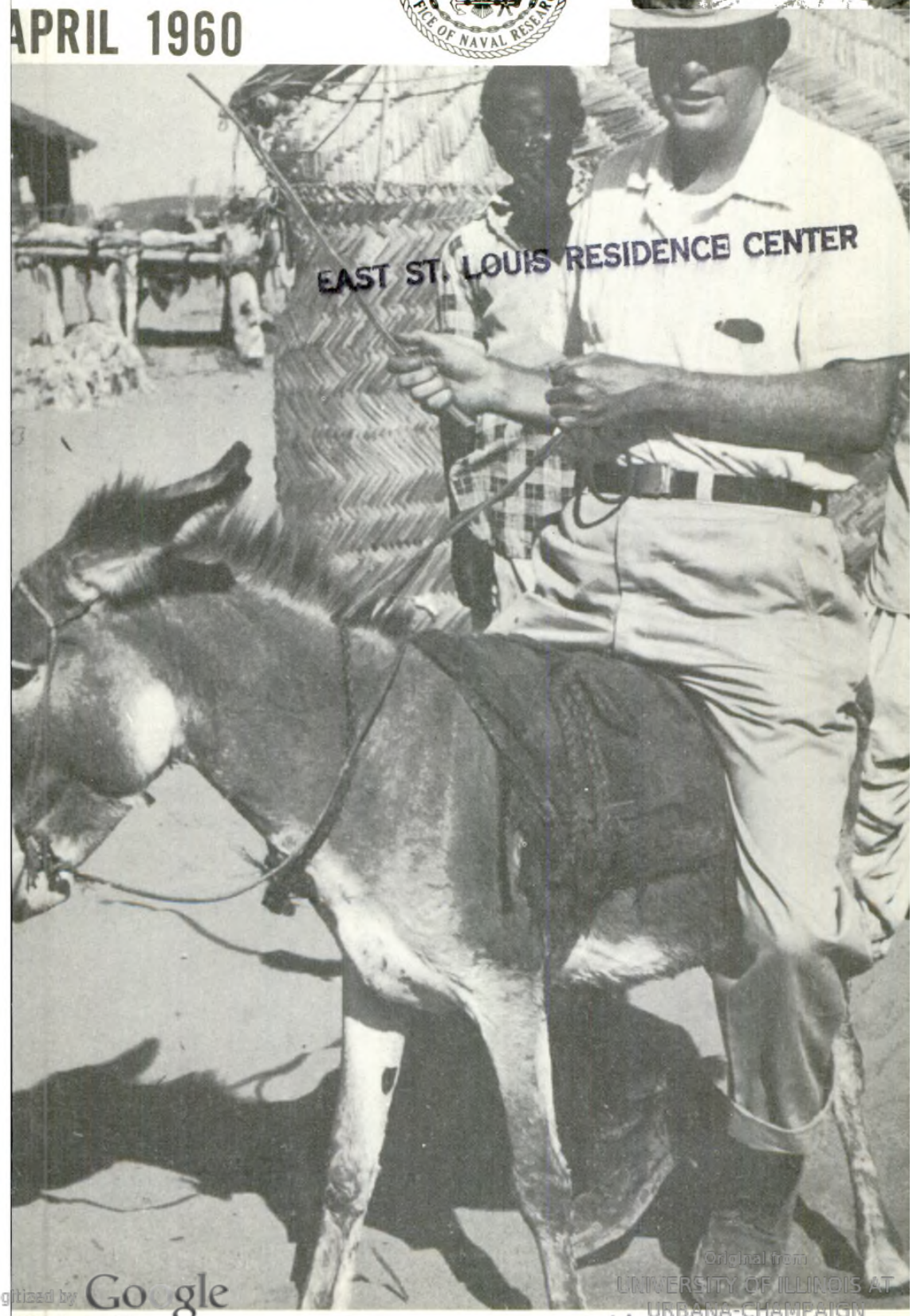
AVAL RESEARCH

REVIEWS

APRIL 1960



Navy Surgeons Transplant Ovarian Tissue

A team of doctors at the National Naval Medical Center–CAPT George W. Hyatt, CDR Thomas B. Lebherz and LT F. William Sunderman–have met with encouraging success in their efforts to transfer live ovarian tissue from human embryos to women who have had their ovaries removed. While it is still too soon for complete evaluation, the doctors hope their technique will make it possible to restore to normal hormonal imbalance secondary to acquired or cogenital absence of the ovaries. This information was presented to the Armed Forces Obstetrics and Gynecologic Seminar in May 1958 and to the Military Surgeons in 1959. The Clinical research was begun at the medical center with the intention of exploring ways to overcome or get around present blocks to successful transplantations of all glands whose secretions are necessary to life. The tests were started with ovarian gland tissues because the female sex glands met three research criteria: A relatively large number of women of child-bearing age have had their ovaries removed; there may be sufficient numbers of ovaries obtainable from post-mortem specimens; and the ovary is a gland not needed to maintain life.

The Navy physicians performed their first ovarian tissue transplant in a woman patient 2 1/2 years ago. Another woman patient was similarly treated that same year, and a third such operation was performed last year. Results, they report, have been "encouraging" in one case, but the doctors cautioned that they need a full 5-year, wait-and-see period at which time the transplant should be biopsied before claiming the operation safe and successful.

The ovarian tissue transplants are designed to eliminate the need of taking hormone shots or pills by young women who lack their own ovarian functions, such as those who have undergone total hysterectomies. They do not maintain the ability of the normal ovary relative to fertility. Some such patients require the hormone replacement treatments for 20 or more years. Without ovarian function or hormone replacement therapy, many women of child-bearing age face premature aging processes–heart condition, decalcification of the bones, and other conditions associated with old age.

Many attempts have been made in the past to transplant ovaries from one person to another, but all proved futile. Unpredictable success has been noted using the healthy remaining portions of partially diseased ovaries when transplanted into the same patient. The person-to-person transplants were defeated by a probable antigen-antibody barrier to acceptance of foreign tissue, the body's refusal to accept living tissue from another person. The Navy doctors believe they may have circumvented this by using living ovarian tissue from a less than 16-week-old fetus by applying a technique that was originated by Professor P. J. Gaillard, University of Leyden, Holland. They sliced this embryonic ovarian tissue into bits less than half a millimeter thick, the tiny pieces were first grown on cultures, and then transplanted to pieces of live tissue on a section from the lining of the abdomen taken from the patient who would later undergo the implantion operation. To further promote growth, the material was nourished in the blood serum taken from the prospective patient. When the research shows that the ovarian tissue growth continues without the destructive challenge of the patient's own flesh and blood, the doctors may be "almost sure" they have developed a successful technique.

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ONR's Geographic Research Program

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A dozen years ago it was officially recognized that geographic research could make a valuable contribution to the Navy, and a program was accordingly initiated in the Office of Naval Research. It would be difficult to trace all the background of this recognition, but certainly a major factor was the knowledge that none of the operations the Navy engages in can be divorced from the surface of the earth, or from the land areas on that surface. The land areas provide the bases, the major targets, the military objectives, and the raw and manufactured materials which equate with naval power. It is the content of the surface of the earth that is the object of geographic research. This content includes both the natural and the man-made phenomena.

The geographer is not only interested in the spatial arrangement of these physical, biotic and cultural elements; his research is largely devoted to gaining an understanding of the ways in which these phenomena interact and the processes that govern their behavior, especially as these interactions and behaviors differ from place to place on the surface of the earth. Geography, then, attempts to deal with the environment of places, and to organize this knowledge of innumerable places into an understandable and meaningful form. The profession is made up of a wide variety of geographers—some concentrating on climates, some on land forms, on vegetation, on transportation, ports, urban areas, manufacturing, land use, and so on, while others are concerned with all aspects of particular places or regions. The mixtures and varieties of interests among geographers are as numerous as their subject matter is diverse.

Just as geographers specialize in order to put power behind their attack on the unsolved geographic problems and to penetrate the frontiers of knowledge, the Geography Branch of the Office of Naval Research also has to concentrate its efforts, since the whole field of geography could not possibly be encompassed in a single research program. The ONR solution has been to concentrate on problem areas, both of knowledge and of the earth's surface where information and understanding are in critical short supply. Four problem areas have been recognized: the Arctic, the coastal zones of the world, fundamental methodology and foreign areas, and the interpretation of the results of airborne sensing devices. This focusing of the research program results in no serious restrictions on the kinds of geographic research that can be sponsored since the four problem areas are quite broad; it does allow the assault, however, to place its strength in areas where advances are most needed, both by the Navy and by the science of geography.

ARCTIC GEOGRAPHY

The land and water areas of the Arctic Basin represent in the fullest sense what is meant by a problem area. In whatever scientific direction one looks, knowledge about the physical and biological environment of the American Arctic is for the most part scanty, inaccurate, or wholly lacking. Although there has been a tremendous increase both in the sum of knowledge and in the Navy's capability to conduct arctic operations, the region must continue to be classed as a poorly known area. An enormous research effort is still required to bring the state of knowledge and understanding of the geography of the Arctic to an acceptable level.

A major step toward the acquisition of needed information was the establishment by the Office of Naval Research in 1947 of the Arctic Research Laboratory at Point Barrow, Alaska. (See Figure 1.) From a rather small beginning, the scientific research program conducted at the Laboratory has expanded and intensified, until, in 1959 there were 39 major research projects in progress and 160 scientists and technicians made use of the Laboratory research facilities. Literally perched at the "end of the earth," at the most northerly point of land in the United States, the Arctic Research Laboratory presents a unique research facility. Not only is it well equipped for arctic studies, with both ordinary and special apparatus and supplies, but—even more important—it is a center from which scientists conduct field studies across the entire northern slope and out onto the ice and water of the

Figure 1 — Arctic Research Laboratory, Pt. Barrow, Alaska, USA.

Arctic Ocean. The Laboratory has its own fleet of small ski-equipped airplanes, tracked vehicles, and boats, including the NATCHIK, a 38-foot cruiser specially designed for research in arctic waters. These transportation facilities bring within reach many thousands of square miles of the Arctic Basin and enable the Laboratory to supply logistic support to dozens of scientists scattered around the vast hinterland of Pt. Barrow. In addition to the ONR-sponsored research program, the maintenance of this laboratory by the Office of Naval Research has contributed to or made possible arctic research by many other governmental agencies, 14 different agencies being assisted by the Laboratory in 1959 alone. The Arctic Research Laboratory is under the very able direction of Dr. Max Brewer and is operated through a contract with the University of Alaska.

