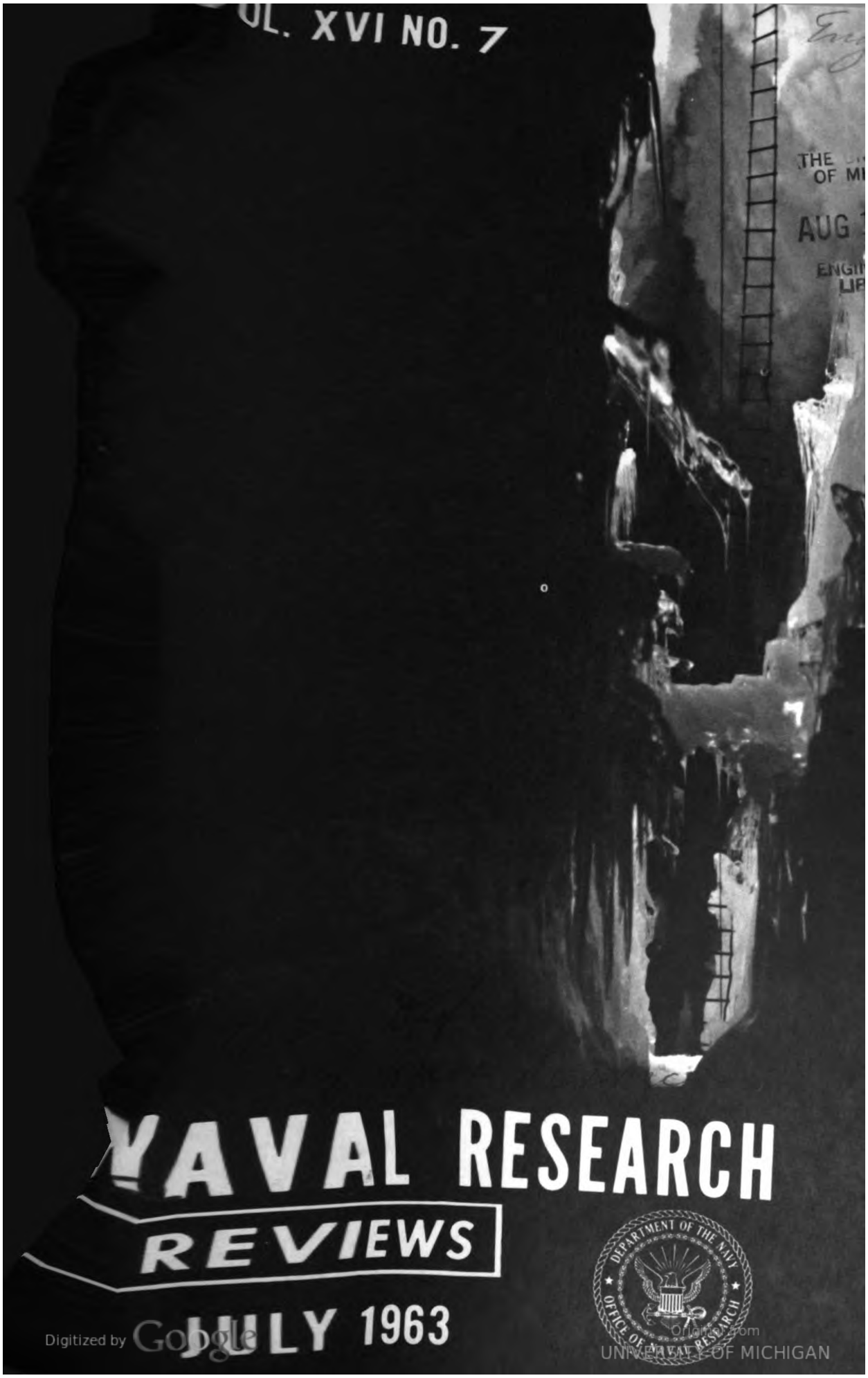

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Many years ago, the eminent physicist Dr. Vannevar Bush—of Carnegie Institution, MIT, and the wartime Office of Scientific Research and Development, to mention a few of his associations—wrote an exceptionally interesting description of science and scientists. Although it was printed in (NAVAL) RESEARCH REVIEWS *13 years ago, it is still timely, and so is being printed again below. Some of the magazine's early readers will remember it, and more than likely will want to look again through Dr. Bush's eyes at the "builders" and their "edifice." And those of our readers who have not seen it will probably want to do so. Here it is again—*

The Builders

Vannevar Bush

The process by which the boundaries of knowledge are advanced, and the structure of organized science is built, is a complex process indeed. It corresponds fairly well with the exploitation of a difficult quarry for its building materials and the fitting of these into an edifice; but there are very significant differences. First, the material itself is exceedingly varied, hidden and overlaid with relatively worthless rubble and the process of uncovering new facts and relationships has some of the attributes of prospecting and exploration rather than of mining or quarrying. Second, the whole effort is highly unorganized. There are no direct orders from architect or quarrymaster. Individuals and small bands proceed about their businesses unimpeded and uncontrolled, digging where they will, working over their material, and tucking it into place in the edifice.

Finally, the edifice itself has a remarkable property, for its form is predestined by the laws of logic and the nature of human reasoning. It is almost as though it had once existed, and its building blocks had then been scattered, hidden, and buried, each with its unique form retained so that it would fit only in its own peculiar position, and with the concomitant limitation that the blocks cannot be found or recognized until the building of the structure has progressed to the point where their position and form reveal themselves to the discerning eye of the talented worker in the quarry. Parts of the edifice are being used while construction proceeds, by reason of the applications of science, but other parts are merely admired for their beauty and symmetry, and their possible utility is not in question.

In these circumstances it is not at all strange that the workers sometimes proceed in erratic ways. There are those who are quite content, given a few tools, to dig away unearthing odd blocks, piling them up in the view of fellow workers, and apparently not caring whether they fit anywhere or not. Unfortunately there are also those who watch carefully until some industrious group digs out a particularly ornamental block, whereupon they fit it in place with much gusto and bow to the crowd. Some groups do not dig at all, but spend all their time arguing as to the exact arrangement of a cornice or an abutment. Some spend all their days trying to pull down a block or two that a rival has put in place. Some, indeed, neither dig nor argue, but go along with the crowd, scratch here and there, and enjoy the scenery. Some sit by and give advice, and some just sit.

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Prevention of Microbial Resistance to Antibiotics

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The capacity exhibited by all organisms to develop tolerance for new environmental conditions has been an important factor in the continuing existence of life on earth. It has also had adverse effects on some creatures. To man, one of the most disturbing of these effects is being manifested through the resistance certain microbes develop for the "wonder" drugs he uses to counteract diseases. These drugs may slow or stop the progress of a disease one day or in one person, but because of the adaptability of the offending microbes, they may be of no value at all on another occasion or in another individual, and eventually they may even enhance the growth of certain microorganisms.

The peculiar capacity of pathogenic microorganisms to develop strains that are resistant to drugs which upon initial application are lethal to most individuals—and eventually to thrive upon those drugs—did not come into clear focus until Paul Ehrlich and his co-workers made their famous chemotherapeutic researches during the first decade of this century. Over the years, concern for these effects intensified as a greater variety of drugs was produced and wider use was made of them. With the advance of modern chemotherapy, microbial resistance to sulfonamides and antibiotics became a frustrating medical and scientific problem. More recently we have learned that similar adaptability occurs among the cells causing cancerous growths during treatment by radiation and chemicals, and that viruses may also develop this same kind of tolerance and thereby interfere with the therapy of viral infections.

Promising Leads

Because of the danger of these effects, a large research effort is being made to understand and control them. Experiments are proceeding with a wide variety of antibiotics, individually and in combination; studies are in process on the mode of action of antibiotics; and comparisons are being made of the biochemical and genetic differences between normal and resistant strains. Although this work has not yet produced sure-fire measures for preventing the emergence of microbes or other microorganisms that are resistant to antibiotics, some very promising leads have been opened up.

What is perhaps the most significant of these new approaches was discovered through investigations of the biochemical differences between strains of bacteria that are sensitive to drugs and other related strains that are resistant to drugs. These studies, which have been underway for several years at the University of

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Pennsylvania School of Medicine, have enabled researchers, under laboratory conditions—either directly or indirectly—to prevent the emergence of antibiotic-resistant bacteria in inocula containing as many as 100 million normal bacteria. Work leading to this achievement began at the University of Pennsylvania in 1950, under the direction of the author, with support from the Office of Naval Research. The ONR assistance has continued since that time.

A Biochemical Solution

The discovery of a biochemical solution to the bacterial-tolerance problem contradicts the commonly held view that resistant cells arise among normal individuals by "chance," or "spontaneous" mutation. According to the old concept, an antimicrobial agent will kill only the drug-sensitive cells; a few drug-resistant mutants are certain to be present, and these individuals will multiply and carry on the harmful activities of the species. If this view is correct, all attempts to thwart the emergence of resistant strains must deal with those unforeseen events that lead to "chance" mutations. In other words, this concept implies an impasse, at least for the present, because very little knowledge exists about such events.

The antibiotic research done at the University of Pennsylvania was founded on strong doubts about the validity of the old concept. The point of view we adopted was that the resistant cells arise as the result of chemical changes and that these changes are not initiated by mutation. We might begin our argument in support of this view by pointing out that drug-sensitive and drug-resistant forms of microorganisms are known to differ biochemically. We reasoned that if an antibiotic can kill a microbe or make it harmless by effecting a chemical change in the microbe, it can just as easily alter the microbe in some other way—for example, rendering it insensitive to the antibiotic. We know for certain that the latter change occurs frequently—in fact it often continues to such an extent that the microbe becomes dependent upon the presence of the antibiotic for multiplication. If microbes develop resistance in this way, it should be possible, we thought, to forestall those chemical actions that induce resistance and thereby prevent the emergence of many harmful bacterial populations.

Spermine

Our search for the chemical key to such a capability led us finally to a class of complex organic substances, known as polyamines, such as spermine or spermidine, that occur naturally in semen, mammalian tissue, the secretion of certain spiders, in bacteria (in trace amounts), and in a number of other organisms. When we fortified such antibiotics as streptomycin, penicillin, and erythromycin with spermine in liquid media, then inoculated the media with one or the other of three species of bacteria that previously had always developed resistance to each of these antibiotics, all three species of bacteria were wiped out.

