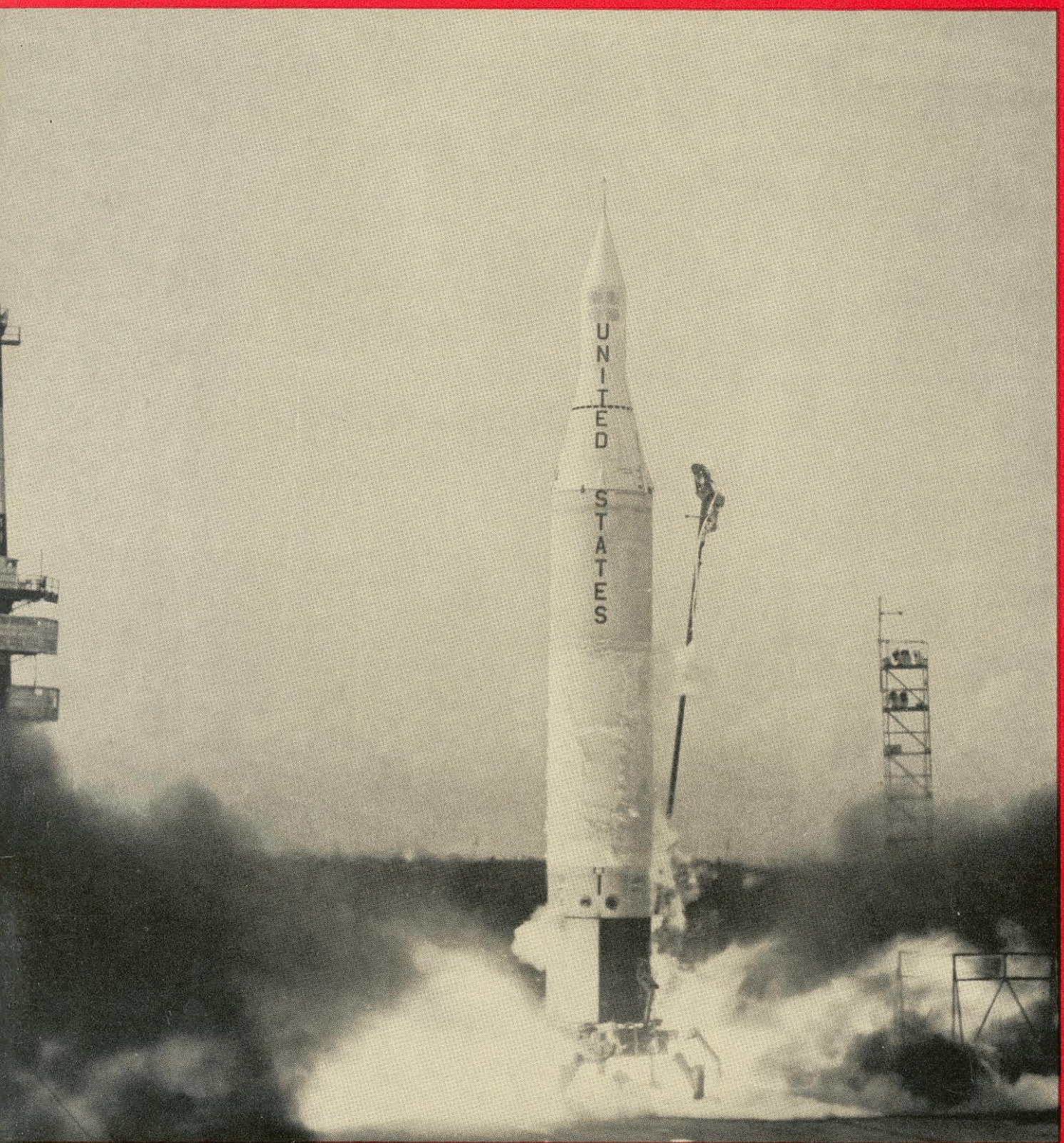
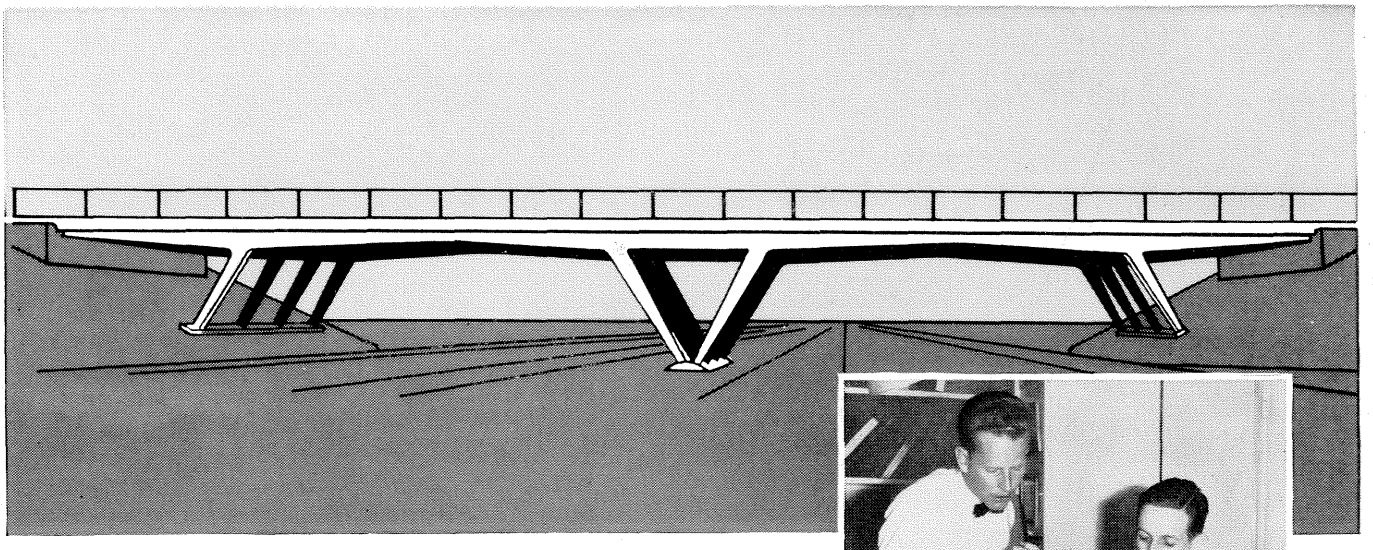
ENGINEERING | AND | SCIENCE

December 1959



Space Race . . . page 15

Published at the California Institute of Technology



1st Award—$4,000—Student Class

Niels Jorgen Gimsing, Hattensens Alle 11, Copenhagen, Denmark
Technical University of Copenhagen (Graduate)
and
Hans Nyvold, Ulrikkenborg, Alle 62, Lyngby, Denmark
Technical University of Denmark (Graduate)

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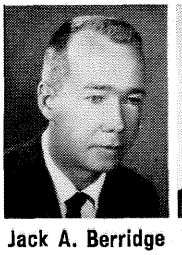

James A. Wood **Jack A. Berridge** **William O. Evers**

Graduates of California State Polytechnic College, San Luis Obispo, Calif.

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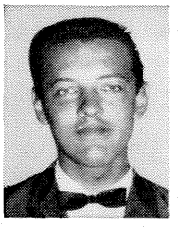
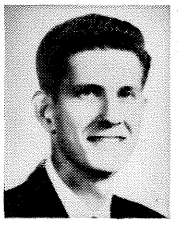
South Dakota State College (Graduate)





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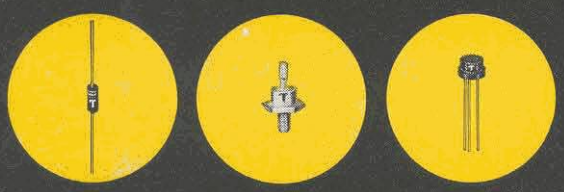

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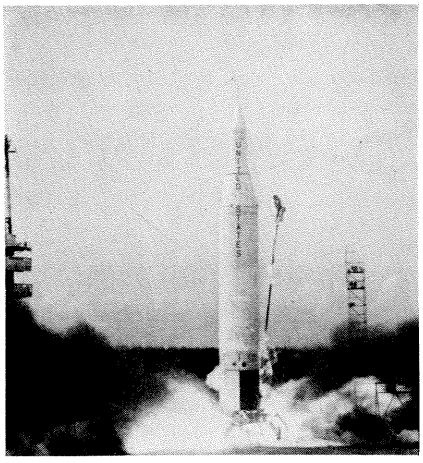

On Our Cover

the Juno II launching of a 91.5-lb. satellite on October 13. Caltech's Jet Propulsion Laboratory was responsible for the upper three stages of the four-stage vehicle. On page 15 Eberhardt Rechtin, head of the Telecommunications Division of JPL, poses a provocative question about our space efforts in, "Who Says There's a Space Race?" The article was originally presented as a speech to The Electric Club of Los Angeles on November 16.

An American Student in India

on page 26 shows the value of the Junior Travel Prizes which give specially chosen Caltech students the opportunity to spend the summer in a foreign country. The prizes were instituted in 1957 with a grant of $4,000 from E. I. duPont de Nemours & Company, Inc.

Before the start of their junior year, students compete for the awards by preparing written proposals for a foreign travel-study project. Two men are chosen each year. Tom Jovin '60, student body president, was one of the lucky ones this year. He writes about his experiences in India during the past summer on page 26.

Picture Credits:

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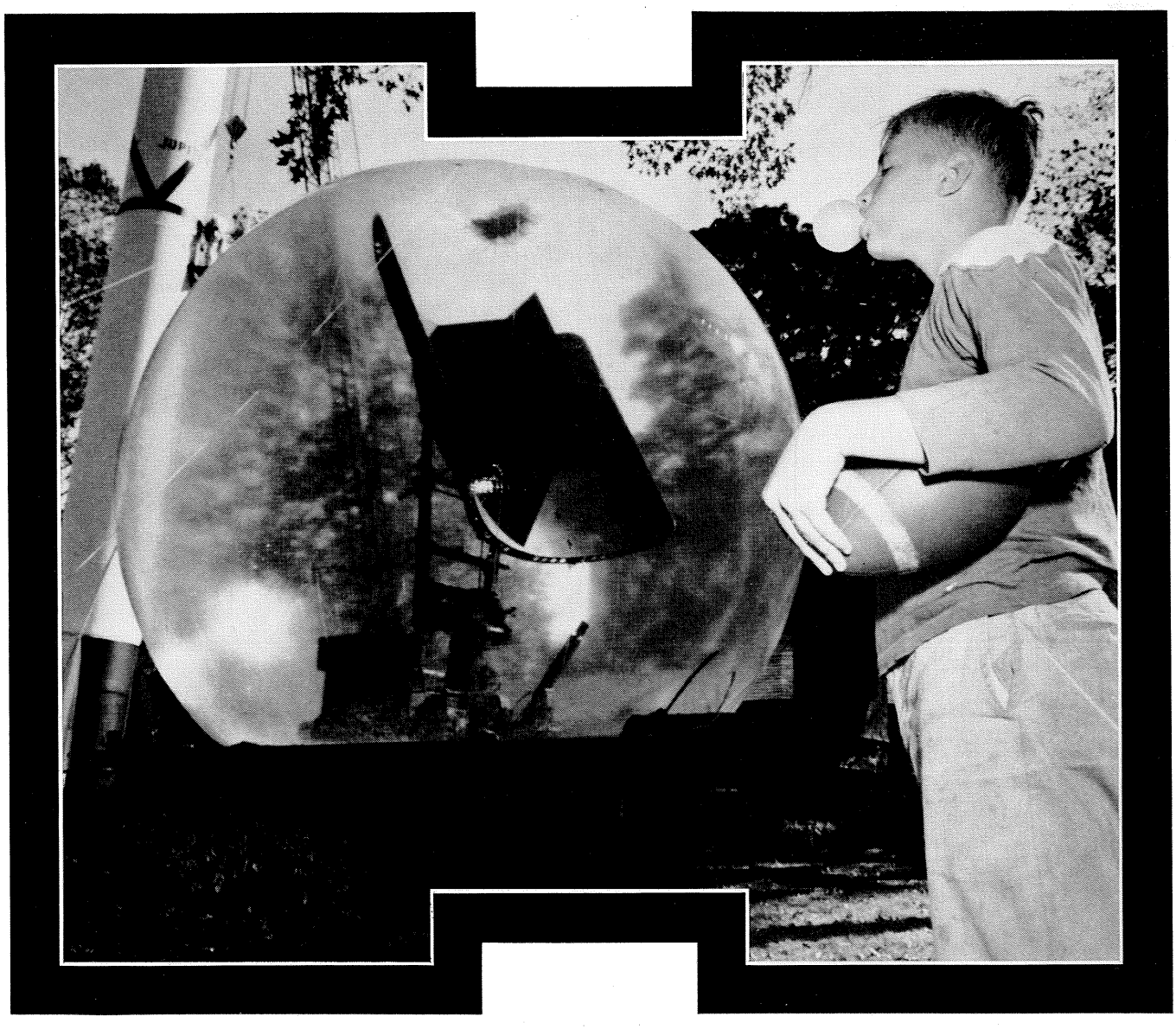
A new dimension in



bubble blowing

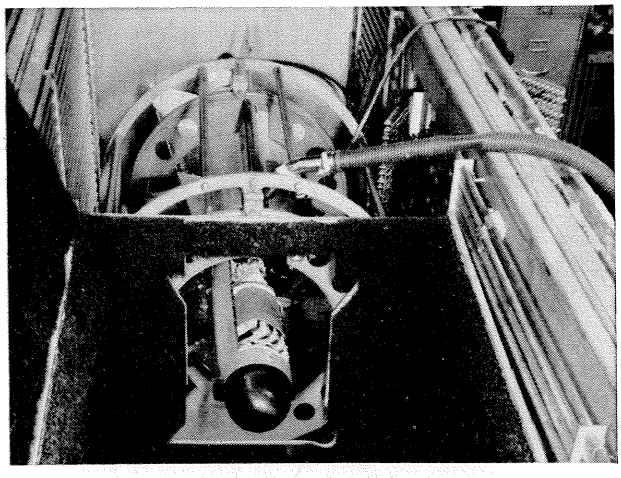
This plastic bubble protects the antenna of a radically new aerial three-dimensional radar defense system.

Sensitive to the inadequacies of conventional radar systems, engineers at Hughes in Fullerton devised a radar antenna whose pointing direction is made sensitive to the frequency of the electromagnetic energy applied to the antenna. This advanced technique allows simultaneous detection of range, bearing and altitude...with a single antenna.

Hughes engineers combined this radar antenna with "vest-pocket sized" data processors to co-ordinate antiaircraft missile firing. These unique data processing systems provide:

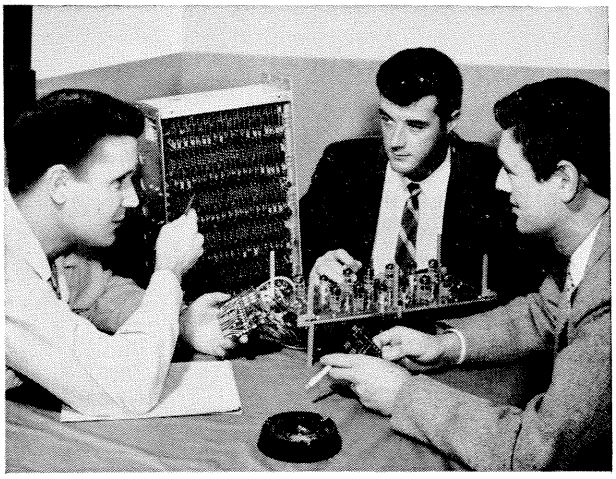
1. Speed—Complex electronic missile firing data was designed to travel through the system in milliseconds, assuring "up-to-date" pinpoint positioning of hostile aircraft.
2. Mobility—Hughes engineers "ruggedized" and miniaturized the system so that it could be mounted into standard army trucks which could be deployed to meet almost any combat problem—even in rugged terrain.
3. Reliability — By using digital data transmission techniques, Hughes engineers have greatly reduced any possibility of error.

Result: the most advanced electronics defense system in operation!



Falcon air-to-air guided missiles, shown in an environmental strato chamber are being developed and manufactured by Hughes engineers in Tucson, Arizona.

Reliability of the advanced Hughes systems can be insured only with the equally advanced test equipment designed by Hughes El Segundo engineers.



Other Hughes projects provide similarly stimulating outlets for creative talents. Current areas of Research and Development include advanced airborne electronics systems, advanced data processing systems, electronic display systems, molecular electronics, space vehicles, nuclear electronics, electroluminescence, ballistic missiles...and many more. Hughes Products, the commercial activity of Hughes, has assignments open for imaginative engineers to perform research in semiconductor materials and electron tubes.

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Books

The Unity of the Universe

by D. W. Sciama

Doubleday & Company . . . $3.95

Reviewed by Allan Sandage, assistant astronomer, Mount Wilson and Palomar Observatories

In the 1920's, some of the most significant books written to stimulate young people in the new discoveries of physics and astronomy were those of Jeans and Eddington. To name a few, *The Nature of the Physical Universe*, *The Expanding Universe*, and *Stars and Atoms* were read by boys who later became leading research men. The impact of some of these books was so great that several unexpected segments of the population were heard from. It is said that a famous New York actress once announced that Jeans' book, *The Mysterious Universe*, is what every girl should know.

There is no question that such books have been of tremendous importance in opening the excitement, the mystery, and the coherence of the world at large to the inquiring minds of youth. Often, stimulation at the right moment (usually in the early years of high school) can decide the career of promising minds. Sciama's book on *The Unity of the Universe* is an attempt to provide a modern synthesis of cosmology in the tradition of the 1920's. In the main, Sciama has succeeded. His book is concerned with various aspects of the astronomical universe both from the observational and the theoretical standpoints. It is written for the layman with no mathematical background.

Sciama is a theoretician, closely allied with the steady state school of cosmology. The book has bias toward the steady state theory. To the neutralist, these statements detract from the logical presentation. Fortunately, the bias is not so strong as to prevent discussion of the conflicting theories of evolving cosmology.

The book is divided into two sections, called The Universe in Observation, and The Universe In Theory. The first section contains five chapters dealing with the observational breakthrough which established that the universe is composed of galaxies at immense distances from the earth which are all moving away from each other at a rapid rate. The presentation is historical, starting from the time of the Greeks and ending with the observations of Hubble. The various chapters discuss the early Grecian geometrical methods of finding distances within the solar system, the history of the quest for the stellar parallax, early speculations of the nature of the Milky Way, a history of the conflict over the nature of the galaxies, and a report of Hubble's discovery of the expansion of the universe.

Deeper waters

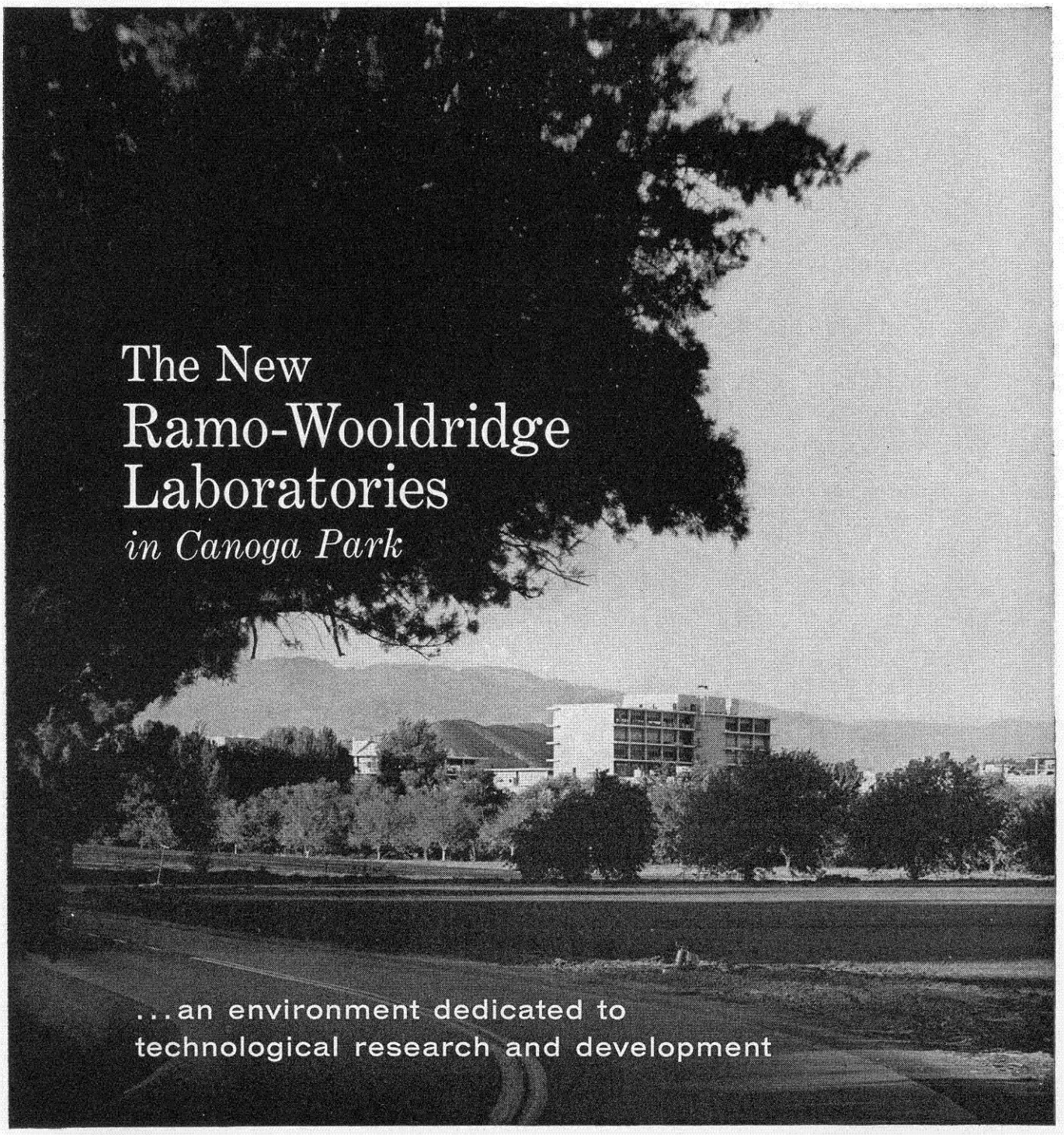
The second section takes the reader into deeper waters. Here the beauty of the theories, the power to stimulate young readers, and the bias of the book appear. The chapters treat, in order, Olbers' Paradox, Mach's Principle, The Principle of Equivalence, The Origin of Inertia, The Clock Paradox, several sections on cosmological models, and The Creation of the Elements.

