ENGINEERING | AND | SCIENCE

January 1961

The great Rose Bowl hoax . . . page 28

Published at the California Institute of Technology

This mark tells you a product is made of modern, dependable Steel.

Whether it jumps to make a discovery that's out of this world, or sits down quietly to spend a century or two on atomic research, steel is the only material that has the strength and vigor to keep up with the reach of modern man's mind.

New Stainless Steels developed by United States Steel withstand the vibration and friction of unearthly speeds. New USS Steel Forgings shape atomic reactors and nuclear power systems. Look around. You'll see steel in so many places—building strength. And steel depends on men like you. For information about the many career opportunities at U.S. Steel, including financial analysis or sales, send the coupon.

USS is a registered trademark

United States Steel Corporation
Personnel Division
Room 6085A, 525 William Penn Place
Pittsburgh 30, Pennsylvania

Please send me career information about U.S. Steel.

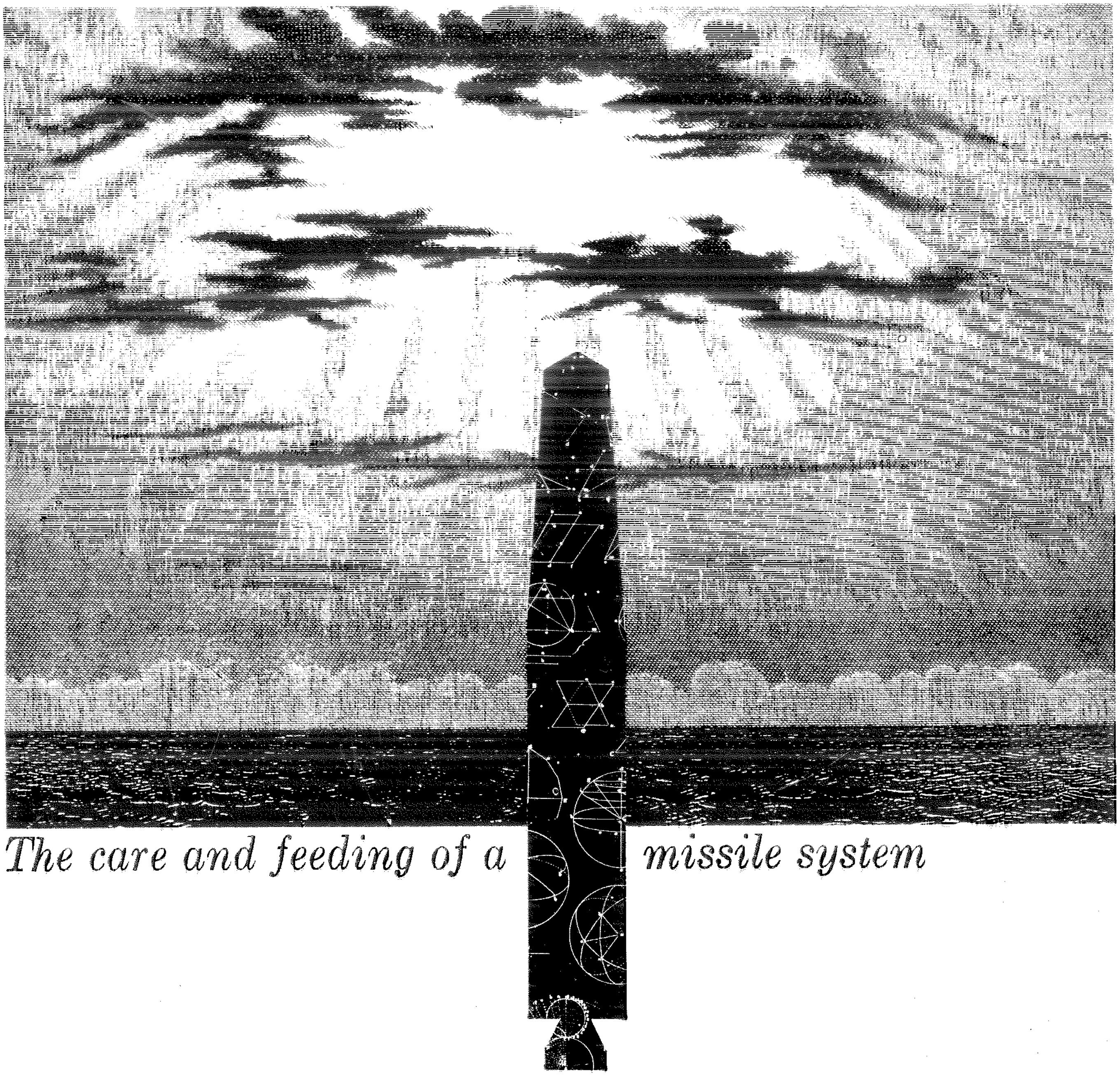
Name ____________________

School ____________________

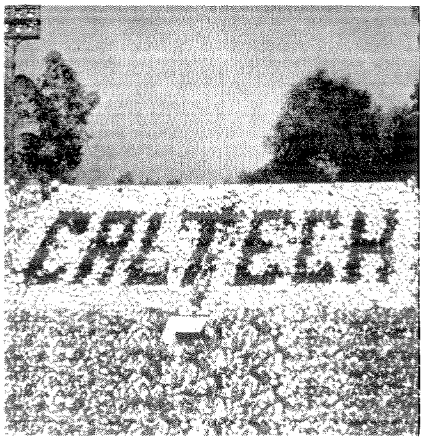
Address ____________________

City ____________ Zone ____ State ____________

United States Steel (USS)



ENGINEERING | AND | SCIENCE



On Our Cover

is pictorial proof of the great Rose Bowl hoax perpetrated by 14 industrious Caltech students on January 2, at this year's Rose Bowl game. The mammoth cheering section which is displaying the Caltech name on our cover is *not* the Caltech student body; these are undergraduates from the University of Washington. And why are they holding up those cards that spell out CALTECH? Well, *they* think the cards spell out WASHINGTON. How did this confusion ever come about? Well, it seems there were 14 industrious Caltech students – and the story of their nefarious deed is on page 28.

Alfred P. Sloan

looks at higher education on page 9. Mr. Sloan is honorary chairman of the board of the General Motors Corporation, chairman of the board of trustees of the Sloan-Kettering Institute for Cancer Research, and president of the Alfred P. Sloan Foundation – which made possible Caltech's new laboratory of mathematics and physics. "An Industrialist Looks at Higher Education" has been adapted from a speech by Mr. Sloan at a dinner in his honor at the California Club in Los Angeles, following the dedication of the new Alfred P. Sloan Laboratory of Mathematics and Physics on December 1, 1960.

Picture Credits:

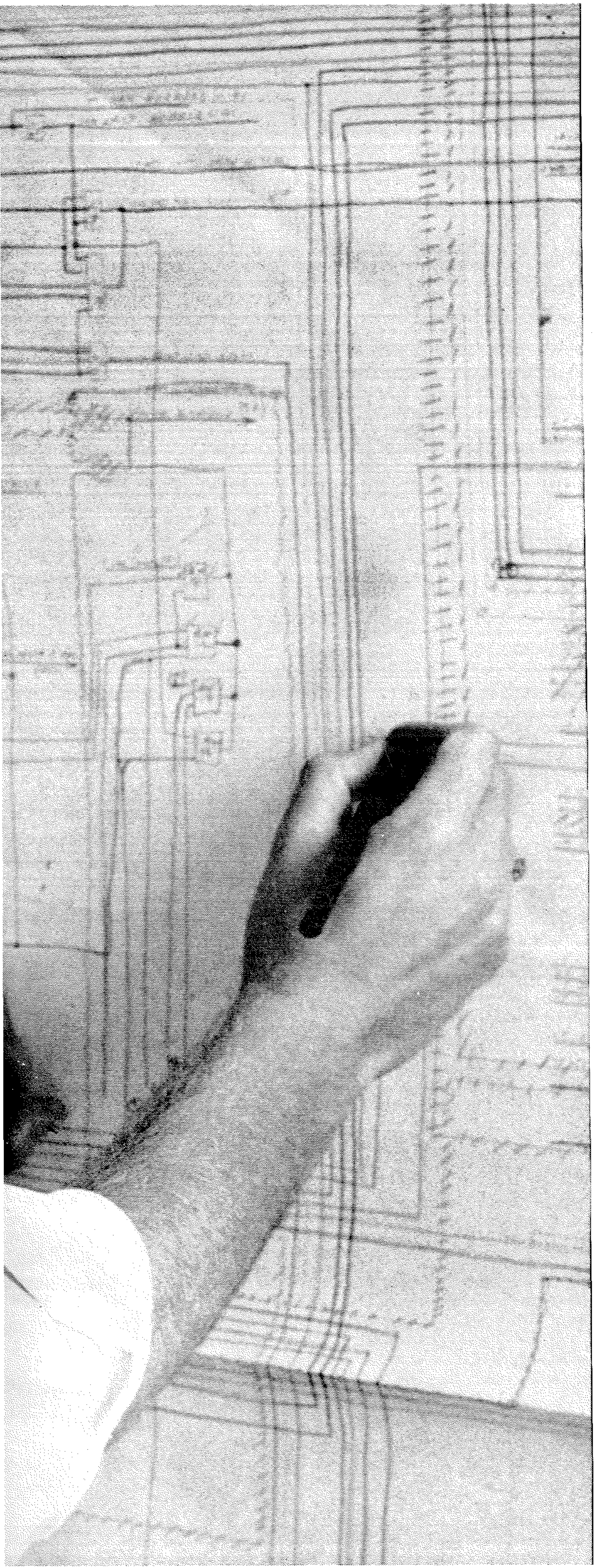
Cover – Bruce Whitehead
9, 11, 13, 14, 16 – James McClanahan
15 (top), 18 – Harvey

JANUARY 1961 VOLUME XXIV NUMBER 4

STAFF

Publisher....................Richard C. Armstrong '28
Editor and Business Manager....................Edward Hutchings, Jr.
Assistant to the Editor....................Gerda Chambers
Student News....................Lance Taylor '62
Roger Noll '62
Photographer....................James McClanahan

Published monthly, October through June, at the California Institute of Technology, 1201 East California St., Pasadena, Calif. Annual subscription $4.50 domestic, $5.50 foreign, single copies 50 cents. Second class postage paid at Pasadena, California. All Publisher's Rights Reserved. Reproduction of material contained herein forbidden without written authorization. Manuscripts and all other editorial correspondence should be addressed to: The Editor, *Engineering and Science*, California Institute of Technology.



HE'S MAPPING NEW WAYS TO BEAT TRAFFIC JAMS IN LOGICAL SYSTEMS

A computer system must be versatile. The IBM 1401 system, for instance, might go to work in a radiation lab, a stockbrokerage office, an air operations center, a refinery, or any one of a hundred other places. Demands upon the individual units of the system will vary widely.

Paul Farbanish analyzes the loads placed on the system by different applications. One of his assignments is to design new and alternate ways for data to move from unit to unit with the greatest speed and reliability.

Like many an engineer at IBM, his responsibility ranges over a wide technical field. To do his job he has become familiar with many challenging areas of electronics. Within the 1401 system alone he dealt with circuits, data flow control, input-output, storage, etc.

If a young engineer wants to move rapidly into the most advanced areas of electronics, he would do well to consider IBM. In the fast-expanding world of data systems and its many peripheral fields, a man is given all the responsibility he is able to handle. New ideas and new ways of doing things are not only welcome but actively encouraged.

The IBM representative will be interviewing on your campus this year. He will be glad to discuss with you the many challenging jobs that are open at IBM—whether in development, research, manufacturing, or programming. Your placement office will make an appointment for you. Or you may write, outlining your background and interests, to:

Manager of Technical Employment
IBM Corporation, Dept. 891
590 Madison Avenue
New York 22, New York

IBM®

You naturally have a better chance to grow with a growth company.

Letters

University of Alaska

EDITOR:

Fritz Zwicky pondering smog (*E&S*, November 1960) appalls me with the narrowness of his view. The solution *is* quite simple. Abandon Southern California!

As I sit in my office I look south through a hundred miles of crystal clear air to the mighty peaks of the Alaska range. The snow reflects the pink hues of sunrise. And it is at a decent hour to be enjoyed – 10 a.m. We spent an hour or so yesterday tracking a moose in the birch forest in back of the campus. A bad traffic jam resulted Saturday when two dog teams decided to exchange sniffs in the middle of College Road. Perhaps you see my point. Abandon Southern California!

E. J. GAUSS '54
Assistant professor of mathematics

New York, N.Y.

EDITOR:

We were very interested to read about "The World's Smallest Motor" in your December issue . . . but what can you *do* with the thing?

MRS. R. L. W. MERTON

The micromotor developed by William McLellan (Caltech '59) has no immediate practical purpose. As Richard Feynman explained in the article that inspired the micromotor ("There's Plenty of Room at the Bottom" – E&S, February 1960), it is just an incentive to more advanced research in the field of miniaturization.

At Electro-Optical Systems in Pasadena, however, some of Bill McLellan's co-workers have made a list of impractical uses to which the motor can be put – such as:

Merry-go-round for flea circus.
Micro-centrifuge.
Motorized needle-threader.
Spiderweb saw (classified).
Personal phonograph –wear in ear.
World's smallest revolving stage.

Books

The Arithmetic of Computers

by Norman A. Crowder

Adventures in Algebra

by Norman A. Crowder and Grace C. Martin

Doubleday .... *each $3.95*

Reviewed by John Todoroff '61

Reading one of the new TutorTexts approximates hiring your own private instructor – and an exacting, but delightful and often humorous one indeed. He is happy to answer questions when the reader cannot follow the instruction, patient to explain just why you misunderstood a question, and ready with new material at a pace suited to each individual.