Curiously, the treatment of bacteria (for example, staphylococci, *E. coli, A. Aerogenes*) with spermine alone in liquid growth media has no apparent effect on the bacteria, even when the spermine is kept in the growth medium for long periods of time. Nevertheless, the substance retains its full killing potential; when combined with an antibiotic, it delivers a lethal blow to those same bacteria that tolerated it so well and for so long by itself.

Unfortunately, a spermine-fortified antibiotic is not effective against bacteria that have already built up a resistance to that antibiotic. The bacteria survive,

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just as they would if the spermine had not been added. As a double-check on this finding, a medium containing the spermine-antibiotic combination was inoculated with as few as from 2 to 100 bacterial cells of proven resistance together with from 10 to 100 million normal bacteria which had not had an opportunity to develop resistance to a particular antibiotic. The few cells known to be resistant survived, and the multitude of sensitive cells died.

For reasons we do not yet understand, spermine does not work with all antibiotics. Mixed with sulfathiazole and Novobiocin, for example, it has no apparent effect on sensitive inocula; resistant strains develop, just as they do if the spermine is not used. However, there may be a way around this obstacle. We discovered that resistant bacteria that cannot be killed by one spermine-strengthened antibiotic, can be killed by another antibiotic plus spermine. Thus through the use of alternate combinations of spermine and an antibiotic, it may be possible to eradicate the germs responsible for most bacterial infections.

Clues to Spermine's Power

How does spermine achieve these remarkable results? Although we do not as yet know, we have made enough observations of spermine's effects to make several good guesses about the nature of the mechanism at work.

● One possibility is that spermine may force bacteria into a rather rigid metabolic routine. In this state, the cells are unable to adjust to the radically new requirements for living established by the antibiotic. So they die. This possibility was indicated to us by our studies of the responses of bacteria to rich and lean growth mediums.

A species of bacteria that has become dependent on a rich nutritional environment for growth will have a better chance for survival against an antibiotic in that environment than in a lean nutritional environment. The richer medium is advantageous, perhaps, because the richer foods offer the choice of alternate metabolic pathways for building up the species' resistance mechanism against an antibiotic. In a lean nutritional environment, this bacteria would probably succumb to the toxic action of the same antibiotic because—being used to the richer medium—it would not have developed the capacity to synthesize substances it needs for growth.

A reverse relationship may govern another species of bacteria—one that can multiply in a minimal medium by using its innate capacity to synthesize all of its structural substances. Such a bacteria can selectively utilize this capacity for synthesis and adapt itself to an antibiotic, thereby surviving. On the other hand, if this same bacteria has access to richer foods, it would seem to be at a disadvantage, for it might then forego the use of its innate capacity for synthesis and thus be acted upon lethally by the antibiotic.

The remarkable property of spermine appears to lie in the fact that it reduces various species of bacteria—living in both richer and leaner nutritional environments—to a common sensitive "metabolic state" upon which any one of the antibiotics mentioned above exercises lethal effects. Under the action of spermine alone, also, the killing effect of ultraviolet light is about 200 fold greater.

● Another possibility is that spermine combines with DNA or RNA, with which the genetic mechanism of the cell is associated, or with both, making them

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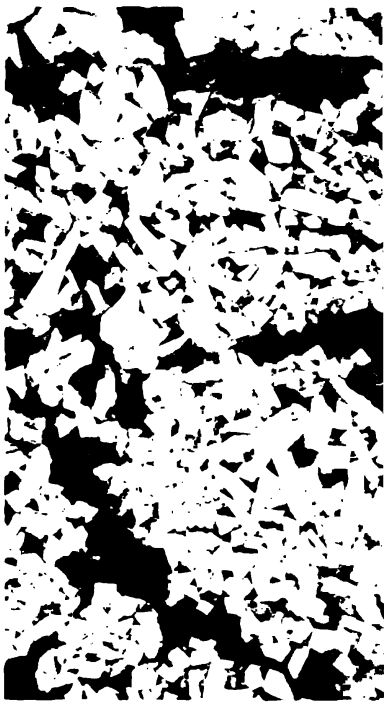
For a number of years, the Office of Naval Research has been interested in determining the needs and potentials for gathering information about the earth environment from a distance. An ONR-supported study of this problem now underway at the University of Michigan is described on these pages. The article is reprinted from RESEARCH NEWS, *April 1963, published by the Office of Research Administration, The University of Michigan.*



Remote Sensing of the Environment

Our perception of the environment in which we live depends on our mode of acquiring and interpreting sensory data. When we taste, touch, or smell, matter is presented directly to one or more of our sense organs; but when we see or hear, our eyes or ears function as "remote sensors." These two organs are able to sense remotely—i.e., to perceive at a distance—because they are sensitive to waves or vibrations emitted or reflected by an object. Certain technical devices which extend the range of human perception are also remote sensors. Their operation is based upon and can in fact be defined by their sensitivity to forces, waves, or vibrations.

Aerial photography, the most familiar of the remote sensing devices, can record objects at great distances and over wide areas. Telescopes and microscopes are similar means of extending human vision. But visible light is only a small part of the spectrum of electromagnetic energy which is radiated or reflected by objects. The remote sensing devices which exploit other parts of the spectrum—infrared and ultraviolet radiation, gamma rays, and microwaves—do more than extend the natural human senses. They provide new modes of perception. For example, infrared sensors, operating at great heights, can show the pattern of thermal energy over an area of interest by detecting radiation to which man is insensitive except in large amounts and at close range.

A Remote Sensing Device can measure some property of an object without having the measuring device physically in contact with the object. At the point of detection, a disturbing influence, either radiation or a force, acts upon the device. The information displayed by the device as a result of this action can give the earth scientist valuable information about the environment. Geologists, geographers, oceanographers, foresters, agriculturists, and meteorologists have been using air and ground photography for years to measure properties of an object,

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Remote sensing by aerial photography has long been used in geophysical research. These aerial photographs show different aspects of ice off the coast of northern Greenland. The photograph on the facing page shows fairly young ice, five miles off shore, which was broken up by wind and waves and then refrozen. The photograph on this page is of snow-covered fast ice, locked to land, with a number of icebergs.

map extensive areas, and monitor conditions that change with time. A photograph allows an investigator to make measurements without actually visiting the site or object.

Other remote sensing devices can contribute other types of information based on various portions of the electromagnetic spectrum or on the forces exerted by gravity and by magnetic fields. Instruments which lend themselves to large-scale observations from high-flying aircraft or from satellites are particularly valuable for remote sensing of environment. By applying the appropriate sensing techniques to specific geophysical problems, scientists are able to gather entirely new kinds of information, some of which could not be acquired by any amount of labor with ground-based instruments. Some geophysical problems that can be studied with remote sensing devices are: determining broad trends in subsurface structure and the differences in rock types within a time-rock group; distinguishing between healthy and diseased vegetation, between snow and ice types, and between clouds and a land, water, or ice background; delineating thermal sources in regions of active faulting and volcanism; mapping ocean currents; studying the earth's net radiation and heat budget; and reconnaissance and analysis of sea ice for naval and merchant marine purposes.

Last Year, the Infrared Laboratory of the University's Institute of Science and Technology responded to a request from the Geography Branch, Office of Naval Research, for a study of the needs and potential for remote sensing of the environment. The study program, directed by Joseph O. Morgan, Research Physicist, is investigating the potential of remote sensing devices for gathering useful geophysical data.

The experience and capabilities which make The University of Michigan exceptionally well qualified to undertake this program were developed largely in

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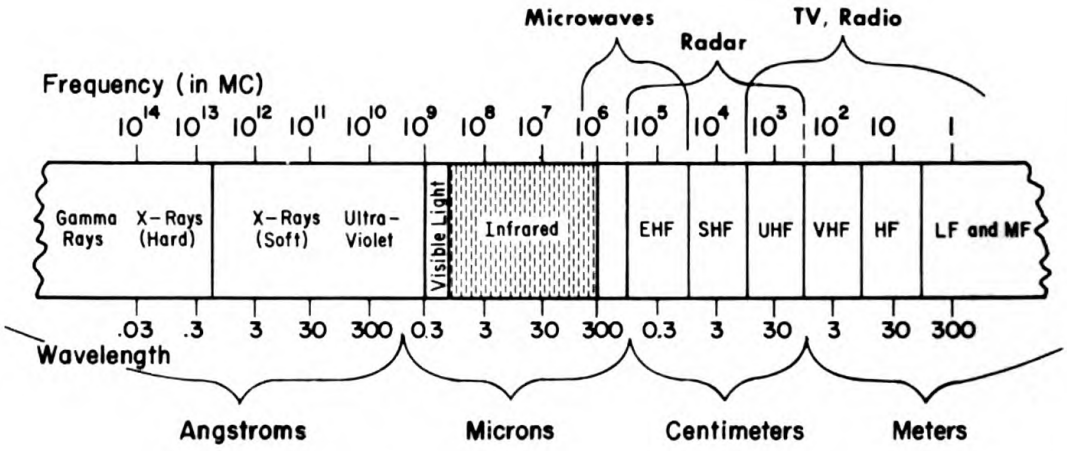
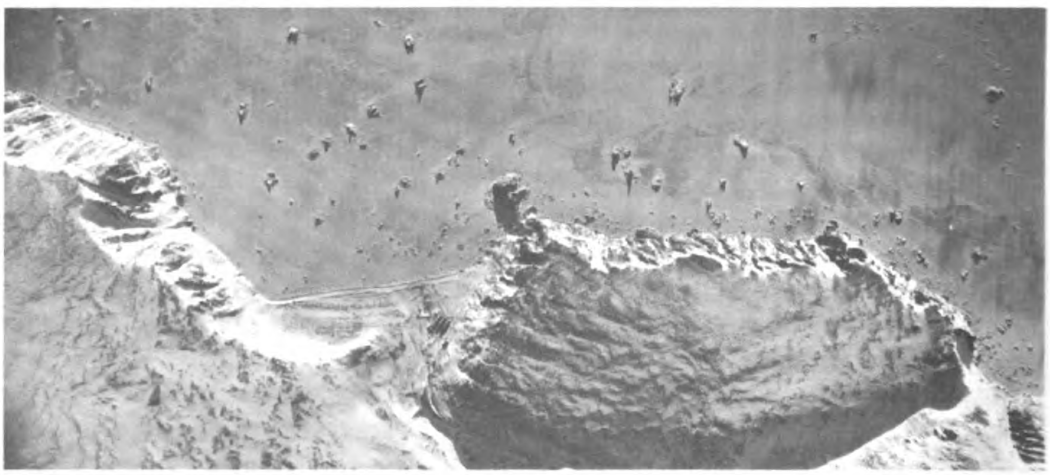


The electromagnetic spectrum

Near Kilauea Volcano, Hawaii, small air vents were recorded by airborne instruments at several thousand feet. A member of the ground party points to one such vent.