The program of arctic geography research includes many fields: geology, geomorphology, pedology, climatology, ecology, cryology, and oceanography. In simplest terms the research can be said to include the study of the whole environment of the Arctic Basin: that of the land, the sea, and the air. Studies of the land are largely concerned with the thermal and engineering properties of permafrost, the permanently frozen ground that underlies the arctic slope; geomorphologic processes and forms of the beaches and bars; morphology of lakes; heat budget of glaciers; and with such geophysical factors as earth potentials and magnetic field fluctuations, especially as these affect communications and navigation.

The investigations of the Arctic Ocean include the whole array of oceanographic interests: bathymetry; ocean floor configuration and sediments; physical and chemical structure of the water; sound transmission charactistics; and sea level and tidal fluctuations. Special efforts have been devoted to obtaining more details of the nature, depth, and slope of the Barrow Sea Valley, an underwater canyon that offers a deep-water channel the best known under the ice of the Chukchi Sea. All these watery aspects offer many challenging problems, but an equally fascinating set of unanswered questions is posed by sea ice, which in terms of techniques of investigation might be considered an extension of the frozen land out over the arctic waters.

Arctic atmospheric studies are aimed at broad problems—such as visibility, illumination, and aurora—and localized, micrometeorological conditions. In the latter category, studies are made of the lower layers of air over the land, lakes, glaciers and sea, both ice-covered and open, to determine heat exchange, temperature, moisture and wind gradients, insolation and radiation values, and other factors. These micrometeorological studies are coordinated with standard upper-air observations taken at the Arctic Research Laboratory, and together they provide new insight into the climate of the region, an especially important element because it influences essentially all physical and biological processes. Studies of these environmental effects on metabolic and other physiological processes are discovering information which sheds new light on the adaptive characteristics of natives and other mammals. Investigations of the relations to the environment of insects, bacteria, and various other microorganisms, assist in understanding arctic problems of disease, sanitation, spoilage, and deterioration.

Briefly stated, these are the kinds of activities that make up the program of research on arctic geography, and although the individual parts of the program may seem scientifically remote and insular, the participants work closely together so that the whole endeavor becomes well-knit and thoroughly coordinated. Further coordination is attained through the mechanism used to support the arctic research program. Although some scientists are on individual contracts, most of the research at the Arctic Research Laboratory is conducted under a primary contract with the Arctic Institute of North America, which works in close association with the Geography Branch.

COASTAL GEOGRAPHY

Another area of the earth's surface which must be classed as poorly known is the coastal zone. Not only is information on the topography, vegetation, climate and human occupance limited, inaccurate, or entirely missing for a good many coastal regions, but the processes that create and modify the physical characteristics of the coasts are little understood, or are known only in the most general terms. The coastal zone—which areally includes the nearshore, the beach, and a section of the mainland extending inland a varying distance, usually to the limits of the influences of the sea—has been neglected scientifically. Investigations by most earth scientists are most likely to ignore the distinctive characteristics of the coastal zone and to classify it roughly with adjoining land and ocean categories; to an increasing degree, however, the zone itself is becoming the object of study.

Although the research program on coastal geography is modest, it does include a variety of studies which may be broadly grouped as being concerned with: beach processes; coastal morphology and environment; acquisition and interpretation of information on little-known coastal areas and islands; and human use of coasts, especially the development and functions of ports.

The processes and mechanisms that create and modify the shape and structure of the beach present a provocative challenge to scientists. This is a problem on which there is considerable general information and a collection of long-held hypotheses, but as often as not "beaches behave in a way that indicates they have not read the rules". It is generally recognized that the configuration and topography of a beach is the resultant of a combination of related factors, such as kinds and amounts of beach materials available, degree of exposure to winds of various intensities and waves of various dimensions, tidal range, nearshore bottom gradient, and velocity and direction of long-shore currents. The difficulty is that although the gross role of these factors in beach behavior is clear, the magnitude of the role of the individual factor or set of factors is still obscure. Research efforts, therefore, are being directed toward the determination of the discrete values of the factors and the ways in which these values vary in combination. Examples of this kind of research are the projects conducted by Columbia University and Woods Hole Oceanographic Institution, in which careful measurements of the beach and nearshore profile are made periodically, and especially immediately after storms. At the same time observations are taken of the wind direction and force, wave conditions,

Figure 2 — Beach-rock formation on the island of Guadaloupe.

tidal stage, and current velocity, direction, and location. From these data it is possible to determine how much beach material moves off of or onto the beach under specific sets of conditions.

The beach presents so many intriguing unsolved problems that it is impossible to cover them all either in this article or in the research program, but one more example of a beach puzzle is worthy of mention. While the Coastal Studies Institute of Louisiana State University was conducting a study of Caribbean beaches to determine the relation of beach profile to the mineral content of the sediments, the scientists came face to face with the problem of beach rock, a fairly common phenomenon on tropical beaches. Beach rock is cemented beach material, but research has discovered that it is unrelated to the kinds or composition of beach materials. The cementing substance is found to be calcium carbonate, but the actual process of cementation is as yet unknown. Study indicates that cementation is not the work of lime-depositing algae and is probably unrelated to the chemical composition of sea water. The presence of beach rock is somewhat erratic, for it is found on beaches with every type of exposure, but all beaches do not have beach rock, either exposed or in incipient stages under the sand where it forms. Exposed beach rock is evidence of an eroding beach, and it indicates the former position of the beach. (See Figure 2.) Research is being continued, to discover the areal limits and controlling conditions of beach rock development, and the mechanisms of cementation. Since these rocks on some beaches can be exposed and then covered by sand is a matter of days or weeks, they constitute a major hazard to beach-landing operations.

Study of beaches has shown that what happens in the nearshore zone has a considerable bearing on beach behavior, so research is also being

focused on this critical area. The Oceanographic Institute of Florida State University and Yale University are conducting research to determine processes and rates of sedimentation and circulation, and the relation of the nearshore and continental shelf sediments to those of the adjoining coast. This research is just starting, but it has promise of yielding much knowledge of use in the Navy's coastal defense activities.

Research on coastal morphology and environments includes a number of studies conducted by the Coastal Studies Institute under the expert direction of Dr. Richard J. Russell. The objective of their studies of deltas and other low-lying coasts is to determine characteristics of the land forms and waterways and the processes of deposition and erosion that shape these alluvial coasts. In addition to these morphological studies, other projects deal with coastal vegetation and coastal climates. Studies of past configuration and environment are sponsored to obtain data on the chronology of long-term coastal changes, which provides a measuring stick for gauging current fluctuations and alternations of coasts.

A good many of the investigations mentioned have been conducted in scientifically little-known areas. For example, research on deltaic and other kinds of coasts by the Coastal Studies Institute has been conducted in Bengal, Baluchistan (see cover), southern Brazil, and the Caribbean, while geographers under other contracts with Louisiana State University have studied the coasts of the Guianas and Colombia. Geographers from the University of California are continuing their field studies of coastal and island areas in the Caribbean and Central America.

Figure 3 — Native hut made of animal dung; Kenya.

To a degree, these and studies in remote parts of Mexico, Borneo, and similar infrequently visited coastal places, are devoted to acquiring accurate information on the physical, biotic, and cultural conditions that exist, for data gathering is still a necessary part of most geographic research. Studies of the islands of the Pacific, under a contract with the Pacific Science Board of the National Research Council, are a good illustration of the fact that sophisticated research often must await the accumulation of information. When the United States was given responsibility for administration of the Trust Territory, a responsibility delegated to the Navy, information on the physical and cultural conditions of the islands was fragmentary, at best. For the first 5 or 6 years the main emphasis of the work was on the gathering of information. It was only when the supply of data became relatively abundant that research could be devoted to such problems as the interrelations of various factors in the environments of atolls. There still remain many areas in the Pacific and elsewhere for which the most elementary geographic information is entirely missing.

Meanwhile, a number of port studies have been conducted in foreign areas, for example, in Europe, the Philippines, and Southeast Asia. The current emphasis is on African ports, both large and small. In addition, studies have been made of selected American ports, primarily to develop valid methods of delimiting port hinterlands. All these port studies provide the Navy with fundamental geographic knowledge of use in its wartime responsibilities of protecting vital shipping lanes and ports, and crippling enemy commerce.

SYSTEMATIC AND REGIONAL GEOGRAPHY

The program under this general title is primarily devoted to the development and improvement of geographical research techniques and methodology, and to filling the gap in knowledge of foreign areas. Under one contract, for instance, that with the National Academy of Science—National Research Council, 45 geographers have been assisted in conducting field work overseas. In addition to the valuable new data provided by these studies, the sponsored research is creating a reservoir of competent geographers with first-hand knowledge of foreign areas, with close contacts with foreign scientists and other key persons, and with field experience which increases their competence and interest in additional foreign research. (See Figure 3.)

Research on methodology and techniques has taken a variety of forms. Among the studies supported are several which are developing new methods of quantifying geographic data and applying statistical procedures to geographic research. One example is the research directed by Dr. Arthur N. Strahler of Columbia University in which new techniques were devised for measuring and analyzing the characteristics of erosional surfaces. These methods, susceptible of repetition, demonstrate objectively the relations between land form dimensions and the controlling factors of climate, vegetation, relief, and rock type. The usefulness of these methods of terrain analysis in military and engineering activities is apparent, since it is now possible to describe terrain elements numerically and thus introduce them into estimating equations.

In all this research it should be noticed that quantification is stressed. In this the Geography Branch program is encouraging a small but increasing group of geographers who are seeking more objective, precise, and penetrating analytical methods applicable to the solution of geographic problems.

In addition to research on methodology and on foreign areas, this program also includes various other studies. For example, research is supported in climatology, both on a world-wide and local basis, to gain new and deeper insight into the causes, occurrences, environmental relations, and changes of climates. Long-term fluctuations are also studied, using such indicators as terraces, sediments, pollens, tree rings, glaciers, and archeological findings to improve the knowledge of the chronology and causes of these climatic changes. Research on present climates is largely devoted to gaining an understanding of the earth's water balance and also the heat and moisture exchange between the earth's surface and the atmosphere. Microclimatological research measures and correlates such factors as vertical and horizontal air movement velocity, air and soil temperatures, air moisture content, precipitation, radiation, and evapotranspiration. A number of new instruments and techniques have been designed to measure the heat and moisture flux.