Olbers' paradox concerns the question of why the sky is dark at night. In 1826, Heinrich Olbers reached the conclusion that in an infinite, static universe populated uniformly by radiation sources (stars or galaxies), the radiation density at every point, such as the earth, would be infinite. Consider any spherical shell of radius dr, at a distance r from the observer. Let the average radiation density be U per unit volume. The radiation emitted by the shell is $4\pi r^2 U dr$. The radiation received at the earth from this shell is Udr. Increase the number of shells without limit and the result is infinite.

Cosmology

Because observations are in direct conflict with this result, some of the assumptions must be incorrect. H. Bondi in his book, *Cosmology*, discusses the possibilities and shows that there are at least three circumstances which can modify Olbers' result:

continued on page 10



The new Ramo-Wooldridge Laboratories in Canoga Park, California, will provide an excellent environment for scientists and engineers engaged in technological research and development. Because of the high degree of scientific and engineering effort involved in Ramo-Wooldridge programs, technically trained people are assigned a more dominant role in the management of the organization than is customary.

The ninety-acre landscaped site, with modern buildings grouped around a central mall, contributes to the academic environment necessary for creative work. The new Laboratories will be the West Coast headquarters of Thompson Ramo Wooldridge Inc. as well as house the Ramo-Wooldridge division of TRW.

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In the future, under the direction of the National Aeronautics and Space Administration, pioneering on the space frontier will advance at an accelerated rate.

The preliminary instrument explorations that have already been made only seem to define how much there is yet to be learned. During the next few years, payloads will become larger, trajectories will become more precise, and distances covered will become greater. Inspections will be made of the moon and the planets and of the vast distances of interplanetary space; hard and soft landings will be made in preparation for the time when man at last sets foot on new worlds.

In this program, the task of JPL is to gather new information for a better understanding of the World and Universe.

"We do these things because of the unquenchable curiosity of Man. The scientist is continually asking himself questions and then setting out to find the answers. In the course of getting these answers, he has provided practical benefits to man that have sometimes surprised even the scientist.

"Who can tell what we will find when we get to the planets? Who, at this present time, can predict what potential benefits to man exist in this enterprise? No one can say with any accuracy what we will find as we fly farther away from the earth, first with instruments, then with man. It seems to me that we are obligated to do these things, as human beings."

DR. W. H. PICKERING, *Director, JPL*

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(1) A certain hierarchical structure to the distribution of sources can give a finite answer.

(2) the sources may have a beginning in time and our observations to very great distances may extend back in time to before the sources began to radiate, or

(3) the universe is expanding.

Hubble's constant

To illustrate the surprising turn which Sciama can and does give to some of his presentations, we see on page 98 the statement ". . . from the observed amount of light in the night sky the actual rate of expansion – that is, Hubble's constant – can be estimated. Thus Olbers could have predicted the expansion of the universe, and could even have made a rough estimate of Hubble's constant, a hundred years ahead of the observer. His failure to do so is one of the greatest missed opportunities in the whole history of science."

And further, on page 172: "Had Einstein remembered, or reproduced, Olbers' argument, he would have seen immediately that his static universe was in disagreement with observation in the most violent way. He would then have been forced to propose an expanding model."

The reader might wish that these two statements were true because the situations w o u l d be a magnificent trick of fate. The statements are examples of Sciama's frequent method of seduction by surprise. But in fact Sciama's claim appears to be false. (1) Most of the light of the night sky comes from the upper atmosphere together with sunlight reflected by interplanetary particles in our solar system. There is in fact no measurement available of the light from the cosmos. (2) Even if Olbers had known what the cosmological light was, he would have to know the radiation density U to calculate the Hubble rate, a quantity he could not possibly have evaluated in 1826.

Clear presentations

The chapters on Mach's Principle, The Principle of Equivalence, The Origin of Inertia, and The Clock Paradox are very clear presentations of the dilemma of Newtonian absolute space, absolute accelerations, the centrifugal and Coriolis inertial forces, and the definition of inertial frames of reference.

Sciama's own theory of the origin of inertia incorporating Mach's principle is explained in simple terms and does much to clarify his published paper in the *Monthly Notices of the Royal Astronomical Society*. He concludes that the inertia of a body is due to the acceleration of all the matter in the universe measured in the rest frame of the body. This acceleration induces a force on the test body which appears as inertia. Sciama derives the gravitational constant as a function of the average density of matter and of the Hubble constant, and concludes that ". . . from observations restricted to our own neighborhood (i. e. the light of the night sky and the laboratory value of the gravitational constant) we can deduce an approximate value for both Hubble's constant and the average density of matter at great distances." This is again a clever statement which suffers from the objections already given.

Cosmological models

The sections of the book on cosmological models treat both the exploding cases and the steady state. The steady state theory as originally proposed rested on the so-called perfect cosmological principle – an *a priori* philosophical dogma. The theory has since been placed on a mathematical basis by Hoyle, who has also given a number of observational tests. Sciama does not discuss these tests but rests his case on a subtheory of the formation of galaxies, on esthetic appeal, and on a belief that the steady state theory contains fewer arbitrary initial conditions than do the conventional models.

It turns out that the most promising of the direct tests concerns the deviation from linearity of the velocity-distance relation of the distant galaxies. Such a deviation was reported in 1956 from observations made with the 200-inch telescope and would disprove the steady s t a t e. However, the results were inconclusive due to certain observational dif-

continued on page 12

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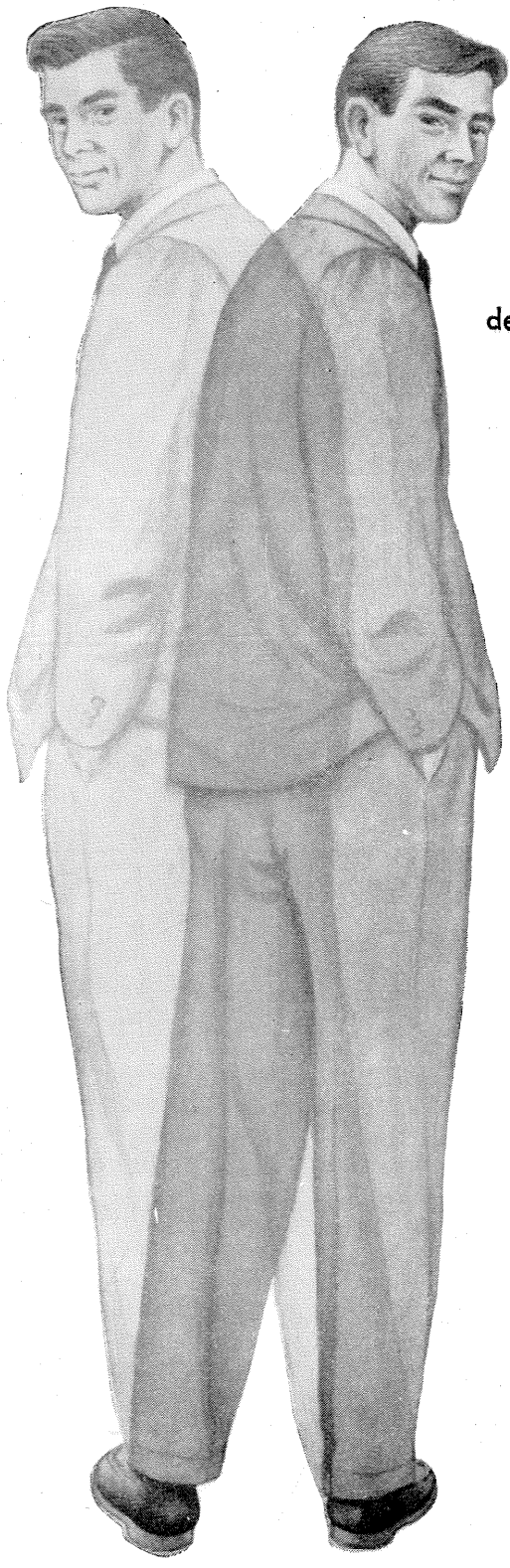

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Books . . . *continued*

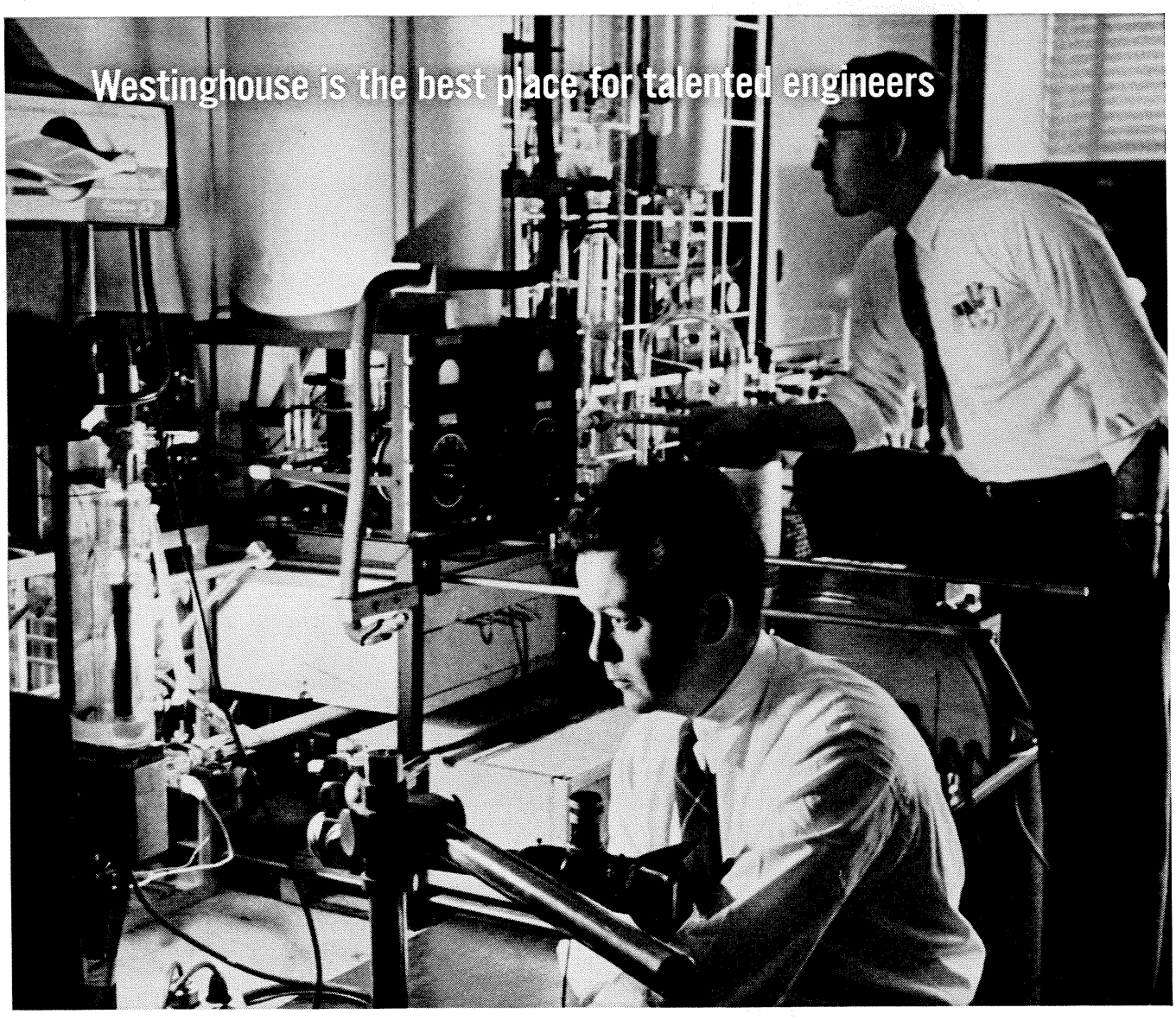
ficulties. But in view of these results it is perhaps not correct for Sciama to state on page 174 that ". . . there is no known observation which is in conflict with the idea (of continual creation)" and hence of a steady state. Assuming the observations are true, the statement which perhaps summarizes the present situation is found on page 114. "(This is) the well known device of disappointed theorists (who) claim that (the experiment) had been performed inaccurately."

The final chapter concerns the formation of the chemical elements. Here Gamow's α, β, γ theory is discussed and is contrasted with the hot stellar interior theory of Hoyle, and Hoyle, Fowler, and the Burbidges. The latter theory is now believed to be the more correct of the two, but it does not prove the steady state, as Sciama contends. The element synthesis theory stands apart from any system of cosmology.

Finally, Sciama suggests that the correct theory of the universe must be unique; that is, it must be completely determinate with all initial conditions specified by the theory itself. Because there is only one universe, there must be only one model with no arbitrary constants. Hence any series of models, such as those of evolving cosmologies which differ from each other by different initial conditions, have an arbitrariness about them if all are theoretically possible. On the other hand, Sciama claims that the steady state model is completely determined, with no "accidental" features, and is therefore to be preferred.

This claim seems a bit exaggerated because at least two features of the theory are taken to be "accidental," i.e., not determined by the theory. These are the value of the Hubble constant and the physics of the creation process. It would seem to this reviewer that the validity of the steady state cosmology or the exploding cosmologies must rest on scientific fact rather than on philosophical speculation.

Although I have criticized Sciama's book in some of its details, the book as a whole should teach and generally stimulate young people who are eager to follow complicated arguments described lucidly and who are willing to learn.



Westinghouse Metallurgists, Dr. M. J. Fraser (foreground) and Dr. H. W. Weart, prepare to photograph a molten alloy sample as one step in the determination of liquid-solid interfacial energy. These direct experimental measurements are the first of their kind ever attempted.

The Metallurgy Lab helps when you need a new alloy to make your idea practical

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Hans Reichenbach...on physics

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—Atom und Kosmos, 1930

ENGINEERING AND SCIENCE
December 1959, Volume XXIII, No. 3

WHO SAYS THERE'S A SPACE RACE?

by Eberhardt Rechtin

Over the past two years there has been a great deal of discussion about a situation called the "space race." There have been statements that the United States is involved in such a space race. There have also been statements that the United States is *not* in a space race at all, but is pursuing an unhurried, but scientific, exploration of the space environment.

It would seem that the first question to be answered is whether or not there really is a race.

A race has certain required elements. There must be a reward or a prize. There must be a significant achievement made in order to acquire this reward. There must be an interested audience. And there must be at least one participant. It is worth noting that it is not necessary to have two participants in order to make a race. We can all think of examples of a single participant who is racing against time, racing to beat his own previous record, or racing as a sheer and often beautiful exhibition of skill and strength.

If the ingredients of a reward, a significant achievement, an interested audience, and at least one participant are taken as the criteria for a race, then there most certainly is a space race, since we have one highly demonstrative participant—the Russians—and ample evidence of the achievements, rewards, and interest to the audience.

Let us then consider the race from the point of view of the Communist government and society of the USSR. The Russian Communists have certain overall objectives. They want a strong Russian Communistic society. They want to expand their sphere of influence. And they want an increasingly favorable economic situation for Russia – i.e., a higher standard of living, greater productivity, and a favorable world market which will permit them, in capitalistic terms, to make a profit.

The Russian Communist government must therefore decide if the overall objectives would be met by putting money and energy into space activity. There is not much question that the original Soviet missile program was a direct consequence of a military need to counter our Strategic Air Command. In the simplest terms, it was necessary for the Soviets to be able to fire at and over the SAC bases and to be able to fire accurately and swiftly. The Soviets therefore had considerable incentive for a missile program.

At about the same time, the United States recognized this Soviet move and consequently also embarked on a missile program with considerable incentive. However, this missile program, although it has been essential in producing large boosters, is not the same thing as a space program. This difference is evident even in the Russian program.

According to the Soviet scientists, it was no simple task for them to get their space program started. Apparently it took several years. As the possibly apocryphal story goes, a very serious question was raised in the upper Soviet government circles as to whether or not the Soviets should launch space vehicles at all. Supposedly, certain members of the Soviet government were very seriously concerned that such space activity might trigger the United States into engaging in this race of missiles and space before the Russians had a sufficient advantage. In other words, these Soviet officials felt that they would like to have the United States sleep on a bit longer. However, the decision was made to fire satellites and so the space age began.

Judging from the results, it appears to me that neither the Russians nor the Americans remotely

Eberhardt Rechtin, chief of the Telecommunications Division of the Jet Propulsion Laboratory, is one of the relatively early participants in the U.S. missile and space programs, having joined JPL with a PhD from Caltech ten years ago.

guessed the prizes which the Russians would pick up as a result of their success. The Russians probably guessed a bit better than we did, but there is ample evidence that even they did not understand the full story. I base my opinion on the fact that the Russians are still going around picking up prizes which, had they foreseen the situation, they would have been prepared to pick up a long time ago.

The prizes

The prizes which the Russians have picked up in these early laps of the space race are well worth looking at in a little detail. Some of the prizes can be valued in cold cash. The Russians probably spent on the order of 500 million dollars in order to launch the first several sputniks. As a direct result of these launchings, the Russian technical prestige took a large discrete jump upwards in the world market. Making a highly conservative guess of the cash value of this jump, based upon the size of the world market and the size of various governmental expenditures, the first several sputniks meant a return on the world market on the order of five billion dollars. Therefore, by spending 500 million dollars the Russians got back about ten times that amount.

To illustrate the economic effect with a story: Suppose that you were a civil servant in South America or in Asia and you were responsible for choosing a contractor to build a bridge. Because your own country has no bridge-building contractors, you must look to other countries of the world.

We will consider two cases. First, consider the case when you are trying to decide on this contractor in about 1954. You would probably consider getting your bridge from the United States, the United Kingdom, or perhaps West Germany. It is unlikely that you would consider a Russian contractor too seriously. For the second case, let's change the date to 1958. The countries which immediately come to mind to perform this technical task of building a bridge are now Russia and the United States.

Well, the prize of technical prestige in obtaining more of the world market is relatively obvious. Another prize, very easily overlooked by us, is an advantage which is probably of even greater value to the Russian Communist leaders. The Russian Communists have clearly identified themselves in the minds of the Russian people with the success of the space race. The Russian people are understandably and justifiably quite proud of this remarkable technical achievement. Such an achievement is an enormous boost to nationalism and patriotism, and the Russian Communists have succeeded in adding this asset of patriotism to support for Russian Communism.

The fact that the Russian Communist government is now in far better standing with the Russian people is evidenced by at least two facts. The one fact is that the absolute dictator of Russia could afford to be out of his country for a period of three months. Secondly, we no longer hear that "if we could only reach the Russian people directly, they would throw off the Communist yoke." Such talk no longer seems quite realistic.

The sputniks also greatly changed the world picture of the average Russian. I was talking to a Norwegian the other day and he remarked that the stereotyped picture of the Russian used to be somewhere between an ape and a Tartar on a frothing horse. The massive, violent, and not too intelligent Russian bear is no longer a very good description of the country that can launch space vehicles. It would have to be a pretty intelligent bear to take pictures of the far side of the moon. This re-evaluation of the Russians has also shown up in such things as very well attended classes in Russian at the Jet Propulsion Laboratory. The attendees recognize that it is going to be quite worthwhile to be able to listen to what the Russians say *in Russian*. Not too many years ago, the attendees would have been investigated by Senator McCarthy.

An effective demonstration

Continuing on our list of prizes, we find that the Russians have managed to demonstrate to the world the detailed characteristics of the ICBM technology in a way which is perhaps even more effective than going to war. Not too many years ago there was a question whether the Russians had any rockets at all. Then the question changed to whether they had very much thrust to their rockets. Until very recently there was the question of whether or not, given a large thrust, the Russians could hit anything with their rockets. Now the only remaining question is whether the Russians can recover a device from a long ballistic flight outside the atmosphere. It is reasonable to expect that demonstration within about three months.

The Russian demonstration of ICBM technology has been almost oriental in the air of mystery which has been given to it. The Russians have yet to show the U. S. a picture of their ICBM, perhaps because a picture tends to dispel some of the mystery. And yet, the Russians have essentially told our military people that they have rockets which are more than capable of landing sufficient payload anywhere on the earth with an accuracy of five miles or better. They have shown us the threat without telling us how to build the club.

