ENGINEERING AND SCIENCE

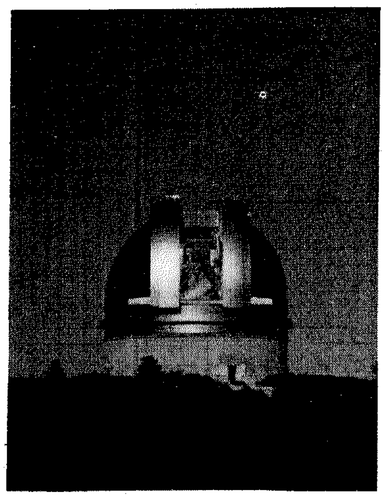
JANUARY / 1951

New Palomar Pictures . . . page 8

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

ENGINEERING AND SCIENCE

IN THIS ISSUE



THE PICTURE on this month's cover is one of the most striking shots we've ever seen of the much-photographed observatory on Palomar Mountain. It was taken at night, by the light of a full-moon, with a one-hour exposure. The lights inside the opened dome were turned on for 15 minutes during this time. The result: a really great photograph. You'll find some recent pictures taken by the telescope itself on pages 8 and 9.

UNDERSTANDING SCIENCE

The article on page 10 by Dr. Linus Pauling, Chairman of the Division of Chemistry and Chemical Engineering at the Institute, was originally written for UNESCO (the United Nations Educational, Scientific and Cultural Organization).

Anyone interested in obtaining extra copies of it may do so by writing to the Natural Sciences Department of Unesco, 19 Avenue Kleber, Paris 16—or to E & S. We say this in advance because we expect there will be a demand for extra copies of the article for some time to come. Any proposal as reasonable, and as revolutionary, as Dr. Pauling makes in this piece is sure to attract a number of readers—and, we devoutly hope, supporters.

PICTURE CREDITS

Cover	Mt. Wilson & Palomar Observatories
p. 4	Edna Sommer
pps. 5, 6	Wm. V. Wright
pps. 8, 9	Mt. Wilson & Palomar Observatories
p. 16	Ross Madden—Black Star

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BOOKS

STATIC AND DYNAMIC ELECTRICITY — 2ND. ED.
by W. R. Smythe
McGraw-Hill, New York, $6.00

Reviewed by Robert B. Leighton
Assistant Professor of Physics

THIS THOROUGHLY REVISED second edition of a text which was already one of the most useful in its field has resulted in an even more useful book. The units have been changed throughout to the rationalized MKS system, much new material has been added in the fields of wave-guides, cavity resonators and antennas, and many of the later chapters have been rewritten and simplified. In addition, many new problems with useful applications are given (with answers, so that the results can be used directly by those who do not wish to work the problems).

Much of the work in the chapters on electromagnetic radiation is greatly simplified through the introduction of orthogonal vector surface harmonics. Many of the results and methods are not to be found in the literature, and the index includes references not only to the text material, but also to the problems at the ends of the chapters. This feature should prove quite useful to engineers who have boundary value problems to solve.

THEORY AND DESIGN OF ELECTRON BEAMS
by J. R. Pierce

D. Van Nostrand Co., Inc., New York, $6.00

THIS BOOK IS an attempt to assemble—with what the author describes as "reasonable orderliness" — the minimum amount of theoretical material necessary for a good understanding of electron flow and electron focusing in devices other than electron microscopes and image tubes. The material is presented completely enough so that it can be understood without reference to other sources. No attempt is made to deal with problems of experimental technique. "Concerning these," says Dr. Pierce, "I offer nothing but sympathy."

Dr. Pierce graduated from the California Institute in 1933, received his M.S. here in 1934, and his Ph.D. in 1936. Since that time he has been a distinguished member of the Technical Staff of the Bell Telephone Laboratories.

THE STORY OF MY PSYCHOANALYSIS
by John Knight

McGraw-Hill, New York, $2.95

THIS STRAIGHTFORWARD, unemotional account of a man's psychoanalysis from start to finish is probably the first time this procedure has been explained in layman's language, and from a patient's point of view. The author (a research chemist writing under a pseudonym) blessedly avoids both professional psychiatric jargon and phony detective-story suspense.

THE PRESIDENT'S REPORT

Highlights from the report, on activities and research at the Institute in 1949-50

by L. A. DuBRIDGE

ONE YEAR AGO it was possible for me to report that "in the national scene there have been no major events which have had noteworthy impact on Institute activities." That statement is obviously not true today. World events of recent months have already had their impact, and it seems highly probable that in the year to come the Institute will be called upon to render services of many sorts to the nation and to the government in this time of need.

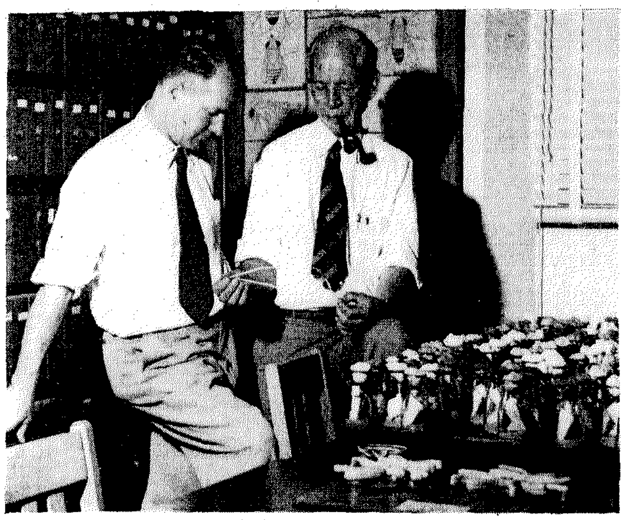
The outbreak of hostilities in Korea resulted in increased demands upon the staff and has called for more intensive work on the part of those already engaged in governmental activities. Dr. C. C. Lauritsen, Professor of Physics, was asked to make a six weeks' trip to Korea to report on the use and requirements of various new weapons. The Institute's Jet Propulsion Laboratory has been called upon to make alterations in its program and increase its efforts in certain areas. It is evident that the expanded program of military research may also involve the Institute in other ways which cannot now be foreseen.

In order to meet some of the present and anticipated problems arising from the emergency, two Faculty committees have been established. One will examine the ways in which the Institute staff and facilities can be most adequately and effectively employed. The other will study problems arising from calls on staff and students from Selective Service or mobilization of Reserve Officers.

In a certain sense, the Institute faces now the problem of mobilizing to serve the nation in time of emergency. However, it must be remembered that in a very real sense the Institute is *always* mobilized. Its regular program of education and research in science and engineering is vital to national welfare and security in peace or in war. To disrupt these activities at this time would be highly dangerous. It is of vital importance to continue and even to accelerate the rate at which our supply of young scientists and engineers is being built up. During the past four years the shortage of scientists and engineers, caused by the cessation of training during World War II, had just about been overcome. Now, however, the demand for such men is taking another upward spurt, and the training schedules should be increased accordingly.

In a period of long-continued emergency, it is also important to continue and accelerate *basic* research. From this research will come the new knowledge from which new applications of importance to national welfare and security will emerge. It would be as foolish to reduce our basic research activities in this country at this time as to reduce our production of steel and other critical materials.

For these reasons, it is essential that the Institute now remain strong, that it conserve its resources and improve its program. To this end it is important that we retain intact, to the greatest extent possible, our "team" of educators and research workers—one of the most competent and most closely integrated of all research teams in the world. Individual members of this team will, of course, be called upon to serve, either in part-time capacities or on leave of absence for short or long periods, in such capacities as are most appropriate to their talents and experience. Furthermore, the members of this team will remain continually alert to the problems of national defense and to possible ways of converting the basic



Biology: Division Head G. W. Beadle, Prof. Alfred H. Sturtevant and bottled drosophila used in genetics research

knowledge of science or engineering to the development of instruments or techniques to assist in solving these problems. But to be of maximum ultimate value the team should remain at "home base".

It is important in this period that a proper balance be maintained in the nation's research program; some effort should be devoted to immediate applications, some to development programs of one, two or three years' duration, and the rest to basic programs of longer range importance. The immediate-and intermediate-range programs will be largely the responsibility of government laboratories, but the universities retain primary responsibility for the longer range programs.

Research at the Institute

THE CALIFORNIA INSTITUTE of Technology is one of the great centers for research in science and engineering in the world. Because its research activities are so extensive and so diverse, the following remarks can be regarded only as a brief review of a few random samples of developments which have occurred during the year.

Astronomy

ABOUT ONE YEAR AGO the Hale 200-inch telescope and the 48-inch Schmidt-type telescope at Palomar went into full routine operation. The Schmidt telescope has now made excellent progress on its four-year program of surveying the entire sky visible from Palomar Mountain, a project which is financed through the generosity of the National Geographic Society. It has now become more clear than ever that the 2,000 or so plates which will be taken in this survey will be by far the most complete, the most detailed, and the most valuable map of the sky which has ever been attempted; and they will constitute an "atlas" which will be a guide to astronomical research for many, many years to come.

The Hale 200-inch telescope is now performing in a manner which equals or surpasses the fondest hopes of those who designed and built it. It is in operation every clear night. By June 30, 1950 a total of 510 direct photographs had been obtained. A large number of these photographic plates have been taken to secure more detailed information about the dimensions, magnitudes and distances of known or newly discovered extra-galactic nebulae (galaxies consisting of millions of stars, each similar to the Milky Way galaxy of which our own sun is a member). From studies of the distance and velocities of such nebulae the most important information about the structure and nature of the universe will be obtained. It will require many years of painstaking studies, however, before any great new generalizations about the nature of the universe can be made. To show the magnitude of the problem of studying nebulae it need only be mentioned that in the ten per cent of the sky which was mapped by the 48-inch Schmidt-type telescope up to July 1950, more than 350 new *clusters* of nebulae had been discovered. Some of these are at distances of approximately 300 million light years.

The astonishing extent of the popular interest in the Palomar Observatory is indicated by the fact that during the past year nearly 150,000 people made the journey to Palomar Mountain to see the Hale telescope. This public interest is in many ways gratifying, but the unexpected volume of visitors presents a practical problem, which can be solved only by providing more adequate facilities for the public on Palomar.