Other examples of systematic geographic research could be cited, but only one more will be mentioned: research in medical geography. If at this point you begin to wonder just what geographers exclude from their field, perhaps another glance at the beginning of this article is warranted, for there it was explained that geographers are concerned with all phenomena of the surface of the earth. Surely disease is a part of the environment, and its occurrence is intimately connected with that environment, which includes man. The studies in medical geography, supported by a contract with the American Geographical Society, are directed by Dr. Jacques M. May. The incidence, frequency, and intensity of various diseases were mapped on a world basis as were the distributions of disease agents, hosts, and vectors to discover, among other things, what relations existed between disease and factors of the physical and cultural landscape. This approach provides valuable assistance in the solution of many epidemiological and preventive medicine problems. It also provides greater insight into the environment of places.

PHOTO INTERPRETATION

Originally the photo interpretation program was established for the sole purpose of improving the techniques of using aerial photographs only as a source of environmental information. During the early phases, the preparation of photo interpretation keys and guidance materials for interpreters were especially emphasized. Now, both scientific and military user of aerial photographs have become much more skilled and the need for keys is diminished, but three new problem areas in the general field of airborne acquisition of information have appeared. As these new needs became apparent, the objectives of the research program were promptly altered to enable the Office of Naval Research to take a leading postion in the solution of the new problems.

One of the fundamental needs in the use of records obtained from all airborne sensing devices, such as radar and cameras using standard or special purpose film, is a complete knowledge of the reflectance characteristics of natural features and man-made objects on the earth's surface. To assist in meeting these needs, research on the properties of light reflected from forest vegetation has been initiated at the University of Illinois. Spectrophotometric properties may be expected to change seasonally and with many other alterations in the environment, so that a full understanding of the measured qualities of reflectance should provide useful clues to such factors as soil moisture and various micrometeorological conditions that individually are not recorded by the sensor. The research, therefore, is concerned with the measurement and analysis of reflectance characteristics and with the environmental conditions which accompany any changes in these characteristics. It is expected that the research program in time, will also include the analysis of spectral reflectance of other surface features.

Another important need is research which will lead to improved use of development of new airborne sensing systems for rapidly determining environmental conditions. Under a contract with the Department of Meteorology, University of Wisconsin, Dr. Reid A. Bryson and his staff are experimenting with the use of combinations of a wide variety of sensors, including several cameras with different types of filters and films, various radiometers, and instruments for recording meteorological data. While the aerial surveys are being made, careful field investigations are conducted so that the survey data may be checked against actual ground conditions to determine not only the validity of the sensing devices, but also the extent to which environmental conditions may be inferred from the survey data. The area covered by this research is a wide segment of the subarctic and arctic extending north from Wisconsin through Canada. Particular attention is given to the freezing and thawing characteristics of lakes and their thermal regimes as indicators of local and regional environmental conditions.

The third photo interpretation field that presents a problem is concerned with decreasing the time spent in scanning aerial photographs and in recovering geographic and other information from them. With the ultimate objective of adding a degree of automation to photo interpretaion, studies are being made of currently available electronic scanning devices, densitometers, and other instruments to determine their capabilities to render geographically accurate enumerations, measurements, and descriptions of earth features portrayed on photos or maps. In addition to the investigations of available equipment, other research, utilizing the principles of the newly developed "perceptron," an electronic cognitive system with self-organizing biological-type componentry, is directed toward the design of a highly mechanized photo-interpretation system.

These four major programs—arctic geography, coastal geography, systematic and regional geography, and photo interpretation—then, are the research activities of the Geography Branch. In trying to make this article brief, many facets of the work were omitted. No attempt was made to describe the program in its relation to other research activities within and outside the Navy. The reader will probably be aware that in several research areas, work has been and is being done by other agencies and under other programs.

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Navy Presents Fourth Annual Conrad Award

Dr. Ralph E. Gibson, Director, Applied Physics Laboratory of The Johns Hopkins University at Silver Spring, Md., was presented the fourth annual Conrad Award on March 9. The medal and citation were presented to Dr. Gibson during the 3-day symposium on "Naval Problems in Electromagnetic Radiation", sponsored by the Office of Naval Research, at Pasadena, Calif. The award, established by the Secretary of the Navy, is made in recognition of and reward for outstanding achievements in research and development for the Navy. It is named for the late CAPT Robert Dexter Conrad, USN, who, as first head of the Planning Division, ONR, was the primary architect of the Navy's basis research program.

Previous recipients of the award were Dr. Alan T. Waterman, Director, National Science Foundation; Dr. Charles C. Lauritsen, Professor of Physics, California Institute of Technology, and Dr. Robert M. Page, Director of Research, U. S. Naval Research Laboratory. Dr. Gibson was chosen for the 1960 award because of his individual research contributions and his contributions to the Navy. The latter includes the technology of solid-propellant unguided rockets and the development of guided missiles.

The citation, signed by the Secretary of the Navy, reads as follows:

"For outstanding contributions to the development of solid rocket propellants and guided missiles. As Vice Chairman of Section H of the National Defense Research Committee and later as Director of Research of the Allegany Ballistics Laboratory, his foresight in appreciating the potentials of solid propellants for assisted take-off of aircraft, for unguided rockets and guided missiles, and his effectiveness in speeding development, were major factors in the successful outcome of World War II and the Korean campaign.

"As Director of the Applied Physics Laboratory of The Johns Hopkins University, his leadership both as a scientist and administrator made possible the successful transition from wartime to peacetime activities, and from fuze development to guided missile development in the Laboratory, thereby hastening the introduction of the operational guided missiles into the Fleet."

Dr. Ewing Receives New Geophysics Award

A new major award for scientific research has been established. This is the Vetlesen Prize, intended to be comparable in scope to the famed Nobel Prize, but restricted to workers in the Earth Sciences. Recipients of the award will be selected by a jury assembled by Columbia University. The award consists of $25,000 and a gold medal. It will be given for "outstanding achievement in the sciences resulting in a clearer understanding of the earth, its history, or its relations to the universe." The first recipient is Dr. Maurice Ewing. He is director of the Lamont Geological Observatory at Columbia University. Dr. Ewing has been associated with ONR programs and with other Navy programs dealing with geophysics and oceanography for many years. (ONR, New York Branch Office)

Cholesterol: The Perplexing Metabolite

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Cholesterol, one of the body chemicals that has attained the limelight of both scientific and public interest during the last decade, currently is a topic of scientific curiosity, dietary faddism, and medical controversy. The curiosity of scientists concerning cholesterol — the perplexing metabolite, or product of metabolism—stems from increased knowledge of its role in the metabolic processes of the body. Scientists want to know: what tissues of the body synthesize cholesterol, what are its uses, and what happens when it is absent or present in abnormal amounts. From the standpoint of public interest, cholesterol is "the talk of the town" because of recent publicity in the press and magazines in regard to the relationship of elevated blood cholesterol levels to heart disease. Even the marketers of oils, shortenings, margarines, and similar fatty substances have "gotten into the act" by using labels of their products which imply that the use of their product "is sufficient in itself to reduce blood cholesterol levels." This, of course, leads us to medical controversy. The implications—which have been made to associate definitely high blood levels of cholesterol with heart attacks, atherosclerosis (a type of arteriosclerosis, or so-called "hardening of the arteries"), and other disorders of the blood vessels—were based on data that is premature, experimental, incomplete, and contradictory. The offshoot of these implications has lead to skepticism in the medical profession with regard to branding cholesterol as the number-one villain in the complex of causative factors in certain cardiovascular diseases and disturbances.

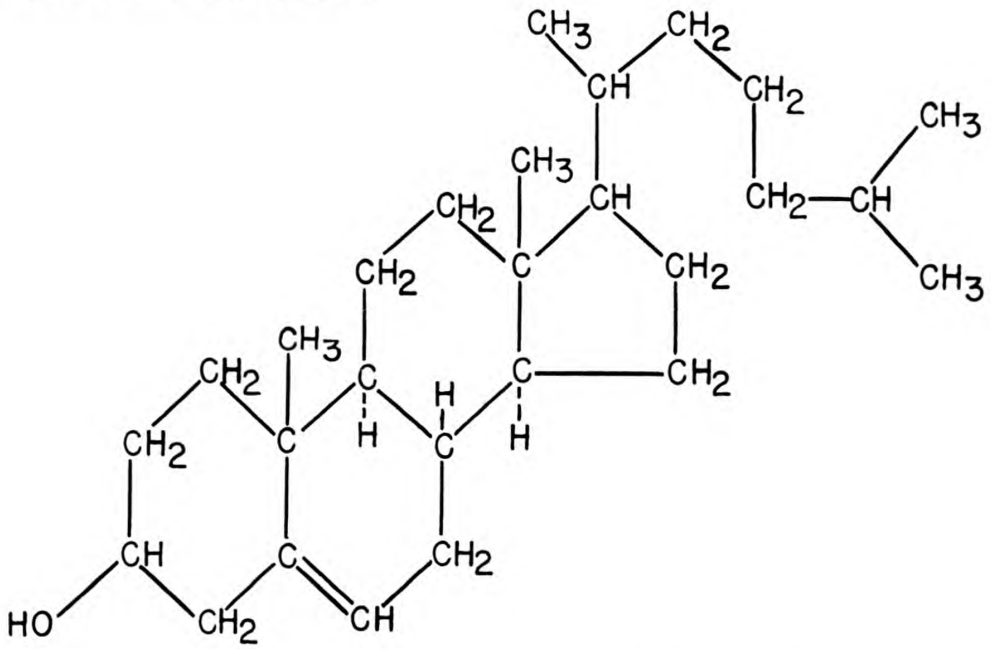


Figure 1 — Schematic formula of cholesterol.

Chemically, cholesterol (Figure 1) is an organic substance belonging to a group of crystalline or solid alcohols known as sterols. Yet it often is considered as if it were a member of the fat or lipid family, because most of the cholesterol in the human body is associated with fatty acids and lipoproteins (fat-containing proteins)—either in blood plasma or in body tissues. It is a chemical substance which is essential to the body, but there is a belief that cholesterol possesses the potential of being somewhat dangerous when present in an excessive quantity.

Among the tasks cholesterol performs in our bodies are:

- It serves as a structural component of tissues such as nerve tissues.
- It is a precursor to vitamin D_3.
- It is a precursor to the body steroids and steroid hormones.
- It is a precursor to the sex hormones—testosterone in the male and estrogens in the female.

In some microorganisms it has been shown to be an essential component of the cell wall. That sterols, especially cholesterol, are indispensable to the growth of insects has been amply established by nutrition studies, but significantly these studies reveal that many of these insects—such as cockroaches, beetles, and bees—cannot synthesize cholesterol for their needs; it must be part of their diet. Notwithstanding, current thinking puts cholesterol in a Dr. Jekyll-Mr. Hyde role, on the premise that cholesterol is the principal causative factor of atherosclerosis.