Aerial photograph of shoreline of northern Greenland showing snow-covered permafrost and some icebergs in the frozen ocean.



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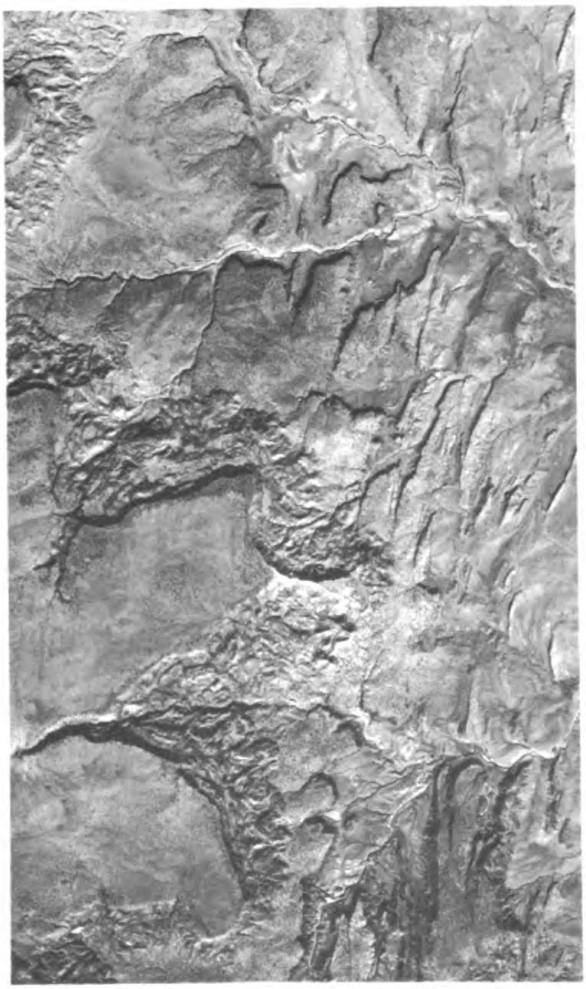
frared remote sensing at 5000 feet over eenland revealed a snowbridged crevasse, re being explored by University of Michi- n and Army personnel. A view of the in- rior of the crevasse is presented on the front ver.



sing stereo pairs of aerial photographs such the one reproduced at right, taken at an titude of 30,000 feet over New Mexico, S. Geological Survey geologists are able make many determinations about rock rmations—primarily the distribution, ickness, attitude, and faulting of the units. f special interest in the photograph at ght is a fault zone, indicated by the numer- us parallel lines extending from the top to e bottom of the photograph.

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work on Project Michigan, a large-scale research program sponsored by the U.S. Army Signal Corps. For more than nine years, the various laboratories and groups within the Institute of Science and Technology have been developing for Project Michigan improved equipment and techniques for surveillance of potential combat areas. This work has produced a group of scientists and engineers intimately familiar with the design of such remote sensing devices as radar systems, gravimeters, and magnetometers. The University has, moreover, in the faculty of the various earth science departments an invaluable source of information about potential applications of these remote sensing devices.

At Temperatures above absolute zero, all objects radiate electromagnetic energy by virtue of their atomic or molecular actions. Since this radiation is propagated outward *ad infinitum* without dependence on a transmitting medium, it would be possible to detect the radiation from an object located anywhere in the universe if a sensitive enough detector could be devised.

The total amount of radiation emitted from a body rises with the temperature of the body. As the temperature increases, the peak of emitted radiation occurs at progressively shorter wavelengths. For a body at an ordinary terrestrial temperature (300°K), the peak of emitted radiation occurs at 9.6 microns, which is in the infrared portion of the electromagnetic spectrum. (A micron is one one-thousandth of a millimeter.) The amount of radiation falls off rapidly toward the shorter wavelength portion of the spectrum and more slowly toward the longer wavelength portion. The amount of radiation emitted at either extreme of the spectrum is very small.

For sensing at wavelengths shorter than about one micron (the region of visible light), photographic or television systems are used. For sensing at wavelengths longer than a few millimeters, radar systems are used. The latter are "active" systems because they themselves provide a source of radiation, and record information by measuring the amount reflected back to them by some object. Passive instrumentation, as the name implies, acts strictly as a receiver; it sends out no radiation of its own, and operates in that region of the spectrum between wavelengths of one micron and a few millimeters.

With Respect to the Wavelengths Employed, examination of specific remote sensing techniques reveals both limitations and capabilities. Sensors carried by aircraft or satellites must sense through the atmosphere. This intervening medium often limits the operation of these sensors severely, for the atomic and molecular constituents of the atmosphere absorb and scatter much of the energy radiated or reflected from terrestrial objects. At short wavelengths (the ultraviolet portion of the spectrum), atmospheric scattering is so nearly complete that at the earth's surface these measurements are of little value. The wavelengths in the visible spectrum and in the portion of the infrared region nearest in wavelength to visible light lend themselves to sensing by photography, which gives high resolution of the details of an object. Photography, of course, can be used only in areas illuminated by the sun or by artificial means.

The atmosphere is strongly absorbing for infrared wavelengths except in specific regions of high transmission, usually referred to as atmospheric windows. Fortunately, one large atmospheric window occurs in the region between eight and fourteen microns, which coincides with the region of peak radiated power from terrain objects. Because of the longer wavelength of infrared radiation and some limitations in current infrared sensor performance, pictures

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made by using this region of the spectrum are generally inferior in resolution to aerial photographs; but since the energy used at, say, ten microns depends on the natural thermal radiation from objects, the resulting picture presents an entirely different kind of information—thermal or "heat" imagery instead of light reflectance imagery. Therefore, infrared measurements are not restricted to daylight or to seasons which afford suitable numbers of daylight hours. Atmospheric radiation studies of cloud surfaces can be made day or night, and thermal measurements can be conducted in polar regions during the dark winter season.

Beyond the infrared portion of the spectrum is the microwave region. The shorter-wavelength part of this region lends itself to passive sensing devices. Passive microwave sensors can overcome some of the limitations of infrared sensors for two reasons. First of all, infrared devices cannot sense through some kinds of weather (fog, for instance) as well as microwave sensors can. Secondly, emission in the infrared portion of the spectrum is from the surface layer of most natural objects. Microwave radiation, on the other hand, is emitted from varying depths, depending on the composition of the material. As a result, some information about interior phenomena of materials is available through microwave sensing.

In the Longer Microwave Region, there is very little naturally occurring radiation, which means that radiation for sensing at these wavelengths must be generated by active systems. Active microwave, or radar, systems have a number of practical applications to geophysical problems. They can measure distances with great accuracy. Airborne radar can make maps in which there is no foreshortening. Within certain microwave bandwidths, all-weather mapping of terrain is possible. From such maps an interpreter can deduce something about the composition of the terrain. In certain other bandwidth intervals, information about cloud composition and cloud cover can be obtained; and in still others, information about the ionosphere can be obtained. Even in the very long wavelengths of the electromagnetic spectrum (from UHF to HF), remote sensing devices are now being employed in induced polarization studies to investigate the moisture content and layering of the top few feet of soil.

The special capabilities of two old, reliable geophysical tools, the magnetometer and the gravimeter, have been extended by adapting them to airborne or satellite platforms. The problems posed by the acceleration forces that act on the sensitive gravimeter in an aircraft have been largely overcome, and a workable instrument capable of making rapid, relatively sensitive measurements of gravity variations over the earth's surface has been devised.

The Present Study Program comes as a natural adjunct to the field research programs conducted by the Infrared Laboratory during the last five years. The field programs have been sponsored by the U.S. Army Cold Regions Research and Engineering Laboratory, the U.S. Army Electronics Laboratory, the Office of Naval Research, and the U.S. Geological Survey. Since 1958, Mr. Morgan has taken his infrared measurement teams, both airborne and ground-based, into such diversified climatic areas as Houghton, Michigan; northern Greenland; the Sonoran Desert and Yellowstone National Park; and the entire state of Alaska from Anchorage to Point Barrow and north to floating ice island T-3

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(78° north latitude); the tropical rain forests of Puerto Rico; the Everglades of Florida; the Appalachian Mountains of Virginia; the northern Rockies of Montana; and the Gulf of St. Lawrence and the Canadian Maritime Provinces. Members of this Group assisted this year in an infrared data collection program over the volcanic areas of the Island of Hawaii.

The Greenland mission of November and December, 1960, was the first airborne research program to be attempted over the icecap during the winter darkness. A Project Michigan C-47 airplane was flown to Thule Air Base by IST pilots, and Research Associate Dana C. Parker, geologist and image interpreter for the Special Applications Group, spent a month at Camp Century, an Army outpost built entirely under the icecap surface, where he was able to study the icecap environment from above and below. He was responsible for ground measurements and provision of navigation assistance to the airplane's crew. The valuable and in some cases entirely unexpected data obtained during this trip led to a second mission in March, 1962, in which greatly improved airborne instrumentation was used.

These Field Programs and subsequent analyses have provided many new data relevant to research in the earth sciences. The thermal data acquired in Houghton and Greenland are of potentially great value in the study of snow surfaces and icecap phenomenology. Theories pertaining to crevasse detection formulated by the Army Cold Regions Research and Engineering Laboratory and substantiated during the Houghton phase of the work in cold environments were further substantiated in Greenland, and an airborne technique for accurate detection and location of snowbridged crevasses, which often cannot be detected by visual means, has resulted.