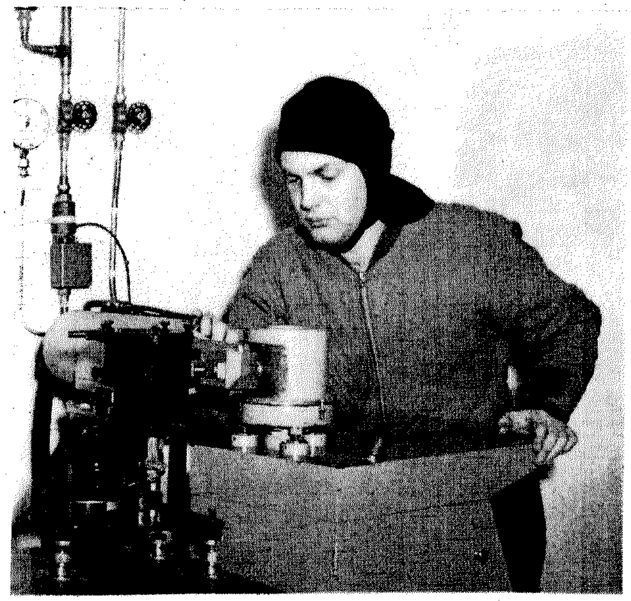
Biology

A NOTABLE EVENT of the past year in the Division of Biology was the inauguration of the full research program in Earhart Plant Research Laboratory. Among numerous projects now under way are (1) the identification of plant-damaging smog constituents and their manner of action on plants; (2) the effects of day and night temperatures on the growth, flowering and fruiting of such plants as the tomato; (3) a determination of conditions favorable for the growth of the plant *Veratrum* and production by it of alkaloids useful in the treatment of hypertension; and (4) an investigation of factors influencing growth and sugar formation by the sugar beet.

Through a generous grant from the James G. Boswell Foundation, the Division is in a position to strengthen greatly its research program in virology. As a means of summarizing the present stage of knowledge of plant, animal and bacterial viruses and of seeking effective ways of gaining new knowledge about these important disease-producing agents, a special three-day virus conference was held at the Institute in March 1950 (E & S, April). With this conference as a background, plans are now being made to extend the Institute's virus research program to include work on animal viruses.

Of several major research activities of the Division the study of protein synthesis may be taken as an example. For some years, Professor Henry Borsook, Professor A.

J. Haagen-Smit and a number of their colleagues, through contract with the Office of Naval Research and the U. S. Atomic Energy Commission, have been investigating the manner in which proteins are made by animals. These giant-molecule compounds are essential constituents of all living things—viruses, bacteria, plants, animals and man. They are of many kinds, all made from a common set of some twenty building blocks compounded end to end to form long chains. The component parts are known as amino acids. Their structures are relatively simple and well understood by chemists, but the way in which they are built up to form proteins remains one of biology's unsolved problems. This is a problem of the most fundamental importance, because proteins are key substances in growth, in reproduction, in heredity, in the structure and function of enzymes, and in many other aspects of the normal functioning of organisms. In fact it can be said that the problem of protein synthesis impinges in one way or another on every branch of biology. By tagging individual amino acid building blocks with radioactive carbon atoms in strategic positions, and allowing these marked smaller molecules to be put together by living cells or suitable preparations made from living cells, the Borsook team is able to recover the resulting proteins marked in certain of their component parts. By carefully breaking up such proteins, much as one would break a pattern of dominoes into sidechains and subgroups, the investigators are finding it possible, since they can follow the distribution of radioactive carbon, to learn a great deal about how the original amino acids were put together to form the large and complex protein molecules.



Chemistry: Dr. Sheldon Crane in new cold room designed to further studies of components of protein molecules

Engineering

WITH THE SPACE made available by the new Engineering Building, the research program in this division will now be able to move forward at an accelerated rate.

In the field of engineering seismology, important progress was made during the year in the systematic study of the response of typical buildings to actual earthquake waves. Records of typical earthquakes are supplied by the U. S. Coast and Geodetic Survey and the analog computer of the Analysis Laboratory is now able to determine with great reliability and surprising speed the response of various types of structures to different types of earthquake shocks.

The Analysis Laboratory, with its large analog computer, and its newly installed digital computer, is now able to handle a wide variety of engineering calculations. In addition to the studies in seismology above mentioned, important studies of the vibration and flutter of aircraft structures have been carried out, yielding results of enormous value to aircraft engineers.

The number of wind tunnels for aeronautical studies now operating under Caltech auspices was increased to eight with the dedication of the new Merrill Wind Tunnel on August 31, 1950.

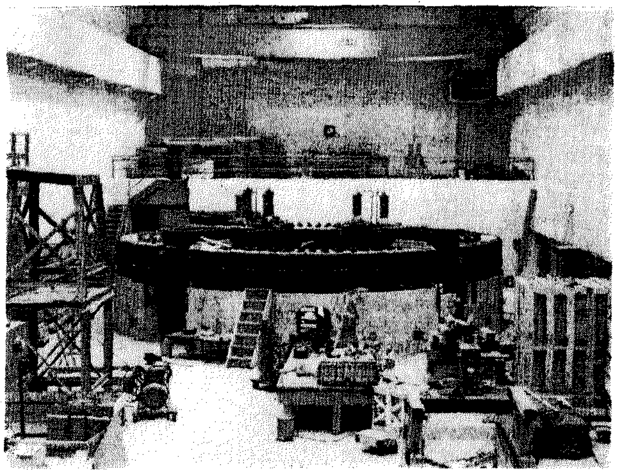
With all of these facilities, research in aerodynamics, in structures, and in fluid mechanics continued on a high level during the past year. The advent of supersonic planes and guided missiles has introduced a whole new set of problems in this field and it is now necessary to investigate not only the behavior of air at these very high speeds but the behavior of new types of structures at all available speeds.

The new Guggenheim Center for jet propulsion research has completed its first year of operation with special attention to theoretical research in jet propulsion and the training of students in advanced aspects of this important field.

The Institute's Hydrodynamics Laboratory is without question one of the best equipped laboratories of its kind in the country. Though a knowledge of the flow of liquids around obstacles is as important to the marine engineer as a knowledge of the flow of air around obstacles is to the airplane engineer, it is rather astonishing that the latter field, though younger, is far more highly developed than the former. This is partly because air is a simpler material to work with than water, though it is also partly because experimental studies of liquids have been less vigorously pursued. This situation is being remedied in the Hydrodynamics Laboratory, where two types of water tunnels have yielded important information on fluid flow. The knowledge of hydrodynamics is desired not only by the marine engineer who designs ships, submarines and torpedoes, but also by engineers who are interested in propellers, pumps, turbines, and the flow of liquids through pipes.

Chemistry

THE GATES AND CRELLIN Laboratories of Chemistry are now one of the leading centers in the world for studies in structure of molecules and crystals. These studies



Physics: Construction is well under way on billion-volt synchrotron, world's most powerful electron accelerator

employ an amazing array of modern techniques, including X-ray and electron diffraction, infra-red and microwave spectroscopy, and the use of radioactive tracers.

There is an especial attempt under way to investigate the structure of complex organic molecules, which are of importance in biochemistry. In addition to the work which has been going forward on the structure of amino acids and peptides, good progress has now been made toward a structural determination of chloromycetin and work has also begun on aureomycin and other anti-biotic compounds. A special room, designed for operation at temperatures as low as —40° F and equipped with X-ray facilities, is expected to advance greatly the work on the study of components of protein molecules.

The work in the field of immunochemistry and medical chemistry has shown increased activity. In the annual report of the Institute for 1948-49, Professor Pauling reported that a group working under him with Dr. Itano had discovered that the disease sickle cell anemia is caused by an abnormality in the structure of the hemoglobin molecules in the blood. This was the first human disease which could be identified as a "molecular disease". Further studies of this type of hemoglobin molecule have been made, together with a study of the genetic factors which determine the ratio of abnormal to normal hemoglobin molecules in the blood of those suffering from the disease. In the course of this study a new abnormal form of hemoglobin has been discovered, associated with a new disease which previously had not been differentiated from sickle cell anemia. The individuals suffering from this disease have in their red cells a mixture of two kinds of abnormal hemoglobin, sickle cell anemia hemoglobin, and this new third variety. These two abnormal types seem to be related genetically, one type coming from one parent and the other from the other.

These studies, and many others in chemistry and biology, illustrate again the great advantage of uniting these two great fields of science as they have been united in recent years at the California Institute. The joint program of chemical biology initiated several years ago is yielding remarkable dividends in new knowledge.

Physics

THE MAJOR DEVELOPMENT in the field of physics during the past year was the beginning of the construction of a billion-volt electron synchroton, a project being carried out with the support of the Atomic Energy Commission. This will be the most powerful electron accelerator in the world and will be a most important tool in studying new phenomena in the field of high-energy physics. The synchrotron work will be a connecting link between the low-energy nuclear phenomena, which have been studied here for many years under the direction of Dr. C. C. Lauritsen and his group, and the cosmic-ray physics work which has been carried on by Professor Carl D. Anderson. Preliminary operation at low energies is anticipated by the spring of 1951.

In the field of cosmic rays, Professor Anderson and his colleagues have obtained important evidence for the existence of two new unstable particles. Preliminary evidence for these had been found by two British workers, Rochester and Butler, in 1947, but Anderson's work furnishes definite confirmation and provides further information about the properties of these particles.

Professor C. C. Lauritsen and his colleagues in the Kellogg Radiation Laboratory have continued their work on studying the energy levels of light nuclei and securing further information on nuclear reactions which are of significance in the energy release in the sun and stars. Their results were studied by Professor Bengt Stromgren of the University of Copenhagen while he was a Visiting Lecturer in Astronomy, and he was able to make new calculations of the temperature of the sun. As a result it now seems likely that the nuclear reactions responsible for the production of solar energy may be different from the ones which have usually been assumed in recent years. Specifically, the direct reaction between two protons seems to play a more important role than has been previously thought.

Professor Jesse DuMond has continued his precision measurement of the gamma rays from various artificially radioactive nuclei, and has proceeded with the construction of a precision beta-ray spectrograph for accurate determinations of the energies of the electrons ejected by radioactive nuclei.

Geology

IN THE FIELD OF SEISMOLOGY the Institute group under the leadership of Professor Beno Gutenberg has continued to play a leading role in the rapid advances which have been made in this field in recent years. Improved instrumentation and improved interpretation of seismic phenomena has added greatly to our knowledge of the internal structure of the earth, and there have been great improvements in the precision and value of seismic measurements. The Institute laboratory now participates in the sea wave warning network inaugurated by the United States Coast and Geodetic Survey, in which reports of strong earthquakes are collected and analyzed in such a way as to give warning to stations in the Pacific of the possible approach of large tidal waves. Further advances have also been made in the study of "microseisms", which are the small seismic disturbances caused by storms at sea. The path of such storms can now be followed and warning given of their approach to various stations.

