply didn't like him. As a result, he attempted to shine academically and concentrated on grades. Grades assumed a tremendous importance for him: they were what would show everyone that he was, after all, a worthwhile young man. The only activity in school life that showed up on his record was membership in the Math Club, and it turned out that this was automatic on admission to the advanced math course of senior year. For the rest, the boy concentrated solely on getting high marks.

**College Board scores range from 800, the highest possible, to 200, the lowest score given. The national average score is 500, and two-thirds of the scores reported in any one year will lie between 400 and 600. Roughly 95 percent to 96 percent of the scores will be between 300 and 700. A score in the 700's will thus place a candidate in the upper 2 percent or 3 percent of the students taking the examination.*

This score scale is the SAT score scale. The achievement tests are reported on the same scale, but the achievement scores are tied to SAT scores. Thus, if a more able group, generally, takes a particular achievement test, as is the case with the Advanced Math test, the average score will be higher and a score in the 700's will mean less. The national average on the Advanced Math test, for example, is 600; and about 20 percent of the students taking the test score in the 700's.

The interviewer presented the case to the Admissions Committee, who voted to reject the boy. The decision was not based on the boy's lack of group acceptance, but rather on the fact that he was a "compensator." A compensator is someone who makes up for lack of general acceptance by concentrating in an area where he can do well – marks. Grades, rather than learning, take on great importance for him and he will argue and struggle for the A+ over the A to an extent surprising to the beholder. The good grades this boy has achieved in math and science do not indicate anything at all as far as desire to work in these areas is concerned; they indicate simply a desire to be accepted for his attainments.

But the Admissions Committee was not so much worried about the proper field for this boy: its foremost concern was that the competition of a small, highly selective college like Caltech might be so keen that the boy, once admitted, would not be able to get his A's, might not even end up in the upper half of his class. Such a perfectly possible occurrence might well rip the boy wide open emotionally, and the psychiatrist in residence would see more of him than the faculty for the limited period he would be here.

Perfect potential

Case #2 attended a parochial school in the Middle West, where he ranked number 2 in a class of 94. His College Board scores were: SAT-Verbal 624, SAT-Math 765, Physics 726, Advanced Math 800, English 645, giving him a PGPA of 3.139 and a rank on our final list of 111. The boy was strongly recommended by his school, which praised his "superior ability, especially in math and science," and his "excellent character" as well. He was described as respected by fellow students for his superiority in studies, his accomplishment in activities, and his personality. His activities were Student Council, varsity basketball and baseball, Forensic Society, and membership in a dance orchestra. The interviewer found him strongly interested in Caltech, a prospective student of electrical engineering, and well aware of what electrical engineering was about.

The interviewer recommended Admit; the committee agreed. This is a fairly normal, uncomplicated case.

Case #3 attended an independent school in the Middle Atlantic states, where he ranked 6 out of 89. His College Board scores were: SAT-Verbal 687, SAT-Math 683, Advanced Math 614, Chemistry 678, English 589, giving him a PGPA of 2.468 and a rank on our final list of 658. He was strongly recommended by his school, whose headmaster wrote, "He applies himself with serious purpose to his studies and has the definite ability and interest to do good work in science." The school listed him as respected by his fellow students for superiority in studies, accomplishment in activities, leadership in activities, success in athletics, interest in other students, and personality.

The interviewer was impressed with this boy and made a fight case of him, as was certainly necessary at rank 658. He agreed with the school that he was a splendid campus citizen, but he was particularly impressed by the boy's accomplishment in mathematics, where he had compressed four years' high-school work into three and had launched himself well into the study of calculus on his own. He was further impressed by the boy's mature attitude toward his academic goals. The boy was as good in the humanities as in the sciences (and the College Board scores bear this out). Though strongly interested in the humanities, the boy had already determined the field he wanted to work in (biochemistry) and had done enough investigation in the field, under the guidance of a good chemistry teacher, to know a good bit about what he was aiming at. The chemistry teacher corroborated the boy's story and recommended him highly.

Committee action: On the basis of the interviewer's "fight," the school's recommendation, and knowledge based on experience of the value of this particular school's stamp of approval, the Committee voted to Admit.

The search proceeds

This is perhaps enough to give a general picture of the admissions procedures at Caltech. Rather than a summary, a word in farewell may be in order. The Freshman Admissions Committee has no thought that it has achieved the ultimate in admissions *expertise* – or even that it is using all the right and all the best criteria. The Committee is sure of some things, however. In the first place, its members go all-out to get the best freshman class they possibly can. They spend a great deal of their own time and the Institute's money doing this, and they feel that both the time and the money are well spent.

In the second place, they feel sure that there are ways of improving on their methods and they are doing their utmost to find them. The procedures change each year – probably not always for the better. But each change is an attempt to close up some chink whereby an undesirable student was admitted, or to sharpen a hook from which a very desirable student made his escape before he was landed.

And in the third place, the committee members know that, whether or not they are using the best data and the best methods, and regardless of how far they are from reaching Utopia, Caltech gets a freshman class every year that any college would be proud to see enter – a class whose individual decisions to come to Caltech have saddened the hearts of Directors of Admission the country over.

The Month at Caltech

Another Hundred Years

Caltech's 13-week television series, "The Next Hundred Years," has gone over so well that the show is being extended for another 13 weeks, to May 3. The programs, which feature Caltech scientists demonstrating and describing their current investigations, are presented as a public service by KRCA-Channel 4 and the National Broadcasting Company. They are shown in the southern California area on Channel 4, Saturday evenings at 6 p.m. The last two shows of the initial 13-week series will feature Dr. Robert Sharp, professor of geology, whose subject is "The Ice Age Cometh?" on January 17 and Dr. John Richards, assistant professor of chemistry, in "Nature's Moldy Factory" on January 24. The second series of programs starts on Sunday, February 8 at 8:30 p.m.