It is probably no coincidence that the Russians began mentioning (and we began considering) co-equal summit meetings just after the launchings of the sputniks. It is now no longer Russia, Great Britain, and the United States as the three great powers; it is now Russia versus the West, even-up. That particular advantage Mr. Khrushchev probably appreciated very quickly after the first sputniks. However, there

was another prize which he evidently did not see (or choose to exploit) until very recently. This prize was the direct association of the space successes with "the results of forty years of Communist Society" as a compelling argument in the Communistic conversion campaigns.

We often disposed of the earlier claims of the Communists that their political society was better than our political society by a simple comparison of our standards of living. Now, however, Mr. Khrushchev has made it quite clear that he wishes to compare, not present status, but rather rate of progress when considering the two societies.

The Soviets have recently added another element to this particular line by announcing that they were now going to make loans on the world market quite comparable to those made by the United States, but with the exception that there would be fewer visible strings. We can expect to hear of the remarkable achievement of the Russian Communists in evidencing such a complete recovery of a country by its own efforts within 15 years of an obliterating war.

The real surprise is that the *expected* prize of all this space activity was supposed to be science and discovery, and yet this prize seems to come last on the list. Until very recently the Russians had not made any astonishing scientific discoveries, and it almost appeared as if the United States held the monopoly. Unfortunately, that U. S. monopoly no longer exists, and the Russians have made scientific discoveries which are recognized as such throughout the world. The Russians have told us that the moon has no magnetic field, nor does it have any Van Allen belt. It is unlikely that anyone will question this discovery. The Russians have taken a picture of the other side of the moon and have named the various topological features. It is doubtful if there will be any argument as to whether the Russian names will be adopted.

What will the Russians do next?

The Russians will most certainly continue in the space race since this race very well meets the overall objectives of the Russian Communist society. The race, to them, is economically, politically, and psychologically a sound program to direct against the principal competitor of the USSR, the United States. The Russians have succeeded in putting us in the position of "acute embarrassment" which they can certainly exploit ruthlessly. In the long run, the Russians probably realize, as we do, that exploration has always paid for itself, if you have the time to wait for the final returns.

From the economic standpoint, it can be shown that certain types of space vehicles will more than pay for themselves. Both communication and weather satellites can be used to make money. The Russians, could, for example, set up a worldwide communication system which would be considerably better and more reliable than our high frequency radio system in use today. The Russians could then rent and control this communication system.

The Russians have, of course, long since told us that they intend to stay in the space race. Recently, two well-known Russian scientists, Federov and Blagonravov, reportedly *outlined a Russian space program which might very well be underway. These two scientists are recognized professionals who help direct the USSR program and who are not given to idle comment or spectacular proposals in the public press. They were reported as stating that a Soviet satellite bearing two men will orbit the earth for 14 days by the end of this year. Four weeks after that firing, two men with a TV camera will make a round-trip to the moon, circling it twice.

In March or April of next year, two men and two women are scheduled to make a trip around the moon for more than half a year. The program intends to send rockets to Mars and Venus during 1961, to Mercury and Jupiter shortly thereafter, and to send manned ships carrying from two to six men to Mars and Venus. If this sounds fantastic to us, we should remember that, from their advanced position, the view of the immediate future might well be clearer than what we see from further back. In some ways, this difference in what we see is one of the more dramatic illustrations of the relative positions of Russia and the U.S.

Based on this kind of evidence, I think it is fair to conclude that there is a race. What we may not have realized is that the Russians are in it whether we are in it or not. In a sense, we are so far behind that the Russian competition does not even look back to find out where we are.

Should the United States enter the race?

Fortunately, or otherwise – as you prefer – the United States at the moment is neither in nor out of the space race. We have made no declaration to accept the Russian challenge. We have no programs whose avowed intent is to close the gap between ourselves and the Russians. We have one or two programs whose hopeful intent is to try to keep the gap from getting wider. At the present time, one of the most remarkable features of the U.S. position is the almost complete lack of urgency to the space program. This lack of urgency is justified, presumably, by a statement that we are in a scientific program and not a race. I have not yet figured out why coming in second in science is any different or better than coming in second anywhere else.

The remaining indication that we are neither in nor out of the space race is the present funding level. The National Aeronautics and Space Administration bud-

**The authenticity of the report, published in* Missiles and Rockets, *is not known. While its dates might be questioned, its order and choice of missions are plausible.*

get is now somewhat less than what the United States pays to ship and store surplus wheat. Our space program is less than two percent of our defense budget. The space program costs less than ten dollars per year per U.S. adult, or roughly one evening's entertainment per year.

On the other hand, we have not declared ourselves *out*, either, and unless we do, the rest of the world probably assumes we are in. The results of continuing at our present level are not particularly encouraging. In the last two years we have dropped six months to a year further behind in the process of organizing, re-evaluating, carving out paper empires, and fighting over who is going to be the boss to tell the professional what to do.

The results of continuing as we are were illustrated the other day in a meeting at JPL in which we were attempting to plan the missions for a set of space vehicles in 1961 and 1962. We went through the process of setting up a logical and technically sound program, only to be shocked at the end of our efforts to find that the first half of our fine program had already been accomplished by the Russians. The frustration of the few professionals in the space business was well illustrated by the comment made by a colleague of mine just last week. He stated that the closer you get to the space program, the more of a sinking feeling you get.

A waste of money

Putting it in somewhat different words, continuing at the present level is largely a waste of money. At the moment, we are paying for the privilege of being the perfect straight man for the Russians. As Dr. T. Keith Glennan, NASA Administrator, has stated: "We cannot run second very long and still talk of leadership."

In a perfectly objective way, we should therefore consider the results of declaring ourselves out of this game. We might well save ourselves a great deal of embarrassment. We would have to yield the field to the Russians and admit that they are highly successful. What would hurt is that we would have to admit by inference that their stated reason for success, namely the Communist society, might also be true.

If we declared ourselves out of the race, we would definitely need a different race as a substitute. This other race must have drama and interest and must have exportable advantages. Unfortunately, neither our standard of living nor our foreign aid can be used as a satisfactory substitute. The statement that "we went military" is not a particularly good counter-argument to the Russians' space activity because the Soviets went military too. On the other hand, we would at least quit being the straight man, quit wasting our money, and stop some of the endless frustrations.

We should also consider the results of declaring ourselves *in* the space race. It will certainly cost us more money than we are presently spending. However, even if the amount spent was trebled or quadrupled over the present NASA budget, the net effect on the nation would still be very small. If the NASA budget was quadrupled to two billion dollars a year — to take an extreme case — it would represent less than three percent of the national budget, less than five percent of the defense budget, and less than one-half of one percent of the gross national product (one measure of our standard of living). Space is therefore not in the same class as the defense business, or our standard of living.

Why meet the challenge?

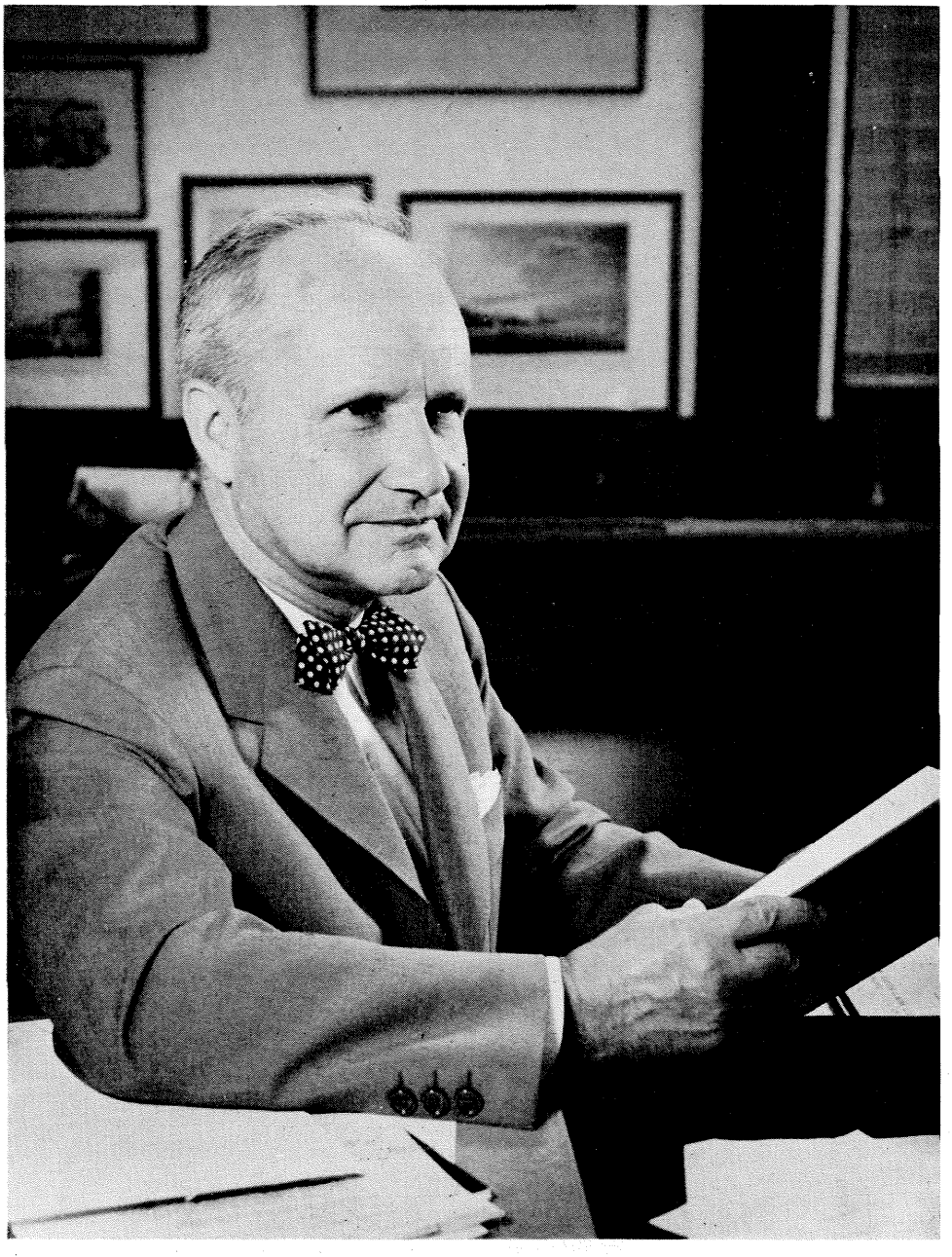
On the other hand, one might question why meeting the Russian *space* challenge is more important than meeting their challenges in other fields. There are at least two reasons for meeting the space challenge. Missiles and space vehicles, by their very nature, require high competence in many different technical disciplines; consequently, success in space reflects success in mathematics, physics, chemistry, propulsion, medicine, communications. A space success reflects broad competence. The second reason is that space is a very good investment in terms of value returned per effort spent; i.e., the prizes are well worth the trouble.

As another feature in declaring ourselves in, we are going to need clearly defined goals — specifically, whether or not we intend to accept the Russian challenge. We will need facilities and priorities. We need a very hard-boiled look at the past performance of groups in the United States, and a willingness to let the finally-chosen professionals run their own race. As I see it, one of the most effective ways is to give both support and authority to the NASA to do its legally assigned job. A major step in this direction was taken by the President in making his decision that the Army's rocket expert, Wernher von Braun, and his team should join NASA.

Even if we declare ourselves in tomorrow morning, it will take some years of not being first. It will take a great deal of patience from the American public.

On the asset side, there is very little question that we would get the approval of the free world. We have often been an underdog, but so far we have never yet refused a fight. The Russians have picked up a lot of prizes. There is no reason why we should not pick up similar prizes, including such things as national pride, sales in the world market, and world communications systems. The space business is a fair and dramatic field in which we can display our own talents. We too can acquire some of the benefits of new discovery.

After all, there is undoubtedly some truth in the story that the Russians were doubtful as to the desirability of launching the space age. The United States is no insignificant competitor in any field in which it accepts the challenge.



Earnest C. Watson, professor of physics and dean of the Caltech faculty.

The Retiring Dean

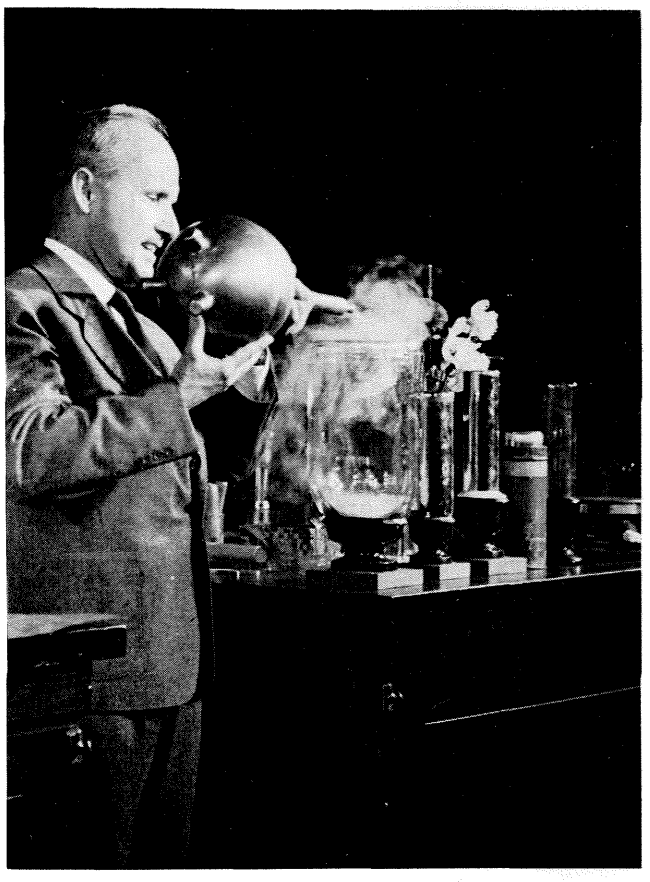
Earnest Watson, dean of the faculty for the past 14 of his 40 years at Caltech, leaves the Institute this month to become scientific attaché to the United States Embassy in India. Dean Watson and his wife will leave for New Delhi in January for a two-year term.

In a formal statement, President L. A. DuBridge said:

"It is fitting to express on behalf of the administration, faculty and trustees the great debt of gratitude which the Institute owes to Dean Watson for his devoted service over the past 40 years.

"He has been a dedicated and effective servant of Caltech. No one on the faculty is more admired as an individual, or is more respected for his part in bringing Caltech to its present position of leadership. As dean of the faculty, he has never compromised with the highest quality requirements for faculty members, yet has dealt gently and understandingly with all faculty members on their personal and professional problems.

"He will be sorely missed, but his friends join in wishing him every success in the new and important task he has undertaken. He will be an ideal representative of the U.S. scientific community abroad."



Earnest Watson not only started the Friday Evening Demonstration Lectures at Caltech, but, year after year, gave the lecture on liquid air, which was the best of them all.

The story of Caltech is in many ways the story of Earnest Watson. Born in Sullivan, Illinois, in 1892, Watson was graduated from Lafayette College in Easton, Pa., then went to Columbia University in New York to ask the advice of Dr. Robert A. Millikan about doing graduate work in physics. Dr. Millikan, at that time one of the world's great physicists, offered Watson a scholarship at the University of Chicago. Watson accepted, serving as an assistant in physics there until 1917.

During World War I Watson worked on one of the first military research projects – the anti-submarine program – at the U.S. submarine base in New London, Conn. Dr. Millikan, who had moved west to start an outstanding university of science and engineering, asked him to come to the Throop College of Technology in Pasadena. Watson joined the Throop faculty in February 1919, a year before the name of the school was changed to the California Institute of Technology.

Starting out as an assistant professor of physics, Watson promptly took over the task of supervising the planning and construction of the Norman Bridge Laboratory of Physics. He also started the Friday Evening Demonstration Lectures – which still continue, and which remain one of the Institute's most valuable public relations efforts.

In the 20's and early 30's Watson did research on the spatial distribution of the photoelectrons ejected by x-rays. He designed and constructed one of the first beta-ray spectrometers in the world, for use in that work. In 1937 he published, in collaboration with Millikan and Roller, the revised edition of the famous physics text, *Mechanics, Molecular Physics, Heat and Sound.*

For a quarter of a century Watson was a right-hand man of R. A. Millikan. When Millikan retired, Watson became acting chairman of Caltech's Division of Physics, Astrophysics, Mathematics and Electrical Engineering. He was made an associate professor in 1920 and a full professor in 1930.

World War II

During World War II Watson took on the overwhelming job of administrative director of Caltech's rocket project, supervising an organization that did 80 million dollars' worth of work for the government in rocket research, development and manufacture. About 4,000 people were employed on this project for the Navy.

For a short time, during the war, Watson relieved the late Dr. Richard Tolman as vice chairman of the National Defense Research Committee, which – among other things – supervised the development of the atomic bomb.

After the war Watson was made dean of the Caltech faculty. In recent years his administrative duties have precluded his doing research, but he has continued teaching. And he has pursued his hobby of collecting old prints and books on the history of physics. He has won national recognition for his studies in the history of science and for his remarkable collection of manuscripts, pictures and prints on the subject. He has published nearly 80 articles in the *American Journal of Physics,* depicting the history of physics. Three years ago he presented Caltech with a collection of 300 very rare scientific books, including first editions of Galileo, Copernicus and Kepler.

An assortment of jobs

In addition to serving as dean of the faculty and as acting head of his division, Dean Watson has presided as chairman of the faculty board and as acting president of Caltech. He is a fellow of the American Physical Society and the American Association for the Advancement of Science, and a member of the American Association of Physics Teachers, History of Science Society, American Association of University Professors, Foreign Policy Association, Phi Beta Kappa, Sigma Xi and Tau Beta Pi.

He is also a member of the Twilight Club of Pasadena, Friends of the Huntington Library and of the Pasadena Library Board, of which he has been chairman since 1956.

A bachelor most of his life, Dean Watson met Jane

Werner while they were on a Mediterranean cruise in 1954. A few months later they were married in Scotland. Mrs. Watson is the author of nearly 200 children's books, including *The World of Science,* which he helped her write.

At a dinner honoring Watson on November 23, William A. Fowler, professor of physics, presented the retiring dean with a scroll from the Caltech faculty:

"The faculty of the California Institute of Technology takes pleasure in presenting this memorial to Earnest C. Watson on the occasion of his completing 40 years of service to the Institute and 14 years as dean of the faculty.

"His signal achievements include the original planning and construction of Bridge Laboratory, leadership in the teaching of physics, development and maintenance of healthy relations between the public and the Institute, most considerate and unremitting care of all the interests of the faculty, and the cultivation of free and fresh inquiry into principles and policies of higher education as undertaken at the Institute. From the beginning he has won and kept the high esteem as well as the gratitude and affection of his colleagues."

The years of development

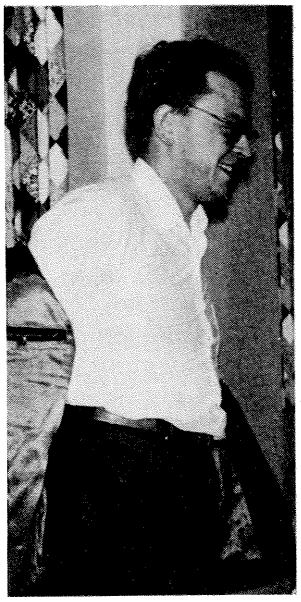
"It has been a wonderful experience," said Dean Watson in a retirement statement, "to live through the years of development at the California Institute of Technology which have raised it from a small, local engineering school to an internationally known institution. Working in the early days with men of such vision and stature as George Ellery Hale, Arthur Amos Noyes, Robert Andrews Millikan, Thomas Hunt Morgan, Richard Chace Tolman and William B. Munro was indeed a privilege. Though these men who shaped the Institute are now gone, the institution whose path they charted with such foresight has moved steadily forward.

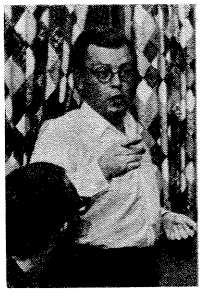
"Equally able and far-reaching men have been found to take the place of these early leaders, and the faculty has been enlarged and strengthened until it now ranks with the very best in the world. What better can one ask of life than the opportunity to live and work in such an environment, helping in small ways to shape that environment and enjoying the friendship of such men?

"I am deeply grateful to the trustees of the Institute for the confidence they have placed in me, and for their continuing support and personal friendship. I know of no institution with a finer and more dedicated Board of Trustees, or one where the relations between trustees and faculty are as good.

"With the success of the current development fund drive, a new era has been inaugurated at the Institute. Still greater opportunities and responsibilities lie ahead for its leaders. It is with some regret and even envy that I step aside at such a time. As a younger and abler man than I takes over as dean of the faculty, with every confidence in the future of the Institute I can wish him no richer reward for his service than the kind of deep satisfaction which has been mine. This is a great institution, with a wonderful Board of Trustees, faculty and student body – and its finest years still lie ahead."

Faculty and staff members honored Dean Watson with a farewell dinner at the Athenaeum, followed by a performance of an original musical, "The Importance of Being Earnest."





Victor Beknyev, addressing an undergraduate YMCA lunch forum.

CALTECH'S FIRST RUSSIAN STUDENT

by Lance Taylor

Caltech got its first Russian student this September when Victor Sergeevich Beknyev arrived from Moscow for a year of graduate study in mechanical engineering. Thus far, Victor has spent a great deal of his time trying to convince everyone that not all Russians have downcast eyes, moldy shoes, and washed brains. Thus far, he has succeeded admirably.