In the fields of geology a variety of investigations have added to our knowledge of the origin and structure of certain types of rocks and the behavior of unusual geologic formations. There is especial interest in the Southern California area. For example, a new and surprisingly abundant source of the rare metals cerium, lanthium, neodymium, and praseodymium, has been found in San Bernardino County, contained in a new mineral known as bastnasite. This mineral also contains thorium and is therefore radioactive. Other deposits of radioactive minerals have also been found in the desert areas of Southern California.

Professor Robert Sharp has continued his studies on the structure of glaciers in Alaska and on the northeast slope of Mt. Rainier, Washington. This work casts light on the origin and age of glaciers and is expected to contribute to the knowledge of chronology of the ice age.

In the field of paleontology investigations of interesting material found in Mexico promise to yield significant results on the interpretations of the history of life on the North American continent.

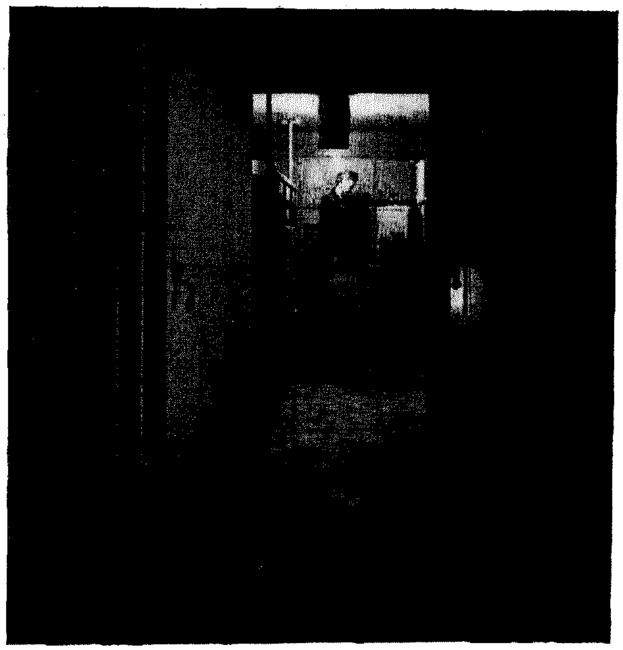
Humanities

THE CHIEF INTEREST in the Division of the Humanities during the past year, and even more during the coming year, has been and will be the examination of the educational program of the Division to determine what forward steps can be taken to improve our offerings to the student body.

Jet Propulsion Laboratory

RECENT WORLD EVENTS have accelerated activities at the Jet Propulsion Laboratory, with increased emphasis, of course, on bringing the results of recent research to bear on the practical problems of design of new types of guided missiles.

Although the Jet Propulsion Laboratory is owned and financed by the Federal Government, it is managed by the Institute under contracts with various defense department agencies, and is an important asset to the Institute's general program of education and research. Much of the work on the design of actual missiles is, of course, kept in a confidential or secret category by the military services. Much of the basic research, however, is not



Geology: Tunnel excavated deep in hill at Seismological Laboratory provides this constant temperature vault

"classified" and is generally published and can be publicly reported.

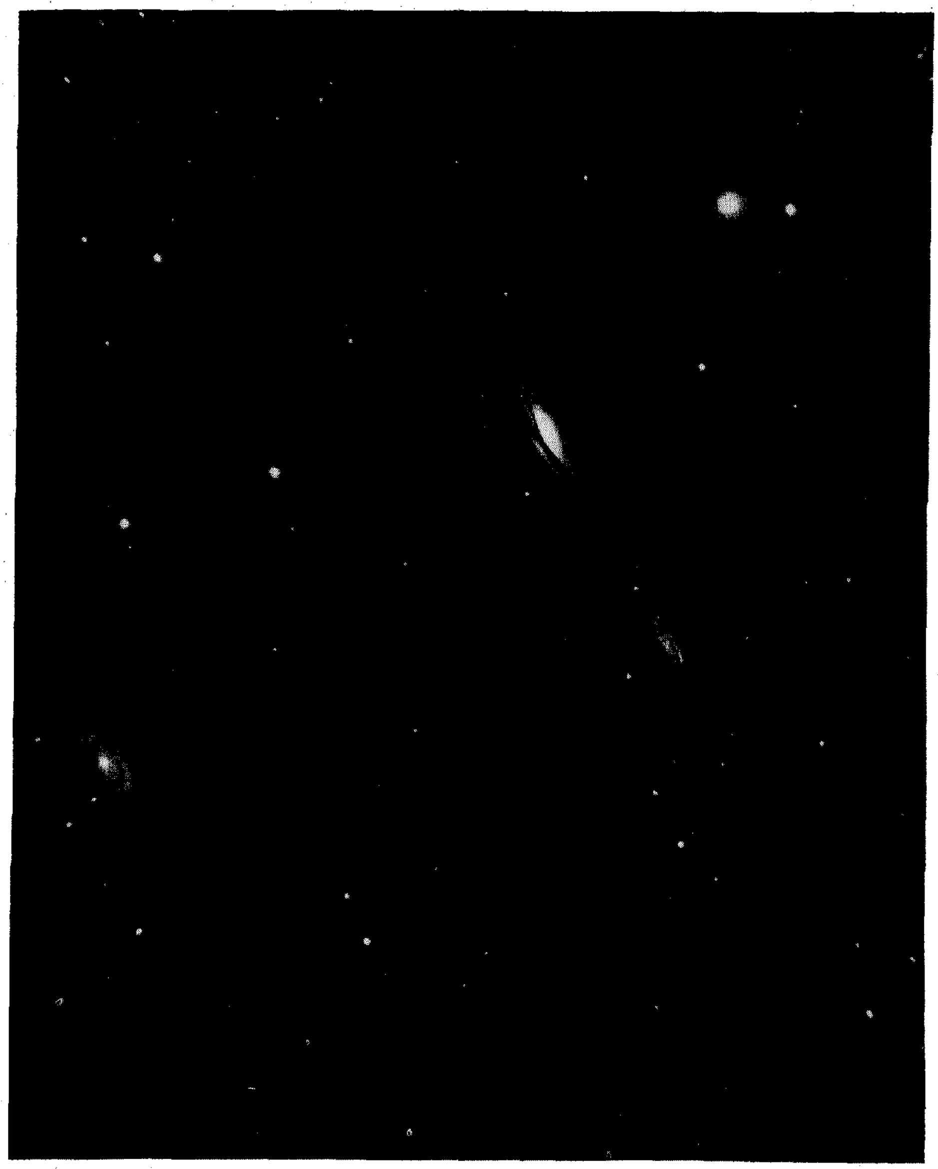
A considerable amount of work directed toward the investigation of the physical properties, the propulsion performance, and the combustion kinetics of both liquid and solid propellants has been developed and is now ready for the pilot plant stage. The reaction kinetics of nitric oxide have received detailed experimental study because of the importance of this material to acid-based propellants. Detailed information on the combustion of existing propellants, of new propellants, and of new combinations of fuels and oxidizers continues to throw valuable light on the basic elements of jet propulsion processes.

During recent years the major program of the Laboratory has been a study of materials of interest in the construction of jet motors. Much of the laboratory work in this program has now been completed, although new investigations are being made on the properties of titanium and its alloys, a material which has recently come into great prominence.

The problems of heat transfer, critical in all jet motors, have been the subject of many fundamental investigations.

In the engineering field the mechanical and electronic design aspects of the so-called ORDCIT guided missile were brought to completion and a sample of this missile was successfully fired. This is one of the first ground-to-ground guided missiles to be built and flown in the United States.

A new 18-inch by 20-inch supersonic wind tunnel has gone into operation during recent months, and this will contribute greatly to the studies in the flight properties of missiles and jet engines.



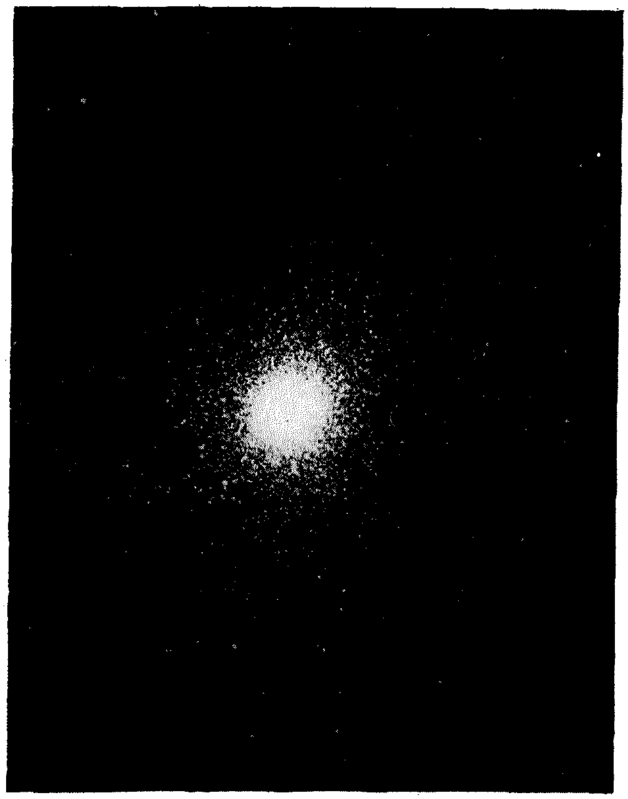
NEW PALOMAR PICTURES

The 200-inch telescope has now taken about 1,000 pictures. Though most of these are working negatives, of interest only to astronomers, some are as spectacular as the samples shown on these pages.