Let us look at the cholesterol-atherosclerosis or so-called "hardening of the arteries" relationship (Naval Research Reviews, December, 1955). Certain basic ideas have been agreed upon. Atherosclerosis is not a product of aging or "wearing out" as such. It is a disease process which is conditioned by metabotic factors of the body. Heredity and its metabolic consequences as well as diet are important. But, ever since scientists found experimentally that a disease analogous to human atherosclerosis could be produced in animals by feeding high-cholesterol diets, many people have been highly concerned. Advocates of the premature theory that cholesterol was principally responsible for bringing about heart disease and atherosclerosis cautioned the population against high-cholesterol contents in their diet.

In the furor little attention was paid to diets with high-fat contents until more was learned about the synthesis of cholesterol in the body. All that mattered was that high quantities of dietary cholesterol be avoided or even eliminated. Such being the case, what happened to our hormones and our tissue structure? Nothing of any serious consquence occurred, for as long as fat was available in the diet and the body, cholesterol was made by the body. In fact, the human body synthesizes about 1.5 grams (about 1/15 of an ounce) of cholesterol per day, a quantity apparently exceeding that consumed in an ordinary diet.

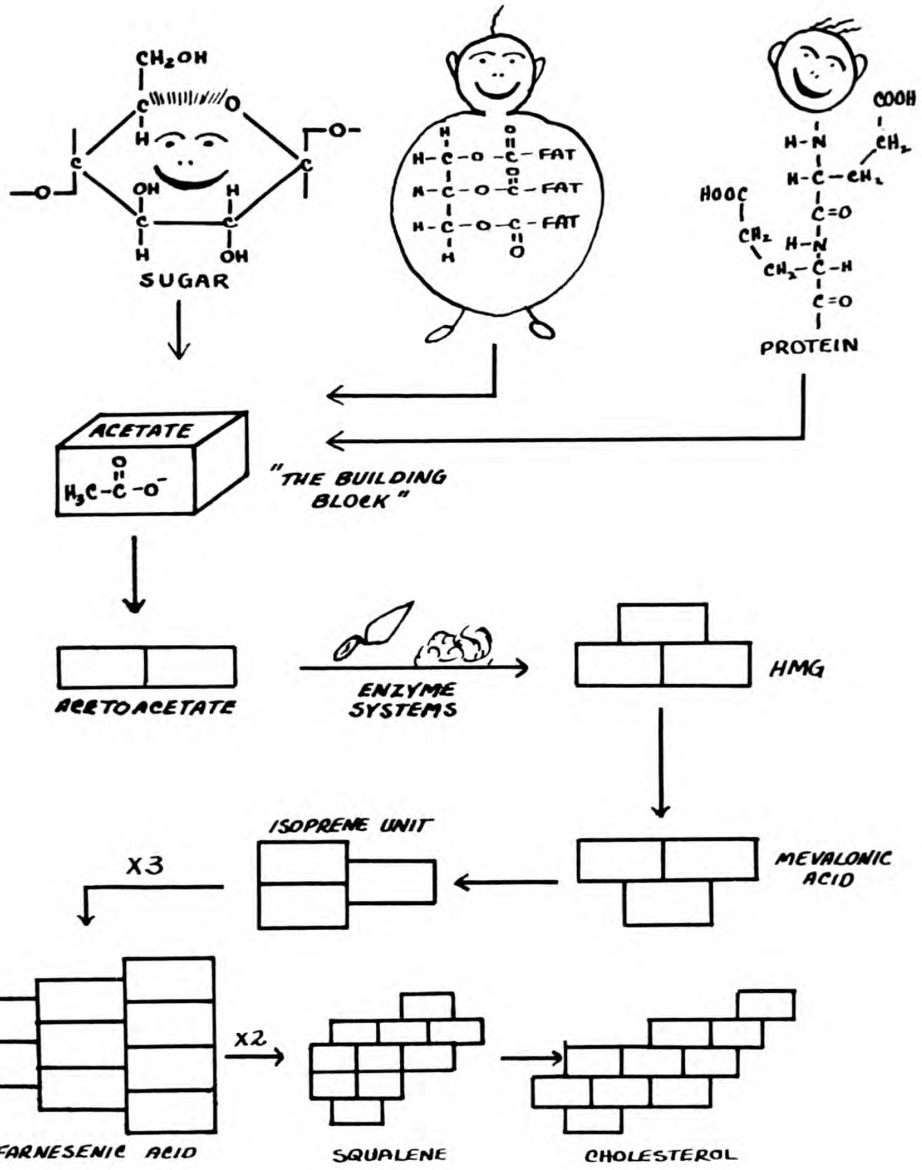


Figure 2 — Schematic representation of the "major" steps in the synthesis of cholesterol in mammals.

Just how does the body make its cholesterol? The body starts by degrading fats (principally) into tiny building blocks known cumulatively as "active acetate." Ingested proteins and carbohydrates are utilized to some extent for this purpose. Active acetate molecules are in the beginning two-carbon products which are linked to coenzyme A, but through a long chain of synthetic events (at least 26 reaction steps) ultimately yield cholesterol. The sequence of "major" events in the synthesis is illustrated in Figure 2. The production of cholesterol goes on readily and steadily despite the complex process involved, furnishing the body with a supply of cholesterol adequate to its needs. It is possible in atherosclerosis that this synthetic process becomes abnormal and the body produces more cholesterol than is needed, or that the body cannot handle normal amounts of cholesterol and fat properly.

An ironical situation presents itself at this point. Brain and nerve tissue contain more than one-third of the body's supply of cholesterol. Yet, when animals and humans are fed isotopically labeled (radioactive) acetate, radioactive cholesterol is found in adrenal glands, skin, intestines, and other tissues except in nerve. The same thing happens when cholesterol containing radioactive carbon (C^{14}) is fed — none of it appears in nerve. It is apparent, then, that cholesterol is not fed to the nerve by an exchange from the blood stream, but that the substance is manufactured by the nerve itself.

This intriguing situation led the author to investigate the hypothesis that perhaps degradative products of nerve metabolism are utilized by the nerve to synthesize its own cholesterol. Acetate and choline are two compounds that are found in nerve which might satisfy the requirement for cholesterol synthesis. Acetate and choline are liberated in the nerve when acetylcholine (the chemical substance in nerves which propagates nerve impulses along the nerve fiber) is split by the enzyme acetylcholinesterase (Figure 3.). To study this possibility, the sciatic nerves of bullfrogs were used. Some of the excised nerves were treated with radioactive acetate and others with radioactive choline. It was possible to isolate radioactive cholesterol from a mature, adult nerve following treatment with C^{14}-labeled acetate. And it was most reveal-

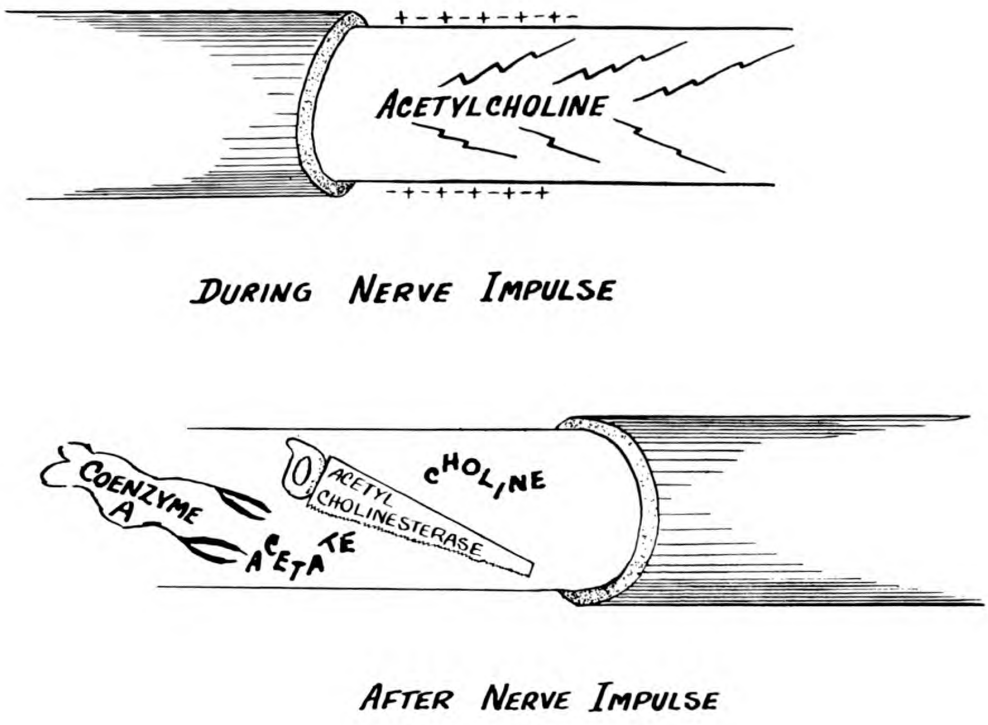


Figure 3 — Schematic representation of the activity of acetylcholine during and after the passage of a nerve impulse.

ing to find that the nerve did use the choline to make cholesterol. As a result of this investigation, we have at least one clue to the mystery of cholesterol in the nerve. The latter contains a considerable amount of fat and, therefore, must have a considerable amount of acetate following degradation of fatty acids. Choline, too, is readily available in this tissue. Consequently, the building blocks are there, the mechanics of the synthetic process are intact, and all that needs to be done is to study this interesting process further in nerve.

What is so important about cholesterol in nerve tissue? Little is known, but we do know that its presence is structurally important and is associated in a mysterious way with the transfer of the nerve impulse.

From the foregoing we can see that cholesterol, is definitely a perplexing molecule. It is essential to our well being, yet it may be the center of a good deal of our biochemical weaknesses. The latter is a point which needs much study for further clarification. One thing that can be said in favor of high blood cholesterol levels is that they aid in identifying disturbances in fat metabolism of the body. Such disturbances may indicate a predisposition to or the presence of atherosclerosis, particularly in young adult males. There is very little doubt of this when one considers that 70 percent of 222 Air Force pilots killed in aircraft accidents—some of ages 20 to 24 years old—showed some degree of coronary artery atherosclerosis. The disease may not have been the causative factor in the aircraft accident; the possibility is food for thought, however, and the disease should be considered in health surveillance programs involving pilots of both the Navy and Air Force.

The clues to the key steps in the synthesis of this important but perplexing metabolite are gradually being unwrapped. Slowly but surely, one of nature's complex mysteries will be solved. Perhaps someday cholesterol may be utilized not only as a concrete diagnostic procedure in cardiovascular and nerve diseases, but as a valuable protective agent in the defense of the body against disease.