The thermal data acquired in Yellowstone Park provided the impetus for the U.S. Geological Survey to exploit infrared techniques over the Kilauea volcano in Hawaii during the period of impending eruption in February, 1963. New surface expressions of the underground volcanic activity were discovered in the airborne infrared data and confirmed by a field survey team. The thermal maps also revealed the existence of several large springs along the shoreline of Hawaii.

The thermal sea-ice studies originally conducted off the coast of Greenland and later over the Arctic Ocean in August, 1962, have led to a three-phase winter program in association with the Canadian government. In this program, which concerns the shipping lanes in the vicinity of the Gulf of St. Lawrence and the polar ice pack, the emphasis will be on analysis and prediction of sea ice.

These are some of the remote sensing applications that have been investigated thus far by the Infrared Laboratory; in them, only radiation in the infrared portion of the spectrum has been used. But in both the infrared and in other spectral regions there are many other applications to environmental research yet to be explored. The study program conducted by the Special Applications Group of the Infrared Laboratory is an effort to open up some of these regions for the benefit of research in the earth sciences.

The Scripps Institution of Oceanography's SPENCER F. BAIRD sailed on June 5 on a four month's voyage to conduct geologic and oceanographic research in the eastern tropical Pacific Ocean and the Caribbean Sea. The expedition, called Bonacca (after one of the islands in the Caribbean), is receiving support from the National Science Foundation and the Office of Naval Research.

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The National Standard Reference Data System

NAVAL RESEARCH REVIEWS, *May 1963, carried an account of a serious problem now facing the scientific community—that of organizing information-handling systems so that all scientific data pertinent to specific investigations can be extracted from the large amount of data that are being published. To achieve such organization within the Department of Defense, studies of the information-processing systems of each military department are now going forward. ONR is coordinating the task within the Navy.*

A step taken recently by the Office of Science and Technology, Executive Office of the President, is expected to assist materially in bringing about efficient information transfer in Government departments, including Defense, and in certain non-Government activities. It is described here.

Dr. Jerome B. Wiesner, Director of the Office of Science and Technology in the Executive Office of the President, has announced the establishment of a National Standard Reference Data System. This national effort, which will be an identifiable part of the National Scientific and Technical Information System (NSTIS), will be administered by the National Bureau of Standards, which is already compiling standard data. The NSRDS integrates to a single point of responsibility the present data-compiling activities of the National Bureau of Standards, Department of Defense, Atomic Energy Commission, National Aeronautics and Space Administration, the National Science Foundation, and several other agencies.

Standard Reference Data Centers covering certain specific areas of effort may be established by or be assigned to various Government Departments and Agencies. Such Centers will be financed and administered by the Departments concerned, but they will meet the quality standards and other requirements of the NSRDS, and they will be included as identifiable components of the NSTIS. The NSRDS may also include Standard Reference Data Centers at universities, research institutes, and other non-Government activities.

Dr. Wiesner, who is also Chairman of the Federal Council for Science and Technology, has said that the Standard Reference Data System will greatly benefit United States engineers and scientists by giving them easy access to the data pertinent to their work. The standard source for scientific data has been the now almost totally out-dated International Critical Tables, an eight-volume publication last issued in 1933. That data source was compiled under the auspices of the National Academy of Sciences, Office of Critical Tables, and published by the McGraw-Hill Book Company.

In recent years the amount of data made available through the stepped-up Federal research and development programs, has become much too large to be handled by a private publishing venture. Also, the flow of new data requires continuing efforts to update collections. Only a national system is able to cope with this information flow.

Under the new system the National Academy of Sciences will act as advisor to the National Bureau of Standards, providing the guidelines to the fields of science and technology having greatest demand for data.

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As presently planned, the program will consist of three parts: an input from scientists in many different locations, a central source of the evaluated data at NBS, and an output system geared to the needs of the nation's scientists and engineers.

The input will come from scientists who are comprehensively reviewing the literature in their fields of specialization and critically evaluating the data for ultimate inclusion in the storehouse of standard reference data. These scientists may be in universities or in industrial or Government laboratories. They will work singly or in small groups oriented to the traditional scientific disciplines. At the same time other scientists, similarly located, will be engaged in experimentally determining the standard reference data that do not exist in the literature. Clearly, the interplay between the two groups must be close and continuous.

The central core will consist of the Standard Reference Data Center at NBS, where the evaluated data will be located on punched cards, on magnetic tape, in notebooks, and in many other forms, all mechanized for storage and retrieval. A review and control office will label the incoming data as to relative quality and reliability. The SRD Center will classify the data into as many major and minor categories as are required by the needs of the data users.

The output will take the form of a series of services aimed at different technical levels and tailored to the needs of various segments of industry. In general, it will be oriented toward the application of the data, rather than toward a field of science. According to present plans, the output services will be provided by the SRD Center and will eventually include:

Periodical Service designed to keep the user up to date on new data acquisitions in the SRD Center.

Subscription Service in which the user pays to receive all available data on a specific subject on a continuing basis.

Referral Service which will handle narrow, one-time requests for data.

Correlation and Prediction Service for computing values where ever possible in areas where some data exist, but where requests come in for specific information not contained in the SRD Center. Values will be computed by making use of correlations based on molecular structure and the properties of related compounds.

Mathematical and Statistical Service which will offer mathematical and computer techniques to customers for evaluating new data for subsequent inclusion in the files of the SRD Center or for individual use.

Aperiodical Products, including tabulations, review monographs, review papers, computer card decks, and computer tapes.

Summary Reviews to provide a rapid assessment of the state-of-the-art in fields where there are few data but which must suddenly be explored because of scientific breakthroughs or crash programs.

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The Energy of "Carla"

Robert E. Stevenson
A&M Marine Laboratory
A&M College of Texas

An ONR-supported study of water temperatures in the Gulf of Mexico before and after violent Hurricane "Carla" has given an indication of the tremendous amounts of energy involved in such storms. The study is reported here by the scientist who made it.

The most dramatic and intense interaction between the sea and the atmosphere takes place during the full hurricane. These monstrous storms draw from the sea the awesome quantities of energy required to sustain them through their short but violent lives.

Because the energy exchange is several orders of magnitude greater than that in a normal tropical storm, hurricanes provide a unique "laboratory" for investigations of air-sea interaction. However, it is virtually impossible to take measurements of water temperature changes as they occur in the area covered by a hurricane. Aboard ships caught in such storms, one does little more than practice survival techniques, and even these are unsuccessful on many occasions. Weather buoys have been broken from their moorings, never again to be seen, and towers have foundered.

Because of these adverse conditions, great interest exists in whatever data investigators are able to turn up on changes in the sea caused by hurricanes. The author was fortunate, therefore, when, through a fortuitous set of circumstances following the passage of Hurricane "Carla" through the northwest Gulf of Mexico, he was presented the opportunity to measure some of these changes.

Path and Force

"Carla" entered the Gulf through the Yucatan Straits on September 7, 1961. From there it travelled in a northwesterly direction and grew into one of the five severest hurricanes to invade the Gulf since 1837. By September 10, as it approached the Texas coast, pressures in the center reached a low of 27.50 inches of mercury (931.2 mb), and winds of 130 knots whirled around the eye. Because of the early and continuous warnings issued by the U.S. Weather Bureau, nearly 500,000 people evacuated the coastal regions. Thus, despite the fury of the winds and the rising storm tides (a maximum of 22 feet where the storm crossed the coast), the loss of life was minimal.

The path taken by "Carla" into the northwest Gulf was fortunate from the viewpoint of investigating its influence on the sea, for it crossed an unusually extensive bulge of low-salinity water. The warm, brackish water formed a surface layer with densities which were considerably less than those of the underlying water (1.01919 as compared to 1.02685, for example). Thus, a great amount of heat could be lost from the low-salinity layer (therefore, lowering the temperature) before the density stratification would be disturbed.

Normally, a low-salinity layer of water lies along the Texas coast where river water emanates through the estuaries and lagoons. In September 1961, this

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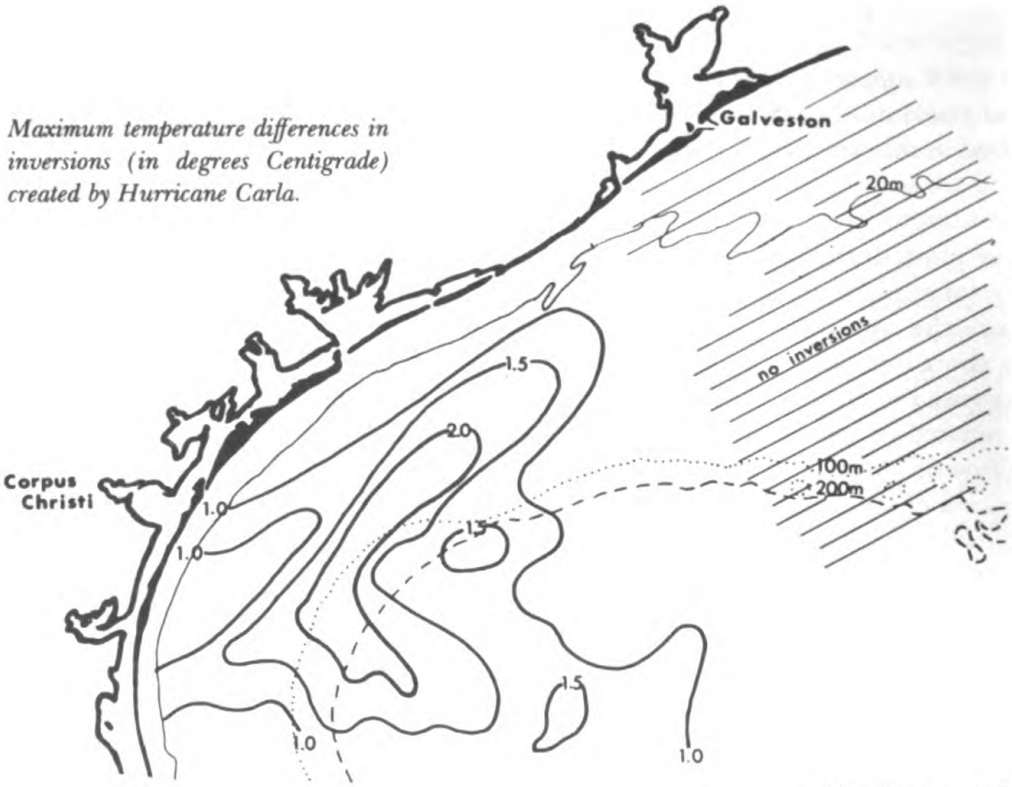
brackish layer extended 120 nautical miles from the coast between Brownsville and Galveston, Texas. Salinities ranged from a low of 29.76 percent at the surface, through 30 percent at a depth of 131 feet, to 35 percent at a depth of 230 feet. Waters with normal salinities of 36.50 percent lay below a depth of 328



Maximum temperature differences in inversions (in degrees Centigrade) created by Hurricane Carla.