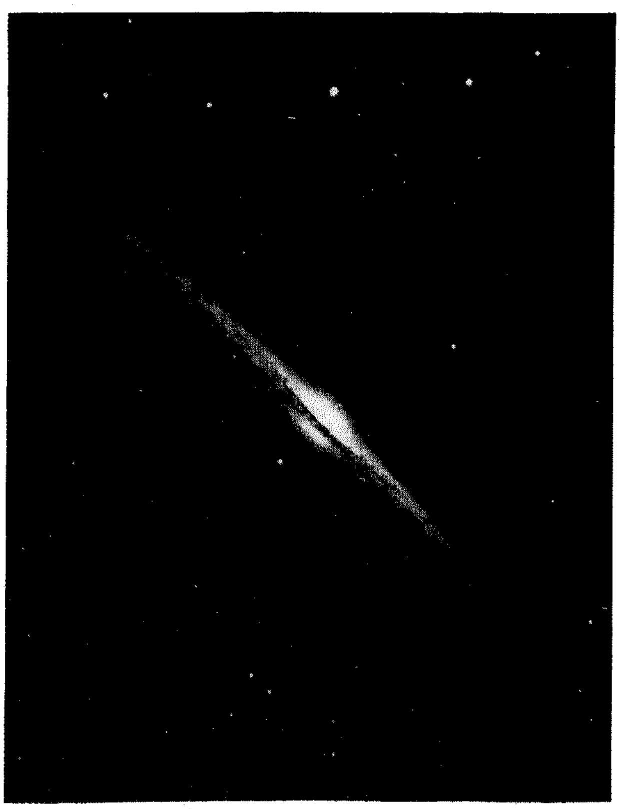
These nebulae in the constellation Leo are of four distinct types: (a) globular, showing no trace of structure; (b) spiral, showing strong band of obscuration; (c) later spiral form, showing arms and starlike details; (d) barred type of spiral, bar extending across nucleus, spiral arms appearing to originate at ends of bar.

This spiral nebula in the constellation of Virgo is 8,000,000 light years away from the earth (one light year being six million million miles). It is in rapid rotation, makes one complete revolution in about 25 million years.

Great nebula in the Constellation of Orion is part of our Milky Way, contains both dark and bright nebulosity.



Average distance between stars in this cluster is about 50,000 times the distance of the earth from the sun.



Spiral nebula seen edge-on. The dark line, made up of dust, is absorbing matter which blots out nebulosity.

This spiral is actually a double nebula—the brighter being one of the few whose arms can be seen in a telescope.

THE SIGNIFICANCE OF CHEMISTRY

To Man in the Modern World

A proposed program for the education of the citizen in science, which would start at the kindergarten level

by LINUS PAULING

IT IS IMPOSSIBLE TO DENY that science has played a major part in determining the nature of the modern world. The food that we eat, the clothes that we wear, the means of transportation that we use in going from place to place, the medicines that keep us well, the weapons that we use in killing each other have all been changed in recent years through scientific discovery.

It may well be contended that the world is now in a dangerous situation because science and its applications have developed faster than the understanding of the average citizen. It is evidently of great importance to attempt to improve this situation through a program of education of the citizen in science. The world in modern times has continued to move toward the ideal democratic system, in which all important decisions are made by the people as a whole. In order for this system to operate correctly the citizen must have knowledge enough of the world to make the right decisions; and in the modern world this means that the citizen must have a significant understanding of science.

Nearly everyone has some knowledge about science in the modern world. We know that stockings used to be made from silk, a fiber spun by the silkworm, and are now made in large quantities from an artificially spun fiber, nylon. We know that penicillin, a substance made by a mold, is a very effective medicine for protecting us against bacterial infection, and that chloramphenicol and aureomycin are effective even against some of the virus diseases. We know that power can be transported from one place to another by the flow of electricity along wires, and that this flow of electricity is in fact the movement of charged elementary particles, electrons, along the atoms that constitute the wire. We know that, through the advance of physics during the last half century, man has discovered how to release the immense amounts of energy that are stored up in the nuclei of atoms; and we know that this knowledge is being used in the manufacture of atomic bombs. We know that uranium and thorium could be used to generate electric power, through the release of the energy stored up in the nuclei of the uranium and thorium atoms, and that the known deposits of minerals containing these elements could provide all of the energy required for the world, at the present rate of use, for thousands of years.

It is evident that these are important facts, that contribute to the determination of the nature of the modern world. In order to get an idea of how important science is to the modern world, we might ask how many scientific facts are now known, in comparison with the number of non-scientific facts. How great a fraction of all of the knowledge possessed by man is now scientific knowledge?

It is impossible to answer this question precisely, because we have no scale for measuring the comparative importance of a scientific fact and a non-scientific fact. Nevertheless, it may be of interest to consider the rate at which our store of scientific knowledge is being increased. During the year 1949 the journal *Chemical Abstracts*, which attempts to review all of the current publications in chemistry and closely related fields, contained abstracts of 70,000 papers in the field of chemistry. Many of these papers report only one contribution to knowledge, which might be described as one new scientific fact. Some of them report two or more contributions to knowledge that might be described as separate new scientific facts—the subject index of *Chemical Abstracts* for 1949 lists 220,000 items. I believe that we may say, as a rough approximation, that about 100,000 new chemical facts are being discovered each year, at present. Perhaps we may multiply this number by 10, to include other sciences as well as chemistry, and thus reach the rough conclusion that about one million new scientific facts are being discovered each year.

How many significant non-scientific facts are added to man's body of knowledge each year? A non-scientific fact may be a historical event, an artistic creation, a historical, economic, or social correlation, a new general idea published in a paper or book. It is, of course, impossible to define a non-scientific fact rigorously in such a way as to be equivalent to a scientific fact. Nevertheless, we might attempt to estimate how many significant, non-ephemeral items of new non-scientific information we have about the world, at the end of 1949, that we did not have at the beginning of the year. It seems to me that the number of these non-scientific facts may well be much less than one million; and that we may accordingly be justified in saying that scientific knowledge is at least roughly equivalent in its significance to the modern world to non-scientific knowledge, at the present time.

Chemistry and the Average Man

The average citizen has a much better understanding of the non-scientific aspects of the modern world than of its scientific aspects. His knowledge has been obtained in part through his studies in school, and in part through his reading and personal experiences. The great mass of people have not had education extending beyond the elementary school, and have accordingly received no instruction in science at all, or at most one or two years of instruction, in geography and general science. The nature of science is such that it is difficult for a man to begin its study without help; accordingly those people, constituting the great mass of the people in the world, who have not studied science in any form in school in general remain ignorant of science throughout their lives, except to the limited extent that scientific information is provided by personal experience.

Because of the nature of chemistry, the average man knows less about chemistry than about other sciences. He knows about many physical phenomena through his own observation—he knows that objects fall toward the earth, that hot bodies emit light and heat, that an electric spark may pass between two conductors at different potentials, that a body continues to move in a straight line unless acted on by some force (he may recognize that the curved path followed by a projectile reflects the effect of the gravitational attraction of the earth on the projectile), and so on. With this knowledge from personal experience, he is able to understand simple explanations of new discoveries in the field of physics, and to appreciate their significance to him and to the world as a whole. Similarly, he has had personal experience with phenomena in the field of biology, geology, medical sciences, mechanical technology, and other fields, which permit him to develop an increased understanding of their nature and their significance in the modern world. His personal experiences with chemical phenomena may, however, be very limited—be limited perhaps to the observation of the chemical reactions that occur in combustion. Chemical phenomena, involving the conversion of substances into other substances, which may have entirely different properties, are so surprising in their nature that it is difficult for a man to develop an appreciation of them without instruction. The average man accepts the facts of chemistry that are significant to him, such as the combustion of gasoline with oxygen in an engine to produce mechanical power, as wonders that are not to be understood; and it is not surprising that he may occasionally be led to believe that some new device, offered for sale to him, can be attached to his automobile engine to permit water to be used as fuel in place of gasoline.

This example illustrates one way in which increased scientific knowledge is of value to man in the modern world. The welfare of the individual is determined in considerable part by the decisions that he makes about his own actions; in general, by the way he spends his money. Much of his money is spent in response to advertising appeals that are based on his understanding or misunderstanding of science. The principle of caveat emptor has become far more dangerous to the citizen than it was in the simple, non-scientific world of past centuries. The citizen is asked to buy products containing ozium, arium, durium—and he is not told what these substances (if they are substances, and not just names) are. Ozium is to be sprayed around within the house, to kill all insects, destroy all cooking odors, protect against disease by killing germs too. Presumably the name ozium was selected because of the hope that the reader of the advertisement would confuse it with ozone, about whose germicidal properties he might have heard. He is asked to buy wonderful new green medicines, containing chlorophyll. Whatever substances, perhaps effective, may be present in the medicines, the advertiser counts on the chlorophyll to sell them. He is banking on the possession of a smattering of scientific information by the reader—and on his lack of possession of more than a smattering. He hopes that the reader will remember that chlorophyll is the wonderful substance in the leaves of green plants, that purifies the air. He hopes that the reader does not know much more—that he does not know that the only thing that chlorophyll is known to do is to absorb carbon dioxide from the air and to liberate oxygen; and that chlorophyll that has been extracted from the plant has, so far as any scientist has been able to discover, no action as a medicine, no activity whatever. Moreover, he must be hoping that the reader of the advertisement will not even think enough to ask why he does not eat a green leaf, a small spoonful of cooked spinach, or other green vegetable, in order to get his chlorophyll, instead of paying a hundred times as much money for inactive chlorophyll in a pill.

In this, and in many similar ways, it is of individual importance to the citizen in the modern world to have an increased understanding of the scientific aspects of the world.

The citizen who is trained in science may also be expected to exercise his political rights more effectively than one not trained in science, both because of his greater understanding of the nature of the modern world and because of his understanding of the scientific method, the way in which conclusions can be drawn from facts. Understanding of the scientific method confers on him the scientific attitude, which gives him an increased chance of reaching the right decision about political and social questions as well as about scientific questions.

One value of training in the scientific method is that it leads to skepticism about all generalizations, "laws of nature." What do we mean by a law of nature? We mean that a number of facts have been seen to be related to one another in such a way as to justify a general statement. For example, when chemical analysis of water was first made it was found that the sample of water that was analyzed contained 11.2% hydrogen and 88.8% oxygen. When another analysis was carried out, with another sample of water, the same result was obtained, and after a hundred analyses had been made—perhaps after only ten had been made—the general law was proposed that all samples of water contain 11.2% hydrogen by weight. This law was accepted for many years; but finally an analysis was made that showed that the percentage of hydrogen in rain water is a little less than 11.2%, and the percentage in ocean water is a little greater. This new observation then required that the earlier law of nature be changed, in such a way as to take into account the existence of isotopes of hydrogen and oxygen, and the fractionation of water molecules containing different isotopes through the process of evaporation of water from the ocean. A scientific law that is based on only ten facts which agree with one another is not considered to be a very sound one—it has only a limited probability of continuing to remain valid, as more experiments are made. A law that is based on a hundred facts, or a thousand, has greater and greater probability of continuing to be correct. A citizen who understands the nature of scientific generalizations will ask himself what the basis is for generalizations in the field of economics, politics, international relations. How many facts have been used in determining the attitude of one nation toward another nation? Is the number of facts in agreement with one another in supporting the attitude so great that there is no room whatever for skepticism about the national policy on the part of an individual citizen ,or is the citizen justified in being skeptical?