Victor, 32, is at Caltech as part of the current USA-USSR student exchange program. The faculty council of Moscow Technical College, where he holds a position comparable to instructor, picked him early in 1959 to come to America as an exchange student, and he applied through the U.S. State Department for doctoral-level work at either MIT, Caltech, Harvard, or Yale. Through some governmental procedure he doesn't understand, he ended up in Pasadena. The Institute pays his tuition costs here; the Inter-University Committee on Travel Grants furnishes him about $175 a month for living expenses, and will take him and the 26 other Russian exchange students now in the United States on a tour of the country next sum-

mer. The Russian government – which supports Victor's American counterparts in Russia – provides him nothing but indoctrination and review of his three years of college English (he's fluent now).

Victor's specialty is air flow in turbomachines, and he practices it here under the tutelage of Duncan Rannie, Robert Goddard Professor of Jet Propulsion. Right now, he is doing theoretical work on air-flow conditions near the walls of an axial flow compressor, with an eye toward designing compressor blades which will behave more efficiently in such "boundary flow." He optimistically plans to build a set of improved blades and test them fully on Caltech's compressor before he leaves next July.

What it's really like in Russia

Above and beyond working on air-flow theory in his office at 05 Engineering, Victor is passionately fond of telling people "what it's really like in Russia." As a member of the Russian Communist Party, he feels a need exists for such explanations, because – like Khrushchev – he believes that eventually Americans as well as Russians will live in a Communistic society.

According to Victor, society is bound to become socialistic, and there's not much of anything anybody can do about it. In fact, the big difference between America and Russia, he says, is that Russians are planning for socialism and Americans aren't. Since they are essential to state social planning, Victor sees nothing wrong with anonymous and autonomous boards that have final authority to censor anything published in Russia. Such boards, he says, are necessary to the growth of the state now, and will disappear when the new society arrives – "in the future." Also billed for future arrival are a state limited solely to distributive functions, and a worldwide machine-supported class choosing their own occupations.

Like any good missionary, Victor argues for his favorite subject at length and with finesse. Often he will expound for 30 minutes on why communism and capitalism are irreconcilably different, and then completely disarm his antagonist by switching to the necessity for co-existence. Only half-a-minute later, he's back on why capitalism must go. Rumors of such tactics brought one of the largest crowds in years to the undergraduate YMCA lunch forum last month, at which Victor held forth. He made no converts, but collected a fair number of slightly bemused friends.

Because of State Department retaliation to Russian retaliation to something else, Victor's sight-seeing area is limited (without special permission) to a circle with a 25-mile radius centered at Caltech. This means he can go to the Santa Monica beaches, Hollywood, and Mt. Wilson – but not to Los Angeles Harbor, Marineland, or Big Bear.

In his two months here, he hasn't violated his honor-system restrictions by going outside the circle, but he pushed his boundary to the limit (25 miles plus 100 ft.) by going to Disneyland in November. (He was crazy about the tree house and the jungle trip.) He has also journeyed to the beach, where he got his first honest-to-goodness look at an ocean, and to sundry places around Los Angeles. Before too long, he hopes for State Department permission to go to the San Francisco area and see some fellow students at Stanford and the University of California at Berkeley, and before he leaves the country he wants to try surfboarding, and is looking forward to seeing the Dodgers win a ballgame.

Victor has a room at the home of Dr. and Mrs. Alfred Ingersoll, across Wilson Avenue from the Caltech campus. He cooks his own breakfast, eats lunch at the campus cafeteria, and dines at the counter at one of the local drugstores. He likes American food – especially hamburgers, and even Caltech Student House fare.

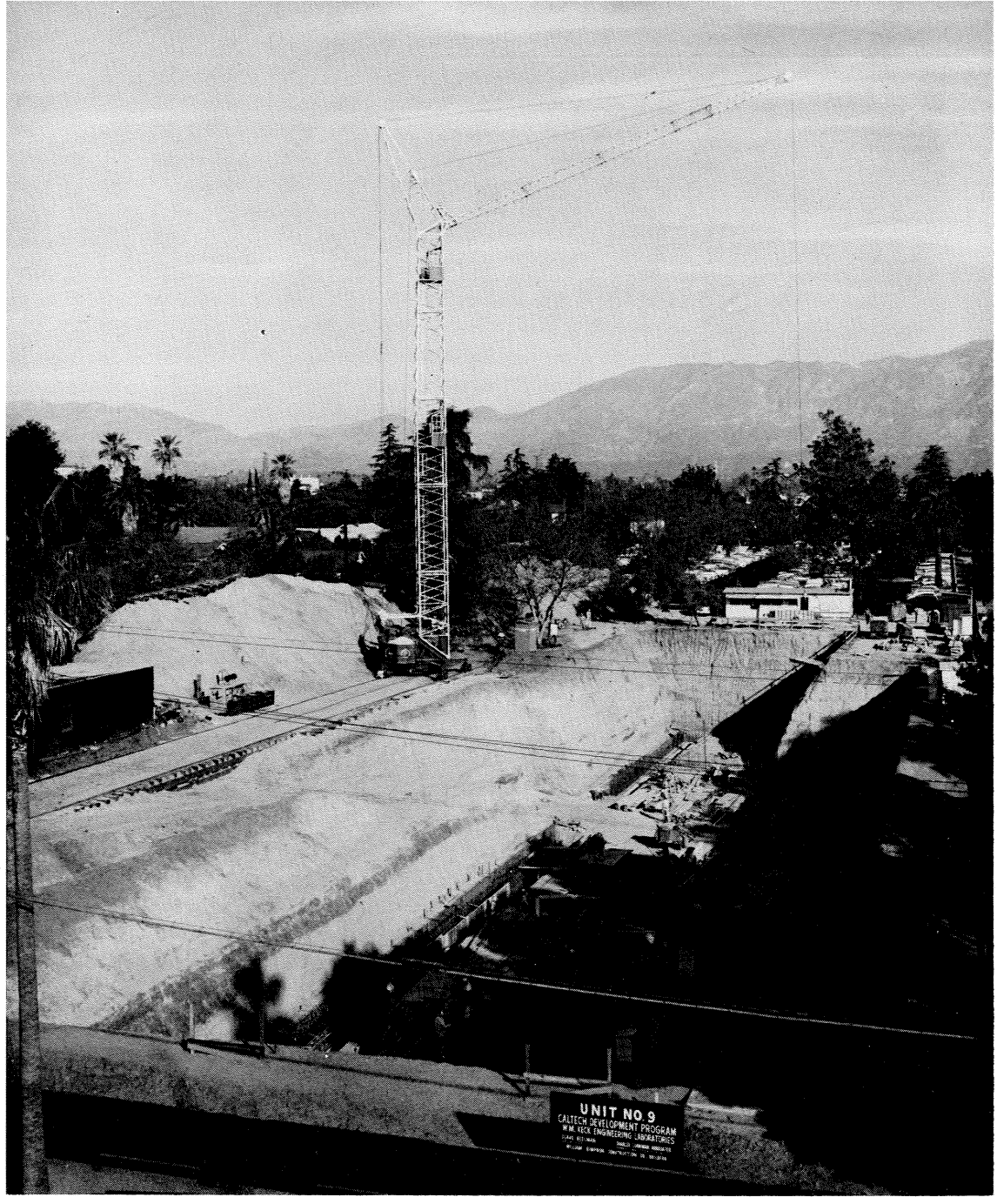
For night life, he goes to movies in Pasadena. He liked *The Cranes are Flying*, a Russian film; and *North by Northwest*. He uses *The Tingler* as an argument in favor of movie censorship boards.

Russian couple on the way up

When Victor came to America, he left his wife Helen and two-year-old son Alyosha home in Moscow. Victor's wife is an engineer too, and works full-time designing refrigeration equipment while Alyosha stays with his grandmother. The Beknyevs have an apartment in Moscow and a country place 20 miles from town. Victor and his wife make, between them, about 37,000 rubles a year – which is considerably above the Russian average. Unlike "Young American Couples on the Way Up," they don't have a car. They ride the train into Moscow, and take the subway when they are in town.

Victor was reared in Moscow and Ulyanovsk, Lenin's birthplace. He was born in the capital, but he, his mother and sister were evacuated when the Russians were threatened in 1941. His father died in Moscow while they were away. Victor attended Russian lower and middle school in Ulyanovsk and Moscow, and skipped the ninth grade. After the war, he went to the State University of Moscow and to Moscow Technical College. He was appointed to the faculty of Moscow Technical College after he graduated, and met his wife when she was in one of his classes.

Like most proud fathers, Victor will pull out a walletful of family photographs at the slightest pretext. But he pulls them out with an extraordinary flourish, as if he were attempting to prove something besides the fact that Alyosha has his yellow hair. Indeed, the whole idea behind Victor's stay as an exchange student is to prove that Russians and Americans can get along together because they are alike. Victor – party devotions aside – makes the idea seem pretty plausible.



Newest addition to the campus — a 120-foot crane to speed construction on the Keck Engineering Laboratories.

The Month at Caltech

Star Attraction

Sidewalk superintendents have been overdoing ever since the huge crane shown above went to work on campus construction last month. Known as a Beatty-Peco Slewing Tower Crane, the machine was developed in West Germany with Lend-Lease funds, and was uncrated and put together here for its first job—helping to build Caltech's new Keck Engineering Laboratories.

With a reach of a quarter of a city block, the crane can lift 8,380 pounds at a 75-degree angle, and is extremely fast at lifting and pouring cement. As construction progresses on the new Keck Laboratories, one of the crane's most important jobs will be to haul materials over the building and lower them into a five-floor elevator shaft.

Of course the crane has been a special delight – and a special challenge – to the Caltech undergraduates. (It was not too many years ago, after all, that the students met the challenge of an Air Force jet-fighter display on campus by spiriting the plane away in the dead of night, and delivering it to the Altadena home of the commanding officer of the Caltech AFROTC). So it was not too much of a surprise to the construction crew on the Keck job when they came to work one morning and found a sign hanging from the top of the crane, wishing them a cheery GOOD MORNING.

Ford Foundation Grant

Caltech has received a $120,000 grant from the Ford Foundation for research in atmospheric science and oceanography. The Institute is one of nine colleges and universities which have received total grants of $1,179,500, primarily for graduate fellowships in various fields of science and engineering. The grants are designed to recruit undergraduate majors in science and mathematics and to expand opportunities for work to and beyond the PhD level.

Carnegie Grant

Caltech has received a grant of $330,000 from the Carnegie Corporation of New York which will permit the extension of scholarship and research in humanistic and social science fields next year. The new program, planned for graduate students, will encompass studies in the philosophy and history of science, those social sciences most closely allied to the work already underway at Caltech, and the impact of science on public affairs.

The new program will begin during the 1960-61 academic year, when outstanding scholars in the humanities and social sciences will be invited to the Institute. Some will be appointed to the faculty, and others will give lectures or take part in forums.

Robert A. Knapp Award

The hydraulic division of the American Society of Mechanical Engineers has established a Robert T. Knapp award in honor of the Caltech professor of hydraulic engineering who died in 1957. Dr. Knapp, who came to Caltech as an instructor in 1922, was widely known for his work in hydrodynamics, and Caltech's Hydrodynamics Laboratory was his concept.

"Dr. Knapp's activities as a teacher, research worker, and Society member gained him the lasting respect and admiration of all his many associates and friends," said the executive committee of the ASME hydraulic division, in setting up the award. "Since a major area of Dr. Knapp's professional activity was devoted to fluid mechanics research, we have elected to award a certificate annually to the author of an outstanding ASME paper in this field. Our aim is to encourage in others the enthusiasm for research and the high standards of technical excellence exemplified by Dr. Knapp."

John A. Anderson

John A. Anderson, retired executive officer of Caltech's Observatory Council, died at his home in Altadena on December 3. He was 83. Dr. Anderson, an authority on optics, spectroscopy, and seismology, helped supervise construction of the 200-inch Hale telescope at Palomar Observatory. He was an expert on solar observation and participated in solar eclipse expeditions in 1905, 1918, and 1923.

A native of Rollag, Minnesota, Dr. Anderson was a graduate of Valparaiso College in Indiana in 1900, and received his PhD from Johns Hopkins University in 1907. He served as associate professor of astronomy at Johns Hopkins until 1916, when he joined the staff of the Mt. Wilson Observatory. He served as executive officer of the Caltech Observatory Council from 1928 to 1948.

Honors and Awards

Charles E. Crede, associate professor of mechanical engineering at Caltech, has been awarded the American Society of Mechanical Engineers' first medal for eminent achievement in machine design. He received the award for his "inspired leadership in the field of shock and vibrations . . . the research, development and application of shock mounts have advanced the field of machine design." The medal was presented at the annual meeting of the ASME in Atlantic City on December 2.

L. Winchester Jones, dean of admissions at Caltech, has been elected a trustee of the College Entrance Examination Board. He is one of eight educators elected this year to the board of trustees, which has 25 members. His term extends to 1962. The College Board, whose membership numbers almost 300 colleges and universities, gives about 600,000 examinations and tests annually. Dean Jones is also scholarship director and associate professor of English at Caltech.

Frank Press, professor of geophysics and director of Caltech's Seismological Laboratory, has been nominated by the Pasadena Junior Chamber of Commerce for the annual "Five Outstanding Young Men of the Year Award of California."

Bruce H. Sage, Caltech professor of chemical engineering, received the William H. Walker award, a certificate and plaque for "excellence of contributions to chemical engineering literature" on December 8 at the award banquet of the American Institute of Chemical Engineers in San Francisco.

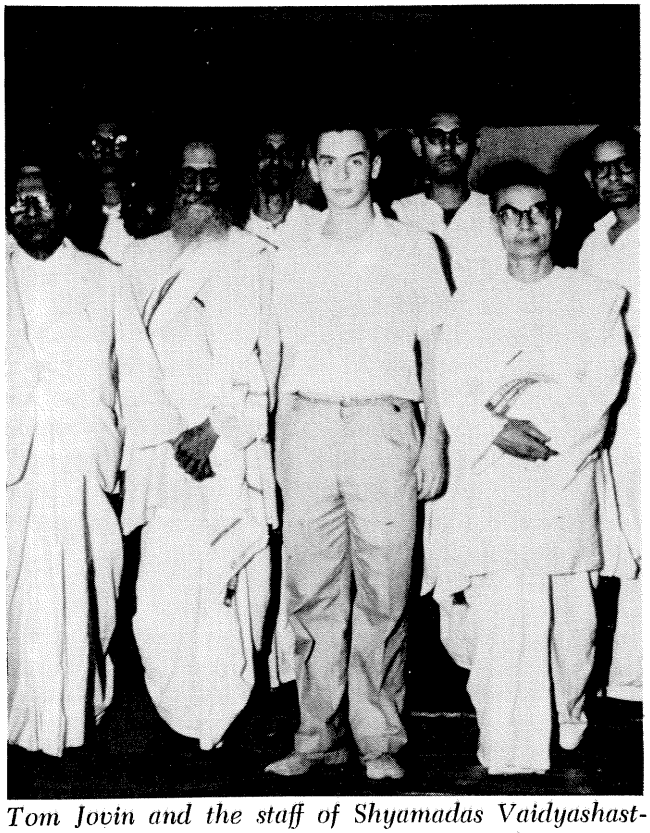
An American Student in India

A Caltech senior probes into a 4,000-year-old Indian medical science

by Thomas M. Jovin

It was my good fortune to be able to spend last summer in India as one of the two winners of the Caltech Junior Travel Prize. The project I presented to the Scholarship Committee concerned the study of indigenous medicines in India.

Why India? First of all, India is not only a fascinating place, but it happens to lie conveniently on the other side of the world. So what I was after was a plane ticket all the way around the world – or, in contemporary terms, I wanted to orbit our little planet while it could still be done reasonably near ground level.



Tom Jovin and the staff of Shyamadas Vaidyashastrapith Hospital in Calcutta. On Jovin's right is Karaji Sri B. Tarkatirtha, a leading practitioner of Indian medicine. On Jovin's left, Kaviraj Vijayakali Bhattacharyya, professor of Indian medicine.

By reason of this choice I was able to visit Japan, Taiwan, the Philippines, Hong Kong, South Vietnam, Laos, Thailand, India, and Pakistan – and, briefly, some spots in Europe on my way back to the U.S.

My interest in Far Eastern medicines did not come by pure chance. I happen to belong to the elite club of premedical students at Caltech. (We are four, in all.) Actually, my knowledge in this field, prior to my departure, was negligible. It was with some surprise then that I encountered in Taiwan the vast practice of a medical system based upon thousands of years of empirical fact. And as I attempted to avoid skepticism and maintain an open mind, an endless succession of shocks threatened the scientific dogma carefully acquired on the Caltech campus.

For example, I would have said that sticking pins into people is nonsensical child's play. Yet there is documentary proof that the practice of acupuncture offers positive treatment for many nervous disorders unassailable by Western medicine. My theme, therefore, will be to indicate that the concept of medical science held in the Western world may well be found lacking in many important and basic respects.

As I went through Vietnam and Laos, I became increasingly aware of a vastly different social and educational context in which "medicine' is practiced among half the world's population. When one considers that, in Laos, there is *one* native citizen qualified to practice according to usual standards – and he is the Minister of Health – it isn't too difficult to imagine why malaria, filariasis, and other parasitic diseases are endemic, and why infant mortality can be well over 60 percent.

In a typical village of Vietnam, one may find a whole hierarchy of "medical" practitioners – with the Western doctor at the bottom of the heap, if he exists at all. For, when in need, the people traditionally turn to the village sorcerer and/or witch doctor, in order

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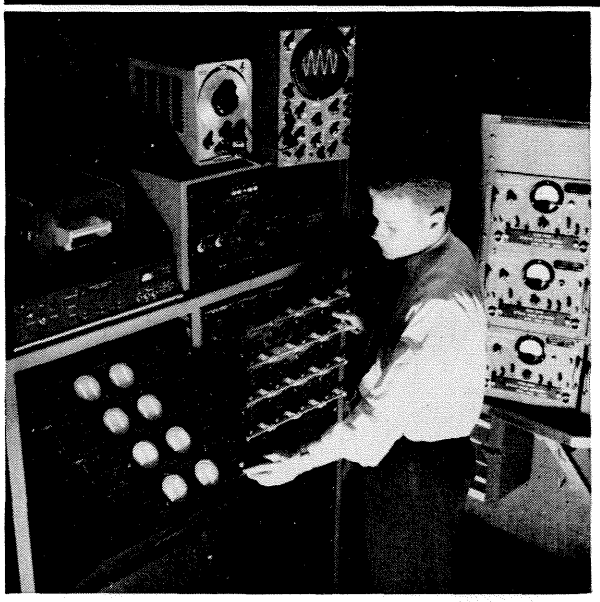
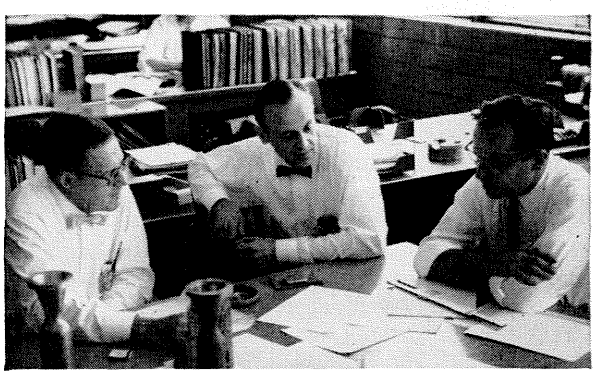
engineers



Automatic systems developed by instrumentation engineers allow rapid simultaneous recording of data from many information points.



Frequent informal discussions among analytical engineers assure continuous exchange of ideas on related research projects.

Under the close supervision of an engineer, final adjustments are made on a rig for testing an advanced liquid metal system.

and what they d

The field has never been broader
The challenge has never been greater

Engineers at Pratt & Whitney Aircraft today are concerned with the development of all forms of flight propulsion systems—air breathing, rocket, nuclear and other advanced types for propulsion in space. Many of these systems are so entirely new in concept that their design and development, and allied research programs, require technical personnel not previously associated with the development of aircraft engines. Where the company was once primarily interested in graduates with degrees in mechanical and aeronautical engineering, it now also requires men with degrees in electrical, chemical, and nuclear engineering, and in physics, chemistry, and metallurgy.