The Velocity of Antarctic Bottom Water

Dense sea water--cold and highly saline--forms in the Antarctic Ocean, sinks to the bottom, and flows northward along the bottom of the Pacific Ocean, according to measurements made by Dr. Hans Suess of the Scripps Institution of Oceanography. Radio-carbon age measurements show an apparent age of 1500 years for water collected at 47 degrees south latitude and an apparent age of 1900 years for a water sample from 15 degrees north latitude. From this data, the net northward transport is calculated to be 7 miles per year.

--ONR Branch Office, Pasadena.

The Combustion of Elemental Boron

Claude P. Talley and Lloyd E. Line, Jr.

Experiment Incorporated
A Subsidiary of TEXACO, Inc.
Richmond 2, Virginia

Elemental boron's reaction with oxygen yields more heat per unit weight—actually, 13.9 kilocalories per gram—than any other solid element, except beryllium. Therefore, elemental boron's potential as a solid fuel is great indeed. To say that a fuel burns with the liberation of a certain amount of heat is quite one thing; but to say how fast or how efficiently this heat is liberated, or how easy it is to get the combustion going, is quite another. An idea of how difficult it is to bring about the combustion of boron may be gained by considering the fact that dust clouds of finely divided material in air cannot be ignited with an electric spark under the same conditions in which finely divided aluminum, magnesium, zirconium, silicon, iron, and various other materials ignite and burn quite readily.

TECHNIQUE

In a program currently sponsored by the Propulsion Chemistry Branch of the Office of Naval Research, Experiment Incorporated is inquiring into the basic mechanisms of the combustion of solid elemental boron by doing carefully controlled laboratory experiments. At the beginning, a decision was made to work with boron of a high degree of purity so that burning rate effect, due to impurities in the solid, could be more easily assessed. Also a technique was devised that would circumvent the problem of high temperature containment of boron. These objectives were met by preparing cylindrical rods which can be heated by electrical resistance to temperatures as high as the melting point of boron in various oxidizing atmospheres. Each rod is prepared by chemical deposition on a 25-micron-diameter incandescent metallic wire in which the reaction, $2BBr_3 + 3H_2 = 2B + 6HBr$, occurs near the hot surface. Compact deposits of 1 millimeter or so in diameter are built up when conditions are carefully controlled. Boron rods of purity in excess of 99 percent by weight, of defined geometric shape and with built-in leads through which a heating current may be passed, were available for high temperature studies up to the melting point of boron (ca. 2300° K). Conditions have been developed for making deposits of polycrystalline (Figure 1) and glassy boron (Figure 2). The latter form is nearly amorphous to X-rays.

Two general experimental procedures have been used. One is to follow the uptake of cold oxygen as a function of time when it surrounds the incandescent boron cylinder at different solid temperatures and gas pressures. Temperatures were varied between 1000 and 1900° K and pressures between 1 and 0.1 atmosphere. The other is to measure the linear rate of flame propagation when a boron rod is burned in cigarette fashion at about 2500° K in a stream of oxygen at various pressures. Mechansims are then deduced from these kinetic results

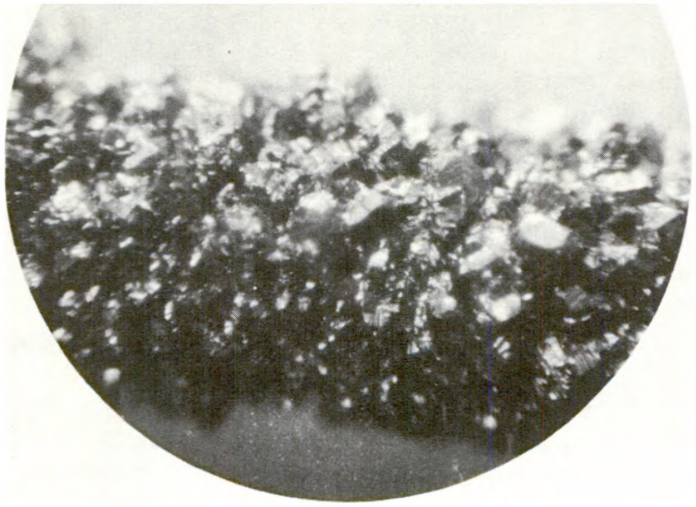


Figure 1--Photomicrograph of a polycrystalline boron rod (approximately 1 millimeter in diameter).

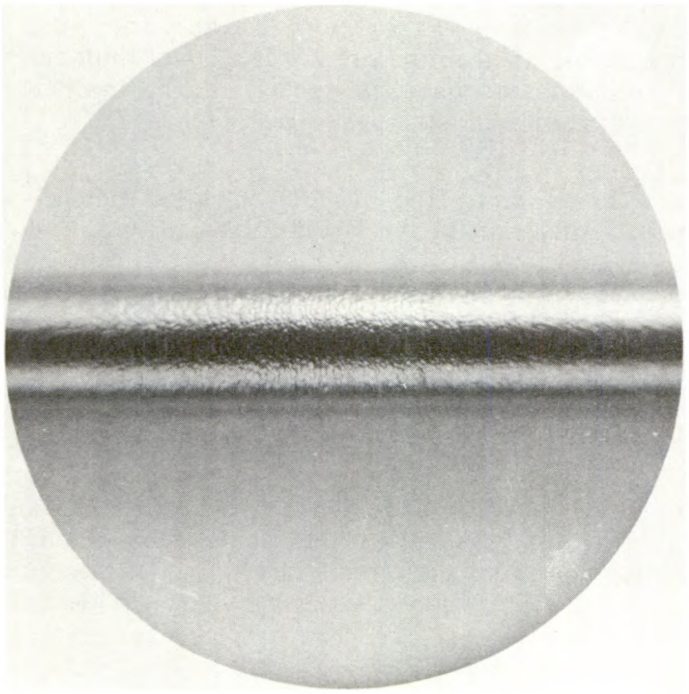


Figure 2--Photomicrograph of a glassy boron rod (approximately 1 millimeter in diameter).

together with the known thermodynamic and physical properties of boron oxide and microscopic observations of the incandescent surface during a run.

RATE-LIMITING STEPS

To understand the rate-limiting processes in the combustion of solids, one must bear in mind that chemical reactions can occur only at or near the solid-gas interface. Oxygen must be transported to the interface and products must be removed in order that the chemical reactions might continue. An important fact in the case of boron is that the product is an adherent, viscous oxide coating over a wide temperature range. As will be seen later, these transport processes are very important for boron.

For orientation purposes one might therefore think of a typical combustion process as involving a sequence of steps somewhat as follows, each step involving a finite period of time. Oxygen must first get to the surface by diffusion or other means of transport. On its way it meets resistance offered by vaporizing oxide or perhaps by diluent (diluting) molecules such as nitrogen. When oxygen reaches the surface, it finds another barrier and must now diffuse through a layer of liquid boron oxide to the boron oxide-boron interface. Now chemical reaction may occur after a period of time, the duration of which depends upon the temperature and activation energy of chemical reaction. The reaction itself increases the surface layer thickness, so that in order for steady state to be maintained, some boron oxide must be removed. This can occur by gravity flow or by evaporation. In evaporation, the oxide vapor will meet resistance in the form of O_2 or diluent molecules. Which of these steps predominates depends greatly on the temperature and to some extent on the ambient gas pressure.

In order to describe the various rate-limiting steps in more detail, Figure 3 shows in a semiquantitative manner — by means of temperature pressure coordinates — the five areas or regions where a particular process or processes is presently thought to be rate limiting. [For experimental evidence of these mechanisms, refer to C. P. Talley, Aero/Space Engineering, 18:37] (1959).

REGION I

At temperatures below the melting point of boron oxide (723° K), the reaction rates are very slow and the oxide film is solid. The rate-limiting step is most likely either the transport of oxygen through the solid film or chemical reaction at the boron-boron oxide interface.

REGION II

Region II begins at temperatures above the melting point of boron oxide (723° K) where the liquid is free to flow away from the reaction

zone under the influence of gravity. Initially, as oxidation proceeds, a liquid-oxide film builds up until it reaches a limiting thickness to give a flow rate away from the reaction zone equal to the rate of production of oxide.

REGION III

As the temperature is increased to 1100° K and beyond, the rate of evaporation of boron oxide becomes greater than the flow rate of liquid oxide from the reacting surface. Therefore, removal of the protective oxide coating by evaporation is the rate-limiting step in Region III.