AUFS on Campus

Edward A. Bayne, the first of four representatives of the American Universities Field Staff to visit the campus in 1959, arrived at Caltech this month to report on political, social and economic conditions in Israel, Iran and Italy. Mr. Bayne, economist and writer, has been studying economic development in Africa, Asia and Europe for the past 16 years. He has been with the AUFS since 1952.

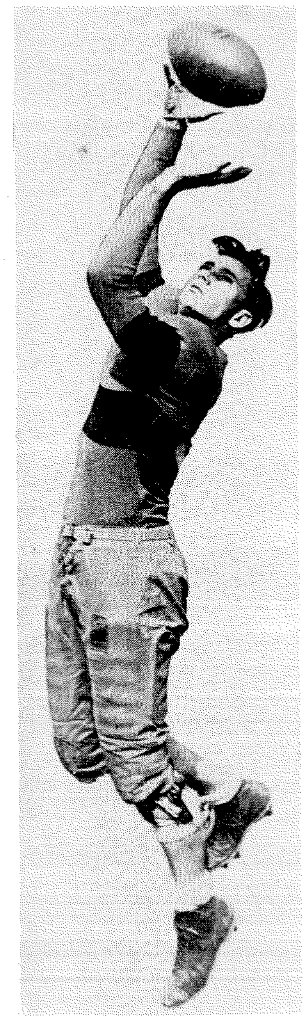
Robert A. Burton, whose field is China, will be on campus from January 26 to February 4. From February 9 to February 18 Charles Gallagher will report on North Africa, and K. H. Silvert, whose field is Latin America, will be on campus from February 23 to March 4.

All four men have just completed 18-month periods of study in their chosen areas, under the auspices of the AUFS which is sponsored by Caltech and nine other universities.

Industrial Relations Grant

Caltech's Industrial Relations section has been awarded a $25,000 grant from the Ford Foundation in order to set up a pre-retirement counseling study for one year. The project will be carried out by Michael T. Wermel, Caltech research associate in economics, and his staff, and will be under the general direction of Robert D. Gray, director of the Industrial Relations Section.

The purpose of the one-year project is to determine the major problems faced by employees at retirement and how companies can assist in the solution of these problems.



All-American Sharp

Robert P. Sharp, chairman of the division of geological sciences at Caltech, has been elected to *Sports Illustrated's* third annual Silver Anniversary All-America. Each year the magazine elects 25 men on the basis of their career success and community service in the intervening 25 years since their senior football season at college. Nomination for the honor is made by each candidate's alma mater, and election is by a panel of eminent judges.

As a Caltech undergraduate, Bob Sharp received a lettter for three years of varsity football as a quarterback and was captain of the team in 1934, his senior year. He was a member of the conference championship team in 1931, and in 1933 he was awarded the Wheaton Trophy for sportsmanship, moral influence and scholarship. Dr. Sharp received both his BS (1934) and his MS (1935) from Caltech and then went on to Harvard for his PhD in 1938. After several years on the staff at the University of Minnesota, he came back to Caltech in 1947 and has been chairman of the geology division since 1952.

Outstanding Young Man

Albert R. Hibbs, chief of the research analysis section of Caltech's Jet Propulsion Laboratory, has been chosen one of California's five outstanding young men of 1958 by the State Junior Chamber of Commerce. Dr. Hibbs was in charge of the operation which determined the orbit of Explorer I, the first successful U.S. earth satellite, and continued to work on this program along with the succeeding lunar probe project (the launching of Explorer III).

Dr. Hibbs received his BS at Caltech in 1945 and his MS in mathematics at the University of Chicago in 1947. He returned to Caltech to work for his PhD in 1950 and, at the same time, began his career at Caltech's Jet Propulsion Laboratory as a junior research engineer. He received his PhD in 1955 and in 1956 became chief of the research analysis section at JPL.

John Scott Award

Renato Dulbecco, Caltech professor of biology, has been awarded the 1958 John Scott Award for inventing a method of isolating and identifying viruses. The $1,000 award was presented at the annual meeting of the American Association for the Advancement of Science in Washington last month. The award was established by John Scott, a Scotch chemist, who died in Edinburgh in 1816. He bequeathed $4,000 with the instructions that income derived from it was to be awarded to inventors. Since then, the fund has grown to more than $100,000 – and the original $20 award is now $1,000 or more. In the 142 years since the award was established, more than 500 inventors have received it. Among them were Thomas A. Edison, Orville Wright and Madame Curie.

Dr. Dulbecco received his MD from the University of Torino in Italy in 1936 and came to Caltech in 1949 as a senior research fellow. He became associate professor in 1952 and has been a professor since 1954. He began his virus research in 1952. His technique involves growing viruses on living cells known as tissue culture. The viruses themselves are too small to watch, but from the changes in the cells the action of the viruses can be determined. Dr. Dulbecco's prize-winning technique has been used in preparing the Salk and other important vaccines.

Dr. Dulbecco's current research at Caltech is one of two projects now being supported by March of Dimes grants. A grant of $73,594 was awarded to the Institute last month for investigations of virus inheritance by Dr. Dulbecco and Dr. Marguerite Vogt, senior research assistant. In experiments involving polio virus mutations, Dr. Dulbecco and his associates are attempting to mate two kinds of viruses to produce offspring combining traits of both "parents."

If viruses can be changed, it may be a step toward developing weakened strains for more effective vaccines.

A second March of Dimes grant of $33,943 will support a program involving the study of certain key components of nucleic acids by Linus Pauling, professor of chemistry at Caltech, and his associates. This group has been investigating the molecular structure of proteins and nucleic acids for the past few years. They will now attempt to determine the incredibly small distances between the atoms of nucleic acid.