The Laws of Probability

The laws of probability have as much significance in non-scientific fields as in scientific fields. We all understand how a life insurance company calculates its premium payments. The statistician for the life insurance company collects information about the number of people dying at various ages—30, 31, 32, 40, 50, 60, 70, 80, 90, 100, even 110 years of age. From all of these data he calculates the average expectancy of life, and thus finds the average number of premiums that will be paid. If he were to say "It is abnormal for a man to live to be 85 years old, or older; therefore I must discard the data about these abnormal people" he would obtain a wrong value about the average expectancy of life, and the life insurance company would go bankrupt. Yet, just this foolish procedure is sometimes carried out in the operation of a democratic system of government. The principle upon which a true democratic system operates is that no single man is wise enough to make the correct decisions about the very complex problems that arise, and that the correct decisions are to be made by the process of averaging the opinions of all of the citizens in the democracy. These opinions will correspond to a probability distribution curve, extending from far on the left to far on the right. If, now, we say that all of the opinions that extend too far to the right—beyond the point corresponding to the age 85 in the above example, say—are abnormal, and are to be excluded in taking the average, then the average that we obtain will be the wrong one. An understanding of the laws of probability would accordingly make it evident to the citizen that the operation of the democratic system requires that every one have the right to express his opinion about political questions, no matter what the opinion might be.

It is of the greatest importance to modern man that he understand the modern world. He must have knowledge enough about the world to make the right decisions—and since the modern world is largely scientific in its constitution, the citizen must understand science.

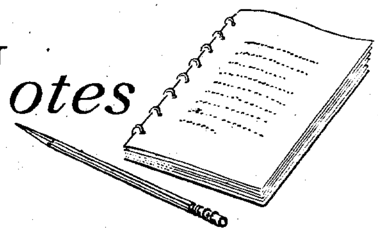
How can the citizen get scientific knowledge? The answer to this question can be drawn from past experience. Hundreds of years ago it was recognized that mathematics is of great value to the individual. Mathematics is a difficult subject; one might be tempted to say that, since it is difficult, the study of it should be put off till the college years. Yet, through experience, we have learned that the way to teach mathematics is to start with the teaching of numbers in kindergarten, arithmetic in the first grade and other elementary grades, and to continue steadily, without interruption, through algebra, geometry, trigonometry, calculus. This is the way in which science should be taught.

Science in the Kindergarten

The time has now come for the study of science to be made a part of the curriculum in every grade, at every level. There should be a class in science in the kindergarten, in the first grade, in the second grade, in the third grade, and so on. Every boy and girl who finishes grammar school should know science, in the same way that he now knows arithmetic, languages, and history. Every boy and girl who finishes high school should know still more about science. Every college student should begin his college work with a sound knowledge of the whole of science—comparable to the knowledge that he now has, at this stage, of mathematics—in order that he might devote his years in college to the more advanced aspects of the subject. Only in this way can we train citizens for life in the modern world. Only in this way can we develop a citizenry able to solve the great social and political problems that confront the world.

In suggesting that the study of science should be carried on throughout the period of school training, I have in mind that it should occupy one class hour every day—that is, one instructional period of thirty or forty minutes in the beginning grades, and forty or fifty minutes in the higher grades. At the present time in many primary schools elementary instruction is given in geography, usually at some time between the fourth and the eighth grade. In addition, it is customary in

Newsworthy Notes for Engineers



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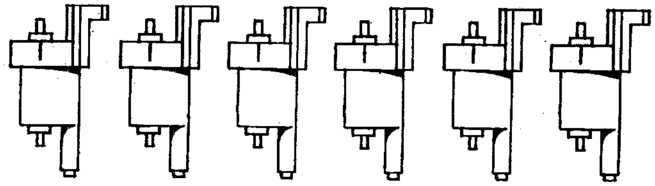

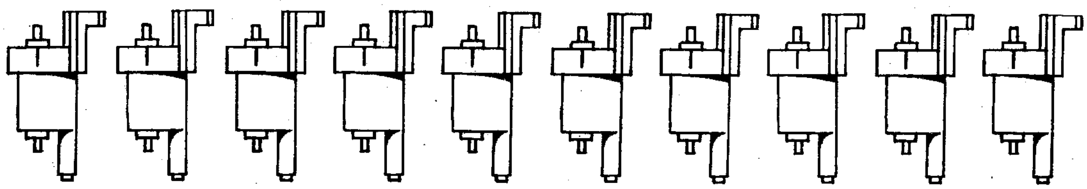

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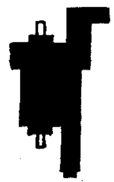
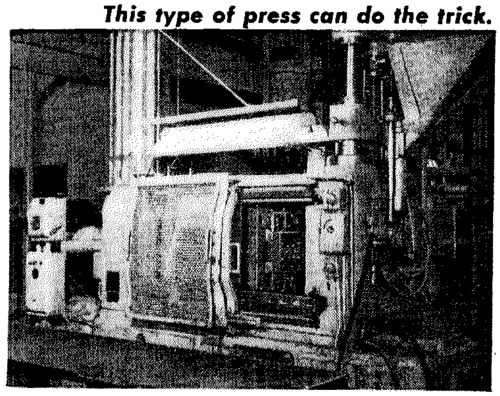


This type of press can do the trick.



These odd looking little gadgets, called "pawls," go into high speed telephone dials used by Bell System operators.

Until recently, pawls (like the black one) were made of molded rubber with a steel pin for the shaft. They did their job well and lasted a long time. But Western Electric engineers decided to try to make them at a lower shop cost.

The engineers came up with an idea—mold the pawl, pin and all—in one piece of nylon. They made some samples—tested them thoroughly—found the nylon pawls would last as long and perhaps even longer in service. Bell Telephone Laboratories tested them—and approved. So Western Electric engineers tackled the production problems—designed new machinery for molding pawls in one piece. It wasn't easy—because all dimensions had to be controlled with extreme accuracy. But today the new nylon pawls are being made in quantities—*sixteen of them for the cost of one of the old type!*

This story of cost reduction—and there are scores of others like it—shows one way that Western Electric engineers help to keep down the cost of equipment produced for Bell Telephone companies and, therefore, the cost of service to telephone users.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

Engineering problems are many and varied at Western Electric, where manufacturing telephone equipment for the Bell System is the primary job. Engineers of many kinds—electrical, mechanical, industrial, chemical, metallurgical—are constantly working to devise and improve machines and processes for production of highest quality communications equipment.

many parts of the world for a course lasting for one year to be given in general science, usually the last year of primary school work, the eighth grade. In a relatively few schools a small amount of information about the nature of the physical and biological world is presented to the students during the first few years of primary school work. If one classroom period per day were devoted to science throughout the years of primary school instruction, the work might begin with very simple discussions of the physical world, including simple demonstrations. The fields of knowledge covered would be largely descriptive in nature, in all branches of science—physics, chemistry, biology, geology, astronomy, geography, etc.; but in addition there could be, even in the earliest years, instruction in the scientific method and the scientific attitude.

Understanding Certain Scientific Concepts

The concepts of chemical change and of atomic structure and other concepts of modern science are no more difficult to understand than the concept that the earth is round. We teach students in the elementary schools that the earth is round, even though convincing proof is so difficult that the fact has been generally accepted only during the last few centuries. In the same way the important basic principles of atomic science could now be taught to beginning students, in the elementary schools, with rigorous proof of the truth of the concepts deferred until a later time.

The principal practical problem accompanying the introduction of instruction in science for one class period each day in all school grades is that of deciding what activities the instruction in science should replace. This decision is not an easy one to make, and presumably the subjects to be replaced or on which decreased emphasis is to be laid would be somewhat different in different schools and in different parts of the world.

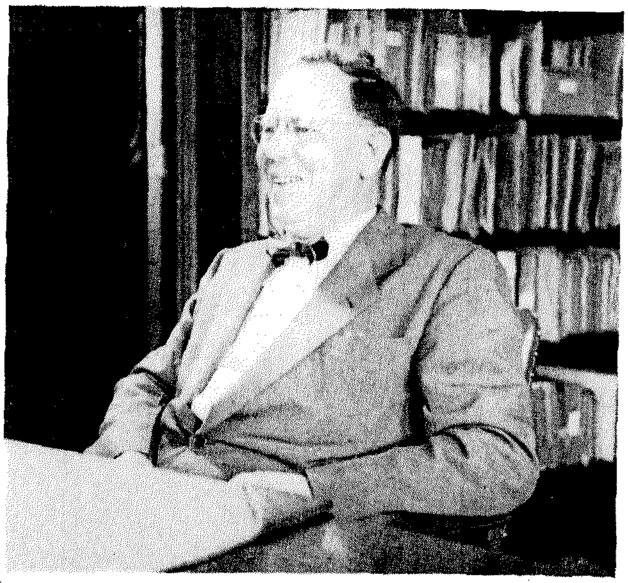
There has been just as great reluctance to introduce extensive teaching of science into the field of adult education as into the field of elementary education. The best methods to be used in giving scientific information and instruction in the scientific method to mature individuals who have only an extremely limited background in science probably still need to be discovered. It is likely that a thorough study of existing alternative methods and a search for new ones would yield very important results.

The argument might be presented that it is hopeless to attempt to give the average citizen an understanding of science, because of the complexity of science at the present time and the enormous rate of increase in scientific knowledge. How can even the foremost scientist keep abreast of the rapidly advancing front of knowledge when millions of new facts are being discovered every year? I believe that this pessimism is not justified, and that, indeed, science as a whole is becoming simpler, rather than more difficult. Many parts of physics have already passed through the stage of greatest complexity—the stage at which the body of knowledge in the field consists of an aggregate of largely disconnected facts. With the recognition of relationships among these facts, great numbers of them can be encompassed within a single principle. An understanding of the field as a whole can then be obtained by the process of understanding the general principles. It is not necessary for every fact to be learned; instead a few of the facts can be considered, in order to discover their relationship to the general principles, and thereafter other facts that, for practical or accidental reasons, come to the attention of the individual can immediately be correlated by him with the general principles. At the present time chemistry is making rapid progress toward the ultimate goal of theoretical simplification; chemistry too has passed through the stage of maximum complexity. In biology and the medical sciences much of the fundamental investigational work now going on consists of a search for the fundamental general principles; we may feel confident that before many years have gone by the most significant of these principles will be discovered, and these subjects too will from that time on become progressively simpler.