All this is accomplished with a format of a half-page of instruction followed by a multiple-choice question. A correct answer sends one on to another page for a pat on the back and an advanced lesson; an incorrect answer directs the reader to still a different page where he will be surprised to find that the book knows just why he made the error. These questions emphasize basic principles rather than rote memorization. All who follow instructions through to the last page will have learned the fundamentals of the subject treated.

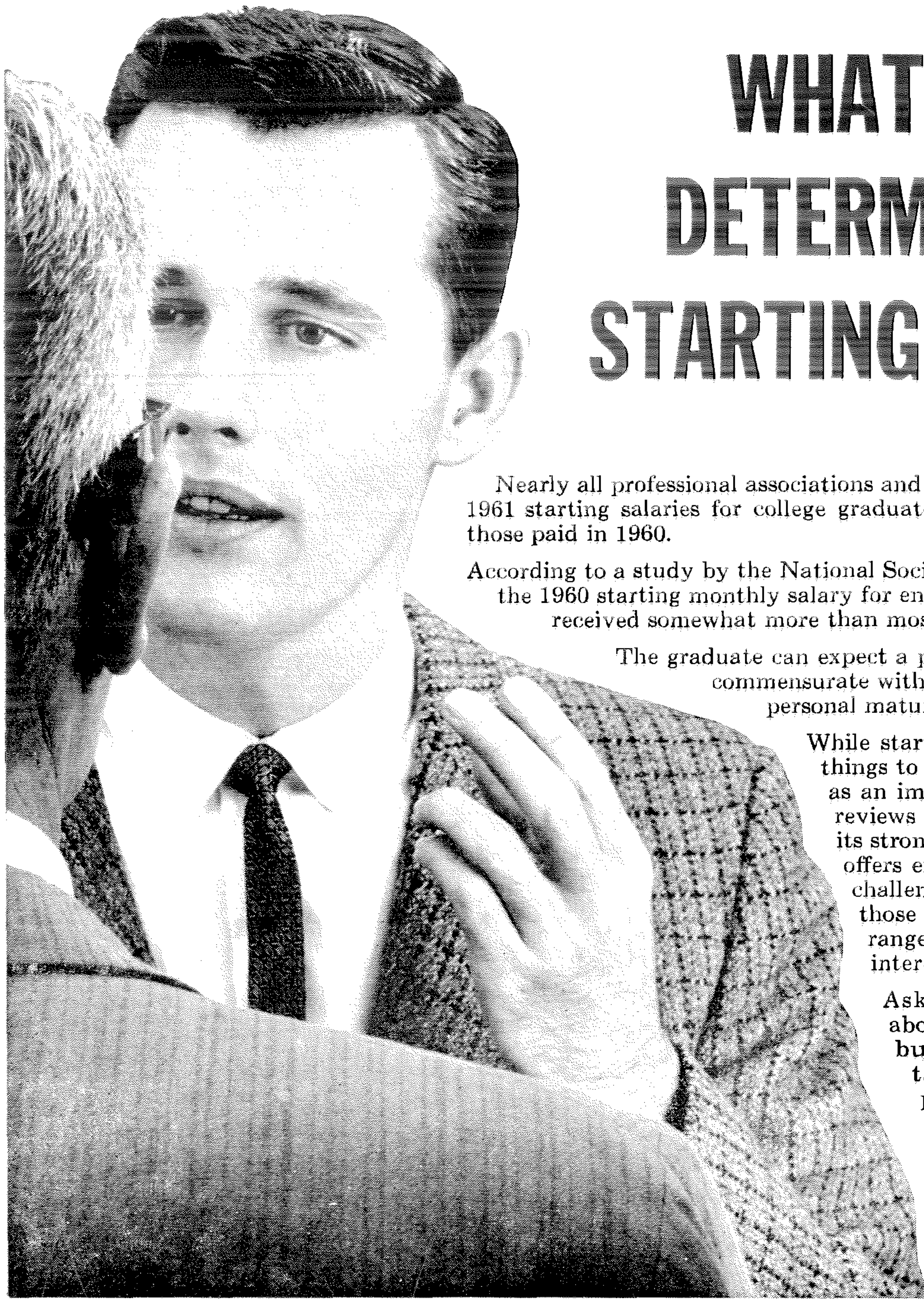
Adventures in Algebra presents elementary algebra in a way well-suited for either a high school student's introduction or an adult's review of the concepts with which mathematicians deal. Symbols and equations are presented hopefully as things quite useful rather than mystical. With the basic assumptions clear one moves step by step to appreciate the rigors of proving a theorem, establishing the sum of a series, and discovering irrational numbers. This is far more basic mathematics than manipulating equations to "solve for x."

The Arithmetic of Computers opens with a review of the principles of the decimal system. Then it introduces other counting systems. Much space is devoted to adding, subtracting, multiplying, and dividing with octal and binary numbers, attempting to show why these systems are more than clever mathematical games, but of essential use for electronic computers.

As the author says in his opening sentence, a TutorText "is not an ordinary book."

Bendix answers your questions

WHAT WILL DETERMINE MY STARTING SALARY?



Nearly all professional associations and employers are predicting that 1961 starting salaries for college graduates will be about the same as those paid in 1960.

According to a study by the National Society of Professional Engineers, the 1960 starting monthly salary for engineers averaged $530. E. E.'s received somewhat more than most other majors.

The graduate can expect a position—and compensation—commensurate with his previous work experience, personal maturity, and academic record.

While starting salary is only one of the things to consider, Bendix recognizes it as an important one, and continually reviews rates and trends to maintain its strong position. In addition, Bendix offers engineers and scientists superb challenges in such dynamic fields as those listed below, with a wide range of freedom to pursue special interests.

Ask your Placement Director about Bendix—**where you can build your career to suit your talents.** If you can't arrange a personal interview, write to C. B. Cleveland, The Bendix Corporation, Fisher Building, Detroit 2, Michigan, for more details.

CAREER OPPORTUNITIES IN CALIFORNIA · CONNECTICUT · INDIANA · IOWA · MARYLAND · MICHIGAN · MISSOURI · NEW JERSEY · NEW YORK · OHIO · PENNSYLVANIA

THE Bendix CORPORATION
Fisher Bldg., Detroit 2, Mich.

A THOUSAND DIVERSIFIED PRODUCTS SERVING THESE FIELDS:

automotive • electronics • missiles & space • aviation • nucleonics • computer • machine tools • sonar • marine

Engineering And Science
January 1961, Volume XXIV, No. 4

President L. A. DuBridge, Alfred P. Sloan, and Caltech Trustee Lindley C. Morton on their way to the dedication of the Sloan Laboratory of Mathematics and Physics.

An Industrialist Looks at Higher Education

by Alfred P. Sloan

Perhaps I can express why I am here this evening by referring to an incident told me by that great scientist and educator, the late Dr. Karl T. Compton. The story is about one of those so-called high-powered industrialists that we read about once in a while – a hypothesis which I do not think has ever been validated – but anyway we will assume it to be a fact for the moment. Bill, I shall call him. Now, Bill served long and faithfully, and in the course of human events time tapped him on the shoulder and Bill retired. A short time after, a group of his former associates called one afternoon to cheer up the old boy and to see what he was up to. After the party got going, someone asked Bill what he did now that he did not have to work the way he used to. Bill said he did not get up as early in the morning as he used to, but when he did, he made a dash for the newspaper. He examined the obituary column and, if his name was not there, he relaxed and made the best of it.

Now, no one could quarrel with Bill's right to relax, but I challenge the thought that he should make the best of it. On the contrary, I think he should make the most of it. He should recognize that he owed our society a debt for the opportunities that had been made available to him. He should be willing to turn back a reasonable proportion of his time and talents, and some proportion of his substance – if he was able to save anything from the tax collector – into the economic stream for the further advancement of the society to which he owed so much. Therefore, as a

A talk given by Mr. Sloan at a dinner in his honor at the California Club in Los Angeles, following the dedication of the Alfred P. Sloan Laboratory of Mathematics and Physics at the California Institute of Technology, December 1, 1960.

"As an industrialist,

I hold that business should accept

the challenge of financial responsibility to education

. . . to keep it not only virile but free."

sort of proxy for this man, Bill, I appear here as an advocate of the advancement of education in all its ramifications, and in the promotion of research – especially basic science – in a way, education's affiliate.

It is academic to say that knowledge is the means of promoting progress along the whole front of human endeavor. It is, nevertheless, a fact. Social values, economic values, human values involving human behavior, health values, security values, spiritual values, all have their grass roots in knowledge, and can thrive only in an atmosphere of expanded knowledge and understanding. And that applies equally to scientific values, which particularly concern us here. Science might be defined as an assemblage of systematized knowledge.

And is it not true that education is the catalyst, or creative instrumentality, upon which the expansion of knowledge depends? Today, in terms of the generalities, higher education is at the crossroads economically and academically. In the enormous expansion of our economic life in the postwar era, many social services have been left behind. Higher education is one of them. Higher education today needs not only modernized patterns of educational values – new frontiers in fact – but it needs money for salaries, bricks and mortar, equipment, and modernization. And, in too many instances, it must meet deficits.

Among the ranks of the higher educational institutions there appears to be no exception as respects these needs. The unaccredited college, the struggling accredited institution, the celebrated prestige university, the outstanding technological institutions, our leading medical schools – all are urgently, in fact desperately, in need. And the sum total of their needs today is staggering. Tomorrow such needs will be further aggravated by an anticipated increase in population, and an expanding demand for advanced education.

Now, why has all this happened?

I believe a revolution has taken place as to the status of education among the activities of our society. It might be dated as the end of World War II. In the old concept, education was an incident – recognized, but little elaborated upon. In the new concept, education is evolving as a problem of major social and economic significance in the deliberations of our society. There is no single cause for this. I am inclined to think the leading motive is the dramatic ascendancy of science, stimulated by the technical accomplishments of the war. This has penetrated into all areas of human activity: business, the professions, government, education itself. It has opened up new vistas of accomplishment for all strata of society. It has stimulated the ambition of great numbers and provided an incentive to make accomplishment worthwhile.

The business impact on education, and the impact of education on business, stand out crystal clear. Over the years, management has moved from a philosophy of "hunch" to a philosophy of "fact." Education becomes of increasing significance to business as the transition takes place, and its impact is accelerated as complexity succeeds simplicity and as technology increases complexity. It is a surprising fact that today the management, and technical and professional groups, are becoming the largest single group in our work force, forging ahead of our individual operators; and the rapidly developing technique of automation stimulates the trend. Thus, we see business as creating not only a market for education, but an expanding market; in fact, education becomes a competitive necessity in business.

Now, what are we going to do about this?

To my mind, higher education should move to a greater utilization of existing facilities – increased turnover we call it in business. The value of time in the educational process should be reappraised. Can we not do the job more quickly and with equal efficiency? There should be a more aggressive acceptance of programs that contemplate prepaid, or postpaid, loans in part. This should have a favorable impact on tuition.

Higher education offers to society a most valuable asset – one that cannot be lost, stolen or destroyed; it enhances earning power; it adds lustre to life. Its value will be better appreciated and more effectively capitalized if it is earned, or paid for in maximum reasonable measure. Giveaways, or something for nothing, either for education or for so-called international benefits, are not respected. They serve to create a hunger for more, always more. Higher education might develop more effective organization within itself for the pleading of its own cause for financial support. Our educational curriculum should be modernized in practical terms of existing social and economic needs. The responsibility of higher education to basic research raises an important question of policy. New techniques utilizing modern instrumentalities should be developed to increase the efficiency of the instruction process.

But that is far from meeting the whole need. Financial support must be forthcoming along a wide front, and in greatly enlarged volume, if we may hope to meet our objective. That is the responsibility of our society as a whole, a challenge that is not by any means being realized.

I believe that two of the most important reservoirs of private and organized resources available for support of higher education that can be greatly expanded are business enterprise and the modern private foundation. Most other reservoirs, if they were adequate in terms of present need – which I question – are drying up because of the impact of high taxation and continued inflation.

It has been a tradition among private foundations that the needs of higher education find their explanation and their justification in the high value which society attributes to education's contribution to our

Tenants of the Institute's new Sloan Laboratory – Back row: Shih, Gaier, Block, Dean, Fuller, Kavanagh, Kobrak, Sands, Glashow, Pellam, Deery, Zachariasen, and Whaling. Second row: Tully, DePrima, Wright, Wielandt, J. Todd, T. Lauritsen, Mercereau, Walker, Gell-Mann, Division Chairman Bacher, and President DuBridge. Front row: Apostol, Barnes, Luxemburg, Chakerian, O. Todd, Dilworth, Erdelyi, Zaanen, Wilcox, Hall, and Ryan.

society. Our schools, colleges and universities conserve the best in our civilization and communicate that best to each succeeding generation. They select and train specialists for the arts, sciences, and professions, and identify capacity for leadership. They carry on basic research that advances man's knowledge of himself and his universe.

The resources of private foundations have already reached imposing totals and will continue to accelerate at least over the next few years. The foundation is, I believe, an efficient means of personal philanthropy, for it provides flexibility, makes possible the recognition of change, and is independent of time.

Foundation policies are developed on an individual basis. Many foundations channel their activities into limited areas. Most prefer, in dealing with higher education, to support projects along a wide front rather than on an individual basis. Many will not support facilities involving fixed capital, but confine their grants to more active programs. The needs of a specific higher educational institution, require, therefore, a special appeal to a foundation, or foundations, likely to be favorably inclined. The individual donor will continue to function but I believe in a descending order of importance. We must look more and more to the private foundation, especially where significant programs are involved.