Alumni News

Winter Dinner Meeting

Life wrote, "Few maritime exploits in history have so startled the world as the silent, secret transpolar voyage of the U.S. Navy's nuclear submarine *Nautilus*, and none since the age of Columbus and Vasco daGama has opened, in one bold stroke, so vast and forbidding an area of the seas." Aboard the *Nautilus* on this epic undersea cruise marking the opening of the fabled Northwest Passage was an all-inertial navigation system built by Autonetics and Autonetics' man to see that it functioned properly – Tom Curtis.

Mr. Curtis will be the speaker for this year's Winter Dinner Meeting of the Caltech Alumni Association to be held at the Rodger Young Auditorium, Los Angeles, on Thursday, January 22. His talk, titled "96 Hours Under the Polar Ice," will give a first-hand story of the *Nautilus* voyage and sister submarine *Skate's* subpolar excursions.

At Autonetics, Mr. Curtis is Section Chief of Guidance System Test Engineering, with responsibility for the supervision of the engineering assembly, test and evaluation of inertial navigation systems. He is a 1939 graduate with a BS in EE from the University of California. During World War II, he was officer-in-charge of the Combat Information Center on the flagship, *USS Augusta*, in the North African, Normandy, and Southern France Campaigns, and now holds the rank of Lt. Commander, U.S. Naval Reserve.

– Hiroshi Kamei, Chairman

Dinner Dance

The Annual Alumni Dinner Dance will be held again this year at the Candlewood Country Club at 14000 Telegraph Road in Whittier on Saturday, March 7. The bar in the poolside lanai opens at 7 p.m. A fried chicken dinner will be served in the Gold Room at 8 p.m. The Candlewood Country Club Orchestra, the same that you danced to last year, will play for dancing during dinner and for the evening. If your party prefers to come for the dancing only, join the party at 9:30. Notices will be mailed late in January.

– Howard G. Preston, Chairman

The vortex tube is a refrigerating machine with no moving parts. Compressed air enters the vortex chamber pictured here and spins rapidly down an attached tube. Pressure and temperature differences build up, forcing cold air out one end and hot air out the other. Requiring no maintenance, a large vortex tube developed by AiResearch scientists and engineers can be permanently sealed in nuclear reactors, and has many uses in industries with spot cooling problems.

Many such pioneering developments are underway in challenging, important work at AiResearch in missile, electronic, nuclear, aircraft and industrial fields.

Specific opportunities exist in system electronics and servo control units; computers and flight instruments; missile auxiliary power units; gas turbine engines, turbine and air motors; cryogenic and nuclear systems; pneumatic valves; industrial turbochargers; air conditioning and pressurization; and heat transfer, including electronic cooling.

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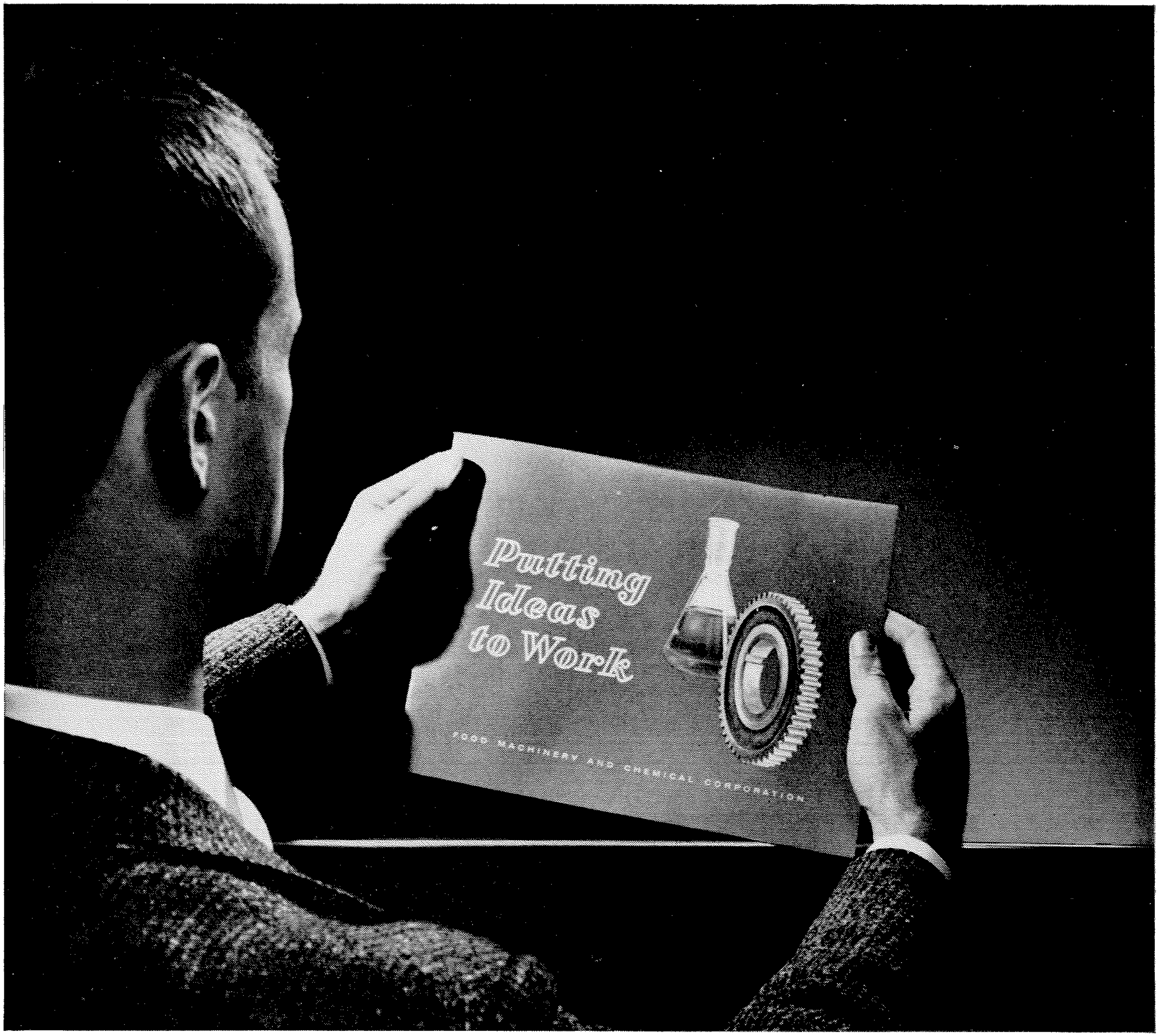
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Personals

1923

John R. North has been elected president of Commonwealth Associates Inc., in Jackson, Michigan, and also a vice president of Commonwealth Services Inc., of New York. He continues as executive engineer of Commonwealth Associates, and as a director of Commonwealth Services. He has been associated with the companies since 1924.