One way in which an increased knowledge of the nature of the physical and biological world can be of value to the individual citizen is through the conferring on him of an increased equanimity, an increased confidence in natural law and order. The well-being of an individual may be greatly impaired by his fear of the unknown, which may far exceed the fear that he would have of a known danger, which he might prepare to meet in a rational way. In a world in which human beings have achieved extreme powers of destruction of one another, through the use of an astounding new source of energy, the non-understanding individual might well become extremely apprehensive, in such a way as to prevent him from making the correct personal and political decisions, and to cause him to accede without a trace of protest to suggestions or orders from a dictatorial leader.

An incidental advantageous result of scientific education for all people which is of more than negligible significance is the personal satisfaction and pleasure that accompany pure knowledge and understanding. The physical and biological world in which we live is truly astounding and wonderful. No matter what the extent of his general education nor the caliber of his mental abilities, every human being might achieve satisfaction and increased happiness through an increased knowledge and understanding of the world. The sources of happiness in life are not so bountiful that mankind can afford to neglect such an important one. If the ever-present oppressing danger of world war can ultimately be averted, and the world can enter into a continuing period of peace and friendliness, the intellectual activities of the average man may become a source of happiness to him comparable to that provided by his emotions.

THE MONTH AT CALTECH



Chester Stock

THE DIVISION OF THE GEOLOGICAL SCIENCES, the California Institute, and American paleontology suffered a severe loss in the passing of Dr. Chester Stock, Professor of Paleontology and Chairman of the division. Death came without warning to Dr. Stock in his sleep in the early morning of December 7, 1950 from cerebral hemorrhage at the age of 58. The previous evening he had chatted in his usual jovial way with colleagues and students after a meeting of the Geology Club, and a few days earlier he had returned from a meeting of the Geological Society of America at Washington, D. C., of which he had just been elected president.

From the time of his coming to the Institute in 1926 shortly after the geological division was organized Dr. Stock prosecuted a very vigorous program of research in vertebrate paleontology. He was interested mainly in the mammalian fossil remains secured from the Tertiary formations of the United States west of the Rocky Mountains and in the northern part of Mexico.

There were several aims in these researches. One was to determine from the collections of bones and teeth made in a large number of Tertiary sandstone and shale formations of diverse ages what kinds of animals roamed over the mountains and plains of western America in the successive epochs of the 60 million-years-long Tertiary period. These creatures were very different from the mammals now living in these regions; virtually all the species are extinct and some whole lineages, such as the oreodonts, disappeared millions of years before Man appeared on this continent or had even originated.

A second purpose in vertebrate paleontology is to determine accurately the geologic age of the formation containing the fossils; because of their rapid evolutionary change mammalian remains are especially serviceable.

Another aim is to infer from the types of mammals found in a formation something of the topography and climate of the country in the geologic epoch when they lived. Further, by assembling the fossil skeletal parts of successive species in the same lineage, such as horses or camels, it is possible to discern the evolutionary development and changes from creatures small and primitive to later or living species usually much larger and more complex in skeletal structure.

Finally, from the structural changes in the animals and the contemporaneous alterations in topography, climate, and food supply it is possible to derive some clues to the causes of evolution. Along the line of each of these aims in paleontology, Dr. Stock contributed (in an important way) through his writings and his teaching.

To secure the fossil material Dr. Stock, with the aid of the late Eustace L. Furlong, Curator, and of William J. P. Otto, Sculptor and Preparator, and students and other assistants, organized many successful collecting expeditions to a large number of fruitful sites and areas in the West. The excellent collections he amassed and catalogued at the Institute for study and comparison purposes compare favorably with those in much older institutions. Age determinations of formations which Dr. Stock was able to make with these materials have been of very great value to petroleum and other geologists.

Dr. Stock's published contributions to paleontology were both numerous and important. He was author of some 170 papers, ranging from short descriptions of individual new species of Cenozoic mammals or brief popular articles to voluminous monographs treating whole groups of species or genera of one family or all the various mammals found at one locality, each of these studies representing months or years of intensive research.

One such group, the peculiar heavy and herbivorous

CONTINUED ON PAGE 18

New television microphone, developed at RCA Laboratories, virtually vanishes when in active use.

Vanishing Microphone lets the stars shine

Now you see it, now you don't! RCA's new "vanishing microphone" is plainly visible when standing alone—but let a television performer stand before it and it seems to disappear.

Called the "Starmaker," this RCA microphone is little larger than a big fountain pen . . . and principles of design based on modern camouflage techniques blend it with an artist's clothing. There's no clumsy "mike" to distract your attention from the artist's performance—and it's also a superbly sensitive instrument.

Through research carried out at RCA Laboratories, the "Starmaker" microphone picks up sound from all directions—hears and transmits every sound the human ear can detect. It's not only small and almost invisible, but it's also one of the most efficient microphones ever devised.

* * *

See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th Street, New York. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey. **Also many opportunities for Mechanical and Chemical Engineers and Physicists.**

RADIO CORPORATION of AMERICA

World Leader in Radio — First in Television but clawed ground sloths, like the horses and camels only recently extinct in North America, claimed Dr. Stock's interest early in his scientific career and were treated in very important publications. He was the outstanding authority on this group for more than thirty years.

Another group to the evolutionary history of which Dr. Stock contributed in a very important way is the horse family, remains of which he collected and studied in forms ranging from the little five-toed Eohippus to the virtually modern horse. His published papers, prepared with great care and fully and effectively illustrated with drawings by the late John L. Ridgway and by David P. Willoughby, were outstanding examples of scientific accuracy and literary form.

His enthusiasm for and arduous application to research in vertebrate paleontology stimulated numerous graduate students to investigational work in that and closely related geologic fields. Striking skeletal mounts and complete restorations of extinct species of mammals and reptiles prepared under his direction are among the most interesting exhibits of scientific materials open to the public at the Institute.

Dr. Stock received his training between 1910 and 1917, and much inspiration, from the late Dr. John C. Merriam, then Professor of Paleontology at the University of California at Berkeley. (Dr. Merriam later became President of the Carnegie Institution of Washington; his son, Dr. Charles W. Merriam is now Associate Professor of Invertebrate Paleontology at the Institute.) Under John C. Merriam Dr. Stock early developed a deep interest in the remarkable and world-famous fauna of Rancho la Brea, now Hancock Park, and beginning in 1913 he published a long series of papers describing different groups of animals entombed there in the tar. In recent years he was very active in guiding the planning of a museum and other exhibits illustrating the fossil-recorded life at this fascinating paleontological site.

Initiated by study of Rancho la Brea collections at that institution, Dr. Stock participated in the scientific activities of the Los Angeles Museum of History, Science and Art in increasing degree for more than three decades and was responsible for the magnificent restorations of prehistoric animal life for the West being exhibited there. He was Chief Curator of Science at the museum in recent years.

Many honors came to Dr. Stock. He was elected a member of the American Philosophical Society, the National Academy of Sciences, the Geological Society of America, the Paleontological Society of America, American Society of Naturalists, American Society of Mammalogists, American Association of Petroleum Geologists, and several others.

With his genial personality and his diverse interests Dr. Stock won a very wide circle of friends. These and his colleagues and his students all respected him and grew very fond of him. He will be very sorely missed from our ranks. —*John P. Buwalda*

Kelvin Medal

Dr. Theodore von Karman, Emeritus Professor of Aeronautics, last month received the Kelvin Gold Medal for 1950, one of the highest engineering science awards in the world.

The Kelvin Medal, awarded in London, is presented by a committee composed of the presidents of the eight major engineering societies of the United Kingdom for outstanding contributions to engineering science. The award was established in 1920, but has been made only eight times since then. It has previously been given to such men as Guglielmo Marconi; Sir Frank Whittle, creator of the first turbojet engine; and the Nobel Prize-winner, Physicist J. J. Thomson. Elihu Thomson, pioneer electrical engineer, is the only other American who has received the award.

Dr. von Karman is now chairman of the Scientific Advisory Board of the U. S. Air Force, and chief technical consultant to the Areojet Engineering Corporation, the rocket manufacturing and development company in Azusa which he helped found in 1942. Until March, 1949, when he resigned to devote most of his time to his work for the Air Force, Dr. von Karman was Director of the Institute's Guggenheim Aeronautical Laboratory and Chairman of the Jet Propulsion Laboratory Executive Board.

The Kelvin Medal is the latest in a long series of distinguished honors which have come to Dr. von Karman. He has received the Presidential Medal for Merit, the highest civilian award for outstanding contributions to the war effort; the Franklin Gold Medal, highest award of the Franklin Institute of Pennsylvania; and the John Fritz Medal, highest engineering award in this country. He has also received the Gold Medal of the American Society of Mechanical Engineers, the Sylvanus Reed Award of the Institute of Aeronautical Sciences, as well as numerous honorary degrees from universities here and abroad.

Student Junket

Forty Caltech students have been invited to serve as official observers for the American Automobile Association in the annual Mobilgas Economy Run to be held this year from March 6th to 9th. The AAA will put a Caltech observer in each car making the run from Los Angeles to the Grand Canyon—and for their trouble the boys will collect $10 a day and expenses. The fact that the Run takes place just a week before final exams here has had little effect on the rush to sign up for this rich extracurricular experience.

THE BEAVER

Some Notes on Student Life

THE CHARACTERISTICS of the undergraduate today are not as easy to describe as they would have been a year or more ago. This does not mean that he is in any major way a different person, but only that the world in which he lives is radically changed from the world of the student of the past.

Every student, as every other person, is concerned with his personal fate. The ways of the world do not ordinarily obsess him, the machinations of the government do not usually involve him, and even his own family's life seems more remote when he enters upon his studies at Caltech.

Today a sense of futility and insecurity controls the student at Tech, as it surely does at other schools. The events of the world over which he has had no control in the past have so involved him that they can no longer be ignored. Indeed, they occupy a good deal of his thoughts in his waking hours and have become the major topic of his bull sessions.