As a matter of fact, the needs are so large and so numerous that even if the resources of a foundation are impressive, limitation and discrimination become a matter of necessity. Nevertheless, the private foundation presents a highly significant and an increasing reservoir of potential support for higher education The foundation, then, must be exploited to the utmost. Its business is to give. It is not permitted by law to create a surplus. And it can give its capital in whole or in part as it may choose.

I should like to inject here a controversial observation. I am opposed in principle to educational support taking the form of endowment. I believe the need is so great, and the available sources so small in proportion, that financial support should be utilized as a spending asset limited to a period not to exceed ten years. We must remember that our prime responsibility is to the existing generation.

The responsibilities of business

As to the responsibilities of business, no thoughtful person can doubt that private enterprise and education have a basic community of interest. The American private college and university, the recognized standard-bearers of education, owe their material existence to the fruits of private enterprise and, conversely, private enterprise owes its extraordinary accomplishments in part to the knowledge created in the educational process. Thus, business gets the benefit of higher education and business has the money to support education.

In return for this support, business has every right to expect that the quality of our educational aims, in terms of today's technology, and the effectiveness with which we are utilizing existing educational resources in pursuing same, will offer the youth it serves unique educational values, thus exerting a substantial influence in advancing the future status of our society in terms of human progress and security. As an industrialist, I hold that business should accept the challenge of financial responsibility to education. It has such a responsibility to keep education not only virile but free. Business must do this in defense of its own great opportunities in our free competitive society.

Council for Financial Aid

Several years ago, in collaboration with the then chairman of the United States Steel Corporation, and the Standard Oil Company of New Jersey, with myself as chairman of General Motors Corporation, there was organized the Council for Financial Aid to Education. Our objective was to create a consciousness on the part of business management of its responsibility to the educational system of our country. And to do this by all proper means, such as education, statistical information, organized effort of all types, including what I shall call – if I may – all forms of sound propaganda.

The activity was liberally financed by four outstanding Foundations. Aside from the difficulties that always exist in starting a new effort, the activity has, I believe, been eminently successful. It has succeeded in developing a gift psychology for higher education on the part of management. It has awakened management to a broader realization of what it owed higher education, and what such education means to it. In addition, and perhaps more important than the material gain, has come a developing acceptance of that basic idea, bound to be accelerated in significance with the passing of time. We can, I am sure, look forward to a widening in scope and a broadening of material support from business as time and the further acceptance of the concept expands and develops.

Well, adding all together, this is how, for right or wrong, an industrialist looks from the outside at the problems of higher education. Its significance as a measure of our prosperity and security stands out crystal clear. Its needs, in terms of financial support, are equally clear and of a high order of significance. Its programs – if I might speak of them in all-embracing fashion – of reorganization and reconstruction to meet changing demands and limitations, involve an enormous complex of more or less conflicting philosophies and procedures. But where there is a will, there is a way, and it is certain that out of all the consideration that is now being given the problem, progress will be made by compromise and adjustment, to the end that the objectives we seek will in large measure be achieved.

Ray D. Owen, professor of biology and acting chairman of Caltech's division of biology.

The Month at Caltech

Biology Chairman

Ray D. Owen, Caltech professor of biology, has been appointed acting chairman of the biology division at Caltech. He succeeds George W. Beadle, who is leaving next month to become chancellor of the University of Chicago (see page 16).

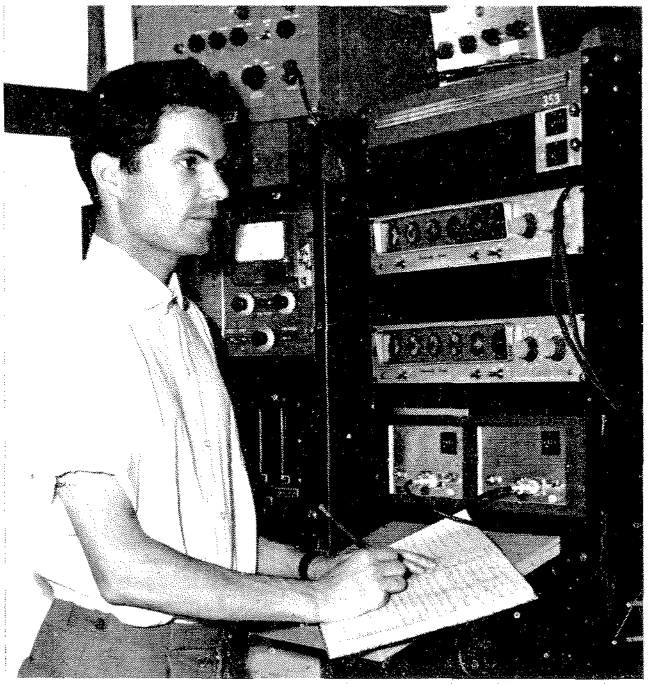
Dr. Owen was born in Genessee, Wisconsin, the son of a dairy farmer. He received his BS in 1937 from Carroll College in Waukesha, and his PhD from the University of Wisconsin in 1941.

He first came to Caltech in 1946 on a Gosney post-doctoral fellowship in biology. At that time he was on leave from the University of Wisconsin as professor of genetics and zoology. He became associate professor of biology at Caltech in 1947 and professor in 1953.

Dr. Owen is widely known for his work with inherited blood groups in animals and man, in the comparatively new field of tissue transplantation. He is co-author with Adrian Srb of Cornell University of the widely-used textbook *General Genetics.*

At Caltech, Dr. Owen is a member of the faculty board, the committees on academic freedom and tenure, educational policies, registration, relations with secondary schools, and a special committee on faculty organization. He has served on the admissions committee for 15 years.

Dr. Owen served as a research participant at the Oak Ridge National Laboratory in Oak Ridge, Tennessee, in 1957-58 and has been a consultant for the Laboratory since that time. He is a member of the Genetics Study Section of the National Institutes of Health, and has served on the grants committee of the American Cancer Society and on a subcommittee on medico-legal problems of the AMA.



Rudolf L. Mossbauer, Caltech research fellow in physics, and winner of the Research Corporation Award.

Research Corporation Award

Rudolf L. Mossbauer, 31-year-old Caltech research fellow in physics, has been awarded the 1960 Research Corporation Award for his discovery of a radiation measure, "the Mossbauer effect," a yardstick that enables physicists to measure precisely, for the first time, the effects of natural forces such as gravity, electricity, and magnetism, on infinitely small particles like photons and parts of the nuclei of atoms.

Dr. Mossbauer is at Caltech on a two-year leave of absence from the Institute of Technical Physics in Munich, Germany. A native of that city, he was educated there and worked at the Max Planck Institute for nuclear physics at Heidelberg.

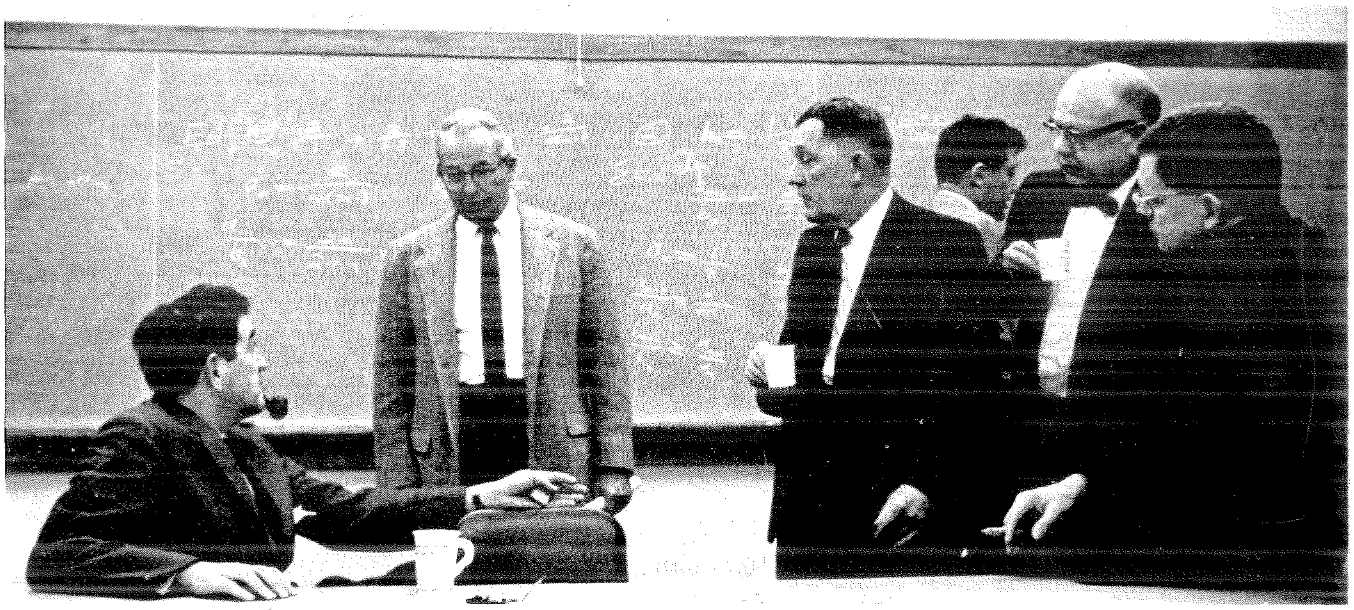
At Caltech, Dr. Mossbauer and his colleagues use his effect to detect minute magnetic properties of the atomic nucleus and the little-known internal magnetic and electric fields in isotopes of the rare earth elements. This research is supported by the Atomic Energy Commission.

The Research Corporation Award, first given in 1925, honors men of science who have made outstanding contributions. Eight out of the 24 previous winners have received Nobel Prizes. The winner of the award receives a plaque, a citation, and a $5,000 honorarium.

Science and Government Seminars

Jerome B. Wiesner, special assistant to President John F. Kennedy for science and technology, visited the campus on January 13 as a lecturer in the Carnegie Program on Science and Government at Caltech. These seminars, held weekly throughout the academic year, are made possible by a grant from the Carnegie Corporation of New York. The lectures this year concern the problems of armament control particularly with respect to national policy and international relations.

The January 20 speaker in the Carnegie series will be Tom Schelling, professor of economics and member of the Center for International Affairs at Harvard University. Future lecturers in the series will include the Rt. Hon. John Strachey, MP; Kenneth Boulding, professor of economics at Michigan State University; Denis Healey, MP, a specialist on foreign affairs—particularly on NATO in Europe; Daniel Lerner, pro-



Jerome B. Wiesner (left), special assistant to President John F. Kennedy for science and technology, meets with Caltech faculty—Robert F. Bacher, Charles Lauritsen, William A. Fowler, and Thomas Lauritsen.

fessor of sociology at MIT; I. de la Sola Pool, professor of political science at MIT; I. I. Rabi, professor of physics at Columbia University; and Sir Solly Zuckerman, professor of anatomy at Birmingham University in England.

AUFS on Campus

On January 8 the first of four representatives of the American Universities Field Staff came to Caltech to report on political, social and economic conditions in foreign areas. Louis Dupree, reporting on Afghanistan, was on the campus from January 8 to 18.

John Hanessian, Jr., who has spent the past six years studying the polar regions, will be here from January 23 to February 1. From 1954 to 1958 he was a member of the staff selected by the National Academy of Sciences to prepare and execute the U.S. International Geophysical Year program. In 1958 he became associated with the Institute of Current World Affairs, and has just completed two years of research in polar problems in England, France, Scandinavia, and the U.S.S.R.

From February 6 to 15, Irving P. Pflaum will report to students, faculty and friends of the Institute on Spanish and Latin American developments.

From February 20 to March 1, Willard A. Hanna will make a return visit to the campus. Since his last visit in 1957-8 he has traveled widely through the Far East from his base in Kuala Lumpur in Malaya.

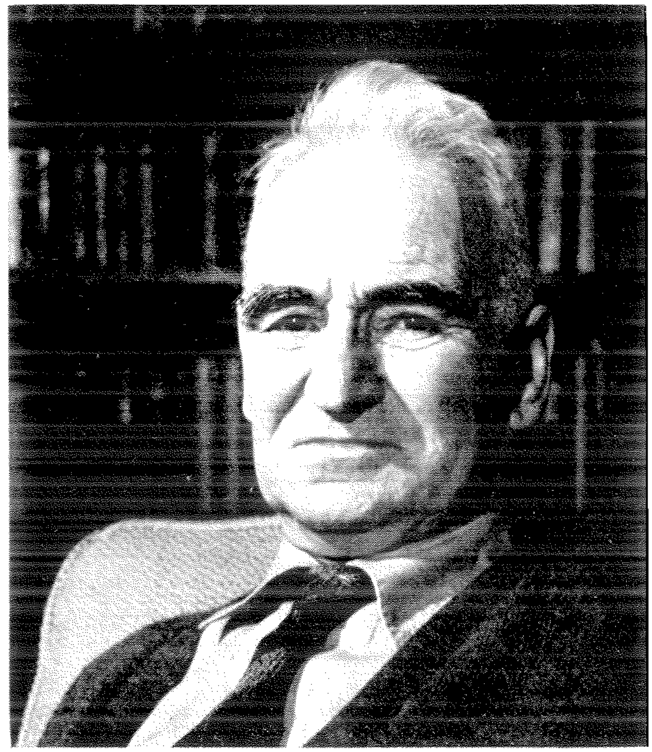
Howell N. Tyson

Howell Newbold Tyson, associate professor of mechanical engineering and engineering graphics at Caltech, died on December 18 at his home in Pasadena. He had been on the Caltech faculty for 24 years.

Howell N. Tyson, associate professor of mechanical engineering and engineering graphics.