1926

Domenick J. Pompeo, head of the instrumentation department at the Shell Oil Company's Emeryville Research Center, recently marked his 30th year with the company. At Shell he has guided an original small group in glass fabrication to a staff of over 50, now doing instrument development, analysis and training for Shell's instrument engineers. In 1956 Domenick was chosen as the outstanding instrument engineer in the Bay Area by the Instrument Society of America.

C. Hawley Cartwright, PhD '30, formerly principal engineer with the Farnsworth Electronics Company in Fort Wayne, Indiana, is now associate professor of physics at Kalamazoo College in Michigan.

1927

John H. Maxson, MS '28, PhD '31, now a consulting geologist in Denver, operates his own plane and specializes in geophoto work. He flew to Caltech for a brief visit in September.

1928

Stratford B. Biddle, Jr., district manager for the Leeds & Northrup Company, has been transferred from the Seattle district to Los Angeles.

1930

Howard Cary, president of the Applied Physics Corporation in Monrovia, has been named winner of the Beckman Award in Chemical Engineering. He will receive the award at the American Chemical Society's spring meeting in Boston. In 1946 Howard formed the Applied Physics Corporation, which designed and manufactured the first commercial recording spectrophotometer, an instrument now used by industrial and medical research laboratories all over the world. A recent development of the company is the Raman spectrophotometer, which is useful in determining the structure of molecules.

S. *Stewart West*, MS '32, PhD '34, is senior associate in an 18-month project on how America can make better use of its scientists and engineers. The study will be conducted by the University of Michigan Institute for Social Research, with a $67,000 grant from the Carnegie Corporation of New York. Scientists in business, government and college work will be interviewed or sent questionnaires to determine their working relations with their colleagues and supervisors, their motivations for work, their level of job interest and satisfaction, and their technical performance.

1932

Clark Goodman has left MIT to become director of research for the Schlumberger Well Surveying Corporation and vice president of the parent company, Schlumberger, Ltd. He had been at MIT for 20 years, the past seven as associate professor of physics. Clark is commuting from his home in Washington, D.C., to the labs in Ridgefield, Conn., because his wife is working in the Department of Health, Education and Welfare. In 1954-55 the Goodmans were in Japan on Fulbrights. Their two children, Gaye and Lanny, attended Japanese school and learned to speak, read and write the language.

1933

L. Jackson Laslett, research assistant in the physics department at Iowa State University, has been elected vice president of the board of directors of the Midwest Universities Research Association for 1958-59.

1934

James W. McRae, MS, PhD '37, vice president of the American Telephone and Telegraph Company, was nominated by President Eisenhower this fall as a member of the Atomic Energy Commission's science advisory committee. The McRaes and their four children have moved back to Madison, N.J., after five years at Albuquerque, N.M., where Jim was formerly vice president of the Western Electric Company and president of the Sandia Corporation, a Western subsidiary.

1935

Gustave Ehrenberg, Jr., is now an engineer with the Brown Instrument Division of the Minneapolis-Honeywell Company in Philadelphia. The Ehrenbergs and their four children live in Havertown, Pa.

Herbert Ribner writes that he has been research associate and associate professor of aeronautical engineering at the Institute of Aerophysics at the University of Toronto in Canada for the past four years. His main interest is in flow noise (e.g. jet noise), he writes, "but a diversionary sound has intruded (music of the spheres?) and I am now chairman of the newly-formed astronautical section of the Canadian Aeronautical Institute."