The Carefree Days Gone By

Whoever would today set pen to paper and write about the carefree and happy-go-lucky life of the student must be demented. The men in the undergraduate school have come here to learn. They realize that theirs is a rare gift which is needed by the high form of civilization in which we live, and that this gift can be utilized to help themselves as well as others. These men have come with a desire to better their position in society; they also know full well that, in the future, they *will* better that society. They are confused, befuddled and sometimes even amused when they view the laws which have been created to control their future lives. Few people have any control over their lives today, but the Tech man does not even have the fortune of a random fate. The result has been to give the student an unequaled sense of futility—which can be observed by anyone on the campus today.

Students and The Draft

Draft laws have been set up. It was thought that good students should be exempt, as their value in other fields would be far greater than their value in the active service. As the law now stands, those in the upper half of the class will be given a 2-A classification, which will allow them to continue their studies.

CONTINUED ON PAGE 20

THE BEAVER . . . CONTINUED

This system has not worked well. Some students have left for easier schools, where they are confident they can attain the upper half. But even those in the upper half here find dealing with the draft boards a very difficult matter. There is no steadfast rule which insists that those in the top half must be deferred. Furthermore, is the population of the school going to be reduced to ½ every year? Indeed, many draft boards flatly refuse to entertain what they term "inequality."

Seniors in a Quandry

The seniors are in a complete quandry. It is difficult for an average Caltech student to be accepted at a graduate school; now it appears that it will be doubly difficult unless he is a veteran—and there are few veterans in the undergraduate body now.

Employment, too, is the concern of all those who are leaving Tech this June. Several companies have stated that the draft status of a student is a matter of indifference to them. Although this is certainly a magnanimous view the seniors view it with considerable doubt, for they know that no company will undergo the expense of training a student only to lose him when his deferment expires. The war industries might get such men deferred longer, but the great majority of industry is still devoted to peacetime production. The companies themselves must be in something of a dilemma over the lamentable state of affairs.

No Incentive

The draft laws have had other unforseeable difficulties. It was first thought that they would serve as an incentive to those students in the lower half of the class—but things haven't worked out that way. Such a student is infused with a sense of futility and desires to quit it all, throw his ambitions to the wind, and join the service for the lack of responsibility he can find along with the good pay and fast life. Already some good men have left the campus, some men who would have done much better in other fields.

Still Good for a Laugh

These matters have reached a place of major importance on the campus. Still, the students managed to find much humor in the situation and the slightest allusion to draft status brings volleys of jokes. They realize, of course, that what must be done must be done, even though they could wish for a more intelligent manipulation of their lives. Theirs is a rather important place in society after all; it would seem regrettable to leave it unfilled.

—Bob Madden '51

ALUMNI NEWS

ALUMNI CALENDAR

1950-51

February 3	Dinner Dance
April 14	Alumni Seminar
May (date to be set)	Family Picnic
June 6	Annual Meeting

Fund Drive

LATE IN FEBRUARY the Alumni Building Fund Drive will be stepped up in an effort to hit the $100,000 mark by the end of the school year. Right now the Fund stands at $69,000, which means the spring drive will be one of the most intensive yet. Don Tillman '45, and Everett Macartney '43, are co-chairmen of the Fund Committee this year. Vice-chairmen include Gordon Alles '22, Phil Cravitz, '29, Allen Ray '35, Fred Felberg '42, and a man still to be selected from the classes of '47-'50.

Seminar

THE ALUMNI SEMINAR Committee held its first meeting on January 3 to start planning the big day on April 14th. Gerald Foster '40, is chairman of the committee this year. Working with him are W. E. Baier '23, Ernest Maag, Jr. '26, Ernest Hugg '29, Kenneth Russell '29, Frank Alderman '30, R. A. Peterson '31, Madison T. Davis '33, R. W. Jones, Jr. '38, James Watkins '40, Paul Hubay '49, William A. Freed '50.

Dinner - Dance

HAVE YOU MADE your reservation for the Alumni Dinner Dance to be held at the Oakmont Country Club on Saturday evening, February 3? There's still time to do it. Call the Alumni Office now.

Chapter Note

THE SAN FRANCISCO CHAPTER was honored by a visit from President DuBridge on December 9, at a dinner meeting in the Alouette Restaurant. Dr. DuBridge's talk on "Caltech in the Nation's Service" was thoroughly enjoyed by a large turnout of 120 alumni, wives and friends.

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745 Alvarado Road, Berkeley
Oronite Chemical Co., 38 Sansome St., San Francisco

VICE-PRESIDENT Jerome Kohl '40
53 Lenox Rd., Berkeley 7
Tracerlab, Inc., 2295 San Pablo Ave., Berkeley

SECRETARY-TREASURER R. R. Bowles '41
7960 Terrace Drive, El Cerrito
Calif. Research Corp., 576 Standard Ave., Richmond

The San Francisco Chapter meets for lunch at the Fraternity Club, 345 Bush Street, every Thursday.

New York Chapter:

PRESIDENT Richard K. Pond '39
95 Forest Road, Fanwood, N. J.
Westinghouse Electric Co., 150 Pacific Ave., Jersey City, N. J.

VICE-PRESIDENT Mason A. Logan '27
17 Pittsford Way, Summit, N. J.
Bell Telephone Labs, 463 West St., New York City

SECRETARY-TREASURER Erwin Baumgarten '40
302 E. Front St., Apt. B-16, Plainfield, N. J.
Calco Division, American Cyanamid Co., Bound Brook, N. J.

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Bureau of Mines
Department of the Interior
Washington 25, D. C.

SECRETARY-TREASURER P. G. Nutting '36
5112 Connecticut Ave., N.W.
Washington 8, D. C.

PERSONALS

1915

Merwin H. Soyster writes from Hobbs, New Mexico, that he's been District Engineer for the U. S. Geological Survey, Conservation Division, Oil and Gas Leasing Branch, since February 1949. He supervises Federal oil and gas leases and development in Lea County, New Mexico, and in west Texas.

1918

Carlyle H. Ridenour, Brig. Gen., has been farming in Marietta, Georgia, since his retirement from the Army in 1945. He's also chairman of the Red Cross Blood Program in the Atlanta region; chairman of the Cobb County Crusade for Freedom; and president of the Marietta Theater Guild.

1922

Harold R. Harris is now Vice President of Pan American World Airways, La Guardia Field, New York.

1924

W. L. Holladay recently received the Wolverine Award of the American Society of Refrigerating Engineers for his paper, "The Design of Low Temperature Test Chambers," which appeared in the July issue of *Refrigerating Engineering.* The award, a jewelled key, was presented at the December meeting of the Los Angeles Section of the Society.

1925

Earl D. Stewart was elected Vice-President at the annual meeting of the Association of Consulting Chemists & Chemical Engineers on October 24th.

1926

Harold W. Lord was a recent patent awardee at the General Electric general office in Schenectady, N. Y. He had a patent granted for an electrical high-frequency pulse translating network—which brings Harold's total number of patents to 67.

1927

Dr. Carol G. Montgomery, M.S. '28, Associate Professor of Physics at Yale University, died of a heart attack at his home in New Haven on December 3. He was 41 years old.

Dr. Montgomery was best known for his writing and editorial work on the monumental M.I.T. Radiation Laboratory Series of books on radar. More recently, he had continued with his work on cosmic ray research, and helped establish the Yale Cosmic Ray Station at Climax, Colorado.

Dr. Montgomery was 18 when he was graduated from the Institute in 1927. He received his Master's degree here the following year, and his Ph.D. at Yale, at the age of 21. From 1932 to 1940, he undertook cosmic ray research at the Bartol Foundation of The Franklin Institute of Pennsylvania. He was then appointed assistant professor at Yale, but was soon called away to M.I.T., where he served as one of the top research men during the war. He returned to Yale in 1946.

He is survived by his wife, Dorothy Durfee Montgomery (herself a physicist who assisted her husband in most of his research), and a son and daughter.

Robert Creveling writes that he has been in Albuquerque, New Mexico, for the past three years, and has just changed jobs—from the New Mexico Experimental Range, where he was in charge of VT Fuze Testing, to one with the Atomic Energy Commission at the Sandia Corporation.

1929

A. J. Larrecq is now President of Power Generators Ltd., and President of the General Engineering and Research Corporation in Trenton, N. J., manufacturers of gas turbines, steam generators, centrifugal pumps, reciprocating pumps, diesel engine superchargers, sewage disposal plants ,etc.

Anthony is married, has a daughter 11 years old, and lives in Yardley, Bucks County, Pa.

Nicholas Mikhailovich Oboukhoff, Ph.D., Research Professor Emeritus of Mathematical Physics at Oklahoma Agricultural and Mechanical College, passed away on July 30 at Stillwater, Oklahoma. He was 77 years old. He is survived by his wife.

1931

William D. Hacker, Jr. writes from New York that he was recently appointed President of the International Sewing Machine Company, American distributors of the Swiss-made Elna sewing machines.

Rudolf C. Hergenrother, Ph.D., has been with the Raytheon Mfg. Co. in Waltham, Mass., since 1946. He is now a department head in the Power Tube Division, and published a paper on Storage Tube work in the July Proceedings of IRE. He writes that he does some private flying for relaxation, especially during vacations—when he takes his wife and one or two of his three boys along—and he's counting on flying to California next summer. His two older boys are now attending Massachusetts University in Amherst.

Lawrence E. Kinsler, Ph.D. '34, is now Professor of Physics at the United States Naval Postgraduate School. He was formerly head of the physics division at the United States Naval Academy and was an active naval officer during the war. He is co-author with Austin R. Frey of a new book entitled *Fundamentals of Acoustics*, published in October by John Wiley and Sons.

1932

Merit P. White, Ph.D. '35, formerly Bomb Damage analyst for the U.S. Strategic Bombing Survey in Germany, and now head of the civil engineering department at the University of Massachusetts, will head the new Massachusetts Civilian Defense Organization committee to study the protection of structures against bomb blasts.

Lt. Col. William Shuler, who went on to West Point after his graduation from Caltech, was decorated for efficiency in World War II and has recently taken command of the Los Angeles Division of the U. S. Army Engineers.

1935

Arthur E. Engelder, Doctor of Medicine in his tenth year of practice, writes from Douglas, Arizona, that he is currently busy promoting an organization for the development of medical and surgical instruments. Arthur has two young daughters, Sally and Barbara.

1937

Richard T. Brice, Ph.D., after leaving the service in 1945, began working for the Otis Elevator Company in New York City. In 1946 he became Advertising Manager for the company and held the post until early last year when he was sent to the Advanced Management Program at Harvard Business School for a three-month training course in business management. After his return to work in June he was appointed chairman of the company's Basic Procedures Committee, and since then has been head-over-heels in a newly inaugurated program of management research.