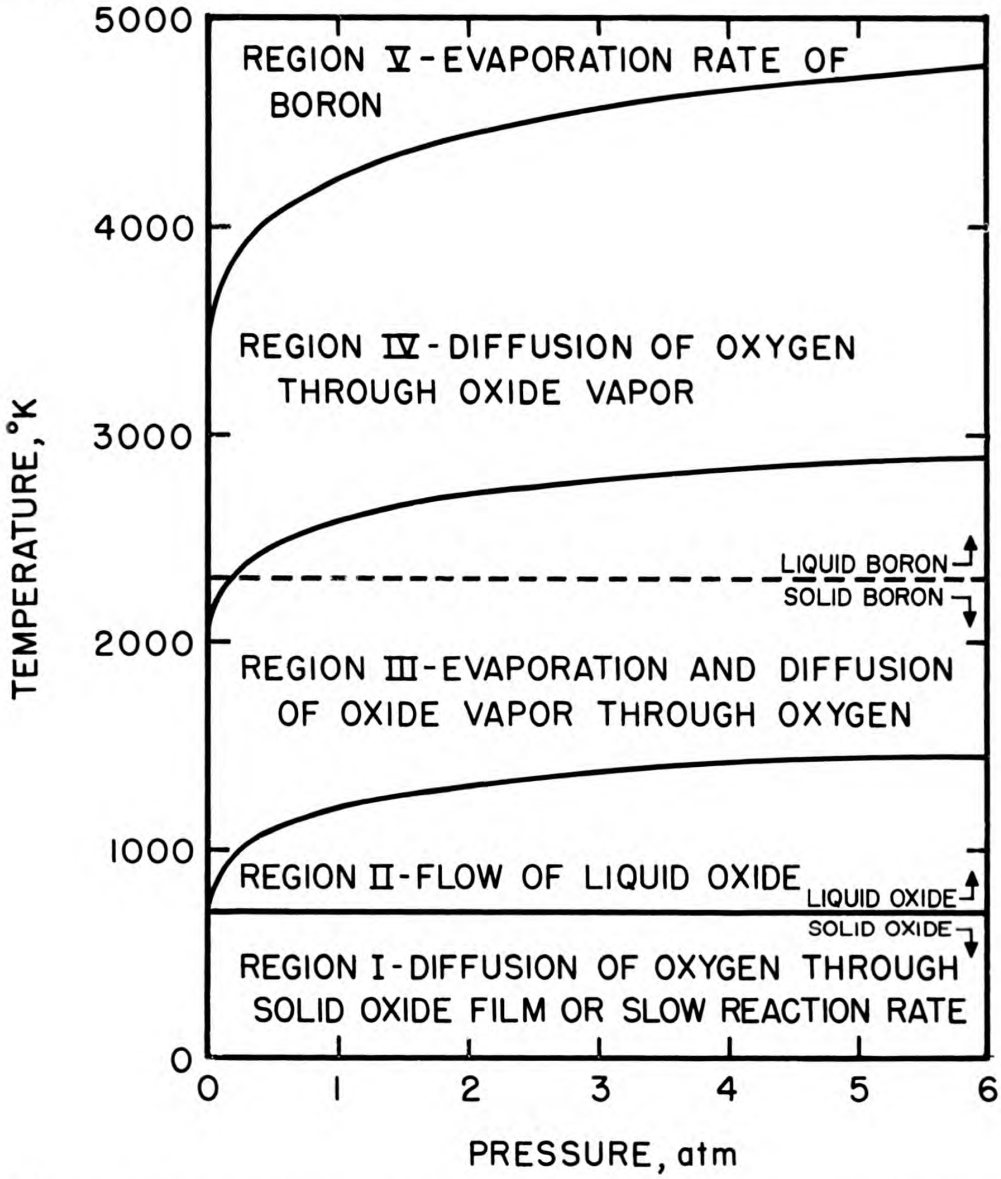


Figure 3--Semiquantitative presentation of the various rate-limiting processes in the oxidation of elemental boron in oxygen as a function of temperature and pressure.

REGION IV

As the temperature is raised higher and higher in Region III, the steady-state film thickness of boron oxide becomes smaller and smaller until the film finally vanishes, leaving the solid boron surface exposed to the gas phase. This situation causes a transition from Region III to Region IV where the rate is no longer retarded by the presence of a protective liquid coating but, rather, is limited by the gas-phase diffusion of oxygen through boron-oxide vapor.

REGION V

At any given pressure, as the temperature is raised in Region IV, the evaporation and subsequent gas-phase oxidation of elemental boron becomes increasingly important. When the vapor pressure of the boron is greater than the total pressure, the evaporation rate of boron would be rate-limiting because it would be faster than the diffusion of oxygen to the boron surface.

SOME CONSEQUENCES OF THE MECHANISMS

What are some of the consequences of these mechanisms? Two may be mentioned. We have observed that powdered boron is more difficult to burn than solid boron. In both cases an igniter must raise the temperature to a value corresponding to the upper end of Region III or to Region IV (thin oxide film or bare exposure of boron), that is, to a temperature such that the boron oxide is evaporated as fast as it is formed and also to preheat layers of boron beneath the surface layer. In the case of a powder, the particles adjacent to the surface become coated by being preheated in contact with oxidizer and by condensation of oxide vapor that has diffused ahead of the combustion zone. This coating acts as a barrier to continued burning, and the reaction ceases after only a few layers of particles adjacent to the surface have burned. In the case of solid boron, however, the material beneath the burning surface is preheated through the intermediate temperature range out of contact with the gas phase, so that no protective film of oxide can form by prior reaction or condensation to retard burning later.

Another consequence of the mechanisms just described is that anything that will affect the evaporation rate of boron oxide should have an effect on the burning rate in Region III. Water vapor is known to increase the evaporation rate of boron oxide, and as expected we have found the oxidation rate to be increased by about a factor of 10 at temperatures between 1300 and 1500° K by the addition of 1 percent water vapor to the oxygen. On the other hand, when about 1 percent silicon was present in the solid boron, evaporation of the boron oxide was retarded in oxygen at 1 atmosphere, and large droplets of liquid oxide collected on the rod at 1455° K, thereby causing Region II to persist at higher than normal temperatures.

Human Engineering in the Navy — 1959

Paul G. Cheatham

Office of Naval Research
Washington, D. C.

Since World War II, a new field of technology, known as human engineering or engineering psychology, has become a recognized and necessary part of the research and development programs for national defense. The engineers who design our military systems and equipments have come to realize more and more that the use of a man as part of the system requires close integration of this man and the equipment he must operate. In fact, the man himself has become the limiting component which frequently determines the over-all effectiveness of the system. Out of necessity, the design engineer has had to add another member to the design team: the human engineer or the human-factors specialist.

A good example of human engineering can be found in the design of telephones for human use. A hand using the telephone is essentially a part of a man-machine communications system, whether it be military or civilian. The evolution of the modern telephone began some 20 years ago when the Bell Telephone Laboratories conducted their pioneer studies of speech and hearing. These early studies, conducted by electrical engineers and physicists, could be described as research supporting human engineering design of the telephone and other communications systems to meet human needs. The design of the telephone itself, the handset and dial, followed. The type of handset now in use was first produced in 1937. The most recent version of this design was based on measurements of thousands of people to establish ear-to-mouth dimensions. The result is a handset which has been shortened to bring the mouthpiece closer so that the speaker's voice produces a better signal. The dial has been changed too. Numbers have been positioned outside so that they would not be obscured by the dialing finger. The white dots make positioning the finger easier and reduce dialing time by about 0.7 seconds. Studies are still under way for a better dialing method. You may soon be using push buttons instead of a dial, if human engineering studies now in progress demonstrate a sufficient increase in speed and accuracy in "dialing" to make the changeover worthwhile.

The human engineer, then, is the member of the design team who studies the man as a component in the system. He derives fundamental knowledge through research about the man's systems characteristics, and attempts in practice to apply principles of good human engineering to the design of man-machine systems, and to specific items of man-operated equipments.

Within the Navy, human engineering gradually achieved recognition as a result of research programs established at various in-service laboratories and facilities. Because these programs were expanding rapidly, the Office of Naval Research thought it advisable to establish a few policies. An ONR Working Group in Human Engineering was therefore organized in August 1952 to study the Navy's requirements and to promote the utilization of human engineering principles in the design of Navy equipment.

The report of the Working Group* indicated that many problems needed to be solved. For example, only 7 percent of the then current Navy man-machine systems which required human engineering attention were receiving it. Programs were uncoordinated, poor communications existed between design engineers and human engineers, and the effectiveness of the programs was limited by less than complete acceptance of human engineering.

To try to find some solutions for these problems, a Human Engineering Section was established within ONR in March 1953. For the first few months, the Section concentrated on such matters as improving coordination and communications between design and construction engineers and human engineers, aiding the bureaus in defining their human engineering problems, and helping them to obtain qualified assistance. In January 1955, the Section was redesignated the Engineering Psychology Branch, giving the field equal status with other major programs of ONR.

The survey undertaken in 1952-53 by the Working Group provided basic data for the Group's primary task, that of recommending action necessary to improve the over-all Navy human engineering program. The study reported in this article was initiated about 5 years later. Its purpose was to bring the 1953 investigation up to date, and to show what changes have taken place in the Navy's human engineering effort during the interval.

THE PROBLEM

The recent study was also undertaken to estimate the current status of human engineering effort in the Navy. Specifically, we wanted to find out how effectively human engineering principles are being applied to major weapon systems design, and to determine the amount and level of human engineering research being conducted in support of the design of equipment for these systems.

We included under the heading "Systems Design" the major weapon, aircraft, and supporting systems in which the human operator is an integral part of the man-machine system, and in which the operator's performance determines, in part, the over-all performance of the system. The heading "Research" included areas of investigation which provide information that can be used in support of the design of a system, and applied human engineering research conducted either to supply data needed for the design of the system, or to evaluate the system. We included also support research which contributes to the general store of knowledge about the man as a system component. For example, studies on the man's ability to handle information, make decisions, or monitor were considered, but basic psychophysiological research was not included. However, it was very often difficult to sort out psychophysiological research studies to determine whether they produce systems-relevant data.

*Wohl, J. G., Nagay, J. A., & Taylor, F. V. Human Engineering in the U. S. Navy. Office of Naval Research, Washington, D. C. February 1953.

THE METHODS

The main body of information was obtained by visiting and talking with in-service and contract personnel, the people actually doing the work. During informal interviews we asked questions such as these: "What are the primary human engineering problems associated with the system you are working on, and what approaches are you taking to solve these problems? What is the level of human engineering effort for this system? At what stage during the design of the system do you first consider human factors? Do you conduct laboratory research in relation to the system? Are human engineers generally well accepted by fellow design engineers within your organization? Can engineers obtain human engineering training, either within the organization or at nearby universities? What is the location of your human engineering group within the organization, and what is its mode of operation?"

THE RESULTS

Adequacy of Coverage. The results show that almost half of the systems under development involve the use of a human operator and require human engineering attention. (An example of a type of Navy system which does not involve an operator would be a propulsion system for an advanced aircraft model.) Of this number needing attention, nearly three fourths were receiving it. A system was judged to be getting proper attention, if that portion of it which needed human factors work was being considered—whether it be the entire system, or only one subsystem within it. This is only an estimate of the adequacy of coverage; however, regardless of its accuracy, it is a considerable increase over the 7 percent reported by the Working Group of 1953.

Level of Effort. Estimates of level of effort were obtained during the interviews with contractor and in-service personnel. The spread in level of effort was very great, varying from 1 to 18 man-months/per month, with a median value of 3 man-months per month. For this reason, no attempt was made to arrive at an average value per system, or to apply a correction factor in order to estimate the effort on those systems which were not included in the sample. Approximately one half of the total effort was being applied directly to weapon, aircraft, and support systems, with a large portion of this effort going toward support systems.

A breakdown was made of the amount of effort for systems and research areas contributed by in-service and contract personnel. We found that the total effort is divided almost evenly between in-service and contract work, and between systems and research areas. However, only one fourth of the effort on systems is being performed by in-service people, the rest being done under contract. The reverse is true for the research areas, with roughly three fourths of this work being done in-service.

Consideration of the Man During Systems Design. The Working Group noted 7 years ago that there was a definite need for more extensive consideration of the man as a part of the total system during the early stages of systems design. It was found during our much more

recent interviews that out of 22 responses to this question, 18 indicated that human factors considerations are a part of early systems planning. They were being written into proposals, and were being considered at the systems analysis, blueprint, or flow chart stages of design. In the remaining four cases, human engineering was considered in connection with equipment components only. It is apparent that during the intervening years the "systems concept" has had an appreciable influence on the design of man-machine systems.