Included in a wide range of engineering activities open to technically trained graduates at all levels are these four basic fields:

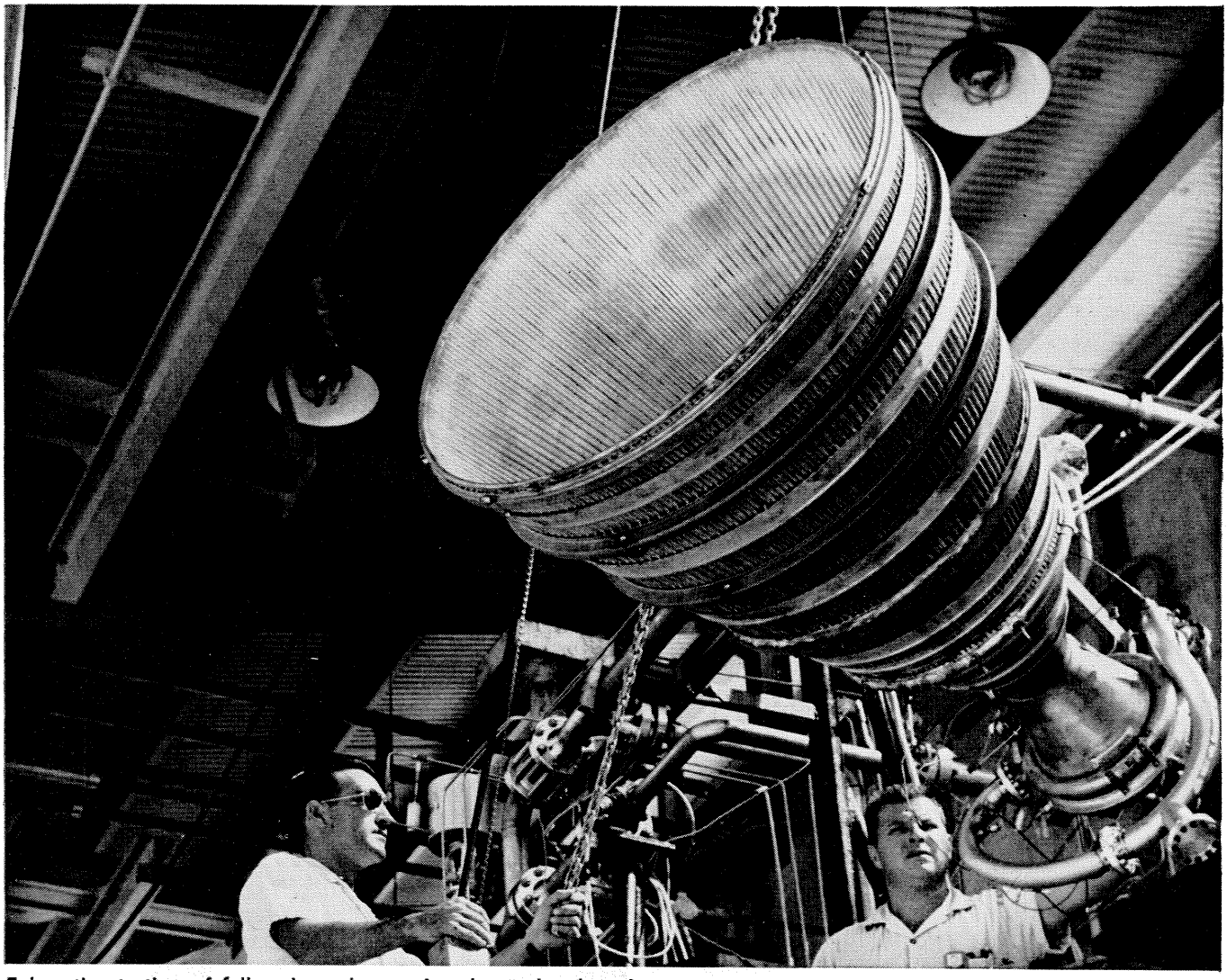
ANALYTICAL ENGINEERING Men engaged in this activity are concerned with fundamental investigations in the fields of science or engineering related to the conception of new products. They carry out detailed analyses of advanced flight and space systems and interpret results in terms of practical design applications. They provide basic information which is essential in determining the types of systems that have development potential.

DESIGN ENGINEERING The prime requisite here is an active interest in the application of aerodynamics, thermodynamics, stress analysis, and principles of machine design to the creation of new flight propulsion systems. Men engaged in this activity at P&WA establish the specific performance and structural requirements of the new product and design it as a complete working mechanism.

EXPERIMENTAL ENGINEERING Here men supervise and coordinate fabrication, assembly and laboratory testing of experimental apparatus, system components, and development engines. They devise test rigs and laboratory setups, specify instrumentation and direct execution of the actual test programs. Responsibility in this phase of the development program also includes analysis of test data, reporting of results and recommendations for future effort.

MATERIALS ENGINEERING Men active in this field at P&WA investigate metals, alloys and other materials under various environmental conditions to determine their usefulness as applied to advanced flight propulsion systems. They devise material testing methods and design special test equipment. They are also responsible for the determination of new fabrication techniques and causes of failures or manufacturing difficulties.

t Pratt & Whitney Aircraft...



Exhaustive testing of full-scale rocket engine thrust chambers is carried on at the Florida Research and Development Center.

For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. R. P. Azinger, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.

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to exorcise the evil spirits from the body and home. Or they may consult the Chinese herb doctor. Or, if one is around, they may seek aid from an Indian physician. But the Western doctor with the needle can be of little help, the natives point out, because he has built his hospital on sacred ground – and pointing in the direction from whence come the evil spirits. So, it would seem that the problem of public health is primarily one of social education in the rudiments of sanitation and clean living.

I arrived in Calcutta, West Bengal, India, on July 26, during a spell of monsoon weather. I had contacts and used them extensively, for my purpose was to assimilate and understand Indian life and society in general during my stay. Dr. Roy, the chief minister of West Bengal, accused me of insanity when I approached him with my desire to study *Ayurvedic* (Indian) medicine, but he did put me on to one of the top men in the field, Karaji Sri B. Tarkatirtha. From that moment, until the end of my visit to India, I was treated like royalty by these men, precisely because the overwhelming majority of Western observers completely depreciate and dismiss Ayurveda as so much hogwash.

The science of life

Ayurveda is the name of one of the original Vedic compositions, dating back 4000 years in the Hindu civilization. It is a Sanskrit word meaning "the science of life," and hence the system of Ayurveda refers to the composite body of theory and practice dealing with the human being and his corporeal existence. The important thing to realize from the outset, then, is that Ayurveda as a medical science is based upon philosophical principles and forms an integral part of Indian culture.

The basic assumption of the Hindu religion is that man consists of three elements – the body, the mind, and the soul *(Atma)*. The first two are temporal in nature and are the subjects of Ayurvedic science; the latter is eternal and universal and represents the ultimate concern of the true Hindu.

The Tri-Dosa theory

The divergence between Ayurvedic and Western medicine occurs at the stage of proposing a theory of health, disease, and treatment. The idea of triplicity in Hindu thought is very common. So it is not surprising that the entire basis for the Ayurvedic system is what is called the *Tri-Dosa* theory. Its basic proposition is that the body is composed of three elements which in Sanskrit are termed *Vaya, Pitta,* and *Kapha.* Phrasing it simply, Ayurveda defines a condition of health as an equilibrum existing between these three principles or dosas – and disease is merely the disturbance of this essential equilibrium.

The great block impeding a scientific exposition of this postulate lies in the fact that the three dosas possess a character which is at once abstract and concrete. They are simultaneously forces and materials, causes and effects, the sources from which evolve all body tissues and physiological functions. The basic problem, then, is one of semantics, for Western science does not possess the vocabulary for dealing with these subtle concepts.

Yet it must be recognized that Ayurvedic medicine possesses, in addition to its lucid axiomatic basis, a great body of empirical observation and formulation developed over a period of many centuries.

Indian pathology and diagnosis

This radical view of the human organism must be evaluated in terms of its application and effectiveness. Ayurveda clearly defines the principles of pathology and diagnosis. Since disease must always follow a disturbance of the dosic equilibrium, then treatment merely involves the restoration of the balance. So, where the Western doctor might approach an infection with the point of view that the causative germ must be eliminated, the Ayurvedic physician would define the nature of the dosic imbalance, treat it, and thereby make it impossible for the invading organism to flourish. He is inclined to avoid antibiotics and to employ tonics and medications of a restorative nature. In short, the infection and the germ are, in Ayurvedic eyes, more symptomatic than causative – a theory that accounts very nicely for the paradox, in Western science, of why certain bacilli inhabit the body tissues normally, yet may suddenly become pathogenic.

Diagnosing according to the dosic concept is a difficult matter. One interesting and highly refined practice is that of "reading the pulse." An Ayurvedic physician with long experience can presumably detect all the factors of the disease by merely sensing the nuances of the pulse.

Psychosomatic medicine

Also of great significance is the approach to the mental-physical relationship. Ayurvedic science is highly psychosomatic in that no distinction is made between purely physical and purely mental processes. This view is reflected in the manner of treatment, which is always very individualistic. For, in order to analyze the dosic condition and prescribe a course of treatment for the specific patient, certain specific points must be carefully considered: constitution, age, condition of the tissues, general body tone, muscular strength, metabolic rate, home environment, climate, likes and dislikes in food and living.

Ayurveda is lacking in one major respect; it does not possess the preciseness and reliability which the

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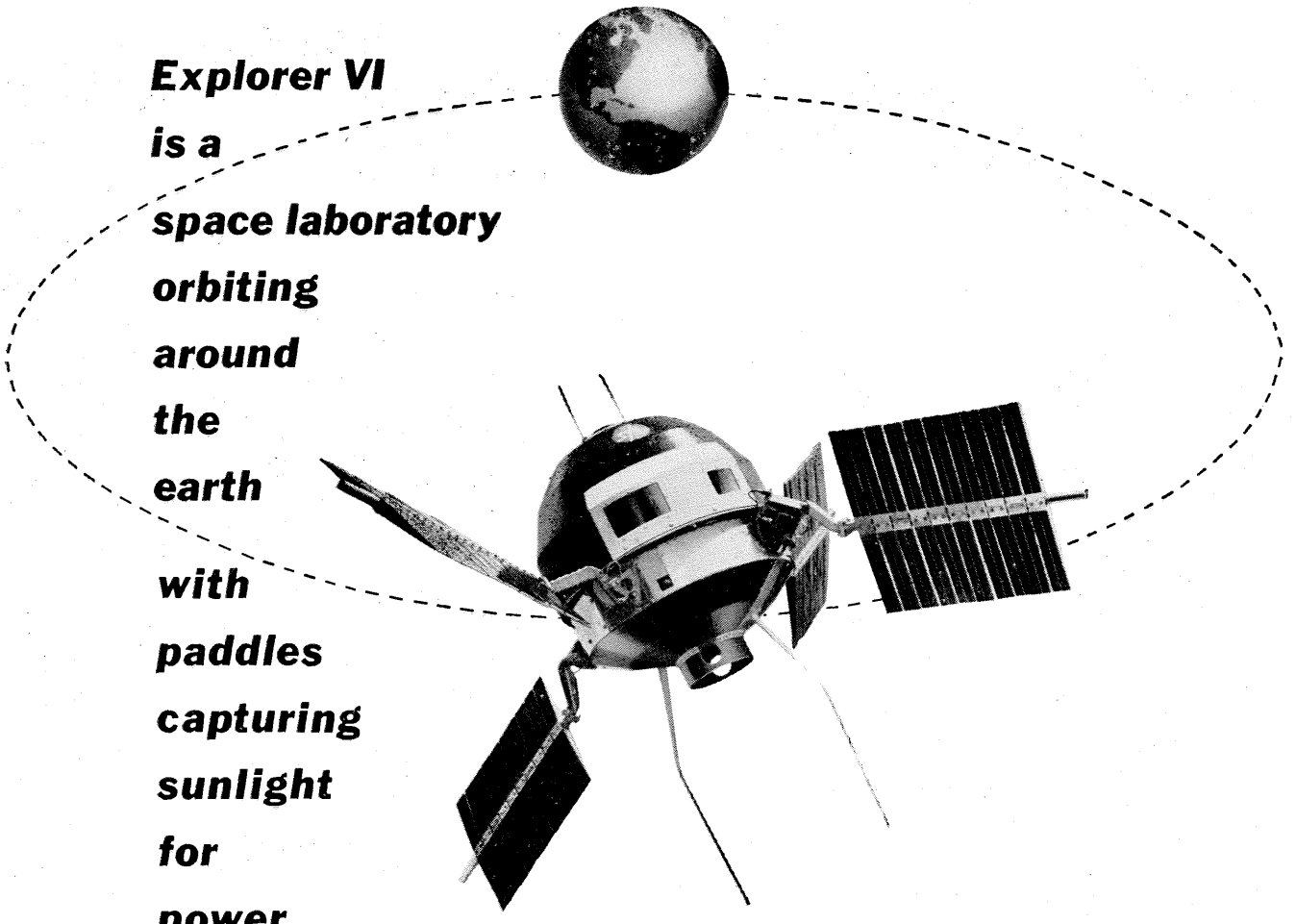
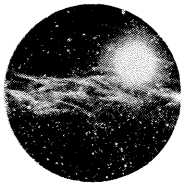
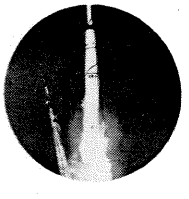
Explorer VI is a space laboratory orbiting around the earth with paddles capturing sunlight for power



The scientific data that will some day enable us to probe successfully to the very fringes of the universe is being recorded and transmitted at this moment by the space laboratory Explorer VI, a satellite now in orbit around the earth ● This project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, will advance man's knowledge of: *The earth and the solar system . . . The magnetic field strengths in space . . . The cosmic ray intensities away from earth . . . and, The micrometeorite density encountered in inter-planetary travel* ● Explorer VI is the most sensitive and unique achievement ever launched into space. The 29" payload, STL designed and instrumented by STL in cooperation with the universities, will remain "vocal" for its anticipated one year life.





How? Because Explorer VI's 132 pounds of electronic components are powered by storage batteries kept charged by the impingement of solar radiation on 8,000 cells in the four sails or paddles equivalent to 12.2 square feet in area ● Many more of the scientific and technological miracles of Explorer VI will be reported to the world as it continues its epic flight. The STL technical staff brings to this space research the same talents which have provided systems engineering and over-all direction since 1954 to the Air Force Missile Programs including Atlas, Thor, Titan, Minuteman, and the Pioneer I space probe.

Important staff positions in connection with these activities are now available for scientists and engineers with outstanding capabilities in propulsion, electronics, thermodynamics, aerodynamics, structures, astrophysics, computer technology, and other related fields and disciplines.

Space Technology Laboratories, Inc.

Inquiries and resumes are invited.

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scientific method can provide. Due to 200 years of foreign rule and cultural suppression, Ayurveda has suffered and declined, to the point where it faces extinction unless drastic steps are taken. The most important of the projected remedies for this situation are a reintroduction of research in Ayurveda, the promotion of education in Ayurvedic and related *(Unani, Siddha)* systems, and the introduction of useful Western concepts into the theory of Ayurveda.

Indian versus American medicine

Great controversy rages in India over the relative merits of Indian and Western medicine. The governmental hierarchy is increasingly in favor of supporting the modern Western system, but the bulk of the population, living in villages, comes in contact only with the indigenous practice. Since a vital factor in India is governmental support of educational and research institutions, opposing camps are desperately fighting for the upper hand in this issue. As a result, colleges and hospitals exist for training in purely Western medicine, pure Ayurveda, or a combination of the two. The problems of semantic and conceptual integration which this arrangement has created are incredible.

In 1931, Sir Mohamed Usman Sahib Bahadur, chairman of an investigatory committee appointed by the Government of Madras, reported:

"It seems to us that the first and foremost problem that we have to address ourselves to is how we can make the Indian systems of medicine rapidly self-sufficient and efficient; for, unless and until this is done, the problem of bringing adequate medical relief within the easy reach of our masses, especially in the rural areas, will not become satisfactorily solved. Moreover, the establishment of institutions of Indian systems will, under these circumstances, remain a proposition of only limited applicability, because it would involve the maintenance of a double set of institutions – one (the Indian, to look after our medical ailments, and the other (the European) to minister to our surgical needs – an arrangement as uneconomical as it is unsatisfactory. Some such arrangement may, however, become inevitable in the transitional stage, but this period should be as short as possible.

New medical centers

We therefore consider that the most urgent and immediate concern for the State is to establish and promote by State aid, State-recognition ,and such other means, the establishment of suitable centres of medical education and the devising of a suitable scheme of studies of Indian Medicine calculated to make those trained under it equal to the task of ministering not only to our medical needs as at present, but to surgical ailments as well. Every scheme of study of Indian Medicine, whether Ayurveda, Siddha, or Unani, should make adequate provision not only for the efficient training in subjects appropriate to itself, but also for the teaching of the essentials of whatever is valuable in Western Medicine.

Consistent with this view, we would like to see the future practitioners of India, no matter to what denomination they belong – Ayurveda, Siddha, Unani, European Medicine, or any other – being so schooled and trained as to be able to bring to bear on the problems of health and ill-health not only the expert knowledge of their own systems, but as far as practicable, the best that is in other systems also."

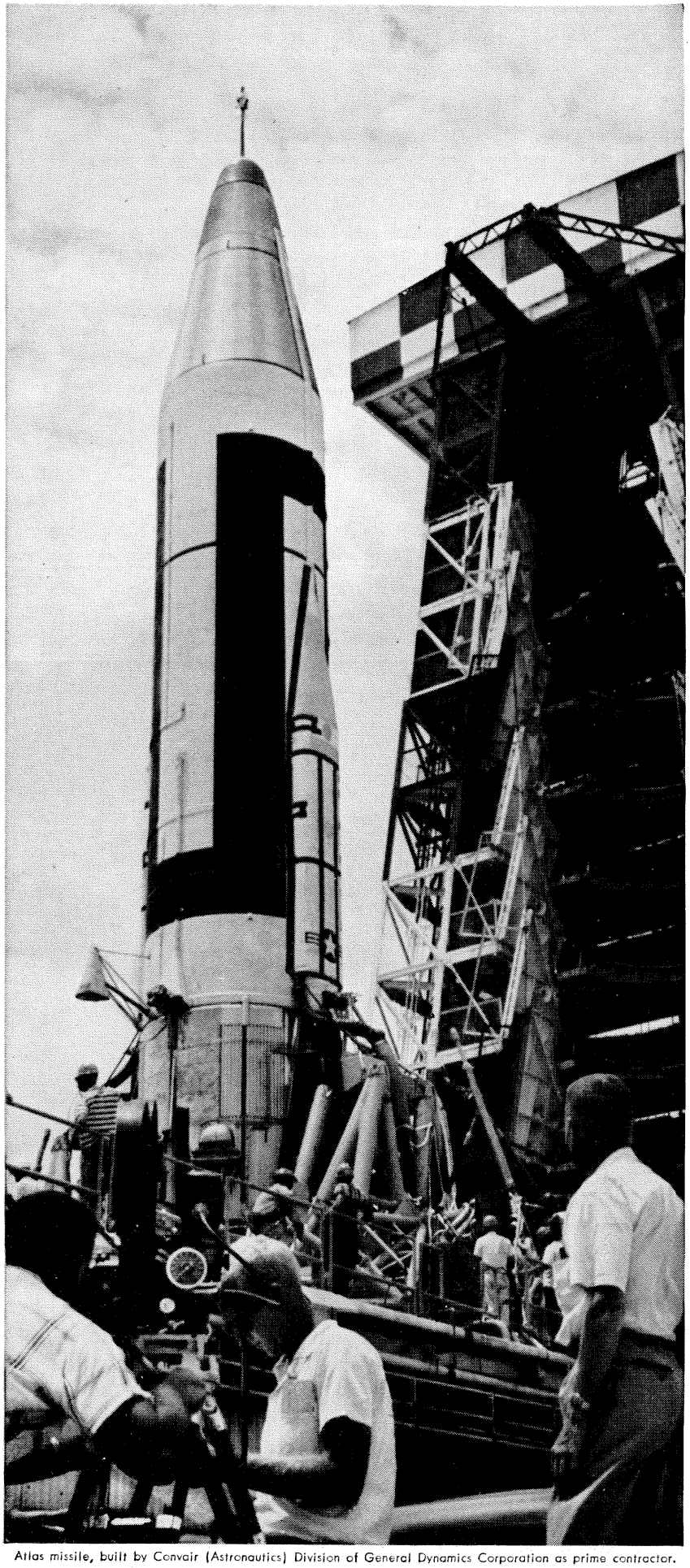
Joining two theories

At the same time, considerable progress is being made in the direction of demonstrating the worth of Indian treatments according to accepted research and analytical methods. For instance, at the Government Institute for Research in Indian Medicine at Jamnagar, Bombay, expert Ayurvedic practitioners are reviewing test cases of polio, cancer, skin diseases, diabetes, and other important ailments. Their techniques of diagnosis and treatments are in strict accordance with Ayurvedic principles. Concurrently, Western doctors diagnose and evaluate the same patients, utilizing scientific techniques and equipment. The two points of view are discussed at the completion of the case histories.

Summing up

In an article on "Traditional Vietnamese Medicine," Dr. Dang Trong, director of Public Health Services in South Vietnam, sums up the central impression I received as an outcome of my study:

". . . You may see that each medicine has its point of view, its angle from which it is viewed, its specialty in which it deals masterly. The part of Eastern medicine is to complement the views of the Western medicine, to widen its horizon in certain aspects, unexplored until now, to give it food for thought, to reveal its inexhaustible mine of long and dependable experience. Even if the principles of this medicine are wrong or incomplete, they are always of some use to the West. Just as the waves, these synthetic views of the East will come, whether one may will it or not, and break against the too-analytical walls of the Western spirit, and oblige it to revise one day perhaps, its conception about man. And the day when we will be able to interpret completely this old medicine and make it join, over the span of the centuries, the most modern treatment to the oldest experiences, on that day, the world may achieve a vast synthesis which unites in one single science the East to the West for the greatest benefit of mankind."



Atlas missile, built by Convair (Astronautics) Division of General Dynamics Corporation as prime contractor.

ANOTHER WAY RCA SERVES DEFENSE THROUGH ELECTRONICS

RCA ELECTRONICS CUTS DOWN THE COUNTDOWN

To our missile experts, "is it ready" is almost as important as "how far can it go." For retaliatory power, missile crews must be able to launch a maximum number of missiles in rapid fire order.

America's intercontinental ballistic missile, the Atlas, had already proved itself for distance on a 5500-nautical-mile range. But checkout and launching took several hours. So the next step in turning the missile into an operational weapon was to make it ready for quick action. RCA was selected to build an electronic system that would radically reduce the countdown time at the Atlas Operational Bases now under construction.

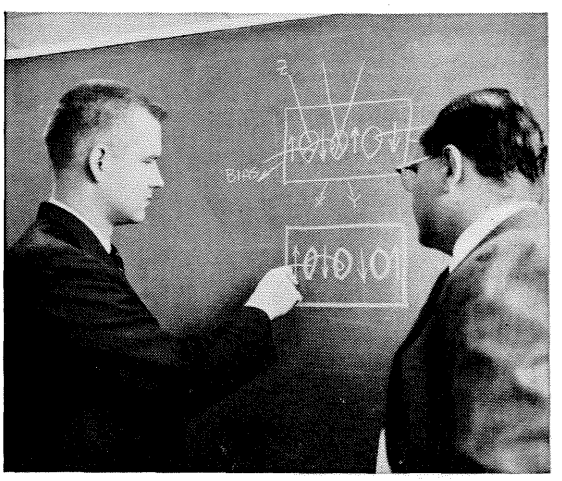
Now, in a matter of *minutes*, this elaborate electronic system can determine if any part needs attention—or signals that the missile will be ready to go.

This automatic checkout equipment and launch control system for the Atlas is one more of the many ways in which RCA Electronics works to strengthen our national defense.

RADIO CORPORATION OF AMERICA

Product Development at IBM

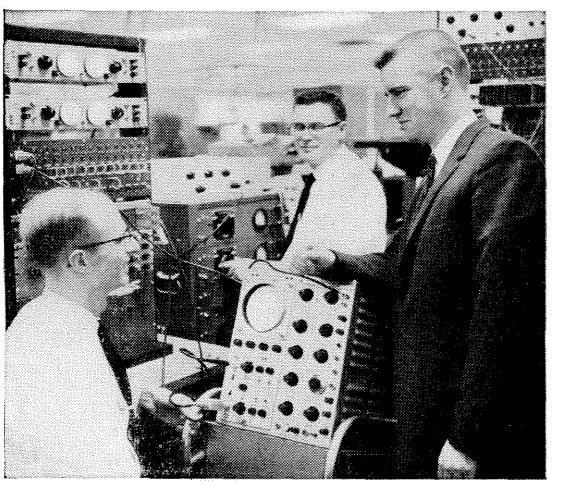
IBM Engineer Richard R. Booth explores electronic frontiers to develop new, faster and larger storage devices for tomorrow's computers.



Computing time cut from six months to one day

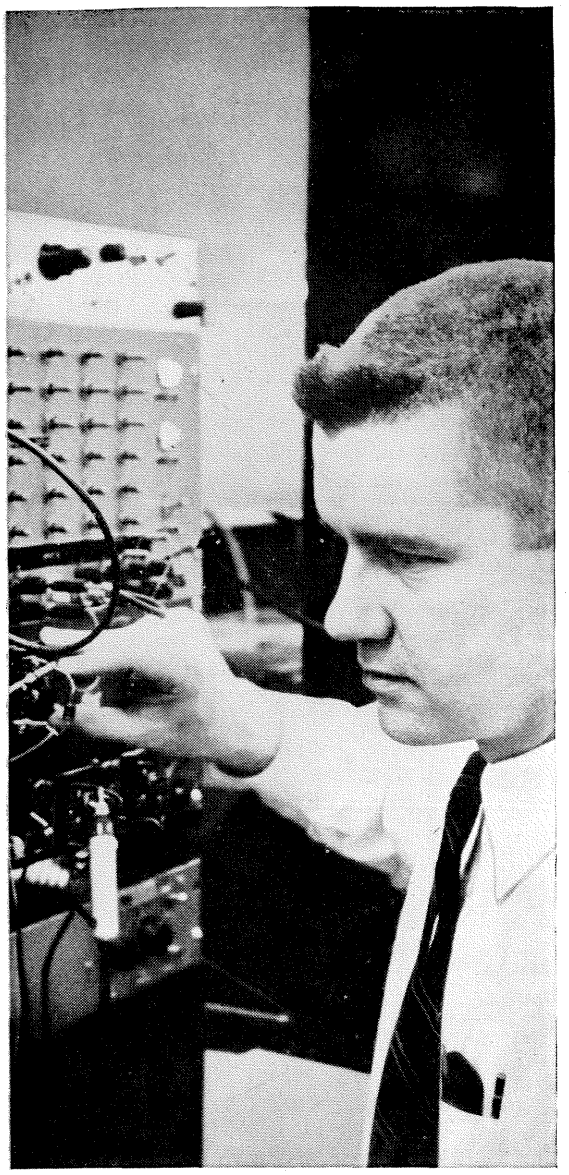
"My job is to design and develop new, high-speed storage devices for a powerful new computer that will perform, in one day, operations requiring six months on present equipment," said Dick Booth as he began a typical day recently. A product development engineer at the IBM Laboratories in Poughkeepsie, N. Y., he started his morning with a conference on a product of great interest to him: a magnetic core storage device with a nondestructive read-out feature. For an hour, he discussed with circuit design engineers the logical devices needed for the register—such as magnetic core drivers and sense amplifiers. Should such devices not be available, the group would work on designs for new ones.

Dick Booth next met with members of the Magnetic Materials Group to establish specifications for the magnetic core memory elements to be used in the register. He also discussed with the group the development of equipment to test the memory elements. "This magnetic core register is based on an original idea of mine," he explained. "When you have a worthwhile idea, you will be given a free hand in proving it out, backed by IBM's resources — plus the assistance of skilled specialists."



Increasing responsibility

At 10:30, Dick Booth reviewed the status of the entire project with the two engineers, two technicians, and one logic designer who make up his team. "My present position is staff engineer," he explained. "It's the second promotion I've had since I joined IBM three years ago with a B.S.E.E. degree from the University of Illinois. I know that there are plenty of other opportunities to move ahead. Furthermore, parallel advancement opportunities exist for engineers in either engineering development or engineering management."



Preparing for the future

In the afternoon, Dick Booth went to the 704 Computing Center to supervise some complex precision computations. "You see how quickly the 704 arrives at the answers," he said. "The computer being developed is expected to multiply more than 500,000 fourteen-digit numbers a second and add them at the rate of one million a second. The computer may be used for design computations for reactors, as well as calculations of satellite behavior. Of course it should have hundreds of other applications."

At 3:30 P.M., Dick Booth attended a weekly class on Theoretical Physics that lasted until 5:00. Afterward, he commented, "You know, IBM offers excellent educational opportunities both in general education and for advanced degrees. One of the engineers in my group has just received his Master's degree from Syracuse University, after completing a postgraduate program given right here at the IBM Laboratory."

A chance to contribute

As he was leaving for the evening, he said, "Yes, I'd recommend an IBM career to any college graduate who wants to exercise his creative ability. IBM will appreciate his talent and he'll have the opportunity to work with specialists who are tops in their fields. I doubt that he'd be able to find a more sympathetic and stimulating atmosphere. Furthermore, he'll have the added incentive of contributing to vitally important projects . . . projects that will take him to the frontiers of knowledge in computer electronics."

* * *

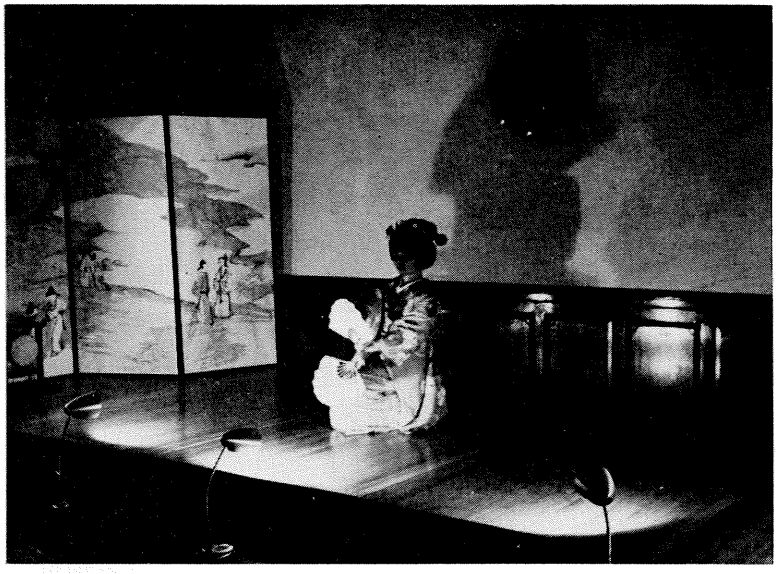
Talented college graduates will find exciting, rewarding careers at IBM. Excellent opportunities are now available in Research, Development, Manufacturing, Applied Science, Sales, and Administration. Find out from your College Placement Office when our interviewers will next visit your campus. Or, for information about careers of interest to you, write to:

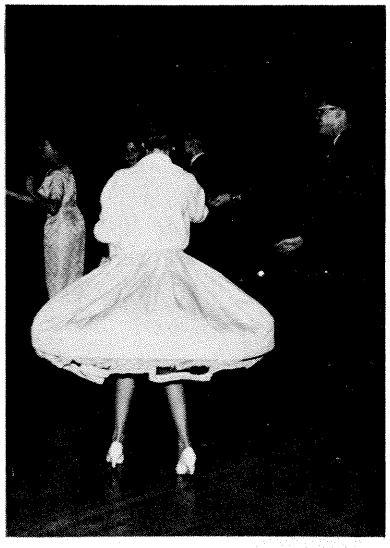
Manager of Recruitment
IBM Corporation, Dept. 839
590 Madison Avenue, New York 22, N. Y.

IBM®

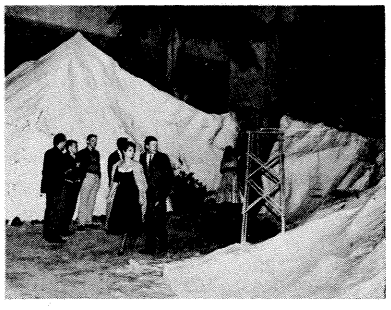
Interhouse Dance

At Caltech's annual Interhouse Dance last month, guests had a choice of dancing in Edgar Allen Poe surroundings (Throop Club); in a Teahouse of the August Moon (Fleming); at a ski resort (Dabney); in settings borrowed from The Odyssey (Blacker); or in a mish-mash of modern art (Ricketts). Some of the dancing – and gawking – guests at the big undergraduate social event of 1959 are shown on these pages.

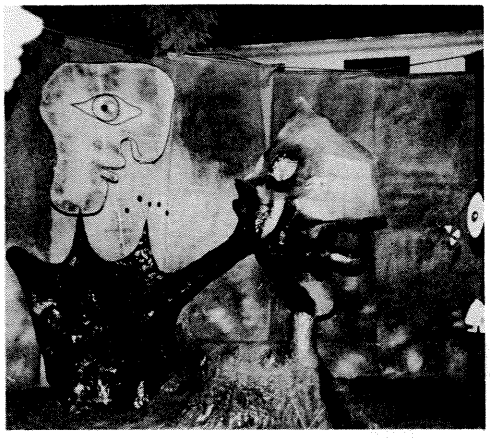




Fleming's teahouse

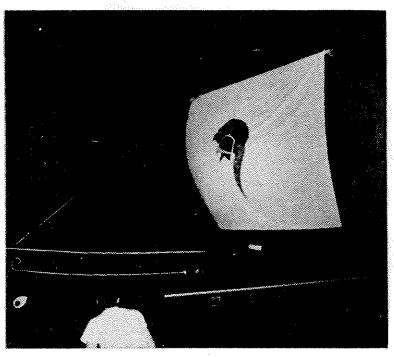


Dabney's ski-jump



Ricketts' art

Blacker's ship



WERE THOSE THE DAYS?

Some reminders of the time when unsophistication was in flower at Tech

Those who visit the basement offices of the undergraduate newspaper, *The California Tech*, (mainstay of southern California's thriving yellow press) will notice a large and untidy sprawl of papers on the forward tables. These are old *California Techs*, dating back to 1918, when the paper was called the *Throop Tech*.

It seems things were different in the old days. For instance, student sophistication and cynicism had not reached their present high levels — as indicated in this excerpt from the front page of the *California Tech* for October 9, 1924.

HELLO!
by H. Fred Peterson

Crack your shell and step outside.
"Don't be another nut,"
Smile and show your sunny side
And leave that gloomy rut.
Smile and say "Hello, old top,"
To everyone you meet
Don't move so fast you cannot stop
An old time friend to greet.
Let's make "Hello" our slogan here,
And use it everywhere,
And watch it spread good natured cheer
And liven up the air.
You do not have to know a chap —
Say "Hello" any way.
And watch the smile spread on his map —
You'll feel that's plenty pay!

(Someone has made an attempt to pencil out the last line and substitute, "Then kick him and run away.")

Further down the page is an article headlined

ROOTING CAPS FOR TECHMEN

. . . rooting caps are to be purchased for the entire student body, including freshmen. The standard orange and white gob caps were considered the best.

Contrast that with the spirit of contemporary Tech men, who have been known to scratch the school's name off their bluebooks.

Here's an interesting column filler from the same issue:

> The most expensive chair in the world — made of solid silver and worth about $6000 — belongs to the Pope. He uses it to sit on.

Advertising, struggling to make a go of it without motivational research, tended to be moralistic in content. Take as an example the Western Electric ad of April 24, 1923:

CAKE EATER — *model of 1900*

He was called dude and dandy then, but you recognize the type.

He majored in haberdashery and took his degree with honors in soxology.

As if that were not enough, he evolved some variations on the cake walk which made them stare.

He even found time to develop a remarkable proficiency on the tandem bicycle, and on Saturday nights he was good enough to bring pleasure into Another's life by wheeling away to the "Ten-Twent-Thirt."

To crowd all this into four short years would seem enough for any mortal. Yet in spite of his attainments there are times, in after life, when our hero wonders.

The glory of his waistcoats has long since faded, while his books are still fresh and clean. Did he perchance put too much thought into the selection of his hats and too little in what went under them?

continued on page 40

AT RAYTHEON...

Scientific imagination
focuses on ... RADAR...
SONAR ... COMMUNICATIONS...
MISSILE SYSTEMS ...
ELECTRON TUBE TECHNOLOGY...
SOLID STATE

Challenging professional assignments are offered by Raytheon to outstanding graduates in electrical engineering, mechanical engineering, physics and mathematics. These assignments include research, systems, development, design and production of a wide variety of products for commercial and military markets.

For specific information, visit your placement director, obtain a copy of "Raytheon ... and your Professional Future," and arrange for an on-campus interview. Or you may write directly to Mr. John B. Whitla, College Relations, 1360 Soldiers Field Road, Brighton 36, Massachusetts.

RAYTHEON *Excellence in Electronics*

This prejudice against wearables was not universal. The next page is half occupied by Silverwoods:

> Was a time when if a man had one sweater he was all the "berries" . . . Now many men have as many as a dozen sweaters – and haunt our great sweater department for new arrivals . . . Better come in and say what so many men aim at us on the first visit, "Golly, I never knew there were so many sweaters in all the world."

Of course life was not all sweaters. There were human elements, also. We find next to the Western Electric ad:

> PHAROS SURPRISE
> DOC GARNER
>
> Thursday afternoon the Pharos *(a fraternity)* found out where Doc Garner and his charming bride were to be for the evening and went in a body to surprise the couple. Doc was taken out of the house where a party was in progress and surrounded by his friends. In spite of the fact that they were his friends, Doc was evidently badly scared and when asked for an introduction to the wife, pleaded for time to calm himself. After introductions the young couple were given the best wishes for a happy life.

Thus we have the picture of hardworking, straightforward folk, unafraid and unashamed to display emotion when emotion was called for. Even the president of the Institute, James A. B. Scherer, sometimes felt called upon to use more than scientific prose. Here he comments on the change of the school's name from Throop College of Technology to California Institute of Technology on February 16, 1920:

> . . . Convinced that this change should be made, the Trustees felt equally assured that the name of "Father Throop" must be perpetually commemorated, both for his own sake and the sake of his noteworthy educational ideals. The city where he lived and which he loved is therefore called upon, as it were, to pay him a beautiful tribute by the transformation of "Pasadena Hall" to "Throop Hall" forever.
>
> Even so, sentiment for the moment is sacrificed, as long association had made the old name dear to all of us. Neverthless I have myself yet to hear from any source aught but enthusiastic acknowledgement of the fact that the Trustees by their unanimous vote on last Tuesday gave the most appropriate possible recognition to the splendid new era which justifies our splendid new name. We have sailed down the river, and now we launch into the deep.

(Ill health soon forced Dr. Scherer to resign from the presidency. In the *Tech* of September 25, 1920, he outlines his plans for the future:

> "No sooner did it become clear that I must seek a change of occupation than I turned to writing which has enticed me since childhood. Writers naturally desire readers. The contemporary photoplay of the better sort affords an army of readers unique in the history of writing. I shall, therefore, endeavor to use the screen, as well as the printed page, as a means of expression."

He was immediately signed to a long-term contract by the Famous-Lasky Corporation.)

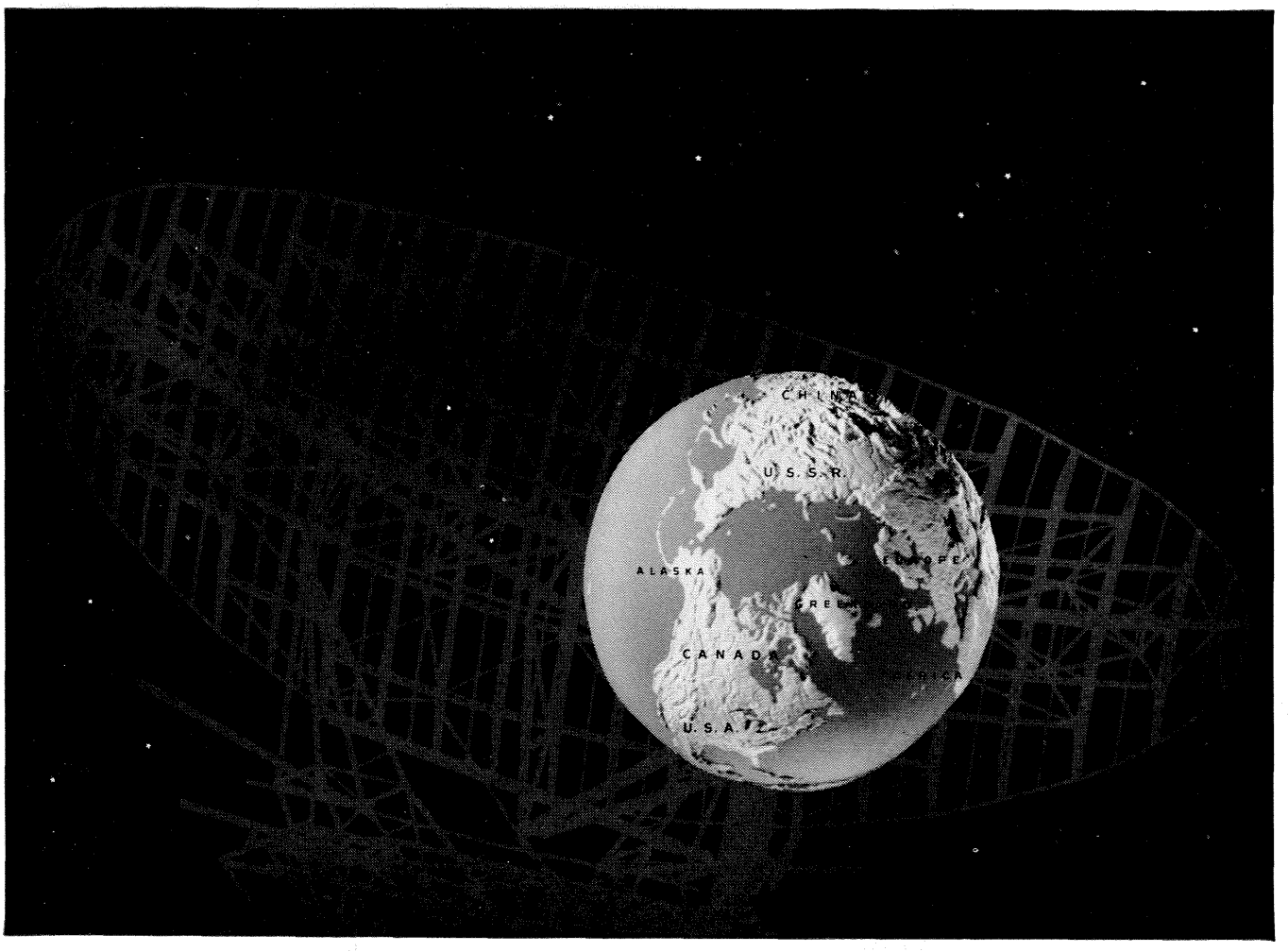
Yes, emotion ran high in those now-lost days, and along with emotion ran school spirit. There was little toleration of "really care" or obstructionist attitudes. The following is quoted from the *Throop Tech* editorial of November 5, 1919, entitled:

> LET'S CAN THE 2.75*
>
> At the Indian game Saturday, some square-faced hulk in the grandstand yelled out that the team had no fight; another bar-fly bellowed to one of the players – "Whad ya think y' ar, one of the umps?" If this is Throop spirit a Kentucky "soak" could get drunk on buttermilk.
>
> We admit the team didn't show the class and the speed they are capable of – BUT – they DID NOT lay down – they DID NOT quit when luck turned against them. Maybe they weren't in the best of condition, but how many of the fellows in the bleachers bawling out their own men – how many of them ever gave up ANYTHING for Throop? . . . BUT – We ARE NOT insinuating that all, or by any means the majority of Throop supporters Saturday showed this raspberry spirit. But there was so much of it apparent that it was hard to distinguish the REAL spirit. And if any such "bush league" stunts are pulled off in the future it is the right, obligation, and duty of every loyal Throop man to mob the offender or be placed in the same class himself.
>
> Maybe all this poor spirit is thoughtlessness, maybe it's lack of appreciation of the true Throop spirit, but what's more, it's going to be STOPPED. To fellows with the real Throop spirit it is obnoxious. And incidentally, the Student Board of Control has a great deal of power and a little publication would make it pretty difficult for the offender to enter any other college in this part of the country.
>
> . . . When Oxy played USC Saturday, they came out holding on to the goose-egg end of a 27-0 score. And did the Oxy supporters once yell "Where's the fight?" No – they cheered their team to the skies (even when their quarter fumbled a kick and a USC man went over for a touchdown).
>
> Now, we're not applauding Oxy; but we are showing WHAT the team – OUR TEAM – must fight next Saturday. And ARE we going to let them fight ALONE or is EVERY man in the TCT student body and faculty going to do his part to redeem for last Saturday?
>
> If any MAN in Throop won't do this much for his Alma Mater, he's dead. DEAD from the neck–BOTH WAYS! And the Tech will gladly pay for the plot of ground, a pot of lilies, and as an added inducement, will print the obituary notice free of charge.
>
> Come on Throop! LET'S SNAP OUT OF IT!