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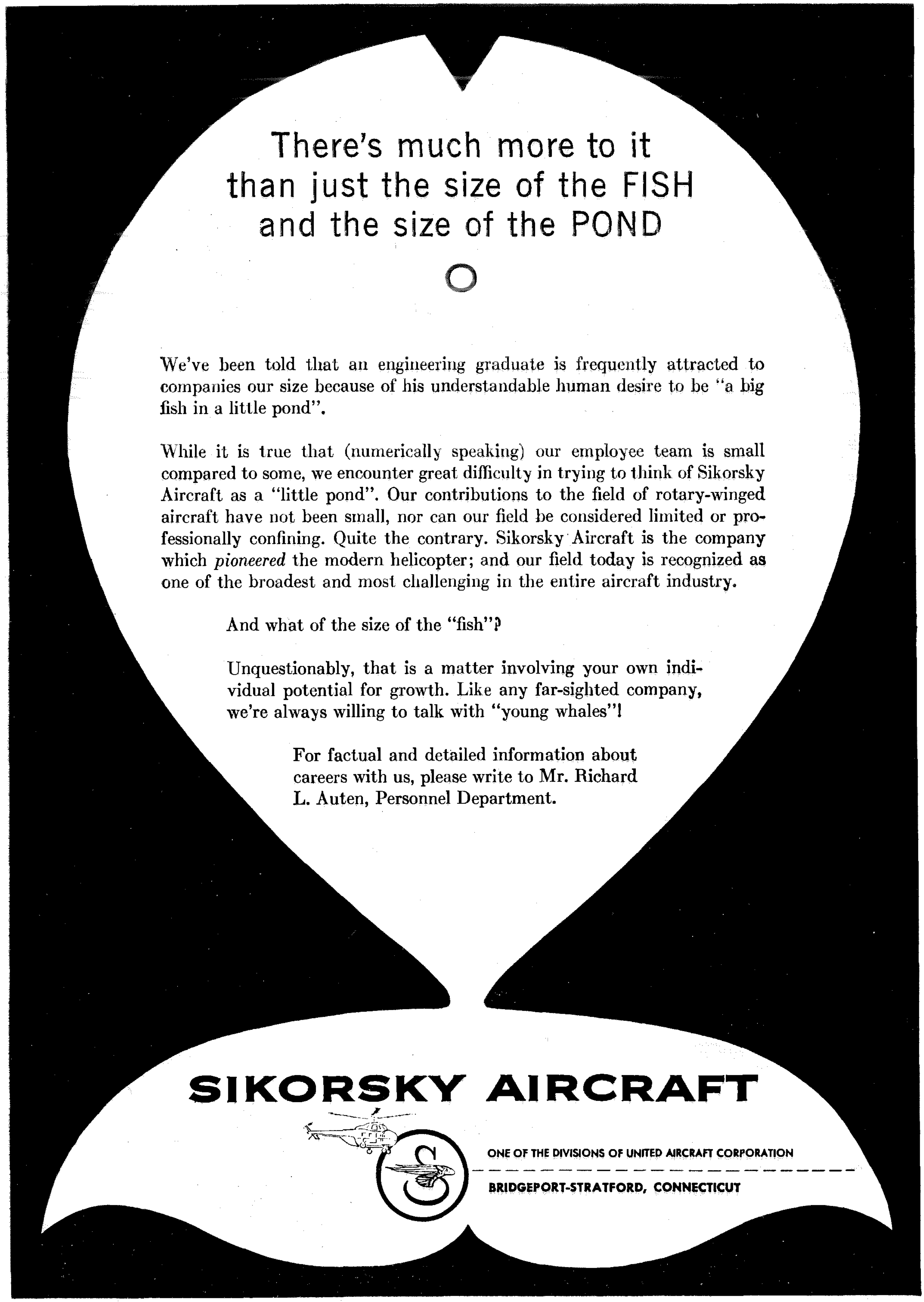
There's much more to it than just the size of the FISH and the size of the POND
We've been told that an engineering graduate is frequently attracted to companies our size because of his understandable human desire to be "a big fish in a little pond".
While it is true that (numerically speaking) our employee team is small compared to some, we encounter great difficulty in trying to think of Sikorsky Aircraft as a "little pond". Our contributions to the field of rotary-winged aircraft have not been small, nor can our field be considered limited or professionally confining. Quite the contrary. Sikorsky Aircraft is the company which *pioneered* the modern helicopter; and our field today is recognized as one of the broadest and most challenging in the entire aircraft industry.
And what of the size of the "fish"?
Unquestionably, that is a matter involving your own individual potential for growth. Like any far-sighted company, we're always willing to talk with "young whales"!
For factual and detailed information about careers with us, please write to Mr. Richard L. Auten, Personnel Department.
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Personals . . . *continued*

Norwood L. Simmons, MS, chief engineer of the motion picture film department of the Eastman Kodak Company in Hollywood, is now president of the Society of Motion Picture and Television Engineers. He has been a member of the Society for nearly 20 years.

1936

Rear Adm. Hubert E. Strange, MS, writes that "I retired from the Navy in 1947 because of wounds and then became mechanical and management engineer for the Navy's Engineering Experiment Station at Annapolis from 1947 to 1955. Now I'm a stockbroker in the Annapolis office of Rouse, Brewer and Bocker – using the principles of meteorology on stocks instead of the weather, which is much more fun."

Louis G. Dunn, MS '37 (ME), MS '38 (AE), PhD '40, is now president of the Space Technology Laboratories. His appointment also marks the separation of the firm from the parent Ramo-Wooldridge Corporation. Louis has served as executive vice president and general manager of the Space Technology Labs since its inception in 1954 as a division of Ramo-Wooldridge. He was formerly director of Caltech's Jet Propulsion Laboratory.

Oscar C. Maier, MS, has been appointed associate dean of the school of engineering at the University of Massachusetts in Amherst. He had been working as director of research and development for the Pullman-Standard Car Manufacturing Company in Chicago.

1938

Robert C. McMaster, MS, PhD '44, professor of welding engineering at Ohio State University in Columbus, is also serving as editor of a new handbook being prepared for the Society for Nondestructive Testing, Inc. He has been granted patents for a xeroradiographic x-ray process and other non-destructive test devices.

1939

John J. Browne, special assistant in the Los Angeles office of General Petroleum, has been promoted to the position of Rocky Mountain Division superintendent of the company's production department in Salt Lake City.

1940

Frank Streighoff writes that, "Last spring my wife and I welcomed our seventh child, Martha, into the family. My principal work is screening for useful antibiotics at the Eli Lilly Company in Indianapolis. It was my good fortune to participate in the finding and development of Vancomycin, an antibiotic in the treatment of resistant Staphylococcus infections which may be available for general use shortly. In our spare time, I am studying in business administration and my wife, Ann, is studying the cello."

1941

Robert E. Rundle, PhD, professor of chemistry at Iowa State College, is spending the year at Oxford University in England, where he is studying at the Clarendon Laboratories.

1942

A. P. Albrecht has been appointed general manager of Space Electronics Corporation in Glendale, California. He had been at Gilfillan Brothers, Inc., as chief engineer. Space Electronics Corporation has contracts with several companies for electronics work in missile and space programs. One of their present customers is Caltech's Jet Propulsion Laboratory.

1943

Clyde A. Dubbs, PhD, '46, has received a grant from the American Cancer Society for research on methods of detecting possible abnormal protein in the sera of cancer patients in order to discover possible new methods of diagnosis and treatment. He received $15,455 for his 20-month project.