Massive waves churned u wall at Galveston, Texas, 7 feet above normal at th graphs courtesy the Galve

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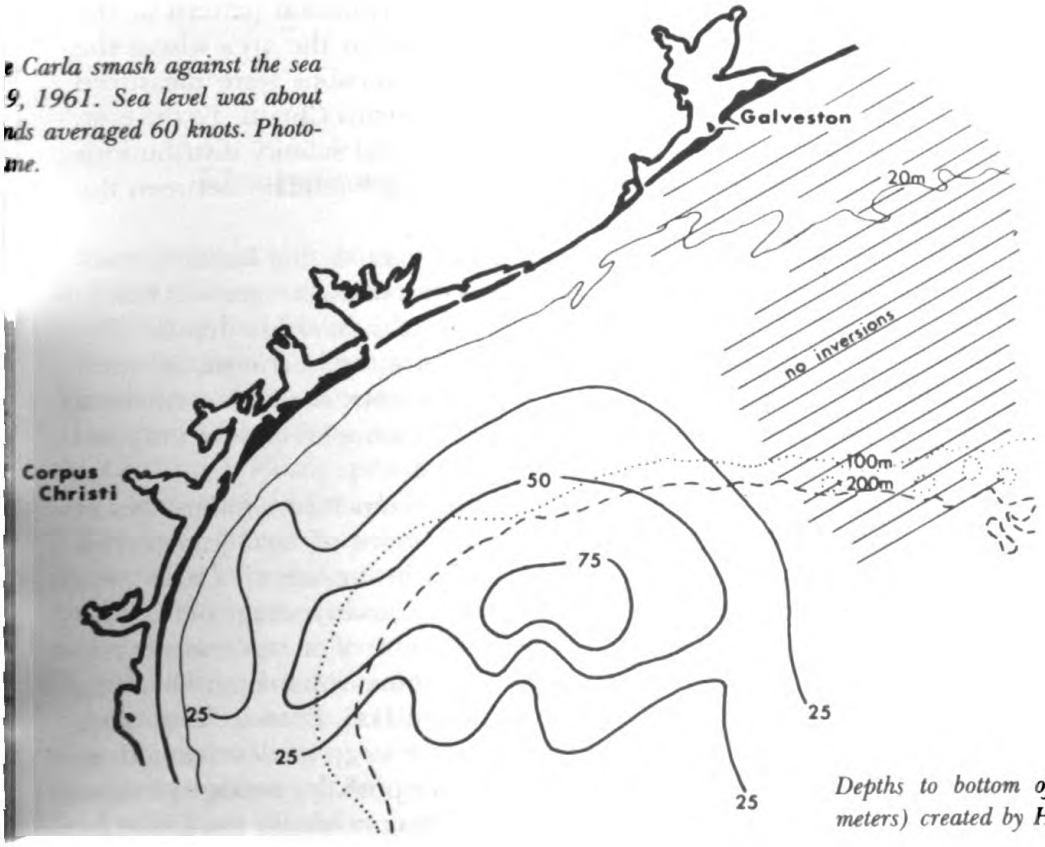
e Carla smash against the sea 9, 1961. Sea level was about nds averaged 60 knots. Photo- me.



Depths to bottom of inversions (in meters) created by Hurricane Carla

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feet. Hurricane "Carla" swept over this bulge of coastal water on September 10 and 11.

The Inversions

A month later, when scientists from the A&M College of Texas cruised in the northwest Gulf aboard the R/V HIDALGO, many of the traces from their bathythermograph casts revealed impressive temperature inversions. Temperatures in the upper water layers were as much as 2.5°C less than in deeper waters, and the inversions extended to a maximum depth of 272 feet. It seemed apparent that the heat lost from the sea during the passage of "Carla" formed the inversions, and that they were "preserved" because (1) the low-salinity surface layer retained a density equilibrium in spite of the temperature decrease, (2) heating after the hurricane was negligible, and (3) little lateral exchange of water occurred in the month following.

Where salinities were more typical of Gulf waters (36.50 percent), southeast of Galveston, the heat loss from the surface increased the water density, thereby causing instability in the upper layers. As a result, convective stirring formed an isothermal layer of water which extended to a depth of 197 feet.

Calculating the Heat Loss

From the distribution and magnitude of the temperature inversions, it was possible to calculate the heat lost from the sea to the hurricane during the 24-hour period from noon, September 10 to noon, September 11. The volume of water involved in the energy exchange was determined by examing the depths to which the cooled surface waters extended. The distribution pattern of the depths shows that the greatest depth of influence was in the area where the hurricane deviated from its northwesterly course. Inversions were measured as close as one mile from the shore in the vicinity of Corpus Christi. To the east, inversions were not present in the waters where normal salinity distributions occurred, and inversion depths shoaled abruptly at the boundary between the two water units.

To determine the temperature ranges in the inversions, the bathythermograph traces were examined, and a rational projection of each trace was made. The distribution of temperature ranges differed from the inversion depths. The greatest differences were to the west of the area where the hurricane deviated and looped, and lay nearly over the edge of the continental shelf. Nevertheless, waters in which the temperature decreased by 1.5°C or more lay close to the path of the storm.

From an analysis of the actual inversion depths and temperature differences at each bathythermograph station, the tremendous amount of heat transferred from ocean to atmosphere during a 24-hour period in the life of "Carla" was calculated. It amounted to 21.5×10^{17} calories per day, or an average of 6×10^{13} calories per second. Expressed in other terms, the amount of energy transferred in 24 hours was sufficient to heat 62 million average homes for an entire heating season in a climate comparable to that of Washington, D.C. Even so, this value does not represent the total heat loss, for certainly energy was exchanged in waters of normal salinity lying southeast of Galveston – probably enough to raise the figure given by somewhat less than an order of magnitude.

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Research Notes

Two Light Planes Land at North Pole

The deepest known penetration of the Arctic Ocean Basin even made by light planes occurred May 24, 1963, when two single-engine Cessna 180 airplanes of the Navy's Arctic Research Laboratory (ARL) landed at the North Pole. The aircraft, which carried scientific personnel and equipment, landed on the Arctic pack ice at the Pole to obtain gravity measurements.

Previously, flights by light planes have been restricted to a 300-mile radius of the ARL, which is located at Barrow, Alaska, and administered by the Office of Naval Research through a contract with the University of Alaska. However, in an effort to make gravity surveys in previously unexplored regions deep within the Arctic Basin, the two planes for the first time used as bases of operation the Laboratory's two scientific stations on the ice islands ARLIS-2 and T-3, which are much nearer the Pole than Barrow.

During a two-week period, between the time of the Cessnas' arrival at T-3 on May 21 and their return to Barrow on June 2, nine sites were temporarily occupied on the pack ice to collect gravity data. The North Pole was reached from ARLIS-2, presently located at approximately 87.1 N, 175.4 E, about 170 nautical miles from the Pole and slowly drifting toward it.

While collecting important gravity data, the scientists aboard the planes were also able to make valuable observations of ice conditions as they exist in extreme northerly portions of the Arctic Ocean. Operations were hampered on only one occasion when bad weather and poor visibility forced the two aircraft to land and spend a 24-hour period on the pack ice about 30 nautical miles south of T-3.

Low-Frequency Electromagnetic Radiation Under Study

Low-frequency electromagnetic radiation will be the subject of a North Atlantic Treaty Organization Advanced Study Institute scheduled for July 22 through August 2 in Bad Homburg, Germany.

The Institute will bring together top scientists in this field for a review and discussion of the current knowledge of the theory, measurement, and instrumentation of low-frequency electromagnetic radiation. Supported by NATO, the Institute is jointly sponsored by the U.S. Naval Ordnance Laboratory, White Oak, Maryland, and the London Branch Office of the Office of Naval Research.

The basic purpose of the Institute is to stimulate new, basic research on low-frequency electromagnetic radiation. Of particular interest is that radiation in the frequency range of zero to 3000 cycles per second which emanates from the earth's ionosphere as a result of bombarding high-energy particles from the sun. Limited research on this subject has been conducted in the past.

Advanced research on this radiation will tell scientists much about inter-solar plasma and radiation belts resulting from solar activity. It will also increase knowledge about the ionosphere and the disturbances in the earth's magnetic field which are caused by low-frequency electromagnetic radiation. One particu-

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larly important result which such advanced research could provide is the level of the background noise caused by this radiation.

Interest in low-frequency electromagnetic radiation has increased in recent years as the result of the observation of phenomena related to it. These phenomena include micro-pulsations, magnetic storms, high-altitude nuclear explosions, and fluctuations in the earth's magnetic field. Another observable phenomenon related to this radiation is "the conjugate point effect" in which a disturbance generated at one of the earth's magnetic poles is propagated along a line of the magnetic field and felt at the other pole. Probably the most dramatic phenomenon associated with the low-frequency electromagnetic radiation is the Aurora Borealis.

Dr. David F. Bleil, Associate Director for Research at the Naval Ordnance Laboratory, organized the Institute and is one of its two directors. His co-director is Dr. I. Estermann, Director of Research of the London Branch Office of the Office of Naval Research.

ONR Captain Named C.O. at DTMB

Change of Command ceremonies were held at the David Taylor Model Basin on June 14 to formalize the assumption of command of that laboratory by CAPT John M. Ballinger, USN, and the departure from that post of CAPT J. A. Obermeyer, USN. Upon taking over as Commanding Officer and Director of the Model Basin, CAPT Ballinger left behind the post of Deputy and Assistant Chief of Naval Research at the Office of Naval Research.

CAPT Ballinger graduated from the U.S. Naval Academy in 1937 and attended the Massachusetts Institute of Technology, where he received the degree of Master of Science in 1941. Much of his Navy career has been devoted to work in Navy shipyards. He served as Deputy and Assistant Chief of Naval Research from January 1962 until last month.