Professor Tyson was born in Rossville, Md., on July 7, 1899, and had lived in Pasadena since 1905. He received his BS from the Massachusetts Institute of Technology in 1920 and served as an assistant instructor there for a year before going to work as a designer at the Bureau of Light and Power in Los Angeles. He was employed as an engineer in private industry from 1922 to 1936, when he came to Caltech.

Surviving Professor Tyson are his wife; two sons – Howell N. Tyson, Jr., (Caltech '50) of Arcadia, and Thomas J. Tyson (Caltech '54) of Livermore; a sister, Dorothy; and four grandchildren.



Eric T. Bell, emeritus professor of mathematics.

Eric Temple Bell

Eric Temple Bell, Caltech emeritus professor of mathematics, died on December 21 in a Watsonville hospital. He was 77.

Dr. Bell was born in Aberdeen, Scotland, and came to the United States in 1902. He graduated from Stanford University in 1904, and went on to the University of Washington for his MS. He received his PhD from Columbia University in 1912 and returned to the University of Washington, where he taught mathematics and won a nationwide reputation for his work in the theory of numbers. After 14 years there, he came to Caltech. He retired as emeritus professor in 1953.

Under the pen name of John Taine, Dr. Bell wrote a number of magazine stories and 13 science fiction novels. He also wrote four learned books on mathematics, 10 popular books in the field, and nearly 300 scientific papers. Since his retirement, Dr. Bell had been working on a book about the work of Fermat, French mathematician of the 1600's.

He is survived by a son, Dr. Taine Temple Bell, a physician in Watsonville, and three granddaughters.

Muriel and G. W. Beadle

Chicago's New Chancellor

George W. Beadle, chairman of the division of biology, and acting dean of the faculty at Caltech, leaves the Institute next month to become chancellor of the University of Chicago.

"The University of Chicago is to be sincerely congratulated," said Caltech President L. A. DuBridge, "on securing as its leader so great a scholar, teacher, and administrator as George W. Beadle. Under his leadership the University of Chicago, already one of the nation's great educational institutions, is certain to attain new heights of educational distinction. The whole nation will profit from such a development.

"At the same time, the loss of Dr. Beadle is a most serious blow to the California Institute of Technology. In the past 14 years he has built here one of the greatest research centers in biological science in the country, and he has brought distinction to the entire Institute. In his new capacity as dean of the faculty he was about to launch a vigorous new program of educational advancement. He cannot be replaced.

"Dr. and Mrs. Beadle were beloved members of the Caltech faculty and they carry with them into their new endeavors the best wishes of a host of friends and admirers in southern California."

Dr. Beadle has been head of the division of biology at Caltech since 1946, and has been serving as acting dean of the faculty since last year. In 1958 he won the Nobel Prize in medicine with Dr. Edward L. Tatum (now of the Rockefeller Institute in New York) for their discovery that genes act by regulating definite chemical events.

How genes work

The Beadle-Tatum discovery gave science its first proof of how genes actually work. Before 1941 there were some indications that genes controlled chemical reactions, but this was not a widely accepted fact. In that year, though, Beadle and Tatum, working at Stanford University, made the significant discovery that the synthesis of vitamins and amino acids in the living cell is under the control of the genes. This in turn suggested that each of the biochemical reactions of a cell is governed by a particular gene.

This discovery opened up a whole new field of research which has led to new knowledge of genes themselves, to new knowledge in biochemistry, and even in bacteriology – where, for the first time, it made possible the study of bacterial genes. During World War II the application of genetic principles resulted in a fourfold increase in penicillin production, as well as the development of new means of assaying vitamins and amino acids in food and tissues.

In making their discovery the men used the red bread mold *Neurospora crassa* (subjecting it to x-rays and ultraviolet light to produce genetic mutations). They have since been identified not only with the discovery, but with the addition of this new tool for genetic research.

A native of Nebraska, Beadle was born in Wahoo in 1903. He got his BS in 1926 and his MS in 1927 from the University of Nebraska School of Agriculture, then went to Cornell University, where he became interested in genetics. After receiving his PhD in 1931, he came to Caltech as a National Research Council fellow. He became an Institute research fellow in 1932, and instructor in biology in 1935. In that same year he went to the University of Paris to work with Dr. Boris Ephrussi, whom he had met at Caltech. While there he made his first important discovery – that a gene controls the eye color of the fruit fly, *Drosophila,* by producing a particular chemical substance.

After a year on the biology faculty at Harvard, Beadle went to Stanford as professor of biology in 1937. He returned to Caltech in 1946 to succeed the late Thomas Hunt Morgan as chairman of the division of biology.

In his 14 years at the Institute, Beadle, with boundless enthusiasm and unflagging energy, has built the biology division into one of the best in the country. As acting dean of the faculty for the past year he has been directing the program, financed by the Carnegie Corporation of New York, to extend scholarship and research at the Institute in the humanities, the social sciences, and public affairs.

Not that administration occupies all his time and talents. He is equally as active, and as adept, as fund-raiser, teacher and public lecturer. He is past president of the American Association for the Advancement of Science, and of the Genetics Society of America. He was a member of President Eisenhower's Science Advisory Committee. He was chairman of the National Academy of Sciences' committee on the Genetic Effects of Atomic Radiation, and chairman of the American Cancer Society's Scientific Advisory Council.

He belongs to the Royal Society of London, and to the Danish Royal Academy of Sciences. In 1958-59 he was appointed Eastman Visiting Professor at the University of Oxford, England. He is co-author with Dr. A. H. Sturtevant (Thomas Hunt Morgan professor of genetics at Caltech) of *An Introduction to Genetics.* Name all the possible honors and awards that can come to a biologist and he has most of them.

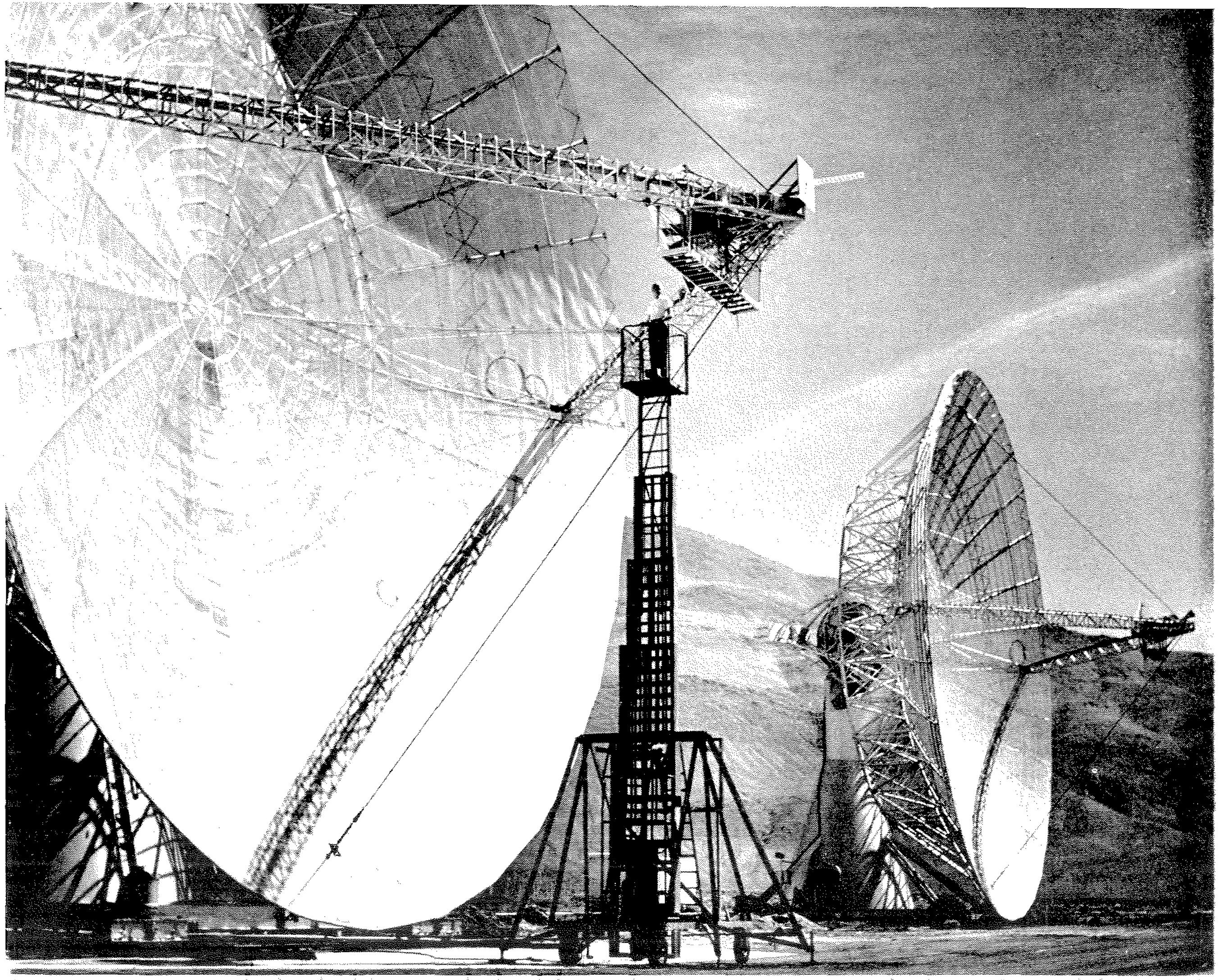
All of this professional activity still leaves Beadle with plenty of time for an active private life as well. Since his home (which used to belong to T. H. Morgan) is located directly across the street from his office on campus, there is a good deal of blending of his private and professional activities. He is a successful gardener, but a good many of the lovely flowers – and the corn – that he raises in his home garden are grown for genetic studies too. So are the Siamese cats he raises.

Beadle leaves the Institute for his new position next month. Mrs. Beadle and their 17-year-old son, Redmond, follow at the end of the school year.

An exciting future

"Caltech is a wonderful place," says Beadle. "I am grateful to have been here and to have had a small part in its growth during these past 14 years. Leaving it is painful. But Chicago is a great institution, too, with a long history of educational leadership. Its future is exciting to contemplate, and I am looking forward with enthusiasm to making whatever contribution I can."

As chancellor of a university with 8,000 students, over 800 faculty, over 55,000 alumni, and an academic budget of over $32,000,000, Beadle will have an opportunity to make plenty of contributions – and make them he will. Chicago's future is even *more* exciting to contemplate now that Beadle's there.



An astronomer uses a hydraulic lift to reach the delicate electronic equipment at the focus of one of the twin 90-foot dishes, to make adjustments before beginning the night's observation.

The First True Radio Star

The first true radio star ever found by astronomers has been identified by Caltech's Radio Observatory, and confirmed by the 200-inch telescope on Palomar Mountain.

The object, known as 3C-48, was identified during a survey of more than 200 radio sources in space. The Institute's Radio Observatory has only been in operation for about 20 months, but in that time it has precisely located more radio sources than all other radio observatories combined. Most of the sources are very distant galaxies, luminous gas clouds, or galaxies in collision. Our sun has been the only object thus far identified as a radio star – but the new find seems to have all the qualities of a stellar object.

The star is located in the Constellation of Triangulum, not far from the Andromeda Galaxy. As far as radio sources are concerned, the object is extremely bright, but optically it is a very faint star and astronomers need a telescope like the 200-inch to get direct photographs or spectrograms. The object had been seen on plates from the 48-inch Schmidt telescope, but showed no unusual characteristics until the 200-inch plates revealed it in greater detail.

Thomas A. Matthews, senior research fellow in radio astronomy at Caltech, determined a very precise location for 3C-48. The radio angular size, determined by the University of Manchester in England, proved to be extremely small. A strong radio signal coming from such a small area indicates an intense surface brightness. This suggests peculiarity in a stel-

Caltech's Radio Observatory investigates one of the most puzzling objects that astronomers have ever encountered

lar object, so Dr. Matthews sought help from optical astronomers to obtain a photograph of that region of the sky.

Allan R. Sandage, staff member of the Mt. Wilson and Palomar Observatories, pointed the 200-inch telescope at the location of the strong radio source and obtained photographs of an object partly surrounded by a faint luminous cloud. Dr. Sandage then took spectrograms with the 200-inch to determine the composition of the object, and photoelectric measures of the brightness and color. The object turned out to have a decidedly stellar appearance and is probably not far from the sun. It could be the remnant of a supernova – a rare, giant explosion of a star.

More detailed spectrograms were taken by Guido Munch, professor of astronomy, and by Jesse L. Greenstein, professor of astrophysics – who are both staff members of the Observatories.

The spectrograms showed a combination of emission and absorption spectral lines unlike that of any other star – ionized and neutral helium, ionized calcium, and possibly oxygen ionized many times, as well as other unidentified features. An outstanding peculiarity of the object is that the spectrum shows no hydrogen, normally the elemental fuel of stars. All in all, the star is one of the most puzzling objects that astronomers have ever encountered.

A new facility

Caltech's Radio Observatory, near the town of Bishop, has recently added a new facility which makes it even more effective in mapping the positions of other radio stars and galaxies in the heavens.

Until last September, the Observatory's twin 90-foot steerable dishes had been operating on a 1,600-foot length of east-west tracks. Mounted on railroad-car wheels, the big steel-mesh ears are moved various distances apart to listen to a particular radio source simultaneously. This procedure, called interferometry, simulates the effect of a single reflector equal in diameter to the distance between the two dishes in a given direction.

The original set of tracks limited the astronomers' findings of the diameter to the east-west direction. It also made it necessary to spend hours of observing to obtain precise measurements of the north-south position. Now north-south tracks have been installed which allow determination of north-south positions and diameters in a much shorter time and with a greater degree of accuracy.