Research. We pointed out earlier that about one half of the total human engineering effort was being devoted to research areas, and that three fourth of this work was being done by in-service groups. In contradiction, however, 3 of the 9 Naval activities visited reported that no human engineering research was being conducted whatsoever. Out of 25 of the activities interviewed, 13 indicated no research was being conducted. Eight reported some research, but mostly in relation to a specific system. Four activities conduct research only, with no design applications work.

Acceptance. The topic of "acceptance" was directed toward the relationship between human engineers and their fellow design engineers. In the past, the human engineer has not always been given due professional consideration. The introduction of the design team, composed of both engineering psychologists and engineers, has contributed to a closer, more harmonious working relationship. Not one of the groups reported anything but very good cooperation. It is apparent that human engineering has attained prestige. The era of having to sell human engineering is gone, possibly because the need has become so apparent.... more engineers themselves have become interested in the human factors field and have become members of the human factors team.

Training. The general comment has been that trained human engineers are hard to find. To alleviate this shortage, many organizations offer some on-the-job training and short courses for their engineers. These measures have proved effective; taken together with similar courses frequently available at local universities, they have increased the organization's human engineering capability. On the other hand, research people need traditional training in the scientific method, so the short course has not helped research groups which are in need of more qualified people.

Human Engineers and Company Organization. The location of the human engineering group within the organizational structure has a direct bearing on its effectiveness as part of a larger systems design team. Human engineering groups were found to be predominantly line functions, on a level with other engineering or research groups. They work either as a group whose output is passed on in the form of recommendations to other groups working on a system, or as individual team members assigned to work with other engineers on specific parts of the system. The interdisciplinary team approach was the most frequent mode of operation. The median size of a human-factors group was five people, but the size ranged all the way from one to 57. The total number of human factors people working for organizations included in this survey was 233. Only three organizations reported having no organized human-factors activity, nor any human engineers.

DISCUSSION AND GENERAL COMMENTS

Research and Application. The most notable fact to be brought out by this survey is that the data of applied experimental psychology are being applied by human engineers to the design of Navy systems. The Working Group found five years ago that most of the applied effort was done at in-service laboratories, and most of the research was being conducted by contractors. Today, we find the reverse to be true. The explanation for this lies in the fact that the same in-service groups were covered during both surveys, but the private organizations visited by the Working Group were mostly consulting firms and universities, rather than aircraft and electronic companies. This migration of human engineers to industry and into applied work is a result partly of new human factors requirements being written into military systems contracts, and partly to a bandwagon set in motion by industrial competition. The net result is that the laboratories have been relieved of much of their day-to-day human engineering duties, and have gone back to supporting research. This is considered a most healthy development from which the Navy will gain tremendously.

There is still an urgent need for more applied research to supply the human engineer with the data he needs. During the interviews, different opinions were expressed on what should be the content of research and where it should be conducted. In spite of these differences, though, it was generally agreed that hardware oriented people can do better applied research since they are closer to the problems, whereas, the more basic research should be done in the universities. The feeling is that applied research should be directly related to the day-to-day problems of the systems designers so that immediate questions might be answered. On the other hand, good supporting research is needed as well, to provide fundamental principles for man-machine systems design which might be applied to any future systems.

Coordination and Communication. The earlier Working Group found coordination and communication to be one of the major areas in need of corrective action. That problem of coordination has almost disappeared in the interim. The problem of communication, however, is still critical. Although communications among human engineers, design engineers, and the operational Navy have been improved as a result of better coordination, there is still much to be done. The need for more effective exchange of information, created by the rapid growth and expansion of the field, has been reduced somewhat by human engineering conferences sponsored by the armed service and professional societies. For example, ONR has held seven annual human engineering conferences attended each time by some 200 representatives of the government, industry, and the universities. Dissemination of information has been improved in many other ways, the major ones being large-scale documentation and bibliographic services, a general guidebook to the design of man-machine systems, and smaller guides covering special aspects of human engineering.

Availability of Trained Human Engineers. The need for qualified human-factors personnel is increasing steadily, and the supply has not kept up with the demand. In part, the universities are at fault in that

they have not made changes in their curricula rapidly enough to take care of the need. On the other hand, the university does not know what is needed unless the user industry or government is able to state clearly what is demanded of a well-trained human engineer. There is definitely a state of confusion in the profession itself as to what a human factors man is and does.

Professional clarification is needed first. Then, based on user requirements, the universities can offer courses or complete programs in human engineering for those wishing to go into this field as qualified people. In the meantime, the interim measures now being taken, that is, short courses and on-the-job training and research, will have to be augmented gradually with a more integrated program of study.

A LOOK TO THE FUTURE

During the past five years many of the trouble spots in the human engineering field, reported by the Working Group in 1953, have been cleared up. A few of the old problems still exist, however, and new ones are being created by new engineering developments. The most notable of these is the urgent need for more research in support of systems design.

First, so-called "gap filling" studies are needed to fill in the bits and pieces of information which were not collected during earlier, more hurried experiments. This kind of work, though uninspiring to the experienced researcher, might well be used to train the on-the-job worker or the graduate-student summer employee. Many of the blank spaces in our human engineering handbooks could be filled in this manner, and the information would have real value for the design engineer.

A broad view of research needs to be taken for predictive purposes, if what is done in the laboratory today is to have any value for the design of future systems. The implication here is that we must continue to search for general human engineering principles which can be applied to a variety of types of systems.

More immediately, the direction and content of human engineering research needs to be defined in relation to changing systems design concepts, and especially those involving automation and the use of man in automatic systems. The question to be asked is no longer just when and where do we put the man in the system, but why is he there at all. The human engineer, five years from now, should be able to answer that question.

More data is still being obtained from observations conducted by the Navy's recent Project Strato-Lab high-altitude balloon flight. A careful analysis reveals that the water vapor above the reflecting cloud covering of Venus is about the same as that above the high clouds of the Earth. Temperatures for both are about the same. Dr. John Strong of Johns Hopkins University, Baltimore, Md., states: "We are planning to confirm our own findings of water vapor by other observations and to continue to get the answers to the old and new problems concerning Venus..."

Research Notes

Oceanographic Expeditions — 1960

Nine long oceanographic expeditions--covering approximately 90,000 miles--have been planned for 1960 by the University of California's Scripps Institution of Oceanography. Two of the cruises will take researchers into waters never before visited by the University fleet --the Caribbean Sea and the Indian Ocean. This month (April) the research ship SPENCER F. BAIRD will sail several thousand miles west of Cape Mendocino, studying earth magnetism. Research such as this helps describe the structure of the upper layers of the earth.

Last month the research ship ORCA engaged in geological studies of the sea floor and the land beneath the Gulf of California, with the scientists aboard using a newly modified instrument called the sonoprobe. Beaches in the Gulf of Mexico region were also studied as a part of this investigation. Three expeditions are scheduled for May: One will travel to the tip of Baja California to investigate oceanographic conditions at the time of the tropical tuna migration and to study oceanic "fronts," between two water masses. The other expedition (Tethys Expedition, named after a sea nymph in Grecian mythology) will cross the equator and travel 5 degrees south before making port in Honolulu. Samples of the small creatures of the ocean at a depth of about 2 miles will be taken. The distribution of these creatures will be compared with the better-known, near-surface creatures. Also on this expedition, geological studies will be conducted south of Hawaii. Leaving in mid-May will be the Limbo Expedition. This expedition gets its name because no ports of call will be made. The vessel HORIZON will sail to a point about halfway between California and Hawaii, remaining there for several weeks to measure currents in waters 3 miles deep. The only other measurements in deep water have been made in the Atlantic.

By summer, the University's largest vessel--a 1900-ton Navy salvage vessel (ARS-27) reconditioned for oceanographic exploration--is expected to make a shakedown cruise to Hawaii. Some scientific work may be conducted on this voyage, but it will be secondary to testing the ship and her new equipment. In August, Scripps' longest expedition to date will sail from San Diego. This, the Monsoon Expedition, will take the ARS-27 across the Pacific and Indian oceans to Mauritius, an island off the Africa coast. After Mauritius, she will visit Indonesia and Australia before returning home. The total distance traveled will be 33,000 miles, more than halfway around the world and back. The chief purposes of this trip are sediment studies in tropical waters and geological-geophysical investigations in the Indian Ocean. The latter are part of an international program in that area: One American and one Russian vessel are already there.

For 3 months, starting September 15, HORIZON will engage in studies of the Peru Current, traveling as far south as northern Chile. In November, SPENCER F. BAIRD will be sent to the Caribbean Sea.

Using a new coring device developed by Kullenberg of Sweden, scientists will attempt to take sediment cores over 150 feet long. These would be the deepest such samples ever taken. This expedition will be made in cooperation with the University of Miami.

Predicting Tsunamis

An improved method of forecasting the destructive sea waves set in motion by underwater earthquakes and volcanic eruptions has been devised by William G. Van Dorn, engineer at The University of California's Scripps Institution of Oceanography. The method depends on the study of records produced on special long-period wave recorders installed on the tiny islands of Wake, Johnston, and Canton in the Pacific. As the destructive waves—called tsunamis—pass these isles, their length, which may be several miles, and height, which rarely reaches more than one foot, are recorded. The recording instruments are especially designed to be sensitive to these waves and no others.

When such waves reach larger islands which slope up gently from the sea floor, such as Oahu, they can increase 20 to 30 times in height. In the past, notably in April, 1946, such waves have resulted in death and severe property damage.

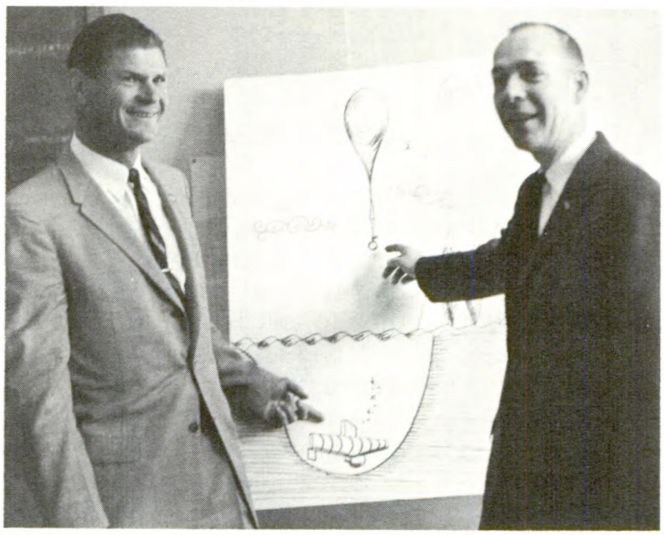
The present Pacific-wide warning system tells only the time, place, and intensity of the seismic activity which causes the waves, Van Dorn says, allowing the islands to be alerted to the risk of high waves, but not providing specific forecasts of wave height. Since the actual height depends on a variety of factors, among them the depth of the quake beneath the earth's surface, a severe earthquake may in one instance produce waves 20 feet high and in another no extraordinary waves at all. Further study may permit actual heights to be forecasts from seismic data alone, Van Dorn says, but this is impossible at present.