CAPT Obermeyer was named Commanding Officer and Director of the Model Basin in 1960 following a tour of duty at the Bureau of Ships as Director of the Ship Design Division. His new assignment is Commanding Officer of the Naval Ship Repair Facility in Yokosuka, Japan.

Assigned to the post vacated by CAPT Ballinger is CAPT E. J. Hoffman, USN, who comes to ONR from the Navy Shipyard, Charleston, S.C.

All About Marine Borers

An 1100-page compilation of references to literature on marine borers has just come off the press at the Government Printing Office. The book, entitled "*Marine Borers—An Annotated Bibliography,*" contains information collected from numerous biological, engineering, economic, and general scientific journals and monographs in many languages which is condensed for the first time under one cover. It comprises about 3540 items, each with a concise information abstract.

Two indexes are appended, one a geographic index of borer damage in the various areas of the world, the other a subject index leading to information on the morphology, distribution, life cycle, and physiology of the marine boring

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animals and on the various methods of borer control and damage prevention.

The bibliography was compiled by the late William F. Clapp and by Roman Kenk with support from the Office of Naval Research. It sells for $7.00 per copy and can be ordered from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

High Navy Award Given NOL Scientist

Dr. Curtis J. Humphreys, head of the Research Department at the Naval Ordnance Laboratory, Corona, California, has been given the coveted Navy Award for Distinguished Achievement in Science. RADM K. S. Masterson, Chief of the Bureau of Naval Weapons, made the presentation on behalf of Secretary of the Navy Fred H. Korth on June 21.

The award, which consists of a certificate, a medal, and a grant of $5000, was presented in recognition of Dr. Humphreys' outstanding and pioneering contributions to the field of atomic line emission spectroscopy. Three major contributions were cited—the placement of uranium in its proper position in the periodic series, his achievement in being first to observe the sixth series of atomic hydrogen, and his development of a new radiometric method of interferometric determination of wavelengths of infrared spectral lines.

Dr. Humphreys, who has been a scientist for the Federal government for the past 35 years, is recognized throughout the scientific world as a leading authority in his field. In 1945 he received an award for participation in the Manhattan District Project, and in 1951 the Meritorious Civilian Service Award of the Department of Commerce.

The Navy Award for Distinguished Achievement in Science has been granted only twice previously, both times in 1962, to Dr. Herbert Friedman, Superintendent of the Atmosphere and Astrophysics Division of the Naval Research Laboratory, and to Dr. Edward L. Alpen, head of the Biological and Medical Sciences Division of the Naval Radiological Defense Laboratory.

Materials-Science Survey

Perspectives in Materials Research, a volume reviewing the emergence of a truly interdisciplinary science of materials from roots in physics, chemistry, metallurgy, and mechanics, and setting forth the challenges to further research on the solid state, is now available to the scientific community. The 771-page survey was prepared through the collaborative efforts of more than 60 authorities in the major materials-science specialties at the invitation of the National Academy of Sciences—National Research Council. The Office of Naval Research sponsored the project.

Dr. Frederick Seitz, President of the NAS—NRC and former chairman of its Division of Physical Sciences, headed the Advisory Committee on Perspectives in Materials Research which organized panels of scientists to prepare the series of individual-area perspectives included in the volume.

Chapters are devoted to The Science of Materials, Cohesive Properties of Solids, Magnetism and Magnetic Materials, Electrical, Optical, and Thermal

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Properties of Solids, Diffusion and Mass Transport in Solids, Phase Transformations in the Solid State, Growth, Structure, and Morphology of Crystals, Mechanical Behavior of Crystalline Solids, Surface Phenomena—The Nature and Properties of Solid Surfaces and Interfaces, Effects of Radiation on Materials, and Techniques and Instrumentation.

Perspectives in Materials Research can be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D.C., for $4.00 per copy.

Administrative Officer Becomes Director of NRL

CAPT Bradley F. Bennett, USN, administrative officer of the Naval Research Laboratory since 1960, has been named Director of the 40-year-old installation. He replaces CAPT Arthur E. Krapf, USN, a World War II submarine commander who has directed the Laboratory since 1959 and who has now retired.

Before coming to NRL in 1960, CAPT Bennett was Commanding Officer of the Office of Naval Research Branch Office in London. Other of his tours have included assignments aboard the USS SARATOGA, Norfolk Navy Yard, Pearl Harbor, Ship Repair Facility, Yokosuka, Japan, and the Bureau of Ships, Washington. He is a graduate of the U.S. Naval Academy, class of 1935, and holds master's degrees in nuclear physics and Naval construction from the Massachusetts Institute of Technology.

In his new post, CAPT Bennett will direct the activities of about 3000 civilian personnel at the 124-acre basic and applied research laboratory located in Washington, D.C.

Replacing CAPT Bennet as administrative officer is CAPT Thomas B. Owen, USN, a 23-year Navy veteran who holds a doctor's degree in chemistry. Before his Laboratory assignment, CAPT Owen served on the staff of the Assistant Secretary of the Navy for Research and Development.

New Technical Director Appointed at NTDC

Dr. Hanns H. Wolff has been appointed Technical Director of the Naval Training Device Center, Port Washington, N.Y., a field activity of the Office of Naval Research that guides industry in the design and production of simulators and other military training equipment. He comes to the Navy civilian post from Republic Aviation Corporation, N.Y., where he served as head of the Electronics Laboratory of the Paul Moore Research and Development Center. In his early years in this country, Dr. Wolff held top technical positions with engineering firms.

Prior to his coming to the United States from Germany in 1947, he practiced electronics engineering and lectured at Technical University of Berlin. He holds an engineering doctorate and teaching doctorate degrees from Technical University of Berlin; has been awarded many invention patents from various countries (including 15 in the U.S.A.), and is the author of numerous technical papers, most of which are in the fields of electricity and electronics.

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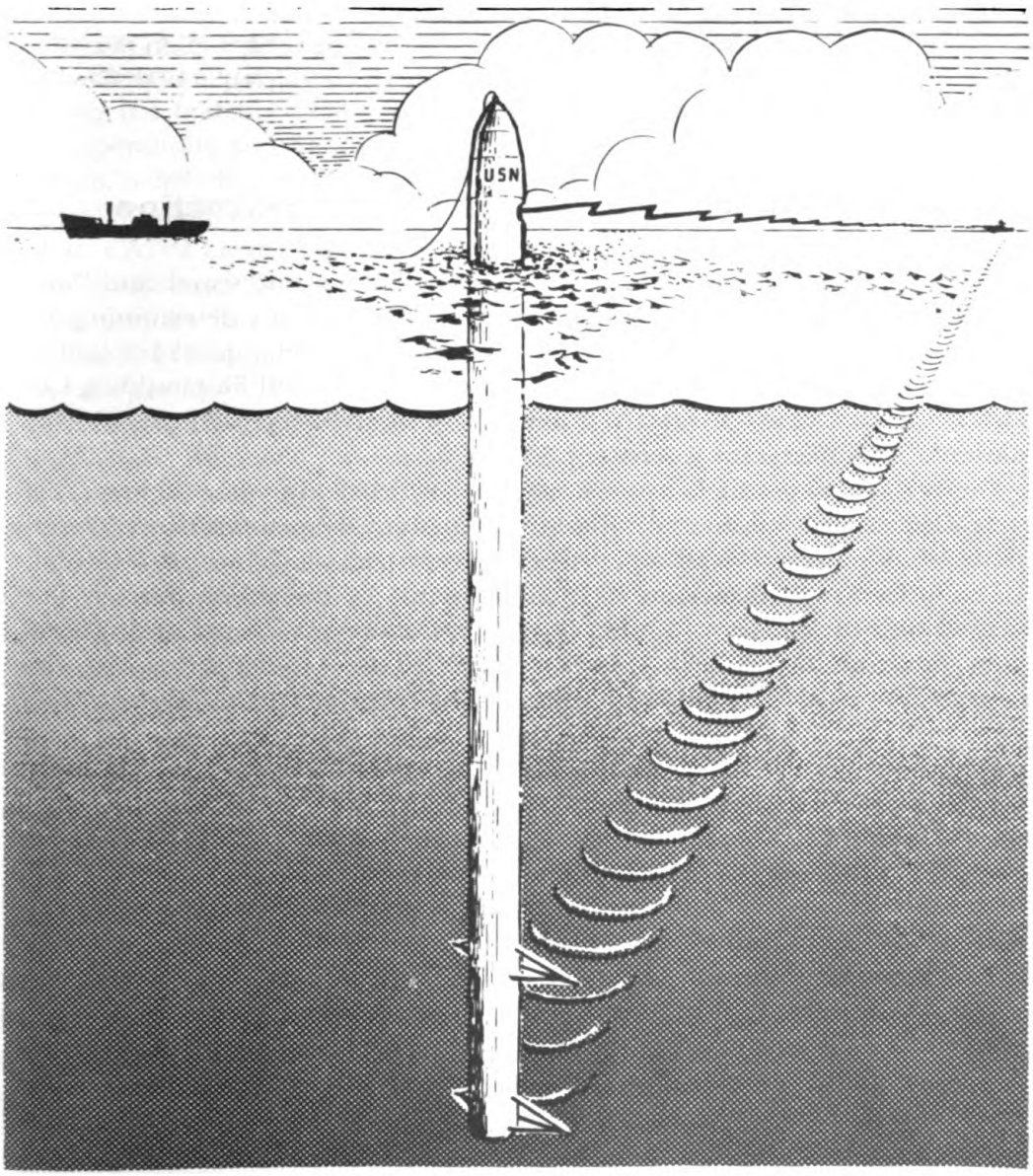
Construction of SPAR Begins

The Bureau of Ships has awarded a fixed price contract to Gibbs Shipyard, Inc., Jacksonville, Florida, for $747,277 for the construction of the Seagoing Platform for Acoustics Research (SPAR).