Other great discoveries

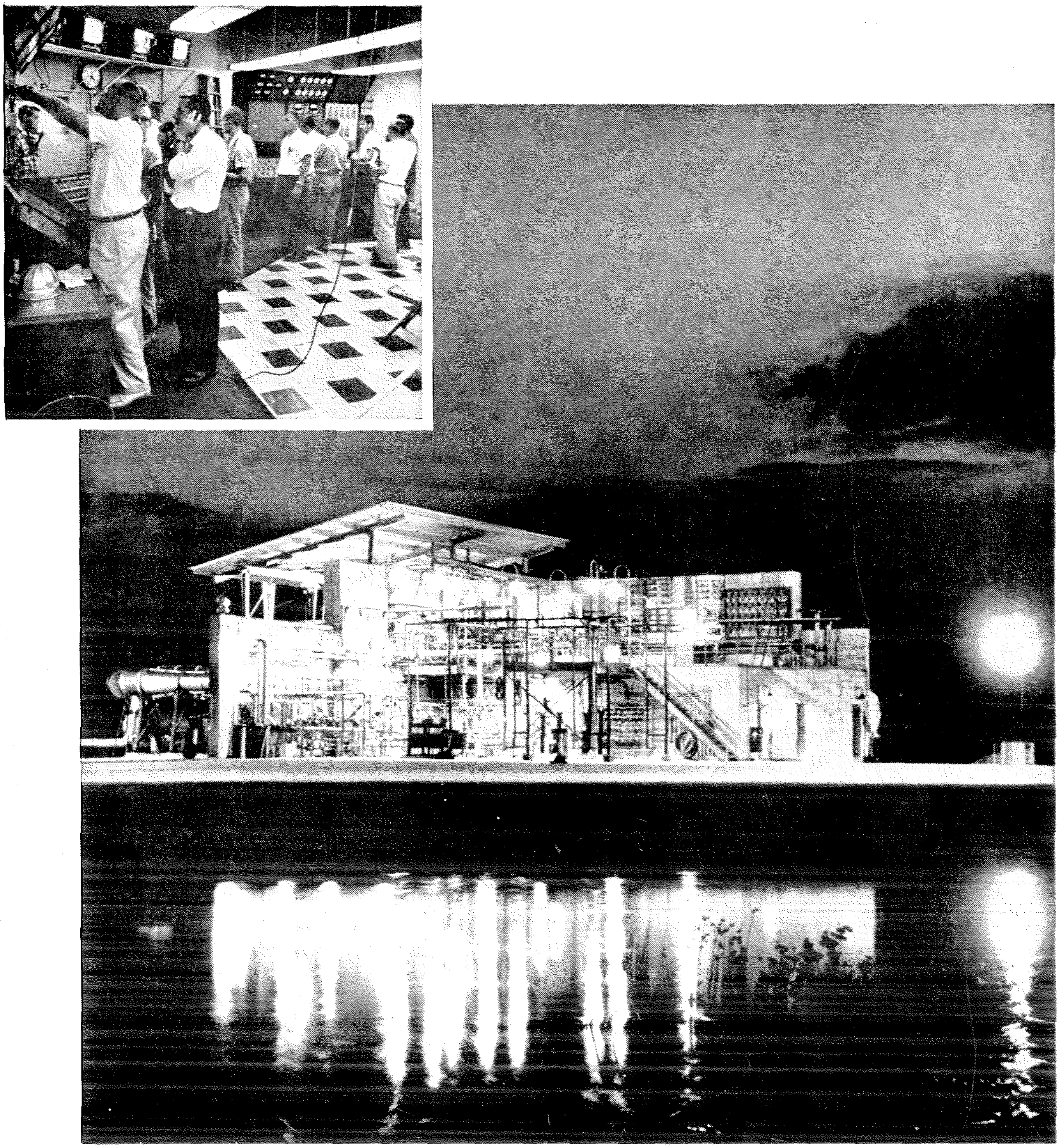
The Radio Observatory has shared in other great discoveries – for instance, in measuring the unexpectedly high radiation from the planet Jupiter. Last year the Observatory showed that this radiation was partially polarized, and came from a belt about 200,000 miles above the planet's surface. It is somewhat similar to the earth's Van Allen radiation belt, but with radio emission on a much greater scale.

Another recent discovery was the pinpointing of the most distant object known to man. This is a far-distant galaxy, a member of a large cluster of galaxies. Identification of the object known as 3C-295 was the combined work of a number of observatories – and the 200-inch Palomar telescope. The clue to its vast distance was provided by the University of Manchester in England, where it was found that the angular size was very small and therefore it was likely that the distance was extremely great.

Two highly accurate positions for this object (which agreed extremely well) were obtained by the University of Cambridge in England and by the Caltech Radio Observatory. A picture of the galaxy was noticed first at Caltech on photographic plates from the 48-inch Schmidt camera. Later, Dr. Rudolph Minkowski, staff member of the Mt. Wilson and Palomar Observatories, photographed the galaxy and obtained spectra with the 200-inch Hale telescope at Palomar, establishing that this galaxy was indeed the most distant object yet known.

Caltech's Radio Observatory was built and is supported by the Office of Naval Research. The extraordinary ability of the Observatory equipment to locate radio objects so precisely that they can be optically identified was built into the installation by its designer and former director, John G. Bolton, who has now returned to his former position as researcher in the Commonwealth Scientific and Industrial Research Organization in Australia.

What would YOU do
as an engineer a



Development testing of liquid hydrogen-fueled rockets is carried out in specially built test stands like this at Pratt & Whitney Aircraft's Florida Research and Development Center. Every phase of an experimental engine test may be controlled by engineers from a remote blockhouse (inset), with closed-circuit television providing a means for visual observation.

'ratt & Whitney Aircraft?

Regardless of your specialty, you would work in a favorable engineering atmosphere.

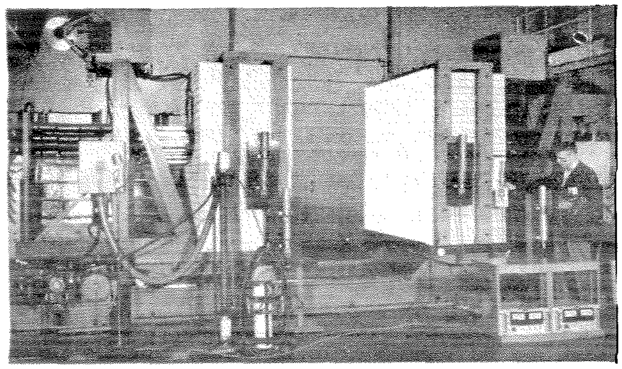
Back in 1925, when Pratt & Whitney Aircraft was designing and developing the first of its family of history-making powerplants, an attitude was born—a recognition that *engineering excellence* was the key to success.

That attitude, that recognition of the prime importance of technical superiority is still predominant at P&WA today.

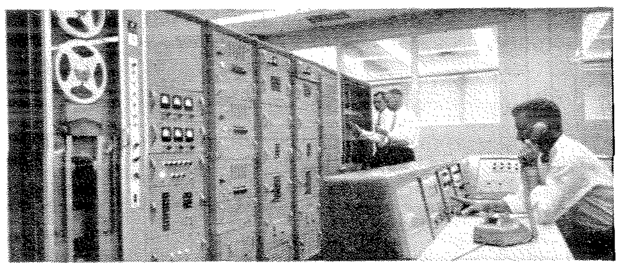
The field, of course, is broader now, the challenge greater. No longer are the company's requirements confined to graduates with degrees in mechanical and aeronautical engineering. Pratt & Whitney Aircraft today is concerned with the development of all forms of flight propulsion systems for the aerospace medium—air breathing, rocket, nuclear and other advanced types. Some are entirely new in concept. To carry out analytical, design, experimental or materials engineering assignments, men with degrees in mechanical, aeronautical, electrical, chemical and nuclear engineering are needed, along with those holding degrees in physics, chemistry and metallurgy.

Specifically, what would *you* do?—*your own engineering talent* provides the best answer. And Pratt & Whitney Aircraft provides the atmosphere in which that talent can flourish.

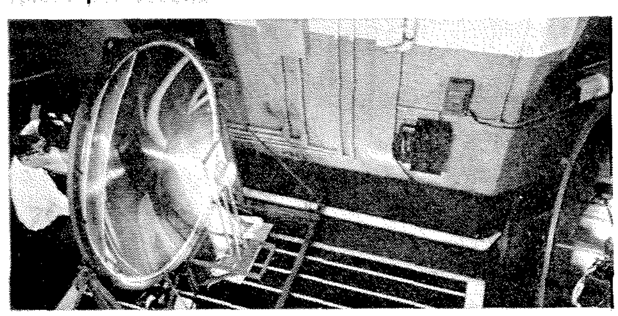
For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. R. P. Azinger, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.



At P&WA's Connecticut Aircraft Nuclear Engine Laboratory (CANEL) many technical talents are focused on the development of nuclear propulsion systems for future air and space vehicles. With this live mock-up of a reactor, nuclear scientists and engineers can determine critical mass, material reactivity coefficients, control effectiveness and other reactor parameters.



Representative of electronic aids functioning for P&WA engineers is this on-site data recording center which can provide automatically recorded and computed data simultaneously with the testing of an engine. This equipment is capable of recording 1,200 different values per second.



Studies of solar energy collection and liquid and vapor power cycles typify P&WA's research in advanced space auxiliary power systems. Analytical and Experimental Engineers work together in such programs to establish and test basic concepts.

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

CONNECTICUT OPERATIONS — East Hartford

FLORIDA RESEARCH AND DEVELOPMENT CENTER — Palm Beach County, Florida

Identifying and Encouraging Potential Scientists

The most challenging aspect of education today.

by John R. Weir

The demand for high-level talent continues to increase — particularly for scientists and engineers. Efforts to meet this demand have been directed mostly toward improving our educational facilities. However, if we are going to develop our human resources to the fullest, the early identification and encouragement of potential scientists is of equal importance.

The high school science teacher is in the key position to identify and encourage the future scientists of America. Through increased knowledge of the psychological characteristics of the high-level scientist or engineer he can make an earlier identification of those students with the potential for success in these fields. Once this is done he can provide the experience and training necessary to develop these potentials.

It is evident that this fact will assume ever increasing importance in the decades ahead. When we consider some of the important elements in an industrializing world, it is clear that the demand for technological knowledge will continue to grow.

I. POPULATION

Populations are increasing the world over, and will continue to increase. It has been estimated that, after a million years of man's existence, in the year 1000 A.D. there were about 300 million people. Only by 1830 — almost 1,000 years later — did world population reach one billion. By 1930 — 100 years later — the second billion was added. By 1965 — 35 years later — the third billion will be added. The UN has estimated that it will take 15 years to add the fourth billion, and 10 years to add the fifth. By the turn of the century there should be six billion people on the earth.

Not only is world population increasing rapidly; the rate of increase is increasing as well. Between 1850 and 1900, world population grew about 0.7 percent per year, doubling the population every century. Between 1900 and 1950 the average annual rate of increase was 0.9 percent, shortening the doubling time to 75 years. The projections for the period from 1940 to 1980 predict a rate of increase of 1.3 percent, a doubling time of only 50 years. This means 6 or 7 billion people by the end of this century, and perhaps 12 to 14 billions by 2050.

II. FOOD

With all these people about to appear, the matter of food immediately becomes of importance. It seems probable that a large proportion of the human race has never had enough to eat. We find references to starvation and famine throughout recorded history, and they continue to appear even today. The reason for this is fairly simple. In the period from 1900 to the beginning of World War II, total world food production increased 10 to 15 percent, but in the same period of time world population increased 30 percent. The war decreased food supplies over most of the earth's surface and the pre-war level was not regained until 1952. But by that time there were many more millions of people to feed. So, there are more people than ever in the world today, and they seem to be getting hungrier.

James Bonner, professor of biology at Caltech, has studied world food problems and has concluded that if we made a maximum effort to apply all of the technology that we have at the present time to all of the potentially cultivable land on the earth's surface,

"Identifying and Encouraging Potential Scientists" is a transcript of a talk given to high school teachers visiting the Institute on Caltech's annual Students' Day, December 3, 1960.

we could produce just enough food to feed these future populations by the time they arrive. Obviously, it would require a tremendous number of scientists and engineers to make such an effort.

III. RAW MATERIALS

Before the Industrial Revolution few consumer goods were manufactured, and only small quantities of raw materials were needed to produce them. With the advent of the Industrial Revolution the machine operator could turn out many more products – but he consumed more raw materials in the process.

An industrialized nation consumes raw materials in vast quantities. For example, the per capita annual steel production in India is about 9 pounds per person. In the United States it is 1300 pounds. India consumes 1/10th of a barrel of oil per person per year, the United States 170 times as much. Obviously, it takes a great amount of technological skill to design and build the equipment necessary to consume raw materials at this rate.

When U.S. levels of consumption are examined in conjunction with the demands of underdeveloped countries, it seems clear that the world has a tremendous challenge ahead of it. If the present peoples of the world now living at extremely low levels of consumption (approximately two billion persons) were brought up to the standard of living of the contemporary United States, we would have to extract from the earth each year 18 billion tons of iron, 300 million tons of copper, 300 million tons of lead, 200 million tons of zinc, 30 million tons of tin, and huge quantities of other metals and non-metals. These are totals that are well over 100 times the present world annual rates.

Surely, a tremendous technical effort will be necessary to reach these higher rates of production.

There is also the matter of the richness of ore deposits. For all of man's existence, up to the last century or two, raw materials have assumed a relatively unimportant part in his struggle for survival. He fashioned only a few artifacts from raw materials lying on the surface of the earth. For example, he could pick up pure copper, fashion it into tools, and use it without further treatment. However, with increased industrialization, uses of copper increased many-fold, and the copper ore that was available decreased in purity. Some time ago we were processing 5 percent copper. Today this has dropped to 0.8 percent. We can certainly look forward to its dropping to an even lower level, perhaps to 1/10 or even 1/100 of 1 percent.