By using theoretical studies and field investigations, Van Dorn has worked out a method whereby the open-ocean wave height, as observed at the smaller islands, can be extrapolated to actual heights onshore at larger islands and on the shores of the Pacific. His work has received support from the Office of Naval Research.

"Navy" Issue of *SIGNAL*

The entire April issue of Signal magazine, the monthly periodical of the Armed Forces Communications-Electronics Association is devoted to current developments in Naval communications. Included are more than a score of articles by officers in charge of communications in the Naval bureaus and in the Fleet, and by scientists who have gained prominence through their research in the field.

On The Naval Research Reserve



LCDR Rechnitzer and CDR Ross identify their exploration.

Research Reservists Dive and Soar

Naval Reservists, both members of the Research Reserve program, have made outstanding contributions to the field of science in the investigation of the deep sea and in the exploration of the upper atmosphere.

LCDR Andreas B. Rechnitzer, USNR, Commanding Officer of Naval Reserve Research Company 11-5, San Diego, California, and an oceanographer at the Navy Electronics Laboratory, is the scientific director of the bathyscaphe project. On 15 November 1959 Dr. Rechnitzer and Jacques Piccard, son of the bathyscaphe's inventor, Auguste Piccard, made the first of several record-breaking explorations of the ocean when they took the bathyscaphe TRIESTE down to 18,600 feet near Guam. Information on temperature structure, water currents, biological observations, and engineering tests of equipment at high pressures was obtained. These two scientists are planning another dive to twice the former depth within the next few months to continue investigation of the great depths.

CDR Malcolm D. Ross, USNR, a member of Naval Reserve Research Company 5-8, Washington, D. C., looked skyward for his explorations. Mr. Ross, a physicist in the Air Branch of the Office of Naval Research, initiated and administers the STRATO-LAB program of utilizing high-altitude manned plastic ballons for upper atmosphere research. He participated in three flights with the late LCDR M. L. Lewis, USN into the stratosphere. The flight on 18 October 1957 established a new, unofficial world altitude record of 85,700 for a two-man crew.

Two New Research Reserve Seminars

The Research Reserve Program has added two new seminars to its list of training opportunities for fiscal year 1961. Both seminars open new areas of study.

PLANNING AND MANAGEMENT SEMINAR

A seminar on Research Planning and Management will be held at Princeton University, Princeton, New Jersey, from 21 August to 3 September 1960. The seminar will be sponsored by the Office of Naval Research and conducted by Naval Reserve Research Company 4-1, Princeton, New Jersey, with the aid and cooperation of Princeton University. Quotas have been established for reserve officers of the Navy, Army, and Air Force who are currently engaged in research activities.

The general theme of the seminar will be a comparison of problems and techniques in Research Planning and Management in the following areas:

1. Government-civilian
2. Government-military
3. Research foundations or institutes
4. Industry
5. Academic

Billeting facilities will be available at the Graduate College, Princeton University; messing on the University campus; and sessions will be held at the Graduate College.

ELECTRONICS COMPUTERS SEMINAR

"Electronic Computers and their Military Applications" will be the subject of a 2-week Research Seminar at Newburgh, New York, commencing on 16 October 1960. This seminar, also sponsored by the Office of Naval Research, will be conducted by Naval Reserve Research Company 3-14, Kingston, New York, with the cooperation of Commander, Boston Air Defense Sector, Stewart Air Force Base, Newburgh, N. Y. This seminar is open to Navy, Army, and Air Force reserve officers.

The objective of this seminar is to give military officers a survey of the electronic computing art and its usefulness in military applications. It is planned to devote the first week of the seminar to the fundamentals of electronic computers and the second week to the applications of computers, both military and civilian uses.

Limited BOQ facilities will be available at Stewart Air Force Base. Information on other accomodations will be given to conferees prior to reporting.

Nuclear Sciences Seminar at Brookhaven to Cover Health Physics

The Eighth Annual Naval Reserve Nuclear Sciences Seminar at Brookhaven National Laboratory will offer a basic course in Health Physics—the profession concerned with the study, evaluation and control of radiation hazards. The convening date is 12 September 1960, at Brookhaven National Laboratory, Upton, Long Island, N. Y.

The course will cover such topics as a general review of Atomic Physics, Biological Effects of Radiation, Area Monitoring and Survey Techniques, Radiation Monitoring Instruments, Decontamination Procedures, etc. Tours of reactors and other nuclear facilities will be included, as well as practical exercises in handling and monitoring radioactive materials.

Navy, Army and Air Force Officers with any of the following qualifications may apply for 14 days ACDUTRA at this seminar:

1. B. S. in Engineering or Science
2. Equivalent practical experience in a related field
3. Successful completion of either "Nucleonics for the "Navy" or "Radiological Defense" Correspondence course

This seminar is cosponsored by the Office of Naval Research and the Atomic Energy Commission. It is being organized by Naval Reserve Research Company 3-9 and the Health Physics Division of Brookhaven National Laboratory.

Research Reservist Makes Address

CDR Archie P. Kelley, USNR, a member of Naval Reserve Research Company 11-6, Phoenix, Arizona, recently made a presentation to the Phoenix Exchange Club in that city. Mr. Kelley, a specialist in nuclear power, was aboard many of the trial runs of the Nautilus, world's first atomic submarine. His talk was concerned with the problems encountered in the development of the nuclear submarines for the Navy.

Histories of Research Reserve Companies

As the 10th anniversary rolled around for many Research Reserve companies, some of them took note of the occasion by publishing a history of their companies. Companies for which copies of these histories have been received are:

NRRC 5-4	Baltimore, Maryland
NRRC 9-1	Chicago, Illinois
NRRC 9-2	Urbana, Illinois
NRRC 9-6	Minneapolis, Minnesota

For the most part, these histories traced the growth of the companies from 1948 when the Research Reserve program came into being. Events within those 10 years were discussed under such topics as the activation of the company, content of the programs for drill meetings, names of charter members and former commanding officers, commendations received, and special events in which the companies participated.

Besides providing worthwhile momentos for company members, these histories served a useful purpose of "stocktaking" for the company—where it has been and where it aims to go.

Dr. Franklin V. Taylor

Dr. Franklin V. Taylor, one of the Navy's pioneer engineering psychologists, died of pneumonia March 12 at the Alexandria Hospital, Alexandria, Va. At the time of his death, he was Head of the Engineering Psychology Branch, Applications Research Division, U. S. Naval Research Laboratory, Washington, D. C. Dr. Taylor came to NRL on October 1, 1945, to establish a psychology group. He authored numerous publications and contributed articles to psychology and engineering journals.

Dr. Taylor made many contributions to designing equipment with simplified control and ease of operation for the Navy as well as other Government agencies. His knowledge of visual perception, learning, and man-machine control dynamics was made available to industry engaged in developing equipment under contract to the Government. In 1955, he assisted in organizing the Engineering Psychology Branch of the Office of Naval Research. In recognition of his outstanding work for the Navy, he received the Meritorious Civilian Service Award and also the Naval Ordnance Development Award.

Dr. Delahay Receives Award

Dr. Paul Delahay, Boyd Professor of Chemistry at Louisiana State University, has received the 1959 Southwest Regional Award of the American Chemical Society. Dr. Delahay, a native of the Netherlands, came to the United States in 1950. He served on both the University of Brussels and the University of Oregon faculties before beginning his work at LSU. As an internationally recognized electrochemist, he has made many research contributions in his field, such as interpretations of current-potential curves from polarographs for processes with partial or total control by chemical or electrochemical reaction, and much work which led to the development of voltrammetry. Some 10 research associates from seven European countries are associated with Dr. Delahay in his work at LSU. He is an ONR contractor of long standing.

--ONR Branch Office, Chicago.

U.S. GOVERNMENT PRINTING OFFICE: 1960 O-545764

Cinderella Satellite*

"It is tempting to think of Vanguard I as the Cinderella Satellite. Little more than three pounds in weight, it was not even supposed to go into orbit when it was launched on March 17, 1958,† and started on a journey that is now expected to continue for hundreds or even thousands of years. The minute size and weight of Vanguard I helped give Premier Khrushev material for his gibes at early American satellites as "oranges" and "grapefruits," unworthy of comparison with the far heavier Soviet sputniks.

"But once again we observe that he who laughs first does not necessarily have the best laugh, or indeed, in this case, reason to laugh at all. Far from being inconsequential, Vanguard I has already established a firm position for itself as a major contributor to man's knowledge of space. It has already circled the earth almost 8000 times and traveled almost 300,000,000 miles, and all through these travels it has been reporting by radio signals whose power is drawn from the sun. Now comes word that observation of its orbit has produced completely unexpected new information, the revelation that the pressure of sunlight—transmitted through light photons which acquire mass and energy, as the relativity theory predicts, as they travel with the speed of light—is altering Vanguard I's orbit by about one mile a year. There would seem to be a sort of poetic justice in the fact that the tiniest satellite of them all has proved to be, and continues to be, one of the most valuable."

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*Editorial, The New York Times, Sunday, March 20, 1960, and used by permission.

†When Project VANGUARD was still "Navy," and the launching vehicles had the ONR brand on their flanks.

Underwater, Nuclear Jet Engine

A patent application on a nuclear jet engine that may propel both submarines and surface craft at speeds of more than 100 miles per hour has been filed by the U. S. Patent Office by Boeing Airplane Company, Wichita, Kan. The inventor, L. J. McMurtrey, said that operation of the underwater, nuclear jet engine would be somewhat similar to propulsion through air, except water would replace air and that no fuel would be used. Mr. McMurtrey is a Navy systems manager in the Boeing engineering department's advanced design section. With the new engine, water would be passed under ram pressure through a nuclear heat exchanger, then through a turbine, and out the nozzle of the engine. The high exit velocity of the steam and water would provide the high thrust. Either a turbojet or ramjet type of engine would be used, Mr. McMurtrey said. With a 2-foot diameter nozzle, a submarine could be propelled through the water at speeds of more than 100 miles per hour.

IN THIS ISSUE

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. Use of funds for printing this publication was approved by the Director of the Bureau of the Budget, February 12, 1958.

Transportation provided for geographic research scientists in Baluchistan. See the article beginning on page 1.