The vessel, a 16-foot steel tube with an overall length of approximately 354 feet and a full-load displacement of 1723 tons, will serve as a floating, unmanned platform for conducting acoustics research (NavResRev, Dec. 1961). During operation, SPAR will be towed horizontally by a tending towship, which will remotely flood the research vessel's aft end causing the ship to settle vertically to a depth of approximately 300 feet in the water. The research vessel will be equipped with hydrophones and other external instrumentation for receiving both underwater sonar signals and above-water radio signals. Research data collected by the vessel will be relayed to the tending ship by electrical cables linking the two vessels.



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The Vacant Desk

A. T. Drury, editor and supervisory editor of *Naval Research Reviews* for more than 12 years, has helped put the magazine "to bed" for the last time. "Ted," as he is known to his many friends at ONR, NRL, and other Navy research activities, has moved to the Navy's David Taylor Model Basin as that laboratory's Technical Information Officer. His associate editor, Richard D. Olson, will now assume full responsibility for the editorship of the magazine.

Looking back through past issues of *Naval Research Reviews*, one cannot fail to find Ted Drury's mark on most of the pages. It is recognizable as clear, concise, interesting reporting of difficult, often highly technical subjects. In a recent "letter to the editor" of *Naval Research Reviews*, the editor of a commercial technical magazine made this comment: "How you manage to fill every issue from cover to cover with excellent material is something of a puzzle to me and other members of our staff." Of course, most of the credit for this compliment goes to Ted Drury.

As one step toward maintaining Ted's high standards in the future, the editor wishes to reaffirm the magazine's policy of welcoming the contribution of articles concerning interesting and significant Naval research conducted at both Government and non-Government laboratories.

Mathematical System Aids Ship Construction

The Bureau of Ships has announced the completion of a Research and Development Project for developing methods for mathematically determining hull forms of ships to be constructed and for programming ships' parts for fabrication by numerical control. The work, accomplished at Todd Shipbuilding Corporation, Los Angeles Division, was jointly sponsored by the Navy and the U.S. Maritime Administration at a cost of $362,000.

The new system produces a surface equation which defines the hull form. This surface equation is solved to produce two-dimensional equations describing the curves of ships' frames and other structural members which intersect the hull.

This information describing the hull contours of individual parts is then merged with the working drawing dimensions on a parts programming sheet. Parts programming language is used to generate tapes to cut the parts by numerical control. The system also has the capability for nesting multiple parts on single plates to minimize scrap loss.

The mathematical lofting and numerical control systems, as they are called, were productively tested by actually cutting plates for the U.S. Navy's Guided Missile Frigate DLG-33. A numerically controlled flame cutting machine was used to make these tests. To program the parts, experienced loftsmen from a shipyard were selected, and after less than two months of training, these men were not only proficient at programming but were also introducing cost saving procedures to the system.

Though these production tests were made for the purpose of demonstrating the capabilities of the system to produce acceptable ships' parts, the tests also indicated that the system, in its infancy, appeared economically competitive with conventional methods and has a potential for achieving significant cost reductions in the future.

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On The Naval Research Reserve

ONR Seminar

The Fifteenth Annual Naval Reserve Research Seminar—sponsored by the Office of Naval Research and conducted by Naval Reserve Research Company 5-8—convened for two weeks in Washington, D.C., on June 9, 1963. Participating were 117 Navy and Army Reserve officers. The objectives of the seminar were to bring the Reserve officers up-to-date on current Naval operations, to interest them in research programs which will contribute new knowledge necessary for a solution of future Navy problems, and to provide a broad view of current research and development activities in the Navy, with emphasis on selected areas of particular interest.

The seminar program was under the general direction of CDR F. H. Langdon, USNR, Acting Special Assistant to the Chief of Naval Research (Research Reserve) and Training Officer. Technical direction of the program was provided by Dr. S. Silverman, Research Director, ONR. CAPT James R. Patton, Jr., USNR, Commanding Officer of NRRC 5-8, served as chairman of the seminar.

During the first week the presentations were concerned chiefly with Naval Naval operations and general aspects of research in the Navy. CAPT E. J. Hoffman, USN, Deputy Chief of Naval Research, welcomed the officers on behalf of RADM L. D. Coates, USN, Chief of Naval Research. In a keynote address, RADM Lloyd V. Berkner, USNR, President, Graduate Research Center of the Southwest, Dallas, Texas, stressed the importance of the Research Reserve and its role in promoting the application of scientific discoveries to the advance of military technology. In the talks that followed on various aspects of Naval operations the seminar had the pleasure of hearing a number of flag officers among the many excellent speakers. VADM William F. Raborn, USN, Deputy Chief of Naval Operations (Development), spoke on "Research and Development Concepts in OPNAV." RADM Thomas F. Connolly, USN, Director, Anti-Submarine Warfare Division, and RADM John B. Colwell, USN, Director, Long Range Objectives Group, discussed the Navy functions for which their OPNAV offices are responsible, and RADM I. J. Galantin, USN, Director, Special Projects, Bureau of Naval Weapons, gave a report on Polaris. Mr. Samuel E. Clements, Executive Assistant to the Director of Defense (Research and Engineering) spoke on "Research and Development Management in the Department of Defense." At a luncheon meeting the speaker was RADM H. S. Monroe, USN, Assistant Chief of Naval Operations (Naval Reserve), who briefed the conferees on the value of a strong Naval Reserve. Research Reservists also had the opportunity at the luncheon to meet CAPT D. J. Mooney, Jr., USNR, who has orders to report to the Office of Naval Research as Special Assistant for Research Reserve.

During the second half of the seminar the state of the art in several scientific fields was reviewed with considerable emphasis on contributions to the solution of Navy problems. Mr. F. B. Isakson, Head, Physics Branch, ONR, was chairman of a session on the subject "Optics in the Navy." A presentation on "Perspectives in Material Science" was chaired by Dr. Ralph R. Nash, Metallurgy Branch, with technical co-chairman, Dr. H. Shenk, Director, Material Sciences Division, ONR, and Dr. F. S. Gardner, Acting Head, Metallurgy Branch, ONR. Papers on the

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topic "Logistics, Management Science, and Decision Processes" were presented under the chairmanship of Dr. Robert J. Lundegard, Head, Logistics and Mathematical Statistics Branch, ONR. COL Ward K. Schaub, USMC, Senior Marine and Amphibious Warfare Officer, ONR, was the chairman for a program on "The Life Sciences and Naval Operations," of which the session on biological sciences was chaired by Dr. Roger D. Reid, Director, Biological Sciences Division, ONR, and that on psychological sciences by Dr. Richard Trumbull, Director, Psychological Sciences Division, ONR.

In these technical sessions, the seminar participants were fortunate to hear speakers who are leading authorities in their fields. Their presentations included many new scientific results, some as yet unpublished, from research programs still in progress which stimulated very active and informative question periods. In the course of the seminar, two days were devoted to field trips. Goddard Space Flight Center of the National Aeronautics and Space Administration and the Naval Research Laboratory were visited. Program briefs were presented and tours conducted through the facilities.

For the morning of the last day the only separate sessions of the seminar were scheduled. To bring the Navy and Army officers up to date, presentations were made on the current status and the future of the Reserve component in each service. Such subjects as Reserve progress and objectives, Reserve promotions, and career planning for Reserve officers were covered.

In the afternoon the seminar concluded with a talk by Dr. Paul Conroy, Chief of Professional Training, U.S. Information Agency, Department of State, on the subject "Soviet Impressions of American Life." Following closing remarks by the seminar chairman, the "Seminar Degree," a certificate attesting to attendance at this fifteenth seminar, was presented to each officer. The overall excellence and value of the seminar were the subject of many comments received during the sessions and were further stressed in critiques written by each officer attending.

Research Reservists Judge National Science Fair

The task of selecting the ten top Navy Science Cruiser award winners for 1963 from a field of over 200 eligible finalists was accomplished by a panel of judges composed mainly of members from the Naval Reserve Research Companies 8-7 in Albuquerque and 8-9 in Los Alamos, New Mexico. The selections were made at the National Science Fair held in Albuquerque, May 6-12, 1963.

Senior judge for the Navy was RADM J. Dean Black, USN, Deputy Commander, Field Command, Defense Atomic Support Agency, Sandia Base, Albuquerque, New Mexico.

Navy Science Cruiser winners had projects as varied in scope as the following: "Radio Controlled Peripheral Nozzle Air Cushion Vehicle," "Gaseous Cause of the Phenomenon Termed Nitrogen Narcosis and the Effects of Traumatic Aero Embolism," and "Centrifuge for Man or Mouse." The award winners, ten in number, were presented with official Navy binoculars and an opportunity to take a five-day science-oriented trip to Naval vessels and to USN research facilities.

Over 100,000 people attending the Fair viewed projects of 411 entrants as well as the outstanding exhibits by NASA, Naval research laboratories, AMA, and industrial contractors.

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Rhode Island Seminar

The fourth annual First Naval District Research Reserve Seminar convened on June 9, 1963, at NAS, Quonset Point, Rhode Island. This year the seminar was conducted by NRRC 1-2 of Providence, R.I., and was attended by 102 Research Reserve officers from all of the continental naval districts. The seminar subject this year was Marine Science.

During the two week period the participants heard lectures and discussions on physical, chemical, geological, and biological oceanography; and on bacteriology, fisheries research, torpedoes, hydrofoils, and other subjects that make up the vast field of marine science. Among the lecturers were scientists and engineers from the University of Rhode Island, Woods Hole Oceanographic Institution, Harvard University, Massachusetts Institute of Technology, and Worcester Polytechnic Institute. The group also made field trips to the Medical Research Laboratory, Submarine Base, and the Underwater Sound Laboratory in New London, Connecticut, during the first week. During the second week the Underwater Ordnance Station and the Raytheon Company in Newport, R.I., were visited. At these activities the latest developments in sonar, torpedoes, and submarine and diving medicine were demonstrated.

The opening morning session was highlighted by remarks by CAPT Robert Milner, Commanding Officer, NAS, Quonset Point, and CAPT A. S. Cleaves, Deputy Chief of Staff, First Naval District, and featured an address by RADM L. D. Coates, Chief of Naval Research. In the afternoon, Dr. Columbus Iselin of Harvard and Woods Hole discussed the history of oceanography and its application to the problems of the Navy. Also on Monday, Dr. von Arx of MIT discussed the many problems involved in the accurate determination of the position of a ship on the sea surface. Following this, Mr. F. C. Fuglister of Woods Hole presented a most complete discussion on the Gulf Stream and the many problems that face scientists in trying to determine the movement of the water masses that make up this complex system.