Where will this end? How low can one go in obtaining necessary raw materials? According to Harrison Brown, professor of geochemistry at Caltech, the lower limit is found in ordinary igneous rocks. These contain most of the elements that are necessary for the perpetuation of a highly industrialized society, and in proportions that are not unreasonable from the standpoint of their industrial use.

One hundred tons of average igneous rocks contains, for example, 8 tons of aluminum, 5 tons of iron, 180 pounds of manganese, 40 pounds of nickel, 20 pounds of copper and 40 pounds of lead. Many of the elements which are not found in sufficient quantity in igneous rocks – such as chlorine, bromine, and iodine – can be found in the oceans. Other elements like nitrogen and oxygen are readily available in the atmosphere. Still others can be found in the practically inexhaustible supplies of limestone, which is a source of carbon; in gypsum, which is a source of sulfur; and in phosphate rock, which is a source of phosphorus.

Given the necessary energy, and enough technological knowledge to develop the processes of extraction, the people of the earth *could*, if need be, support themselves entirely with the leanest of ores, the waters of the ocean, the rocks of the earth's crust, and the air around them.

Here again, vastly increased technical development will be necessary.

IV. ENERGY

It takes energy to extract metals from low-grade ores. It takes energy to manufacture equipment. It takes energy to run it. It takes energy to produce food. Current world energy consumption is about 3.7 billion tons of coal per year. If all the people in the rest of the world were to expend energy at the current per capita rate of the United States, consumption would increase sixfold, to the equivalent of approximately 22 billion tons of coal each year. This is a rate of consumption that would exhaust the fossil fuel reserves of the world in 40 or 50 years. But it is also a rate that is dictated by the U.S. standard of living, which is envied by the rest of the peoples of the world.

To meet the increased demand for raw materials, food, higher standards of living, and industrialization, we must develop other sources of energy.

Dr. Brown has calculated that in every ton of ordinary granite, energy which is equivalent to about 15 tons of coal can be economically extracted in the form of localized uranium and thorium. This means that from the long-range point of view man will be able, if it becomes necessary, to extract his energy needs from the very rocks of the earth's crust – the same rocks that can supply the variety of metals needed for the support of a highly industrialized civilization. However, again, this immediately implies the development and application of very advanced technological skill.

Population is going up exponentially. World energy consumption is increasing exponentially. The richness of raw materials is decreasing. These trends warn us of the tremendous demands for technological and scientific knowledge we will face in the future. In fact we are already facing them in the shortages of engineers and scientists we have witnessed in the last several years – shortages that may possibly be even more clearly understood in the light of past trends.

In the United States in 1900 there were 11 million farmers, in 1950 only 7½ million. Yet in 1900 the 11 million represented 38 percent of the working force, while in 1950 they represented only 13 percent of a labor force that had doubled to 60 million. So, while the labor force had increased rapidly, the proportion of farmers in this labor force had dropped.

Even greater changes occurred among the professions. In 1900 one million professional and technical workers made up 4½ percent of the labor force; by 1950 this group had increased fourfold and now constituted 7½ percent of the working force.

A current report of the Department of Labor notes that, for the first time in the history of the United States, the number of persons employed as professional, office, and sales workers exceeds the number employed in manual occupations. The Department predicts a growth rate for professional and technical workers that is nearly double that for any other occupational group. It expects no change among unskilled workers, and a continuing decline of farmers.

These early trends in the change in demand for high-level talent are now becoming more meaningful. If they continue in the same way for the next 50 years, we will need two or three times as many scientists as will be available.

This is a unique situation. We have no past experience upon which to draw in considering the problem. Furthermore, the shortage of high-level scientific talent is going to be long-lasting – partly because of the forces of world industrialization, and partly because of the complex pattern of personal qualities and experiences necessary to make a scientist or engineer.

At the present time this shortage of high-level talent is perhaps only inconvenient. In the future it will become critical. Therefore, any success in combating it will be of great importance to the future of our society. There are many avenues of approach to the problem, but one of the most important involves the early identification of potential scientists and engineers.

Such early identification and encouragement would go far toward reducing our present waste of high-level talent. And we certainly are wasteful. In the United States only one-third of those young people capable of doing college work actually go on to college. Only one-half of the *very* capable, and only two-thirds of the *exceptionally talented* go on to obtain college degrees. Thus we lose two-thirds of the capable, one-half of the very capable, and one-third of the exceptionally talented – or approximately half a million college graduates each year.

Of all groups that contribute to the development of scientists and engineers in the United States perhaps high school teachers are the most influential. They provide the capable student with his first major exposure to science as a body of knowledge, and to the scientific method as a technique for gaining more knowledge. They are the ones who may provide the inspiration or exhibit the enthusiasm and satisfaction that can be gained from working in science.

To become a scientist a student must make educational and vocational decisions in the 9th, 10th, and 11th grades – long before he has the information or the experience necessary to choose a lifetime career. The high school science teacher is in the most strategic position to help him select goals that are appropriate and attainable.

The science teacher is also in the most strategic position to identify the potential scientist or engineer, and to encourage him to consider science as a career. The more skilled the teacher is in making this early identification, the better he can provide the information and experience that will help develop the student's inclinations toward science.

Little is known at present about the psychological characteristics of potential scientists. However, current research in the psychology of occupations does provide some basis for their identification early in the high school years.

There seems to be a general pattern of psychological abilities and traits that is typical of people in technological occupations. Within this general pattern there are more specific sub-patterns, typical of different kinds of technical activities (such as theoretical scientist, experimental scientist, engineer, sales engineer, technician). The pattern for the high-level research scientist is one of the better known ones. In broad outline, it is as follows:

I. INTELLECTUAL ABILITY

It is necessary to have a certain amount of intellectual ability in order to do the kind of thinking and learning that a scientist must do. But this is more than just having a high IQ. In reality it means having a specific pattern of abilities.

In his analysis of the thinking processes, Professor J. P. Guilford has, to date, identified almost 50 different elements or factors that make up "mental activity." It is probable that different scientific activities require different patterns of factors for success, but these patterns have not yet been worked out. For current early identification we must content ourselves with what are probably groups of factors. For example, to have the best chance of success in a science curriculum a student should be high in quantitative ability, abstract reasoning, symbolic reasoning, understanding logical relationships, and recent and remote memory.

II. VALUES

Many high school students take the Allport-Vernon Study of Values -- a psychological test for measuring an individual's value system. It measures aesthetic,

continued on page 26

economic, religious, theoretical, social and political values. Of these, the potential scientist scores high on Theoretical and low on Economic and Social values.

III. OCCUPATIONAL PREFERENCES

Many high schools routinely administer the Kuder Preference Record to their students for vocational guidance purposes. It measures the kinds of activities the student prefers. The potential scientist has a clear pattern on this test. He should be highest on the Scientific and Computational scales, and somewhat less high on the Literary and Musical scales. He should be lowest on the Persuasive and Social Service scales, and somewhat low on the Clerical and Mechanical scales.

IV. OCCUPATIONAL INTERESTS

The Strong Vocational Interest Inventory measures the degree to which the student's likes and dislikes compare with those of people who are successful in a variety of occupations. The potential scientist scores high on the scales for Artist, Psychologist, Architect, Physician; and on the group that includes the Physicist, Chemist, Mathematician, and Engineer scales. He is also high on the Math-Physical Science Teacher, Musician, and Certified Public Accountant scales. These are the occupational groups whose patterns of likes and dislikes are similar to his. He scores low on the Banker, Mortician, Real Estate Salesman, and Life Insurance Salesman scales. These are the groups whose likes and dislikes are the opposite of his.

V. PERSONALITY TYPE

Lastly, the potential scientist has a specific approach to the world around him. He prefers his intuitions to his senses. He responds more to inner hunches or intuitive possibilities than to the actualities around him. The impressions that come to him from the outside via his senses are much less important to him than the ideas and implications he can derive from them. He prefers thinking to feeling.

In his formation of judgments and values he is systematic, objective, and impersonal rather than sympathetic or antagonistic, personal or subjective. If logic dictates, he will act counter to his feelings. He is introverted rather than extroverted. His main points of reference are internal and are focussed on his ideas, thoughts about himself, and private personal concerns. He gives secondary consideration to the external world of people and things. In David Reisman's term he is inner-directed.

He also tends to withhold judgment until all the facts are in, and he has had a chance to order and rationalize them in terms of his own private system of standards and values. As a consequence of this style of life he tends to be quiet and reserved and somewhat uncomfortable in casual social situations. He is primarily interested in his studies and does very well in them. He is usually original and brilliant in scientific and theoretical subjects. Skeptical, critical, and independent, he is always open to new facts, new experiences, or new conditions without prejudging them. He is generally very determined and often stubborn; he can sometimes be led, but never driven.

With the addition of personality type to the patterns of interests, preferences, values, and intellectual factors, we have what might be called the research scientist profile.

Obviously, a specific scientist will not always match this profile in detail. With as complicated and elaborate a set of patterns as these, there are many ways in which the individual might deviate. But the more closely he matches the profile, the more likely it is that he will have the abilities, motivations, and inclinations to find science a satisfactory and rewarding career. The more he deviates and the more he approximates the profile of some other occupational group, the less likely it is that he will continue to pursue a scientific career.

When we look at what comprises the profile — intellectual abilities, values, preferences, interests, and personality type — it is immediately evident that these are not human characteristics that can be developed overnight in college or high school. In a sense, they begin to develop at birth, with the interaction between an individual's genetic makeup and his environmental experiences. They take a lifetime to form, continuing to crystallize throughout much of adulthood. However, having begun at birth, the profile has much stability by high school age, and by then cannot be drastically altered. Neither the high school nor the college can make a "scientist" out of a "non-scientist." But these patterns often become visible in rather primitive form even before high school age. It *is* possible, then, to make earlier identification than we commonly do today, if we will only pay more attention to what we already know, and if we will work diligently to learn more about these patterns.

This early identification is of crucial importance, because we can provide the most inspiring experiences for a student only after we have identified his unique potential.

Here, then, is the challenge to our industrial society. Only through maximum use of our high-potential talent can we maintain the rate of growth that we have experienced in the past. Only by an increased knowledge and use of these patterns for early identification can high school teachers help their students realize their potential more fully — and can the teacher become more effective as a teacher. This is indeed the most challenging aspect of education today.

THE GREAT ROSE BOWL HOAX

Undergraduate pranks, as practically any graduate will tell you, are nothing new. In fact, freshman knowledge of English literature reveals that pranks have been around as long as the Reeve's Tale – and they probably have a long antiquity before that.

Certainly, at Caltech, undergraduate pranks are as old as the Institute. Hardly a day goes by that some Tech students aren't out-talking people at Pershing Square, or hanging funny signs in obscure places, or engaging in some other moderately interesting frolic. Every so often, however, a truly noble stunt is pulled off – a stunt involving untold man-hours of preparation and imagination above and beyond the call of reasonable likelihood. (Caltech students, so somebody said, are above and beyond reasonable likelihood anyway, so they appreciate noble stunts.)

One of these occurred this month, before a national television audience, during the half-time ceremonies at Pasadena's annual Rose Bowl football game.

On this notable occasion a group of Techmen undertook to "rewrite the scenario" for the University of Washington's half-time card demonstrations. This was a task involving Brobdingnagian dedication. Football game card-sections usually involve upwards of 1,000 students who sit *en masse* and hold up colored cards to form patterns – words and mascots' pictures are favorites. The Caltech pranksters completely changed three of Washington's patterns.

First they made the unwitting Northerners spell out "CALTECH" instead of "WASHINGTON."

Then, when the card-section was supposed to spell out "huskies" in flowing script, they arranged things so that, instead of the "h," the dot over the "i" appeared first. The tail of the "s" showed up next. And then, flowing inexorably backwards, the cards went from "s" to "e" to "i" to "k" to "s" to "u" to "h" – to finally, indeed, spell out "huskies."

Then the pranksters had the card-section depict a Caltech Beaver in place of the Washington mascot.

These surprising substitutions came in numbers 10, 11, and 12 of a projected 14-trick sequence. As a result, the frustrated Husky card-section went out of business after pattern 12.

This particular stunt was undertaken by 14 members of Lloyd House at Caltech. Most of them are in the class of 1962, and most of them belonged to freshman section "K," which was notorious in its year for wacky stunts. Obviously, they've kept their section loyalty, and their fondness for folderol. (In fact, looking to the future, they have approximately 50 prank plans carefully filed away in two overstuffed boxes of IBM cards.)

The Fourteen started work on the great Rose Bowl hoax before Christmas by making a series of telephone calls to various Rose Bowl officials. From these, they discovered that the Washington and Minnesota card-section students would arrive on December 29, and would stay at Long Beach State and Occidental Colleges, respectively.

Picking out Washington to pick on, the Fourteen sent one of their number to Long Beach State, posing as a reporter for the Los Angeles Dorsey High School *Dorseygram*. He arrived 15 minutes after the Washington band and card-section had arrived, and asked for the card-demonstration director. He was sent to Room 105 of a Long Beach State dormitory, where he found the director stashing away his precious cards until New Year's Day. Room 105, the Techman noted, was located only two doors away from an easily-lock-picked entrance to the dormitory.

Approaching his prey and offering him a cigarette, the Techman asked the director just how his card-section worked. The director obligingly told him, down to the minutest detail.

Each of Washington's 2,232 card-section members, said the director, gets his own stack of colored cards to hold up, as well as an instruction sheet that looks something like this:

1. PURPLE	4. VIOLET
2. PINK	5. AQUAMARINE
3. POLKA DOTS	6. ZAFFER

ETC.