Charles P. Strickland, Jr., writes that he has just returned to southern California after two years in Houston, Texas. He is still with the York Division of Borg-Warner Corporation and is now Pacific District Manager. The Stricklands and their three children live in Pasadena.

1944

Floyd W. Preston, associate professor in the department of petroleum engineering at the University of Kansas and also petroleum engineer to the State Geological Survey of Kansas, is taking a two-year leave of absence in February. He will be a consultant in reservoir engineering to the conservation division of the Ministry of Mines and Hydrocarbons of the Venezuelan Government.

1945

R. Clyde Gerber, Jr., has been appointed chief project engineer for the Hallam Nuclear Power Facility of the Consumers Public Power District of Nebraska. The appointment was announced by Atomics International in Canoga Park, California, which is responsible for the design, development and initial operation of the atomic reactor for the plant. The project will be completed by 1961. Clyde has been project engineer for the Hallam reactor, supervisor of the systems engineering unit and a senior research engineer while employed at Atomics International. He has been with the company since 1954. The Gerbers and their three children live in Woodland Hills, Calif.

Robert R. Bennett, MS '47, PhD '49,

is now program director for the Minuteman intercontinental ballistic missile system which is being developed by the Space Technology Laboratories, Inc., in Los Angeles. He was formerly associate director of STL's electronics laboratory and has been with the labs since 1954.

Raymond L. Chuan, MS, AE '48, PhD '53, director of the University of Southern California's Engineering Center, has designed a new type of hypersonic wind tunnel which can test missile models as though they were flying at 20 times the speed of sound and nearly 60 miles above the earth. The wind tunnel was put into active operation at USC in October. It is housed in a $45,000 building built and equipped by SC. The cost to date of the tunnel ($200,000) was shared by the Air Force and Navy.

M. Whitney Nesbitt, MS, is now vice president in charge of sales of the Pesco Products Division of the Borg-Warner Corporation of Bedford, Ohio. He had been director of engineering since he joined the company in 1954. He will also supervise the sales activities of Pesco's Western branch at Burbank, California.

Ralph D. Winter, after receiving his PhD in modern scientific linguistics at Cornell in 1953, topped it all off with a theological degree at the Princeton Theological Seminary in 1956. He writes: "I have been working for some time in Guatemala in San Juan Ostuncalco as an anthropologist for the commission on the Ecumenical Mission and Relations of the United Presbyterian Church.

"Living overseas is a new experience. I am surprised to find that a high proportion of Americans working abroad in medical, agricultural, educational, or other technical assistance fields are what the average American would call 'missionaries,' even though they are not ordained or engaged in any primary sense in ministerial activities.

"My own organization has over 1,000 overseas. Of these over half are in the technical assistance category. We are almost completely withdrawn from the older 'colonial' type of church extension activities in 64 foreign countries where overseas, indigenous 'Presbyterians' run their own work, using us for special tasks, actually outnumbering our membership (3,000,000) in the U.S.

"Speaking as an engineer (still at heart), an anthropologist, a Christian, and—if you must—a missionary, I have been very gratified to find my colleagues out here to be skilled in the local languages and customs, competent, very dedicated, well-equipped, well-adjusted Americans. This is all very far from the deplorable stereotype of popular lore."

1946

Jerome W. Schneider, city engineer of Jasper, Indiana, writes that, after serving for 10 years as county engineer, he recently resigned to open a consulting engineering office specializing in road and bridge design and subdivision planning. The Schneiders have two boys and two girls.

George R. Watt, manager of product planning at the Consolidated Electrodynamics Corporation in Pasadena, has been made director of the newly-established marketing research department of the company.

Robert F. Sensibaugh has been appointed manager of the Denver Manufacturing Division of the Ramo-Wooldridge Corporation. He was formerly director of production planning.

1947

Ordway T. Manning, electrical engineer with Columbia University's Hudson Laboratories at Dobbs Ferry, N.Y., sailed alone on his 30-foot sailboat *Sheliak* in October 1956 on a trip which was to have taken him to San Francisco via the Virgin Islands, Panama Canal and Hawaii. He was last seen on October 21, 1956, when he was sighted by the tanker *Esso Little Rock*, about 200 miles west and south of Bermuda and in the vicinity of a hurricane. When asked if he needed anything, he replied "No." He has not been heard from since that day. Columbia University recently renamed its 65-foot T-Boat from the *R/V Michael* to the *R/V Manning* in his memory.

1948

William A. Drew writes from Fort Wayne, Indiana, that he was married in June 1954 to Frances Tuttle of DePauw University and their son, Robert, was born in October 1957. Bill is assistant actuary at the Lincoln National Life Insurance Company and was also made a Fellow of the Society of Actuaries in 1958.

Richard A. Ferrell, MS '49, writes that he is continuing his research and teaching as associate professor of physics at the University of Maryland—and likes the combination very much. He also reports that he and his wife, Miriam, have adopted a baby girl, Rebecca.

1949

Walter B. King, Jr., MS, has left his position as supervisor of the general metallurgy unit of the Martin Company's Nuclear Division in Baltimore to resume his old job as associate professor of mechanical engineering at the University of Miami.

Rolf Sinclair writes that he is back in the states after spending more than two years in Europe. He had been teaching and doing research, first at the University of Hamburg in Professor W. K. Jentschke's institute—and then at the University of Paris in Prof. Hans Halban's group. He's now in the experimental di-

continued on page 46

vision on Project Matterhorn at Princeton University working on the model C stellarator.

Carlos L. Beeck, product engineer at Cannon Electric Company in Los Angeles, writes that Devon Anita was born on October 30.

1950

William F. Jones, MS, writes that "in February of 1958 I resigned my position with Skidmore, Owings and Merrill in San Francisco and entered the firm of Testing and Controls, Inc. Later, in April, along with three associates, I became one of the owners and principals. Our practice is in the field of soils, foundation and materials engineering and recently we took over another firm, the Hersey Inspection Bureau of Oakland, which provided similar services. So, although it is always a pleasure to find myself named in association with a high calibre firm of consulting engineers such as Jones, Thenn and Associates in Palo Alto (as I was in your November *Personals*) this does not quite fit the facts. For this I must take the blame, as I should have notified you many months ago of the true situation."

John P. Moffat, Jr., has been appointed chief engineer of the Electro Mechanical Instrument Division of Consolidated Electrodynamics Corporation in Pasadena. He was formerly director of quality control for the division and has been with the company since 1952.

1951

Donald E. Sanderson, MS, has been in the mathematics department at Iowa State College since he got his PhD from the University of Wisconsin in 1953. He is now an assistant professor. Don has two sons, 6 and 5, and a 22-month-old daughter.

Edward A. Stern, PhD '55, is now assistant professor of physics at the University of Maryland. He is married and has one child.

1952

John E. Anderson, MS, received his PhD from Iowa State University in chemical engineering in 1953 and is now with the Standard Oil Company in Hammond, Indiana, as a research chemical engineer. The Andersons have four children.

1953

Frederick C. Harshbarger, MS, PhD '57, writes that he is now living with *Wally Short,* PhD '58, and *Alex Thomson,* PhD '58, in San Diego and all three of them are working at Convair's San Diego plant in the physics section, doing motivated basic research related to advanced missile systems.

Pierre Marien, MS, writes that he was a member of the research staff of the Centre d'Etudes Nucleaires in Mol (Belgium) until September 15. He had been studying heat transfer from finned fuel elements to a gas coolant. After September 16 he began work at the Euratom Commission in Brussels as a technical advisor and is also teaching nuclear engineering at the Brussels University.

1955

Gary Felsenfeld, PhD, is now assistant professor in the department of biophysics at the University of Pittsburgh. He had been working as a public health service officer with the National Institute of Health.

1956

John E. Young, in his third year at Harvard Law School, was one of several students at the school who prepared the winning brief in the semi-final round of the Law School's Ames moot court competition recently. The students argued a fictitious case involving trust and tax questions. The three-year competition has been in existence since 1820 and participation in the semi-final and final rounds is a high honor. John has also been elected to the editorial board of the *Harvard Law Review.*

CALTECH CALENDAR

ALUMNI CALENDAR

January 22	Winter Dinner Meeting
March 7	Annual Dinner Dance
April 11	Annual Seminar
June 10	Annual Meeting
June 27	Annual Picnic

ATHLETIC SCHEDULE

Basketball

January 17
Caltech at Pomona

January 20
LaVerne at Caltech

January 23
Occidental at Caltech

January 24
Caltech at Claremont-Harvey Mudd

January 27
Cal Poly at Caltech

January 31
Caltech at Redlands

February 3
San Fernando Valley State at Caltech

February 7
Pomona at Caltech

Swimming

February 13
Mt. San Antonio JC at Caltech

February 20
San Fernando State at Caltech

FRIDAY EVENING DEMONSTRATION LECTURES

Lecture Hall, 201 Bridge, 7:30 p.m.

January 16
Re-creation of Shock and Vibration in the Laboratory
– Charles E. Crede

January 23
Engineering Education in the USSR
– Frederick Lindvall

January 30
Strong Magnetic Fields
– Vincent Peterson

February 6
A Demonstration of Critical Phenomena
– Bruce Sage

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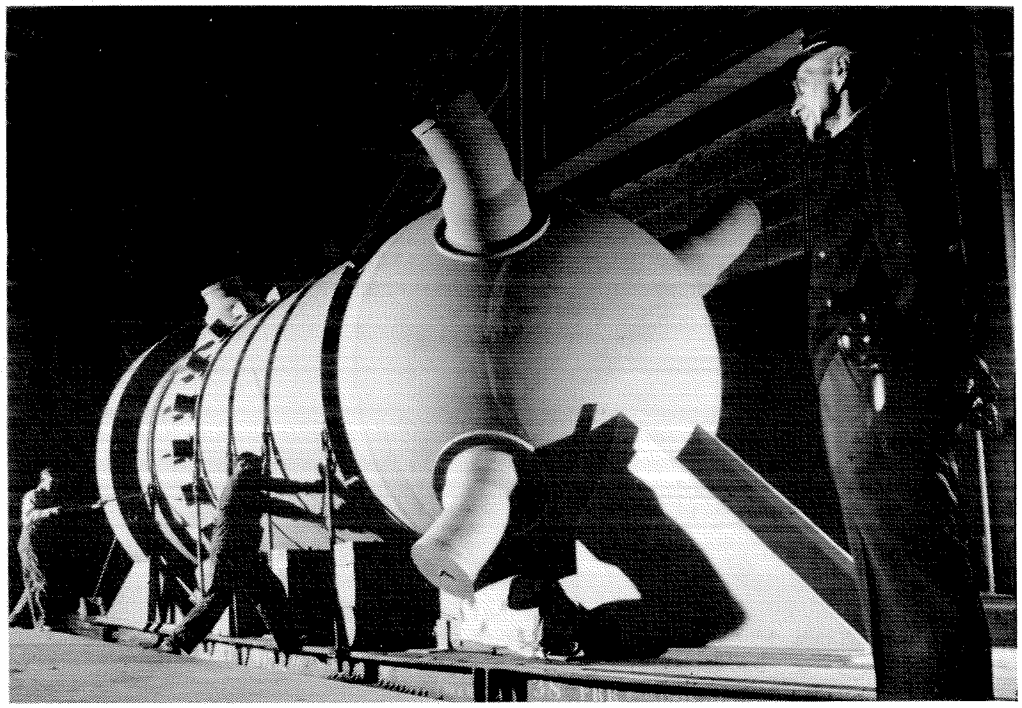
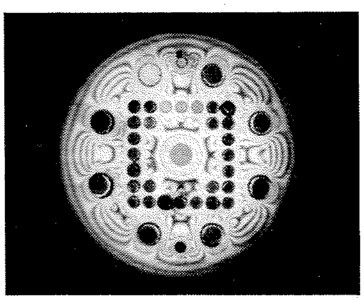
PHOTOGRAPHY AT WORK—No. 25 in a Kodak Series



Nuclear reactor vessel for Shippingport, Pa. power plant designed by Westinghouse Electric Co. under contract with the A.E.C. for operation by Duquesne Light Company.

Where atoms turn into horsepower

Combustion Engineering designed and built this "couldn't-be-done" reactor vessel for America's first full-scale nuclear power station. And photography shared the job of testing metals, revealing stresses and proving soundness.

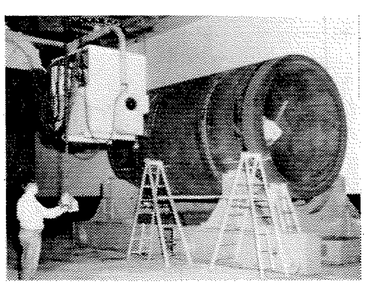


Photograph showing patterns of stress concentration. It was taken of a plastic model of a reactor vessel loaded to simulate the strains a real reactor vessel would undergo.

COUNTLESS unusual—even unique—problems faced Combustion Engineering in creating this nuclear reactor vessel. Nine feet in diameter with walls 8½ in. thick, it is 235 tons of steel that had to be flawless, seamed with welds that had to be perfect. And the inner, ultrasmooth surface was machined to dimension with tolerances that vie with those in modern aircraft engines.

As in all its construction, Combustion Engineering made use of photography all along the way. Photography saved time in the drafting rooms. It revealed where stresses and strains would be concentrated. It checked the molecular structure of the steel, showed its chemical make-up. And with gamma rays it probed for flaws in the metal, imperfections in the welds.

Any business, large or small, can use photography in many ways to save time and money. It can go to work in every department—design, research, production, personnel, sales, and accounting.



Radiographs of the reactor vessel welds were made with a 15,000,000-volt betatron. Every bit of the special steel, every weld had to be proved sound and flawless.

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One of a series

General Electric interviews

Dr. Richard Folsom, President of

Rensselaer Polytechnic Institute,

to explore . . .

Teaching—
A Career Opportunity
For the Engineer

Leading educators, statesmen and industrialists throughout the country are greatly concerned with the current shortage of high-caliber graduates who are seriously considering a career in the field of science or engineering education. Consequently, General Electric has taken this opportunity to explore, with one of America's eminent educators, the opportunities and rewards teaching offers the scientific or engineering student.

Q. Is there in fact a current and continuing need for educators in technical colleges and universities?

A. Colleges and universities providing scientific and engineering educational opportunities are hard pressed at the present moment to obtain the services of a sufficient number of well-qualified teachers to adequately carry out their programs. Projected statistical studies show that this critical need could extend over the next 15 or 20 years.

Q. Why is this need not being met?

A. There are probably three main reasons. These might be classed under conditions of financial return, prestige associated with the position, and lack of knowledge and understanding on the part of the college student of the advantages and rewards teaching as a career can afford.

Q. What steps have been taken to make education a more attractive field to engineering students?

A. Steps are being taken in all areas. For example, we have seen a great deal in the newspapers relating educators' salaries to the importance of the job they are doing. Indications are that these efforts are beginning to bear fruit. Greater professional stature is being achieved as the general public understands that the youth of our nation is the most valuable natural resource that we possess . . . and that those associated with the education of this youth have one of the most important assignments in our country today.

Q. Aside from salary, what rewards can a career in education offer as opposed to careers in government or industry?

A. The principal rewards might be freedom to pursue your own ideas within the general framework of the school, in teaching, research and consulting activities. As colleges and universities are normally organized, a man has three months in the summer time to engage in activities of his own choice. In addition, the educator is in direct contact with students and he has the satisfaction of seeing these students develop under his direction . . . to see them take important positions in local and national affairs.

Q. What preparation should an engineering student undertake for a teaching career?

A. In college, the engineering student should obtain a basic understanding of science, engineering science, humanities and social sciences with some applications in one or more professional engineering areas. He should have frequent career discussions with faculty members and his dean. During graduate work, a desirable activity, the student should have an opportunity to do some teaching.

Q. Must an engineering student obtain advanced degrees before he can teach?

A. It is not absolutely necessary. On the other hand, without advanced degrees, advancement in the academic world would be extremely difficult.

Q. How valuable do you feel industrial experience is to an engineering or scientific educator?

A. Industrial experience for a science educator is desirable; however, with a senior engineering educator, industrial experience is a "must". An ideal engineering educator should have had enough industrial experience so that he understands the problems and responsibilities in carrying a project from its formative stages to successful completion, including not only the technical aspects, but the economic and personal relationships also.

Q. What do you consider to be the optimum method by which an educator can obtain industrial experience?

A. There are many methods. After completion of graduate school, perhaps the most beneficial is a limited but intensive work period in industry. Consulting during an academic year or summer is a helpful activity and is desirable for older members of the staff. Younger educators usually need experience in "living with the job" rather than providing consultant's advice to the responsible individual.

Q. Based on your experience, what personal characteristics are possessed by successful professors?

A. Primarily, successful professors have an excellent and growing knowledge of their subjects, are interested in people, and transmit enthusiasm. They have an ability to explain and impart information with ease. They generate ideas and carry them out because they are devoted to developing their fields of knowledge. They desire personal freedom and action.

For further information on challenging career opportunities in the field of science and engineering education, write to: Mr. W. Leighton Collins, Secretary, American Society for Engineering Education, University of Illinois, Urbana, Ill.

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