The remainder of the first week included discussions of Subsurface Equatorial Currents in the Pacific, by Dr. John Knauss of the University of R.I.,; Underwater Acoustics, by Drs. F. T. Dietz and F. Fiddleton of URI; Oceanographic Instrumentation, by Dr. W. S. Richardson of WHOI; The Deep Sea Floor, by Dr. D. C. Krause; The Narragansett Bay Area, by Dr. L. Alexander; Bottom Characteristics and their Measurement, by Prof. C. E. Miller; Geology of the West African Continental Shelf, by Dr. R. L. McMaster; and Beach Erosion and Related Problems, by Dr. J. M. Zeigler. The first week concluded with lectures concerned with the life in the seas. These included Planktonology, by Dr. C. J. Fish; Phytoplankton, by Dr. T. J. Smayda; Sounds Produced by Fish of the Sea, by Mrs. C. J. Fish; and Sounds Produced by Whales, by Prof. W. E. Schevill.

The second week concluded the series on pure science and concerned itself with the hardware aspects of marine science. Among the topics duscussed were Chemical Oceanography, by Dr. D. R. Schink; Open Ocean Bacteriology, by Dr. J. Sieburth; Suggestions for Improving Marine Fisheries, by Dr. S. Saila; The Economics of Fisheries, by Prof. H. Lampe; New Oceanographic Research Ships, by LCDR M. McLean; New Designs in High Speed Submarines, by CAPT E. S. Arentzen; Recent Developments in Hydrofoils, by CAPT W. Nicholson; Water Entry Problems, by LCDR L. C. Neale; Recent Developments in Torpedo

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Fuels, by CDR E. C. Winslow and Dr. P. Hirschler; Biology of the Sea, by Dr. B. H. Ketchum; ONR Contract Administration, by CAPT A. H. Healy; The Research Reserve Program, by CDR E. F. Kehoe; and Destroyer Developments by CDR Loudermilk of DesDevGrp 2, Newport, R.I. Also included was a discussion of International Cooperation and Communication in the Marine Sciences, by Dr. M. Sears; Developments in the Communication of Marine Sciences Information, by Mr. J. O'Connor; and The Automatic Atlas, by Prof. H. Stommel.

The seminar banquet held on Thursday featured an address by LCDR Harlan D. Pardoe, USN, of the Institute of Naval Studies.

Reservist Given Honorary Degree

LCDR Wayne V. Burt, USNR, a member and former commanding officer of Naval Research Reserve Company 13-5, Corvallis, Oregon, was awarded an honorary Doctor of Science degree by George Fox College (Newberg, Oregon) at its 1963 annual commencement.

LCDR Burt is chairman of the Department of Oceanography at Oregon State University. He holds a B.S. degree from George Fox and the M. S. and Ph. D. from Scripps Institution of Oceanography. He also holds a certificate in aerology from the Post Graduate School of the U.S. Naval Academy.

Summer Seminars

The Research Reserve is sponsoring four seminars in the first quarter of Fiscal Year 1964:

Seminar	Convening Date
Naval Research Laboratory at Washington, D. C.	July 15
Aerophysics Seminar at Denver, Colorado	August 5
Biological Defense at Fort Detrick, Frederick, Maryland	August 12
Electronic Computers at College Station, Texas	August 26

Two of these seminars are new to the training program of the Research Reserve—the Aerophysics Seminar at Denver, Colorado, and the Electronic Computers Course at College Station, Texas. The sponsoring Research Reserve companies have arranged exceptionally fine programs for conferences, which will include Reservists of all services.

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Many Thanks

Upon the recent detachment of CAPT J. W. Jockusch, Jr., USNR, from the Office of Naval Research, where he served as Special Assistant for Research Reserve for the past three years, he was given a collection of letters of appreciation written by members of the Research Reserve Program. RADM L. D. Coates, USN, Chief of Naval Research, made the presentation. CAPT Jockusch's new duty station is the Office of Naval Research Branch Office, San Francisco, where he will serve as Commanding Officer.

RADM Coates, right, expresses his own appreciation to CAPT Jockusch as he gives him collection of letters.

CDR Jennings, second from left, with CDR Robert F. Jaeger, second from right, commanding officer of NRRC 5-3, after presentation of citation. At far left is CDR Leon P. Eisman, commanding officer of the U.S. Naval Unit at Fort Detrick, and at far right, CDR Frank H. Langdon, newly appointed Research Reserve liaison officer.

Former Liaison Officer Honored

CDR Robert N. Jennings, USN, former 5th and 6th Naval District Research Reserve Liaison Officer, was honored recently by Naval Research Reserve Company 5-3 at Fort Detrick, Maryland, prior to his departure for Tacoma, Washington, where he was to take command of a Naval Reserve unit. The event is pictured above.

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Selections for Promotions

Twenty-three officers of the Research Reserve Program were among 3159 Reserve officers of the line selected for promotion to the grade of lieutenant by the selection board, which convened April 9, 1963. The names of the officers selected are as follows:

R. L. Addington	13-1	H. R. Reeve	6-13
T. W. Freeman	12-5	D. B. Rickets	12-3
F. P. Gersbacher	9-7	T. A. Russell	13-2
P. B. Howard	1-1	J. J. Ryan	3-2
H. L. Jensen	9-2	E. L. Stewart	8-3
D. W. Jones	3-12	J. L. Swartwood	13-3
W. H. Luesing, Jr.	6-6	T. C. Taylor	1-1
A. I. McCone, Jr.	5-8	W. H. Thompson, Jr.	6-3
R. E. Mesloh	4-7	E. A. Walsh, Jr.	1-3
G. W. Nagorny	4-2	M. E. Williamson	1-3
J. H. Pereue, Jr.	11-5	F. Zuccoli	3-7
R. W. Race	1-3		

Date of Rank		Designator	Year of Birth	
Earliest	10-26-51	1105 - 14	Earliest	1924
Latest	1-24-61	1355 - 3	Latest	1937
Median	5- 1-60	1405 - 3	Median	1936
		1455 - 2		
		1615 - 1		

Also selected were eleven officers from the staff corps:

Medical Service Corps		Civil Engineer Corps		Supply Corps	
W. M. Hantsbarger	9-12	W. Loewenstern, Jr.	12- 3	R. G. Lunan	9-19
C. T. Ostrem, Jr.	9-19	R. A. Mitchell	5-10	E. Swingle	6-13
K. Powers	9-14	G. W. Moore, Jr.	3- 3		
M. Reich	5- 8	G. F. Sears	8- 5		
E. C. Suitor	5-10				

Selections were announced for the grade of lieutenant commander in the staff corps. The following members of the Research Reserve were listed.

Medical Service Corps		Medical Corps		Dental Corps	
N. D. Bowers	9-10	H. G. Carleton	11-11	W. H. Henry	12-4
R. H. Brownson	5- 5	J. P. Henry	9-23		
C. M. Dienhart	6- 1				
M. E. Rogers	9- 1	Civil Engineer Corps		Nurse Corps	
S. Ross	5-10				
M. Schwartz	9-19	I. H. Stockel	3-1	M. L. Caron	5-5
L. M. Seale	3- 3				
A. F. Yanders	9-16				

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The Builders — Continued from Inside Front Cover

On the other hand there are those men of rare vision, who can grasp well in advance just the block that is needed for rapid advance on a section of the edifice to be possible, who can tell by some subtle sense where it will be found, and who have an uncanny skill in cleaning away dross and bringing it surely into the light. These are the master workmen. For each of them there can well be many of lesser stature who chip and delve, industriously, but with little grasp of what it is all about, and who nevertheless make the great steps possible.

There are those who can give the structure meaning, who can trace its evolution from early times, and describe the glories that are to be, in ways that inspire those who work and those who enjoy. They bring the inspiration that all is not mere building of monotonous walls, and that there is architecture even though the architect is not seen to guide and order.

There are those who labor to make the utility of the structure real, to cause it to give shelter to the multitude, that they may be better protected, and that they may derive health and well-being because of its presence.

And the edifice is not built by the quarrymen and the masons alone. There are those who bring them food during their labors, and cooling drink when the days are warm, who sing to them, and place flowers on the little walls that have grown with the years.

There are also the old men, whose days of vigorous building are done, whose eyes are too dim to see the details of the arch or the needed form of its keystone; but who have built a wall here and there, and lived long in the edifice, who have learned to love it and who have even grasped a suggestion of its ultimate meaning; and who sit in the shade and encourage the young men. (Reprinted by permission from THE TECHNOLOGY REVIEW, January 1945, edited at the Massachusetts Institute of Technology.)

Prevention of Microbial Resistance to Antibiotics — Continued from Page 3

immutatable and thereby preventing them from becoming resistant to the action of an antibiotic.

- Spermine may also change the structure or composition of the bacteria's cell walls so that the antibiotic is allowed greater freedom of movement intracellularly.
- And there is the possibility that spermine simply increases the strength of the antibiotic's lethal mechanism, without performing separate cooperative functions.

What courses future investigations involving spermine and perhaps other substances having similar effects will take is not an easy question to decide. Already, research in this field has burgeoned. It now involves a number of institutions in addition to the University of Pennsylvania and concerns several different animal systems. Needless to say, we are hopeful that we have uncovered a new and important biological principle. If so, it may make possible the wide application of spermine and other similar substances in medicine. At the very least, however, we have had a theoretically important experience, one that is sure to stimulate much more research on the phenomenon of tolerance and the methods of dealing with it.

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IN THIS ISSUE

NAVAL RESEARCH REVIEWS publishes highlights of research conducted by Navy laboratories and contractors and describes important Naval experimental facilities. Manuscripts submitted for publication, correspondence concerning prospective articles, and changes of address, should be directed to Code 740, Office of Naval Research, Washington, D.C., 20390. The magazine is listed for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Subscription price: $1.50 per year in the U.S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. The issuance of this periodical approved in accordance with Dept. of the Navy publications and printing regulations.

EDITOR: Richard D. Olson

An investigator explores a snow-covered Greenland crevasse first discovered by infrared sensing from an altitude of 5000 feet. This photograph was taken using only the light entering the crevasse through the hole cut in the snowbridge by the explorers. See article beginning on page 4.

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