The card-section is divided into numbered subsections. On each stunt, the director calls out section numbers, sounding a little like a deliberate quarterback. When a subsection number is called, each of its members holds up his cards. For example, a director will call out 1-2-3-4-5, and the whole card section will spell out H-Y-M-I-E with each subsection holding up its letter when its number is called.

The would-be reporter also found out that the card-

continued on page 30

section director planned to eat dinner about an hour later. One of the Techmen came back at that time, picked his way into the room, and took an instruction sheet from the middle of the heap the director had hidden behind a table. "They'd never miss one," hissed the lock-picker.

They didn't miss one, either, as the Fourteen discovered after they had made a hurried trip to a nearby printer to have approximately 2,300 near-duplicates of the instruction sheets run off for about $30.

They also discovered that their printer had furnished them with *manila* sheets to replace Washington's *white* ones, but after some futile attempts at dyeing, they gave up and hoped that the gods would mask the difference.

The next day, Saturday, the Techmen again arrived at Long Beach State when the Washingtonians weren't there. (The intrepid pseudo-reporter had discovered that everybody was going to Disneyland that day.) Picking the lock again, they stole the master plans – large pieces of graph paper colored the way the stunts were to appear – from the director's satchel. They then decamped for the Lloyd House lounge.

There, they spread their 2,232 substitute instruction sheets over the tables and floor, and set about stamping them with "correct" instructions – changing the words in demonstrations 10 and 11, and rounding off the Husky's ears and giving him buck teeth to turn him into a Beaver in demonstration 12. Ten hours later, the project finished, five of the Fourteen and 2,232 new cards left once more for Long Beach and Room 105.

Knowing that Washington was elsewhere, celebrating New Year's Eve, the Techmen picked their way into the room once again, replaced the master plans, and substituted the altered instruction sheets for the original ones. Then they returned to Pasadena for a day-and-a-half wait.

Nobody knows whether Washington discovered the substitutions ahead of time – because there would have been no time for re-substitutions anyway. As it stood, the card-section director was observed riding contentedly in the Rose Parade on the morning of the game – and standing open-mouthed in the afternoon when his long-planned sequence went awry in stunts 10, 11, and 12.

Which is all the Techmen wanted anyway. As one of the Fourteen explained: "We just did it to see if it could be done."

—Lance Taylor '62

Among the Missing

The Caltech Alumni Association is trying to complete its file of Caltech publications and is still lacking some of the early issues of the school's annuals. Would anyone who has copies of the following publications be willing to send them to the Association?

THE POLYTECHNIC
1896 through 1912

THE THROOP TECH
1913 through 1915

Personals

1914

Albert W. Wells died on August 3 of cancer. He had retired in 1945 from the engineering department of the Los Angeles Railway. He is survived by his sister, Rachel Wells.

1920

Russell M. Otis, PhD '24, died on November 19 of a cerebral hemorrhage. At the time of his death he was vice president of the Oil Shale Company in Beverly Hills. Dr. Otis had a fellowship with the first physics faculty at Caltech and, under the direction of Robert Millikan, was the first scientist to do research at the Institute on cosmic rays.

From 1924 to 1927 he worked at the Bell Laboratories in New York, where he designed the vacuum tube used in the first transatlantic telephone. He then served as research director at the Hughes Development Company until 1931. He spent a number of years as a consulting engineer in private practice before becoming research director of the Lane-Wells Company in 1941, and in 1952 he became vice president of the firm. He joined Oil Shale in 1958.

He is survived by his wife, a son, Robert, and two grandchildren.

1922

Richard M. Bozorth, PhD, writes from Short Hills, N.J., that he "made a second trip to the USSR at the request of the State Department and happened to be in Moscow at the break-up of the Paris Conference, and in Sverdlovsk (a closed area) when the U-2 was in the news. I received an inscribed gift at the Sixth Annual Conference on Magnetism for founding the conference. I'm retiring from the Bell Laboratories next April and am planning to accept an invitation to spend a year at the University of Tokyo, and also spend some time as a consultant to the U.S. Navy."

1930

Henry Imus is now rotating shift superintendent in the plant superintendent's office of Technicolor, Inc. He is also the proud co-possessor of an Academy Award for an invention of wet printing motion picture film. "Our family is exploding," he writes. "We've got kids in Sacramento (at Aerojet); at the University of Virginia (working for a master's degree in business); and at U.C. Riverside (where our freshman daughter is studying to become a lab technician)."

1931

Brigadier General Benjamin G. Holzman, MS '33, has been named Commander of the Air Force Cambridge Research Laboratories in Bedford, Mass. He was formerly Commander of the Air Force Office of Scientific Research in the Air Research and Development Command. He is married and has a daughter, Katherine, 17.

1932

Walter P. Huntley, a partner in the law firm of Fulwider, Mattingly & Huntley in Los Angeles, died of a heart attack on December 12. A former JPL employee, Walter also worked at Decca Records in Middlesex, England, for over a year before joining the firm of patent attorneys. He is survived by his wife; a son, Michael, who is in the Army in Japan; a daughter, Judy; and twins, Lindsay and Christina.

1934

Paul L. Kartzke, MS '35, takes over as executive vice president of the Shell Oil Company of Canada in Toronto this month. He has been vice president in charge of exploration and production at the Calgary Office. The Kartzkes have three children: Barbara, who graduated from the University of Colorado last June, and is now studying at the University of Geneva; Paul, a freshman at Stanford; and Richard, a student at Lawrenceville Academy in New Jersey.

1938

Charles F. Robinson, MS, PhD '49, director of the Bell & Howell Research Center in Pasadena, has been elected vice president of Consolidated Electrodynamics Corporation, a subsidiary of Bell & Howell. He has been with CEC since 1947.

1940

Comdr. William A. Spooner was transferred last summer from the Bureau of Naval Weapons in Washington, D.C., to Indianapolis, where he is now programs officer at the U.S. Naval Avionics Facility. "My wife and two children (Billy, 8, and Eileen, 6) are having their first experience of living in the Midwest," he writes. "Next February I will complete 18 years in the Navy — a career I never anticipated when I graduated from Caltech. Most of my duty has been in the field of aviation electronics but has broadened into more general management activities since I graduated from the Harvard Business School in 1956."

1942

Parameswar Nilakantan, MS, writes from Bangalore, India, that he is now director of the National Aeronautical Laboratory there. He was formerly director of technical development and production (air) at the Ministry of De-

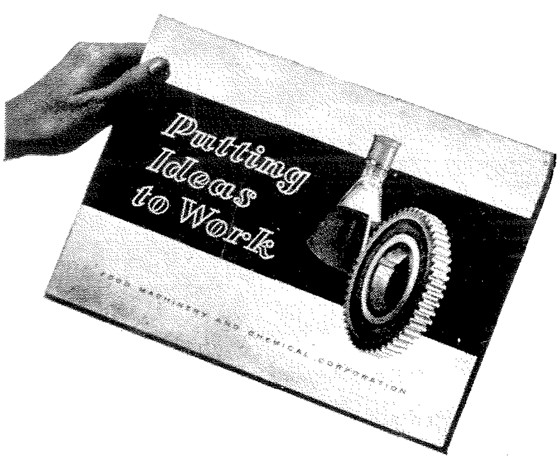
continued on page 36

A REAL CAREER OPPORTUNITY FOR GRADUATES

COMMERCIAL OPERATIONS:

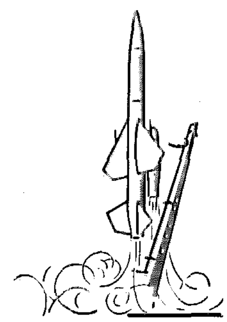
Graduates planning careers in chemical, electrical or mechanical engineering, will be interested in evaluating the opportunities offered by Food Machinery and Chemical Corporation, with headquarters in San Jose, California—a nation-wide organization that puts ideas to work through creative research and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

Personals . . . *continued*

fense of the Government of India. He has been vice president of the Aeronautical Society of India since 1958.

1943

William C. Thompson is now working with digital computers at Autonetics. He was formerly with North American Aviation in Downey. The Thompsons have two daughters, Margaret 3½, and Shelby Lee, 1½.

1944

Walter Fillipone, MS, senior geophysicist at the head office of the Union Oil Company in Los Angeles, writes that he had a visit with *Enrique Silgado*, MS '44, in Lima, Peru, last year. Enrique is teaching at the University there. Walter spent a couple of months last summer in Australia where he supervised the start of Union Oil's exploration in the Surat Basin in Queensland.

Robert McAnlis writes that he and his family are now in New Jersey, where he operates out of the general engineering headquarters of the Johns-Manville Company in Manville. Bob travels to the various Johns-Manville plants in New Jersey and California, acting as a consultant in industrial ventilation and dust control. The McAnlises have three daughters — 12, 10 and 8.

1945

James K. Nason died in Los Amigos Hospital in Downey on November 21 of polio. He had gained national recognition as resident engineer on the Long Beach Bridge and the Long Beach Freeway in North Long Beach, by predicting the amount of settling within one-eighth of an inch. He was on his way to greater success as a construction engineer when polio struck five years ago. After some time in an iron lung and a year of hospitalization he came home. He continued working in a specially rigged wheelchair and also painted pictures as a hobby. He was offered a scholarship by the National Artists School recently. Jim is survived by his wife and two daughters — Cynthia, 7, and Deborah, 8.

1950

Adam Schuch, PhD, is alternate group leader at the Los Alamos Scientific Laboratory in New Mexico. He has been at the lab for 11 years.

John B. Rutherford, MS, is now a partner in a new firm, Rutherford & Chekene, consulting engineers in San Francisco. He was formerly in business for himself as a structural engineer in Los Altos.

Jerome K. Delson, MS, PhD '53, will be in Copenhagen for a year as a consultant in power system planning for the North Zealand Electricity and Tramway Company.

Floyd B. Humphrey, PhD '56, research group supervisor at JPL, now has two daughters — Virginia, born on November 5, and Victoria, 4.

1951

Woldemar V. Jaskowsky, consultant at the Plasmadyne Corporation in Santa Ana, is in Germany for a year at the Institute of Plasmaphysics in Munich.

J. P. Nitsch, PhD, is associate director of a phytotron now under construction at Gif-sur-Yvette, about 15 miles south of Paris. The lab is being built by the French counterpart of the National Science Foundation. "As good followers of Caltech's example and lead in this field," writes Jean, "we have patterned the general disposition of climatic rooms after that in the Earhart Plant Research Laboratory. We have added a biochemistry laboratory and a "semi-phytotron" to the structure — making this phytotron the largest in the world. Even though the lab may still take some 2 years to complete, research work on naturally-occurring plant hormones is already well started, and workers from various countries are coming here. Caltech's pre-and post-doctoral research fellows will always be especially welcome."

1955

James L. Adams, instructor at Stanford University, was married on November 9 to Miss Judith Scholtz at Knights Landing.

1956

Thomas P. Gordon, MS, PhD '59, is now in the research and development department of Five Chemicals of Canada, a subsidiary of S. B. Penick and Co. in Toronto. The Gordons have a son, Christopher, born last March.

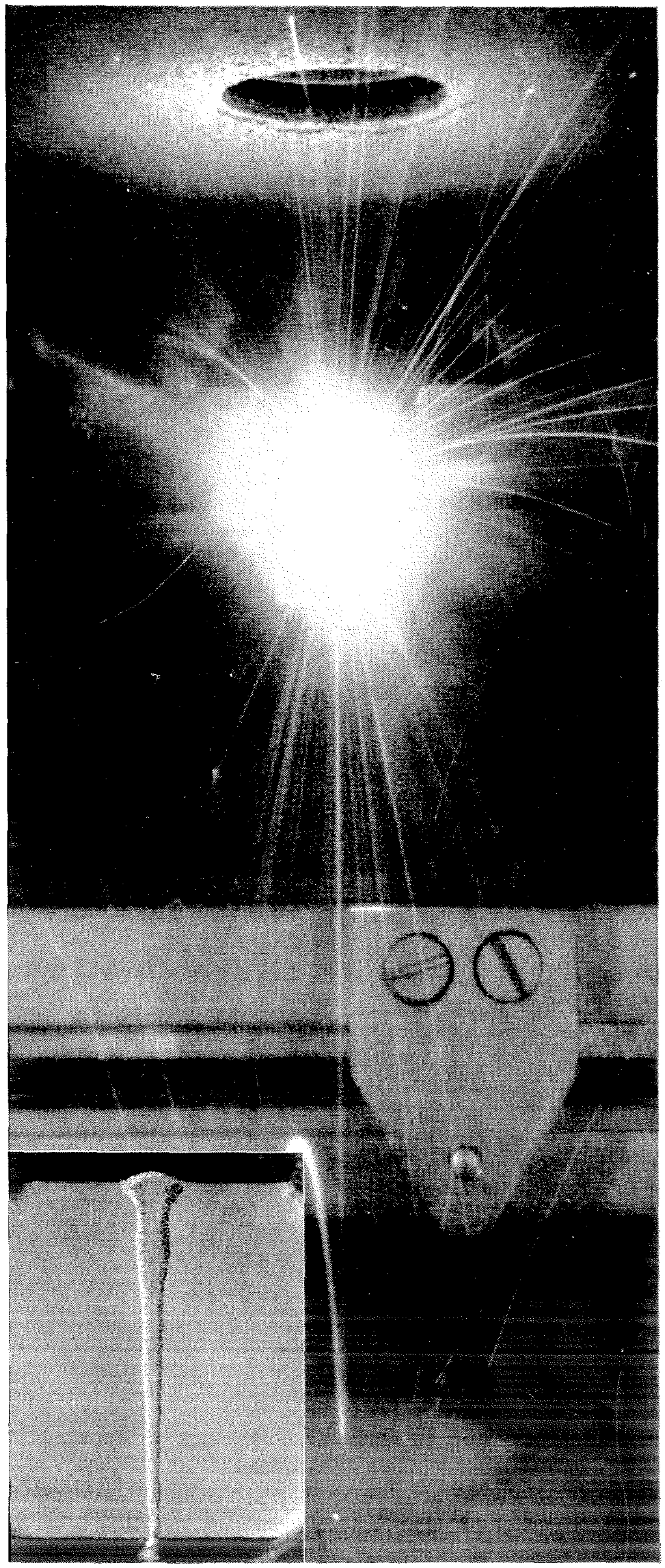
Byron Johnson, Jr., is city engineer of Claremont, Calif. He has two sons — Douglas, 3½, and Neal, 1½.