We never have snapped out of it.

–Brad Efron '60

**2.75 equals alcohol content of near-beer.*



BENDIX WATCHES THE UNIVERSE

(. . . and offers unlimited opportunity for young scientists)

Bendix® Radar is one of the free world's major safeguards against sneak attack. Night and day Bendix radar stations are keeping constant watch all over the globe, alert against aggression. In radar and other technological fields, Bendix is doing outstanding work. And the scope of Bendix activities provides young engineers and scientists exceptional chances for advancement.

Take the field of radar alone. Bendix has had much to do with the development of radar from the earliest pioneering of systems and equipment, and today is a foremost producer of many different types . . . on land, at sea, and in the air. Our airborne radar, for example, is used by more commercial aircraft than any other system. It helps safeguard air travelers by "seeing" storm turbulence as far as 150 miles ahead, allowing pilots to make course corrections to avoid bad weather.

Another example is Bendix Doppler Radar which for the first time allows pilots to determine exact position, ground and wind speeds—without manual calculation. This system is being placed in service by major airlines for both domestic and trans-oceanic flights.

The many diversified projects in which Bendix is engaged offer the young college graduate an unparalleled opportunity to grow as Bendix grows . . . in such fields as electronics, electromechanics, ultrasonics, computers, automation, nucleonics, combustion, navigation, hydraulics, instrumentation, propulsion, metallurgy, communications, solid state physics, aerophysics, structures, and, of course, radar.

Put Bendix in your post-graduate plans. Consult your placement director about campus interview dates or write to Director of University and Scientific Relations, Bendix Aviation Corporation, Fisher Building, Detroit 2, Michigan. It will be well worth your while.

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Fisher Bldg., Detroit 2, Mich.

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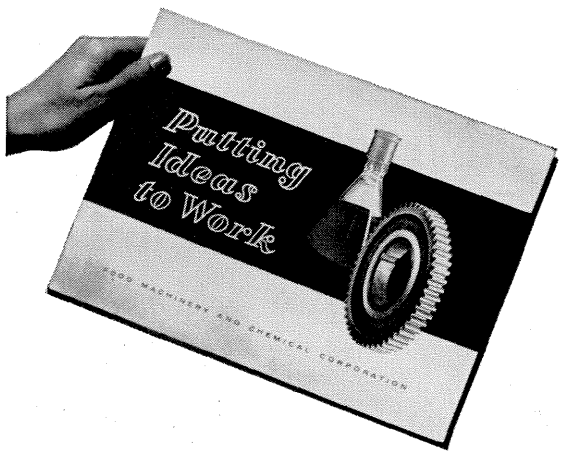
A REAL CAREER OPPORTUNITY FOR GRADUATES

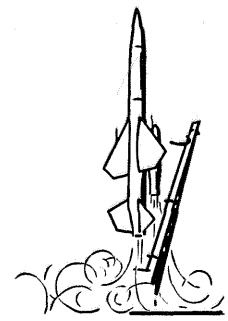
COMMERCIAL OPERATIONS:

Graduates planning careers in chemical, electrical or mechanical engineering, will be interested in evaluating the opportunities offered by Food Machinery and Chemical Corporation, with headquarters in San Jose, California—a nation-wide organization that puts ideas to work through creative research and practical engineering.

FMC offers career opportunities in these fields: Agricultural Chemicals • Agricultural Equipment • Automotive Servicing Equipment • Food Canning & Freezing Equipment • Defense Materiel • Fire Fighting Equipment • Industrial Chemicals • Materials Handling Equipment • Power Gardening Equipment • Packaging Equipment • Food Packing and Processing Equipment • Petroleum Specialty Equipment • Pumps and Water Systems • Waste Disposal Equipment



DEFENSE OPERATIONS:



FMC's Ordnance Division, located at San Jose, California, produces mobile support equipment for military programs including amphibious tracked vehicles and missile ground support equipment. This fully integrated organization and its well equipped facilities provide coordinated control of each phase of every project from design concept through development and production.

The division possesses complete prototype and quantity production manufacturing facilities along with a wide variety of test equipment and processes, as well as complete testing grounds for tracked vehicles and missile handling equipment. Young graduates employed by FMC have the opportunity of working with men of outstanding engineering talent and leadership in mechanical, structural, electrical, hydraulic, and metallurgical specialties.

This challenging field offers tremendous possibilities for the young engineer. Because of rapid advancements in this sphere of activity, FMC is constantly looking for men with the special capabilities for creative engineering and development.

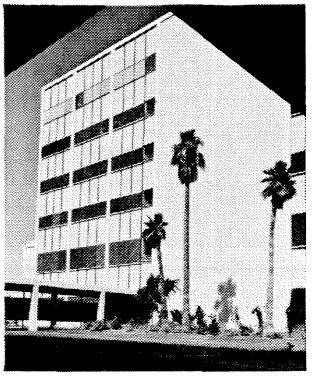
To acquaint students with the broad scope of career opportunities in FMC's diversified activities, we invite you to write for copies of our brochure, "*Putting Ideas to Work*," which graphically presents FMC's operations and product lines.

Address: **Personnel Administration Department**
P. O. Box 760, San Jose, California,
or Industrial Relations Department
161 East 42nd Street, New York 17, New York

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

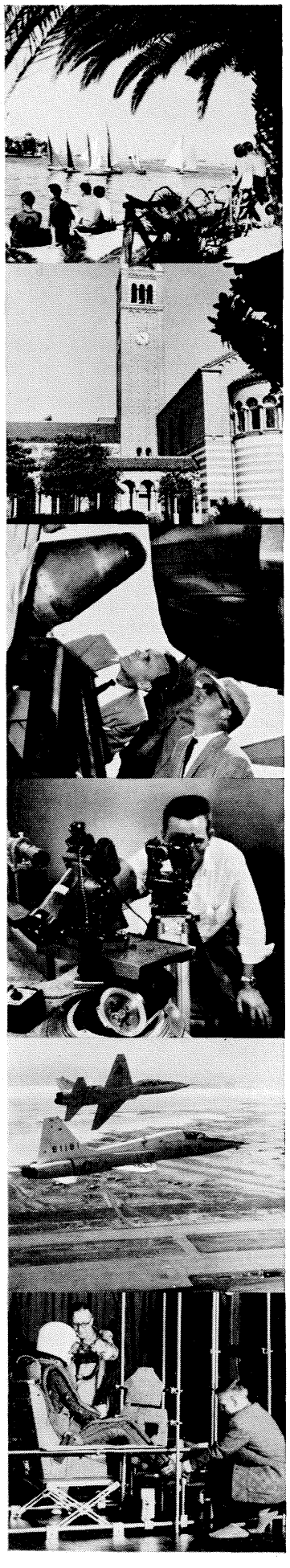
News is happening at Northrop



FIND OUT MORE *about the young engineers and scientists who are making the news happen at Northrop.*

WRITE TODAY *for information about Northrop and all of its Divisions.*

Engineering & Scientific Personnel Placement Office
Northrop, P.O. Box 1525
Beverly Hills, California



Here's a 7-Question Quiz to help you decide on your future:

1 **Where Do You Want To Work?** If your interests lie in the fields of electronics or the aircraft/missile industries, you will want to join the outstanding scientists and engineers in Southern California–the electronic, aircraft/missile center of the world.

2 **Where Do You Want To Live?** If you work at Northrop you'll be able to spend your leisure at the Pacific beaches, in the mountains, on the desert. You'll enjoy an active life in Southern California's incomparable year-round climate.

3 **Want Top Salary?** Northrop's salary structure is unique in the industry. At Northrop you'll earn what you're worth. With this growing company you'll receive increases as often as you earn them. And these increases will be based on your own individual achievements. Northrop's vacation and fringe benefits are extra liberal.

4 **Want Advanced Degrees?** At Northrop you'll continue to learn while you earn with no-cost and low-cost education at leading Southern California institutions. You'll earn advanced degrees and keep current with latest advances in your own chosen field.

5 **Want To Work With Leaders?** Your Northrop colleagues are acknowledged leaders in their fields – men chosen for their capabilities and their skills in guiding and developing creative talents of younger men. These are men who delegate authority, assure you of fair share of credit for engineering triumphs.

6 **Want The Challenge Of Opportunity?** At Northrop you will apply your talents to the work you enjoy – in the fields best suited to your inclination and ability. You'll work with the newest, most-advanced research and test equipment. At Northrop and its Divisions you are offered a wide diversity of over 30 operational fields from which to choose.

7 **In Which Of These 3 Divisions Would You Like To Work?**

NORAIR DIVISION is the creator of the USAF Snark SM-62 missile now operational with SAC. Norair is currently active in programs of space research, flight-testing the USAF-Northrop T-38 Talon trainer and Northrop's N-156F Freedom Fighter.

RADIOPLANE DIVISION, creator of the world's first family of drones, produces and delivers unmanned aircraft for all the U.S. Armed Forces to train men, evaluate weapon systems, and fly surveillance missions. Today Radioplane is readying the recovery system for Project Mercury.

NORTRONICS DIVISION is a leader in inertial and astro-nertial guidance systems. At Hawthorne, Nortronics explores infra-red applications, airborne digital computers, and interplanetary navigation. At Anaheim, Nortronics develops ground support, optical and electromechanical equipment, and the most advanced data-processing devices.

NORTHROP CORPORATION *Beverly Hills California*

Alumni News

Development Program

The alumni phase of the Caltech Development Program set a goal of $1,000,000,000 last spring, to be contributed by Caltech alumni throughout the world.

To date, almost $930,000 has been given by 3,336 alumni (43 percent of the total alumni body). Out of the 33 alumni divisions which have been established in the United States, 8 have exceeded their set goal – Beverly Hills, Long Beach, Pasadena, Santa Barbara, Detroit, Houston, Philadelphia, and Phoenix.

The alumni drive is under the chairmanship of Simon Ramo, PhD '36, executive vice president of Thompson Ramo Wooldridge, Inc.

The alumni gifts form a part of the general Caltech Development fund. To reach the needed goal of approximately 20 million dollars, the Institute now has to raise 2½ million dollars. Three buildings remain to be financed – two undergraduate houses, and a campus dining hall. A portion of the 2½ million dollars still to be raised will go into the Faculty Salary Fund, and will also cover additional land purchases and other building costs not included in specific donations.

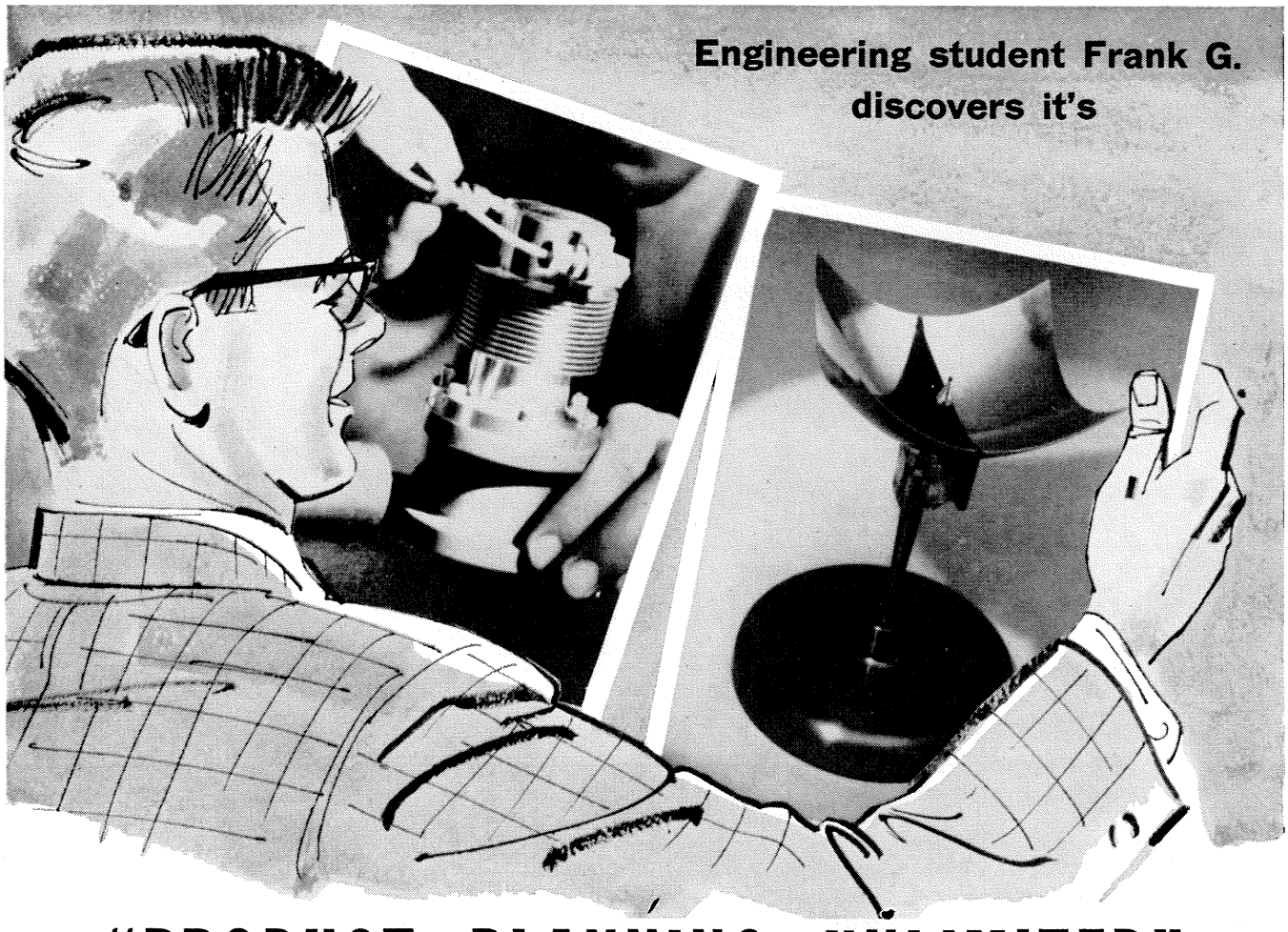
Fall Dinner Meeting

Peter Kyropoulos, formerly associate professor of mechanical engineering at Caltech, will be the featured speaker at the Alumni Fall Dinner Meeting on December 16. The title of his talk: "Styling Is More Than Skin Deep."

It is a widely held view that the styling of automobiles is principally a decorator's function. Dr. Kyropoulos, now technical director of the General Motors Styling Center, feels that the view does not do justice to the reality of automobile styling. In his address, he will draw upon his experience at General Motors to show the multitude of other factors which enter into automobile styling. Selection and placement of components, seating arrangements, vehicle dynamics – these are a few of the considerations which, with decoration, make up the styling function. This subject will be illustrated with a movie and slides.

The meeting this year will be held in the particularly pleasant surroundings of the Club Del Mar, 1910 Ocean Front, Santa Monica. Cocktail hour is 6:15 and dinner will be served at 7:30. Wives and guests of alumni are also invited. Reservations can be made through the Alumni Office.

– George L. Johnston, Chairman, Fall Dinner Meeting



"PRODUCT PLANNING UNLIMITED" at HAMILTON STANDARD

Hamilton Standard has conducted a vast product diversification program which has made it a leader in the field of aerospace equipment.

Established skills in . . .

Fluid Dynamics	Combustion
Hydraulics	Heat Transfer
Electronics	Thermodynamics
Metallurgy	Astrophysics
Vibration	Aerodynamics
Mechanics	Thermoelectricity

. . . are being brought to bear on a varied list of new products such as:

MinIRcooler — A tiny (10 ounce) device for cooling infrared detection equipment to minus 350°F. The coolers have endless applications in missile guidance, mapping, surveillance by orbiting satellites, etc.

SOLAR CELL — A small concave dish-like device with a highly polished surface used to convert the energy of the sun's rays into electrical energy. One potential use is power generation for earth satellites.

Other recently designed and developed products are:

ANTI-LUNG which reverses the cycle of the human lung to reconstruct the atmosphere in a space vehicle or submarine

A REFRIGERATOR with no moving parts

A TOOL that slices diamonds like cheese

THUS ADVANCED "PRODUCT PLANNING UNLIMITED" MEANS "ENGINEERING FUTURES UNLIMITED"

write to R. J. Harding, Administrator — College Relations for a full color and illustrated brochure "Engineering for You and Your Future"

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UNITED AIRCRAFT CORP.
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Manufacturers of: Engine Controls Hydraulic Equipment Electronic Controls and Instrument Systems
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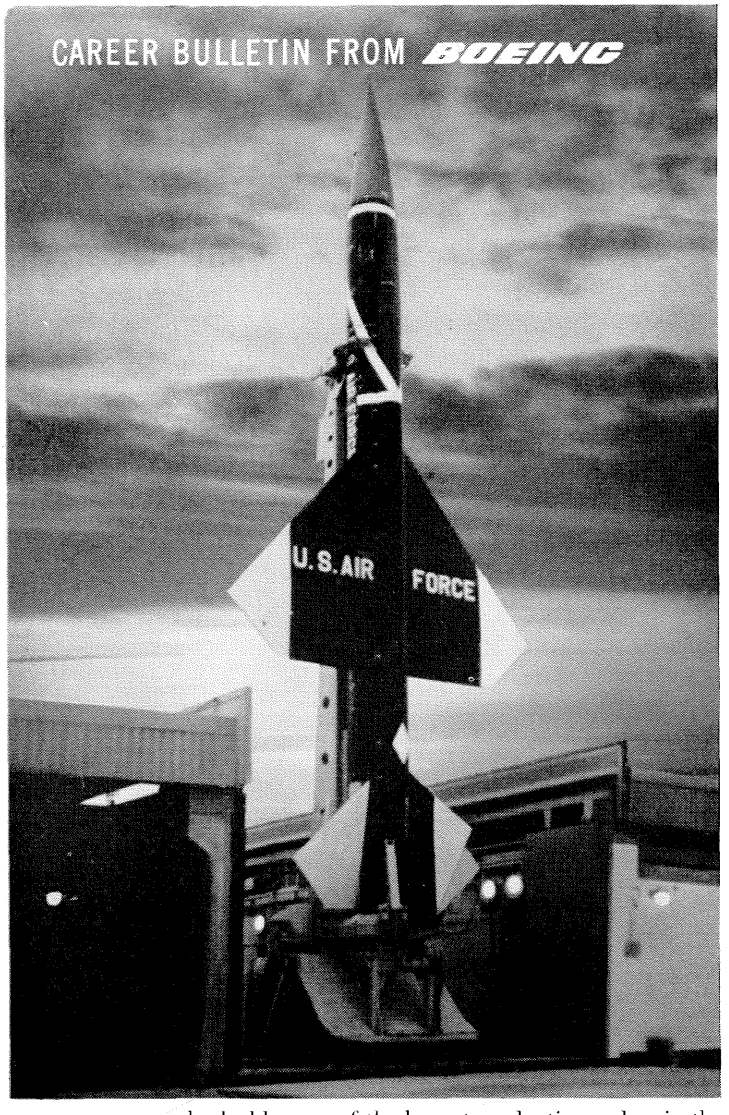
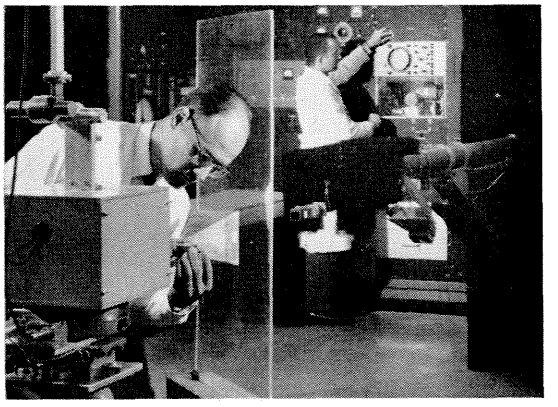
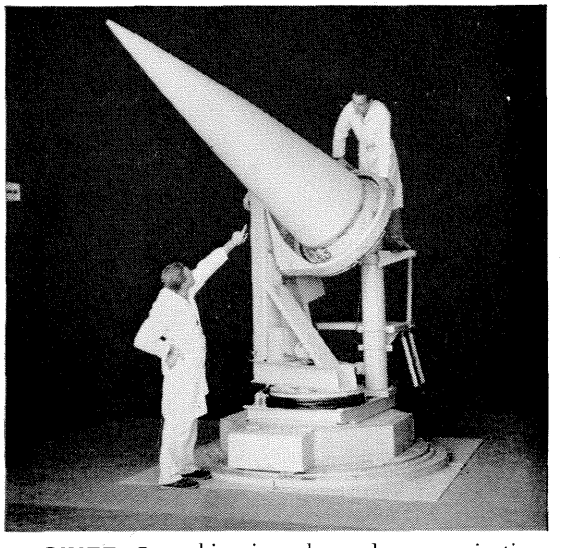


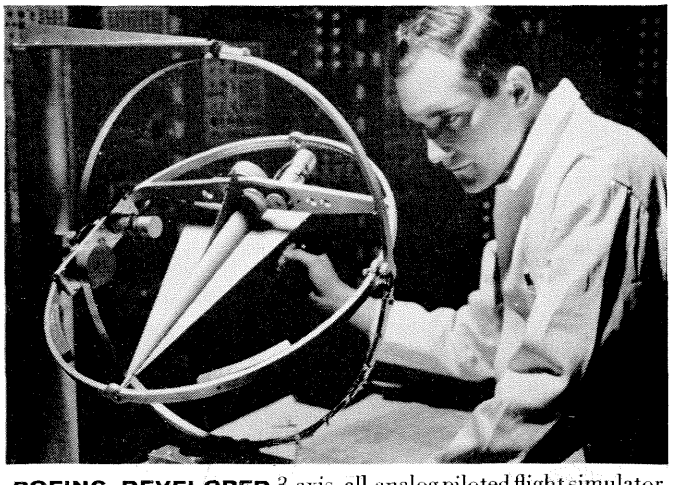
BOMARC, backed by one of the largest production orders in the field of missiles, and other rapidly expanding missile and space-age projects at Boeing offer exceptional career opportunities. Openings also available with Minuteman solid-propellant ICBM, and with other challenging projects in such advanced areas as orbital systems, lunar systems and interplanetary systems.



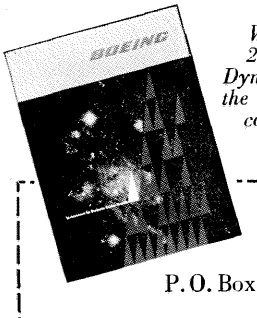
BOEING RESEARCH facilities, most extensive and complete in the industry, give you the solid backup you need to grow in professional stature and get ahead faster. Precision microwave interferometer, above, developed at Boeing, typifies creative assignments open now in Research, Design, Production and Service.



ENGINEERS working in radar and communications are supported by self-sufficient Boeing laboratories, housing equipment such as nation's first automatically recording, precision boresight error range, above. Other openings in infrared techniques, electronic circuitry, and in radar, beacon, guidance and control systems.



BOEING-DEVELOPED 3-axis, all-analog piloted flight simulator. With the rapid growth in importance of electronic installations in both manned and unmanned aircraft, Boeing has greatly expanded research and development work in this area. Openings at all levels in mathematics, physics, electrical, electronic engineering.



Write today, *for your free copy of 24-page booklet, "Environment for Dynamic Career Growth." It pictures the career areas and advantages that could assure* you *a brighter future.*

Mr. Stanley M. Little,
Boeing Airplane Company,
P. O. Box 3822 - UCI, Seattle 24, Wash.

Send me the Boeing career booklet by return mail.

Name .....

Address ..... City ..... State .....

Degree(s) ..... Field of interest .....

Experience .....

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Personals

1911

Harold C. Hill writes that "I've been retired for seven years and I'm still enjoying my hobbies – growing avocados and camellias, and polishing rocks. I also take time out for trout and deep sea fishing. Very busy."

1912

Norman E. Humphrey broke his retirement and started his own business (scales service and sales) in El Centro, in December 1957. "We're making splendid progress," he says, "and are very happy with it. My son, William E., is married and has two wonderful little girls. My daughter, Norma, is married, teaching, and helping her husband through his senior year at Arizona State in Tempe."

1918

Fritz W. Karge writes that "I retired in 1949 from the Union Oil Company of California, but in '50 and '51 I handled several projects for the company and for the oil field waste water companies in Santa Fe Springs and Orange County. Later I was consulted for the design of overland pipe lines for heavy oil in Venezuela, Turkey, Egypt, and Guatemala. We have two married daughters and each has two children. One son-in-law is basketball and baseball coach at Occidental College. The other one is teaching mathematics at a San Diego high school. Being now 75 years of age, my working days are very likely over. Our retirement home in Corona del Mar overlooks the ocean on which I sailed from 1900 to 1911."

1923

Don Loughridge, PhD '27, is now head of a new physical and mathematical research department at the General Motors Laboratories in Detroit. "Much of the work under way in the department is on direct conversion of heat energy to electrical," Don writes, "and before many more decades we may be again riding in electrical automobiles.

"GM is always interested in hiring Caltech graduates. Please contact me if interested."

1927

Charles A. Bradley, Jr., director of glass melting operations at the Corning Glass Works in Corning, N.Y., has been made a fellow of the American Ceramic Society.

1928

Arnold O. Beckman, PhD, founder-president of Beckman Instruments, Inc., has received a lifetime honorary membership in the Instrument Society of America (the highest award of the Society) in recognition of a "long and distinguished career" and for "continuing contributions to science, industry and education."

1929

Maurice F. Hasler, MS '30, PhD '30, president of Applied Research Laboratories, Inc., in Glendale, has been made a fellow in the Optical Society of America. This honor is received by those who have "served with distinction in the advancement of optics."

1930

Ira C. Bechtold is a director of Southern California Electronics, Inc., doing business as Marine Radio Service in San Pedro. Major interest in the company is held by A.A. *Fomilyant* '34.

1931

George F. Wislicenus, MS, PhD '34, professor of aeronautical engineering and director of the Garfield Thomas Water Tunnel at Penn State University, has been made a fellow in the American Society of Mechanical Engineering.

1932

Philip D. Brass, PhD, is now a research associate at the U.S. Rubber Company's research center in Wayne, N.J.

1933

Reinhardt Schuhmann, Jr., is now head of Purdue University's new School of Metallurgical Engineering. He has been at Purdue since 1954.

Trent R. Dames, MS '34, executive partner of Dames and Moore, has been elected to the National Board of Direction of the American Society of Civil Engineers for a three-year term.

1934

Cmdr. Donald R. Rooke is now public works officer at the Parris Island Marine Corps Recruit Depot in Georgia. Previously, he was with Naval Construction Battalion Nine in San Francisco.

continued on page 50

He's an Allis-Chalmers Engineer

He has confidence born of knowing where he's going and how he's going to get there. The graduate training program at Allis-Chalmers helped him decide on a *specific* career — and he had a choice of many. He knows his future is bright because Allis-Chalmers serves the growth industries of the world . . . produces the widest range of industrial equipment. He is confident of success because he is following a successful pattern set by Allis-Chalmers management.

Here is a partial list of the unsurpassed variety of career opportunities at Allis-Chalmers:

Types of jobs

Research
Design
Development
Manufacturing
Application
Sales
Service

Industries

Agriculture
Cement
Chemical
Construction
Electric Power
Nuclear Power
Paper
Petroleum
Steel

ALLIS-CHALMERS

A-5882

Equipment

Steam Turbines
Hydraulic Turbines
Switchgear
Transformers
Electronics
Reactors
Kilns
Crushers
Tractors
Earth Movers
Motors
Control
Pumps
Engines
  Diesel
  Gas

Fields

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1936

Paul H. Hammond is now vice president and general manager of Beattie-Coleman, Inc., in Anaheim. The company is a subsidiary of Coleman Engineering. Paul has also been appointed to the Beattie-Coleman board of directors.

1938

Maj. Gen. William S. Stone, MS, is now superintendent of the new Air Force Academy at Colorado Springs, Colorado. The Stones' 18-year-old daughter, Susan, is studying at the University of Colorado in Boulder, and their son, William, 15, is at Lawrenceville School in New Jersey.

1940

George R. Brown writes from New Canaan, Conn., that he has been promoted to district manager of the Texaco Exploration Company, with headquarters in Calgary, Alberta, Canada. "My wife, 2-year-old son and I will soon brave the icy blasts of the Arctic," he says, "and we hope to find a home before it all freezes up."

Jack Tielrooy writes that "I've been in business for myself as a consulting chemical engineer for almost three years. Although I maintain my office in Fullerton, most of my clients are scattered throughout the country. My activities are devoted almost entirely to the petrochemical field – in management consulting and process design."

1944

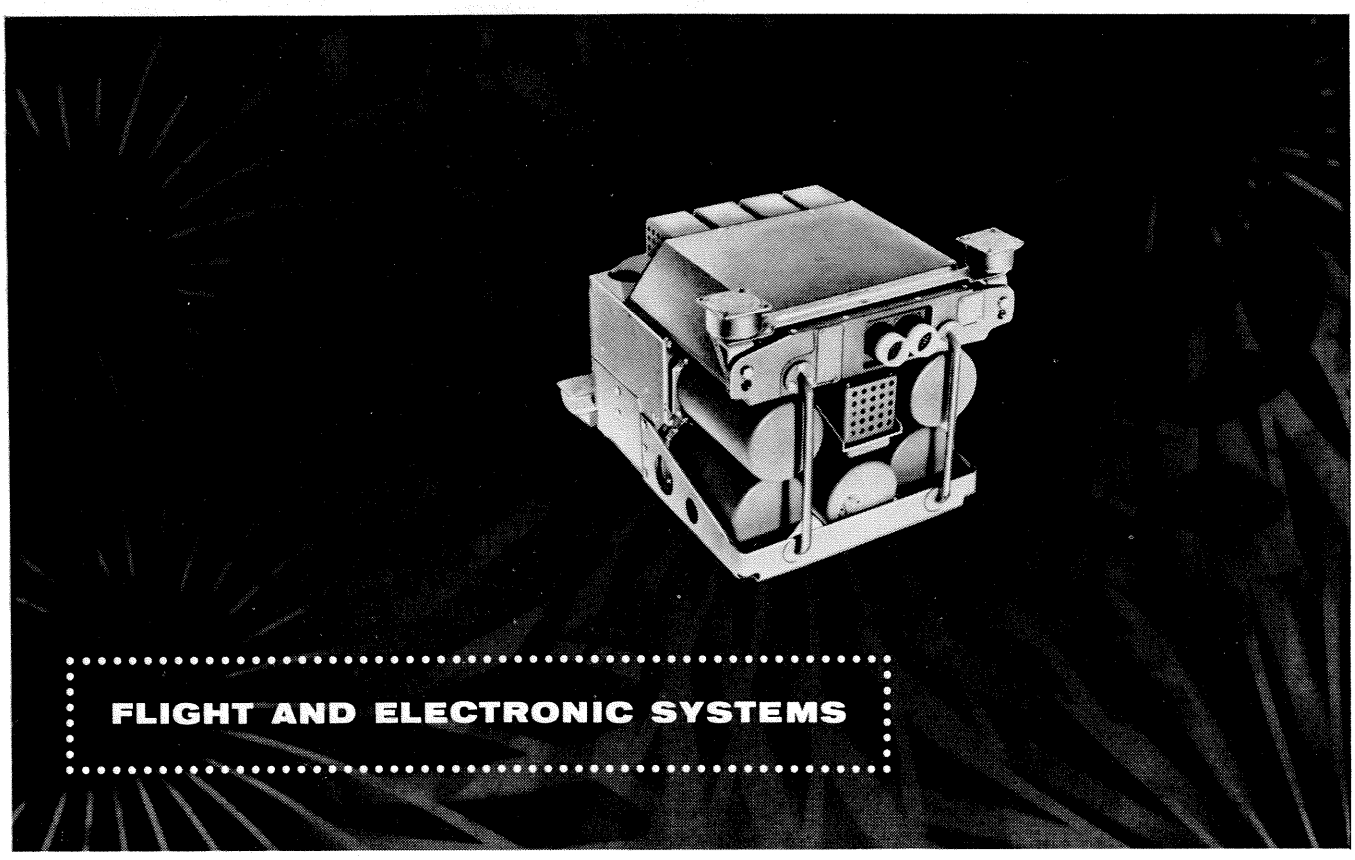
Capt. Albert Furer, MS, AE '44, writes that "since coming to San Diego last year I've had command of the Naval Air Force Pacific Fleet's Airborne Electronic Training Unit, which is based at the Naval Air Station on North Island. To date, we (wife and two daughters, 13 and 8), have been able to withstand the rigors of Coronado's and San Diego's monotonously fine and smogless weather."

William R. Hamilton, president of Baron Industries in Los Angeles, writes that "I've been married almost 15 years now and have three boys – 13, 11 and 7. I recently became a director of the Currier Corporation in San Francisco. Also, I got tired of watching cowboys on TV – so I got my own horse."

1945

Marshall E. McElhannon writes that "I've been working as a general building contractor in Los Angeles since early 1959. Business is just beginning to pay off. My education at Tech has surely provided an excellent background for the various avocations I have followed. We have two lovely girls – 4 and 5½."

continued on page 52



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1948

Martin Robinson, MS '51, AE '52, died of cancer on August 27, 1958. Formerly research engineer for the Douglas Aircraft Company, Martin had been retired for some time except for working a few days out of each month for H. P. Forman. Martin's widow and three children are living in Compton.

James G. Wendel, PhD, is associate professor of mathematics at the University of Michigan. The Wendels have five children – ages 7, 6, 6, 4 and 2.

1953

William D. Gardner writes from Corona that he's working with the City of Riverside as an office engineer. "I got my State registration as a civil engineer about a year ago," Bill writes, "and I'm now secretary of the local chapter of the California Society of Professional Engineers. We have two children – David, 3, and Linda, 1 – and expect another in February."

1954

Paul Concus writes that "in your October issue I read about the completion of my PhD work at Harvard. In addition, other things have happened: While at Harvard, I met Celia Gordon, a Radcliffe grad student in biology, whom I married last March. We honeymooned for 10 weeks in Europe and in July we settled in the Bay Area, where I'm working for IBM in Oakland."

Manuel Morden, MS '55, structural designer at Brandow & Johnston in Los Angeles, announces the arrival of a daughter, Ilyanne, in October. The Mordens already have a son, Daryl.

1955

Oreste W. Lombardi is now a chemist in oceanography at the Michelson Laboratories at NOTS in China Lake. A new son, Harold, was added to the Lombardi family in October.

Thomas B. Howes, MS, is district exploration superintendent for Montana with The California Company, working on the Gulf Coast and throughout the western states. The Howes' have three children – two boys, 7 and 5, and a girl, 2.

1957

Edwin X. Berry is now research assistant at the Thayer School of Engineering at Dartmouth College in Hanover, N.H. He is married and has a 15-month old son, Kim. He got his MA in physics from Dartmouth this year.

1958

Robert A. Mowry, MS, senior engineer at Convair in Pomona, died of asphyxiation from carbon monoxide on July 16. He leaves his wife and three daughters.

1959

Harvey E. Fiala, electrical engineer at the Hughes Aircraft Company in Culver City, announces the birth of a second child, Annette, on October 5.

Mike Milder writes from Harvard Graduate School: "*Bob Lange* is pregnant. He and Jan are expecting in March.

"I have decided to give up extracurricular activities and enter a career in science.

"*Joe Fineman* '58, is back from his Fulbright year at St. Andrews in Scotland. He's here in physics along with Lange and me. Joe and I are rooming together in an apartment on Beacon Hill. We got in touch with *Vince Taylor* '58 (he lives in Boston and attends MIT) and when we told him our address, he informed us that *Dave Leeson* '58, lived at the same place last year. Same *apartment*, in fact."

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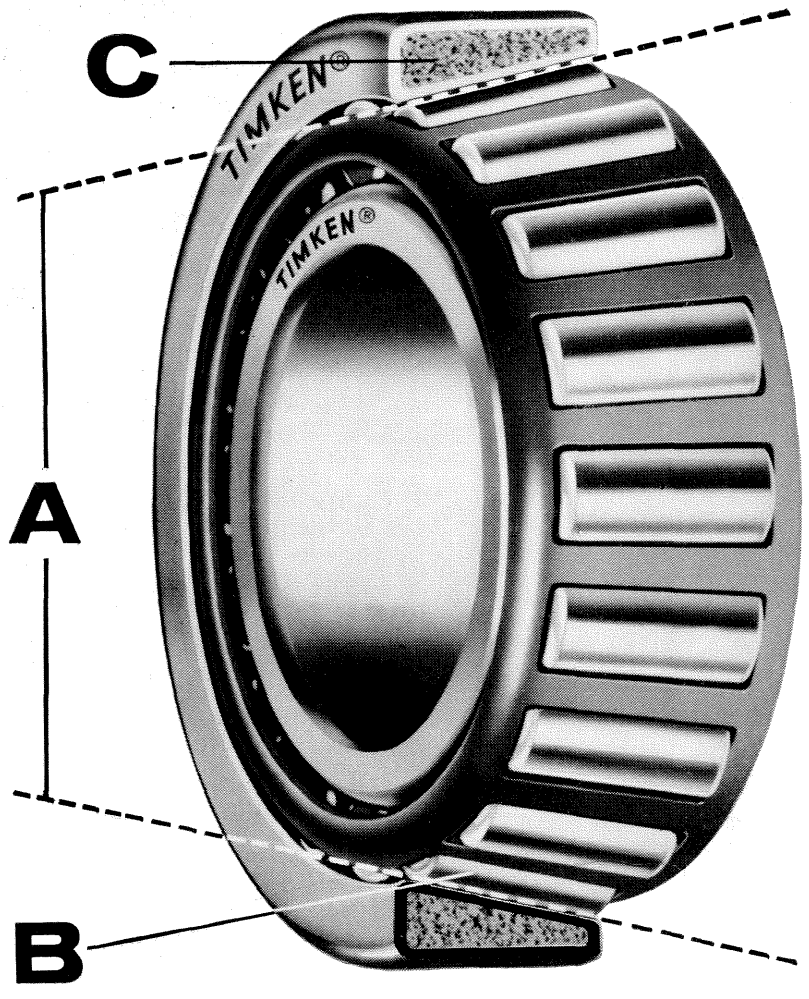

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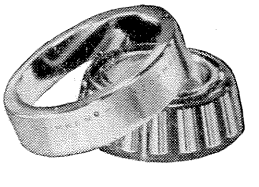

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CALTECH CALENDAR

ALUMNI EVENTS

January 21	Winter Dinner Meeting
March 5	Annual Dinner Dance
May 7	Annual Seminar
June 8	Annual Meeting
June 25	Annual Picnic

ATHLETIC SCHEDULE

BASKETBALL

January 9
Caltech at Claremont-Harvey Mudd

January 12
Redlands at Caltech

January 15
Caltech at Pomona

January 19
Cal Poly (Pom.) at Caltech

January 22
Occidental at Caltech

January 23
LaVerne at Caltech

FRIDAY EVENING DEMONSTRATION LECTURES

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

January 8
The Use of Soils in Engineering
— Ronald Scott

January 15
The Mathematician at the Computer
— John Todd

January 22
Transistors
— Robert Middlebrook

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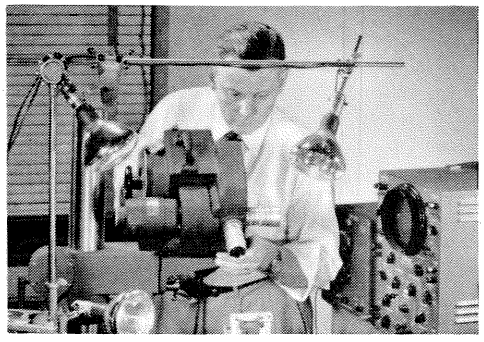

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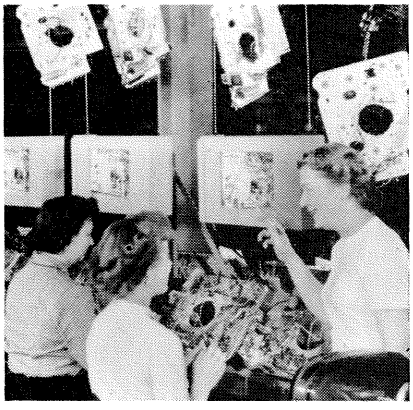

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Interview with General Electric's Charles F. Savage Consultant—Engineering Professional Relations

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies —mature, knowledgeable men— have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body or fund of knowledge to which they have three definite responsibilities. The first is to *generate* new knowledge and add to this total fund. The second is to *utilize* this fund of knowledge in service to society. The third is to *teach* this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas — meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration. This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to encourage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

***LOOK FOR** other interviews discussing: Salary • Why Companies have Training Programs • How to Get the Job You Want.

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