1939

Kenneth G. MacLeish writes from New York that he still holds the same job in the Research and Development Section of the Eastman Kodak Company in Rochester. Recent additions to the MacLeish clan include a son, Kenneth, born in August 1949, and a daughter Anne, born in August 1950.

1941

Stan Rupert, after four years at Johns Hopkins University, has completed all requirements for his Ph.D. in Physics, and is currently working for Professor John Strong (formerly on the Caltech faculty) on a project for the American Cancer Society. The Navy willing—Stan is in the Reserve—he'll continue his work at Johns Hopkins at least until July 1st.

Robert H. Weight, M.S., was recently married to Charlotte Young of Pasadena in Manti, Utah. They motored to Mexico City on their honeymoon.

1942

Alvin Piatt writes from Burbank, Calif., that his first child, Michael Hartley, was born on November 26th.

1943

Chuck McGee married Louise Hanney of Poona, India, on October 20 in Bombay. They return to the U.S.A. in February.

1944

W. G. Jackson, Jr., Commander, U.S.N., writes from Brooklyn to say that he's longing for Pasadena, and putting in his time Material-ing instead of Engineer-ing.

Garman Harbottle is, at present, a research associate in Nuclear Chemistry at the Brookhaven National Laboratory at Upton, N. Y. In 1949 he got his Ph.D. degree in chemistry at Columbia University—and got married too, by the way.

1945

Merritt A. Williamson, M.S., reports

from Hammond, Indiana, that Roxanne Louise, his fourth daughter, arrived on October 26th. Merritt is still Associate Director of Research for the Pullman Standard Car Manufacturing Co. in Hammond.

1946

David C. Lincoln, M.S. '47, is now doing development work on remote-controlled aircraft for the Sperry Gyroscope Company. He married Joan Rechtin (Scripps '49) last July and they are now living in Hicksville, N. Y. "Only trouble with it back here," says Dave, "is that California's 3090 miles away."

Ed Gould received his Ph.D. degree from UCLA last June and is an Instructor in Inorganic Chemistry at the Brooklyn Polytechnic Institute, New York.

Clifford O. Harvey, Jr., is a Methods Engineer for North American Aviation, at the Los Angeles International Airport. He took two years of graduate work in Business at the University of California prior to this job. Cliff reports that *John A. Anderson*, '46, is also employed at NAA.

Howard E. Jessen of La Canada, Calif., married Mary Susanne Carson in Omaha, Nebraska on December 16. They'll settle in Omaha.

1947

Albert Mueller and Ardita Williams were married on December 16 in San Marino.

David O. Caldwell spent the summer doing research at the Los Alamos Scientific Laboratory, and is now continuing his work toward a Ph.D. degree in nuclear physics at UCLA with the aid of an AEC Predoctoral Fellowship. He was married to Miriam Ann Planck on November 4.

George B. Melrose, M.S., was married last May to Darl Ann Babcock of Kenmore, New York. Since their wedding trip to Bermuda they have made their home in Kenmore. *James S. Lesko*, '48, was an usher at the wedding. George is currently employed as an aerodynamicist at Bell Aircraft.

David Purdon, Lt. Comdr., U.S.N., Prof. Degree, who was reported missing after the crash of a J-1 North American Attack Bomber at sea on October 28, has been listed officially as killed. David was piloting the bomber off Guantanamo, Cuba, after taking off from the carrier *Franklin D. Roosevelt*. The accident is believed to have been caused by loss of operational power in the controls of the plane, which was the heaviest bomber to be designed for carrier action.

1948

Richard Allan Ferrell, M.S. '49, was recently awarded the $1000 top prize in an essay contest conducted by the Gravity Research Foundation of New Boston, N. H. He is now working for his Ph.D. in nuclear physics at Princeton University, under a fellowship granted by the Atomic Energy Commission.

James G. Wendel, Ph.D., says he's "still Instructor at Math at Yale; married, no kids."

Dave Carlisle, Ex '48, writes from Korea that he is a platoon leader in the 77th Engineers, a 25th Division unit that is probably the most decorated company there. Dave goes on to say, "Yesterday, Thanksgiving Day, was both solemn and joyous . . . Thanksgiving dinner was wonderful—turkey and *all* the trimmings, and far more than we could ever eat."

1949

Bill Palmer writes from Sioux City, Iowa, that he is now working for Minneapolis Honeywell in Minneapolis, and was married to Margaret Curray (Oxy '50) last August.

William Nelson Harris, M.S. '50, recently became engaged to Sally Garrett of Altadena. Bill is working in San Francisco.

Theodore W. Rose has bought a home here, and is now working at the Downey Plant of North American Aviation. The Roses' expect an addition to the family in April.

1950

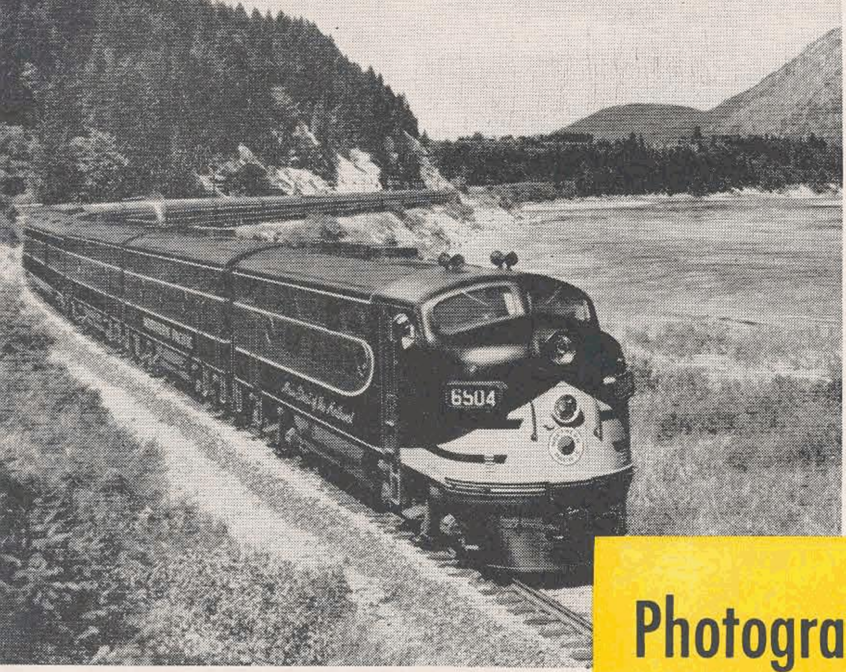
L. R. Scherer, Lt. Comdr., U.S.N., recently completed Helicopter Training at Lakehurst, N. J., under the auspices of the Bureau of Areonautics.

Major J. H. Hottenroth, M.S., is an Instructor in the Dept. of Mechanics at the U.S. Military Academy in West Point, N. Y.

Bruce Stowe writes from Harvard, where he's a Biology grad student, that he's got plenty of Caltech company in Cambridge. Other Harvard grad students are: *Jim Hendrickson*, '50, and *Roger Picciotto*, '50, in Chemistry; *John Inman*, '50, in Medical Sciences; *Carl Price*, '49, in Biology; *Jay Linderman*, '49, in Business School; and *Larry Nobles*, '48, in Geology.

At MIT, the grad students from Tech include *Fernando Corbato*, '50, and *Milt Andres*, '49, in Physics; *Bob Walquist*, '49, and *Max Matthews*, '50, in Electrical Engineering; and *Len Herzog*, '48, in Geology.

Working in Cambridge are *Len Hedrick*, '48, and *Walter Mudgett*, '49, who is working at the Raytheon Manufacturing Co.



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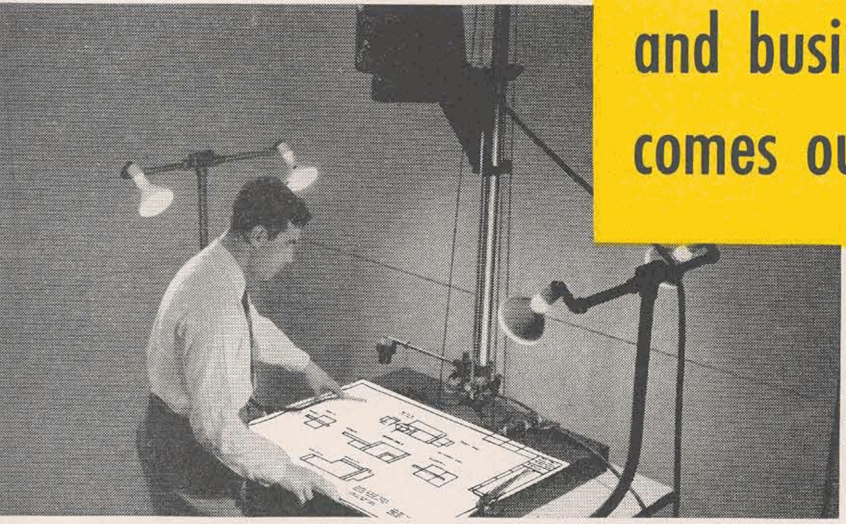

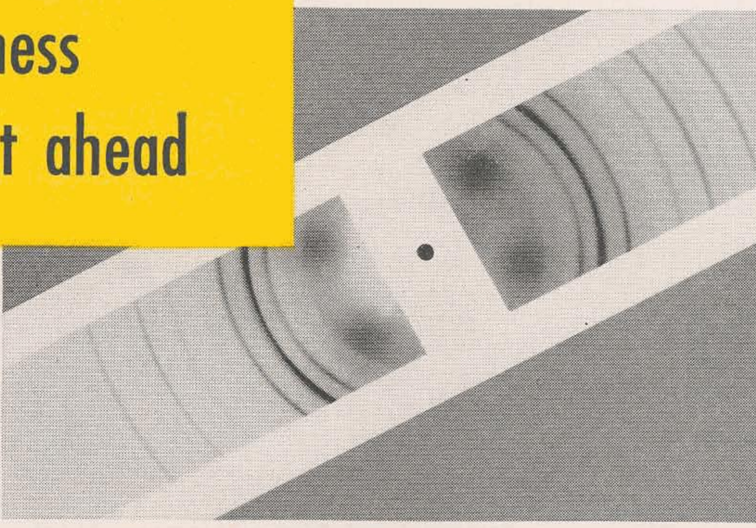

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