Raymond Orbach writes that "after getting my BS in physics, my wife and I moved to Berkeley where in 1958 our son, David, was born. In January 1960 I received my PhD. Since then we have been living in Oxford, England, where I have been doing research at the Clarendon Laboratory on an NSF fellowship. Our second child was born here — a girl, Deborah. With the renewal of my NSF grant we expect to be here yet another year."

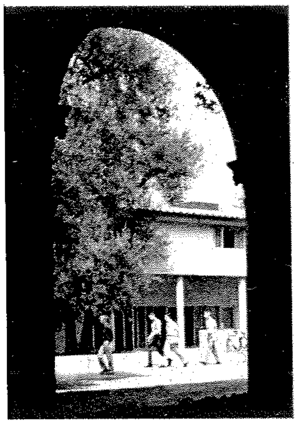
1957

Lt. Pierre Lesgourgues, MS, is still in the French Air Force serving as a pilot in Algeria. He hopes, however, to return to civil engineering in the spring.


what is
availability?



CALTECH CALENDAR



ALUMNI EVENTS

March 4	Annual Dinner Dance
May 6	Annual Seminar
June 7	Annual Meeting

ATHLETIC SCHEDULE

BASKETBALL

January 20
Caltech at Occidental

January 24
Whittier at Caltech

January 27
Caltech at LaVerne

January 28
Caltech at Upland College

January 31
UC Riverside at Caltech

February 4
Pomona at Caltech

February 7
Cal Western at Caltech

February 10
Claremont-Harvey Mudd at Caltech

FRIDAY EVENING DEMONSTRATION LECTURES

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

January 20
India
—Robert Huttenback

January 27
Essential Oils
—A. J. Haagen-Smit

February 3
Organic Photochemistry
—George Hammond

February 10
Blood and Heredity
—Ray Owen

ALUMNI ASSOCIATION OFFICERS

PRESIDENT
Ralph W. Jones, '38

VICE-PRESIDENT
Holley B. Dickinson, 36

SECRETARY
Donald S. Clark, '29

TREASURER
John R. Fee, '51

BOARD OF DIRECTORS
Robert J. Barry, '38
Franklin G. Crawford, '30
Frederick W. Drury, Jr., '50
John D. Gee, '53
William L. Holladay, '24
Howard B. Lewis, Jr., '48
Claude B. Nolte, '37

ALUMNI CHAPTER OFFICERS

NEW YORK CHAPTER

President — Harry J. Moore, '48
I.B.M. Corporation, 590 Madison Avenue

Vice-President — James C. Townsend, '54
404 East 65th St.

Treasurer — H. Nelson Upthegrove, '54
56 Center St., Bernardsville, N.J.

Secretary — Frank B. Jewett, Jr., '38
Vitro Corporation of Ameria, 261 Madison Avenue

WASHINGTON, D.C. CHAPTER

President — Frank H. Shelton, '49
Armed Forces Special Weapons Project

Secretary-Treasurer — Richard G. King, '49
Applied Physics Laboratory, Johns Hopkins University
Silver Springs Maryland

SAN FRANCISCO CHAPTER

President — James A. Ibers, '51
Shell Development Co., Emeryville

Vice-President — Lee A. Henderson, '54
Weld Rite Company, Oakand

Secretary-Treasurer — Edwin P. Schlinger, '52
Scott-Buttner Co., Inc., Mountain View

Meetings: Fraternity Club, 345 Bush St., San Francisco
Informal luncheons every Thursday

CHICAGO CHAPTER

President — Laurence H. Nobles, '49
Department of Geology, Northwestern University, Evanston

Vice-President — Philip E. Smith, '39
Eastman Kodak Company, 1712 Prairie Avenue

Secretary-Treasurer — Thorne J. Butler, '51
Medical Center, Northwestern University

SACRAMENTO CHAPTER

President — James W. Dunham, '29
Division of Small Craft Harbors, State of California, Dept. of Natural Resources

Vice-President — Eugene W. Bolster, '45
Aerojet-General Corporation

Secretary-Treasurer — G. Donald Meixner, Jr., '46
State of California, Dept. of Natural Water Resources

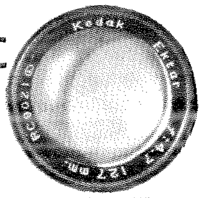
Meetings: University Club, 1319 "K" Street
Luncheon first Friday of each month
Visiting alumni cordially invited—no reservation

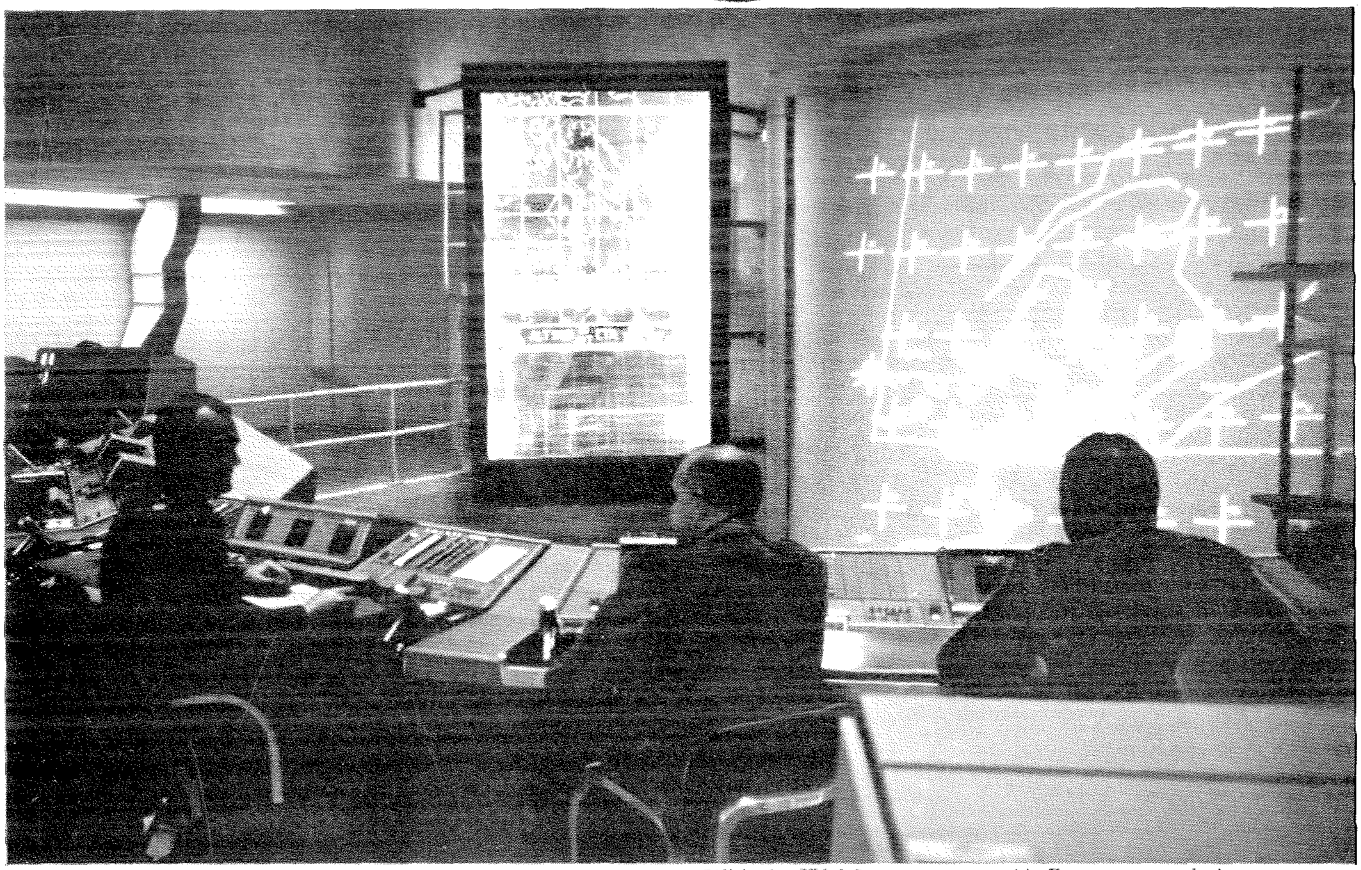
SAN DIEGO CHAPTER

Chairman — Maurice B. Ross, '24
3040 Udal Street

Secretary — Frank J. Dore, '45
Convair

Program Chairman — Herman S. Englander, '39
U.S. Navy Electronics Laboratory

If your sights are set  on electronics–



With the IBM Sage computer, Air Force personnel view computer-generated displays projected in the Command Post.

–you'll find **Photography at Work** with you

THE engineer working in electronics finds photography one of his most valuable tools. For example, he uses camera and film to capture and study the fleeting transient on the oscilloscope face.

X-rays and film provide him with a check on the internal integrity of sealed components. Even intricate circuits can be printed and miniaturized by photographic methods.

There's hardly a field on which you can set your sights where photography does not play a part in simplifying work and routine. It saves time and costs in research, on the production line, in the engineering and sales department, in the office.

So in whatever you plan to do, take full advantage of all the ways photography can help.

CAREERS WITH KODAK:
With photography and photographic processes becoming increasingly important in the business and industry of tomorrow, there are new and challenging opportunities at Kodak in research, engineering, electronics, design, sales, and production.

If you are looking for such an interesting opportunity, write for information about careers with Kodak.

Address: Business and Technical Personnel Department,
Eastman Kodak Company.
Rochester 4, N.Y.

EASTMAN KODAK COMPANY
Rochester 4, N. Y.

Kodak
TRADEMARK

One of a series

Interview with
General Electric's Earl G. Abbott,
Manager—Sales Training

Technical Training Programs at General Electric

Q. Why does your company have training programs, Mr. Abbott?

A. Tomorrow's many positions of major responsibility will necessarily be filled by young men who have developed their potentials early in their careers. General Electric training programs simply help speed up this development process.

In addition, training programs provide graduates with the blocks of broad experience on which later success in a specialization can be built.

Furthermore, career opportunities and interests are brought into sharp focus after intensive working exposures to several fields. General Electric then gains the valuable contributions of men who have made early, well-considered decisions on career goals and who are confidently working toward those objectives.

Q. What kinds of technical training programs does your company conduct?

A. General Electric conducts a number of training programs. The G-E programs which attract the great majority of engineering graduates are Engineering and Science, Manufacturing, and Technical Marketing.

Q. How long does the Engineering and Science Program last?

A. That depends on which of several avenues you decide to take. Many graduates complete the training program during their first year with General Electric. Each Program member has three or four responsible work assignments at one or more of 61 different plant locations.

Some graduates elect to take the Advanced Engineering Program, supplementing their work assignments with challenging Company-conducted study courses which cover the application of engineering, science, and mathematics to industrial problems. If the Program member has an analytical bent coupled with a deep interest in mathematics and physics, he may continue through a second and third year of the Advanced Engineering Program.

Then there is the two-year Creative Engineering Program for those graduates who have completed their first-year assignments and who are interested in learning creative techniques for solving engineering problems.

Another avenue of training for the qualified graduate is the Honors Program, which enables a man to earn his Master's degree within three or four semesters at selected colleges and universities. The Company pays for his tuition and books, and his work schedule allows him to earn 75 percent of full salary while he is going to school. This program is similar to a research assistantship at a college or university.

Q. Just how will the Manufacturing Training Program help prepare me for a career in manufacturing?

A. The three-year Manufacturing Program consists of three orientation assignments and three development assignments in the areas of manufacturing engineering, quality control, materials management, plant engineering, and manufacturing operations. These assignments provide you with broad, fundamental manufacturing knowledge and with specialized knowledge in your particular field of interest.

The practical, on-the-job experience offered by this rotational program is supplemented by participation in a manufacturing studies curriculum covering all phases of manufacturing.

Q. What kind of training would I get on your Technical Marketing Program?

A. The one-year Technical Marketing Program is conducted for those graduates who want to use their engineering knowledge in dealing with customers. After completing orientation assignments in engineering, manufacturing, and marketing, the Program member may specialize in one of the four marketing areas: application engineering, headquarters marketing, sales engineering, or installation and service engineering.

In addition to on-the-job assignments, related courses of study help the Program member prepare for early assumption of major responsibility.

Q. How can I decide which training program I would like best, Mr. Abbott?

A. Well, selecting a training program is a decision which you alone can make. You made a similar decision when you selected your college major, and now you are focusing your interests only a little more sharply. The beauty of training programs is that they enable you to keep your career selection relatively broad until you have examined at first hand a number of specializations.

Furthermore, transfers from one General Electric training program to another are possible for the Program member whose interests clearly develop in one of the other fields.

Personalized Career Planning is General Electric's term for the selection, placement, and professional development of engineers and scientists. If you would like a Personalized Career Planning folder which describes in more detail the Company's training programs for technical graduates, write to Mr. Abbott at Section 959-13, General Electric Company, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC