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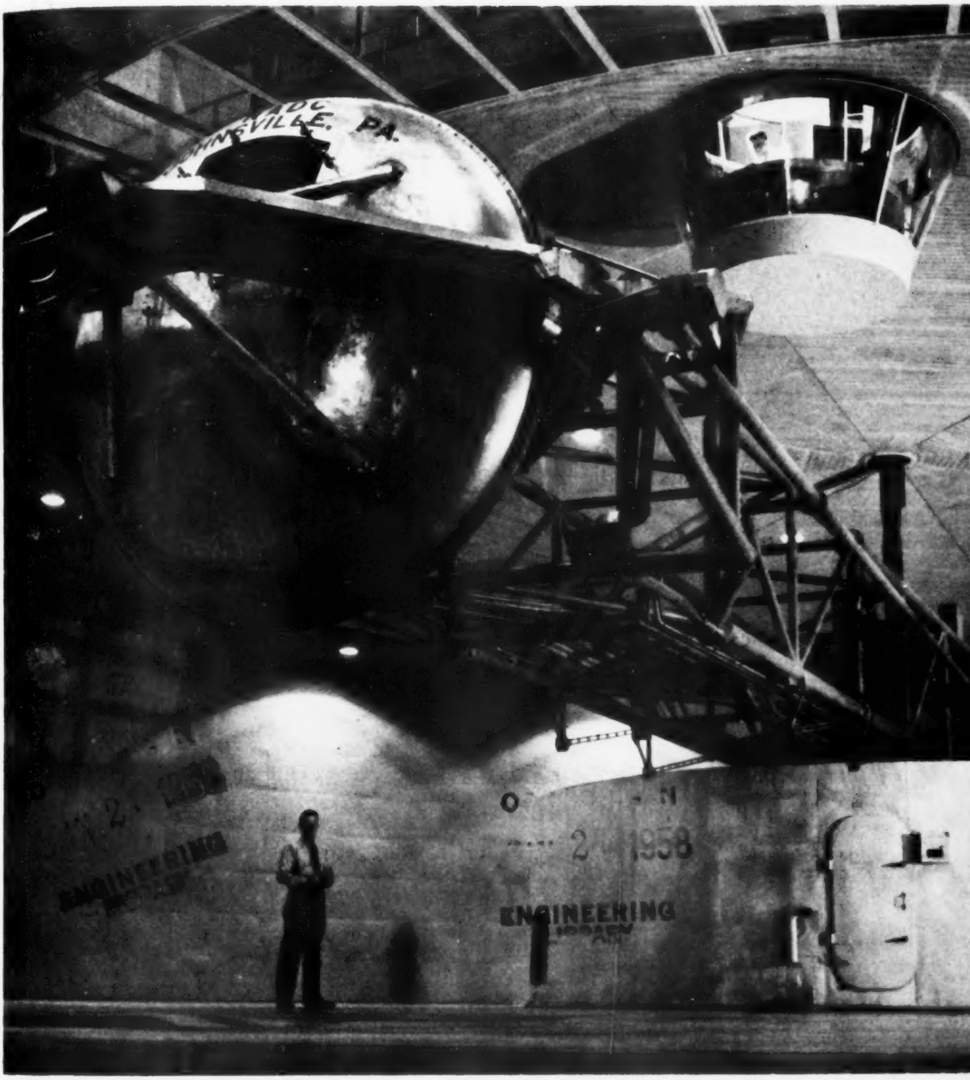
RESEARCH REVIEWS



DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

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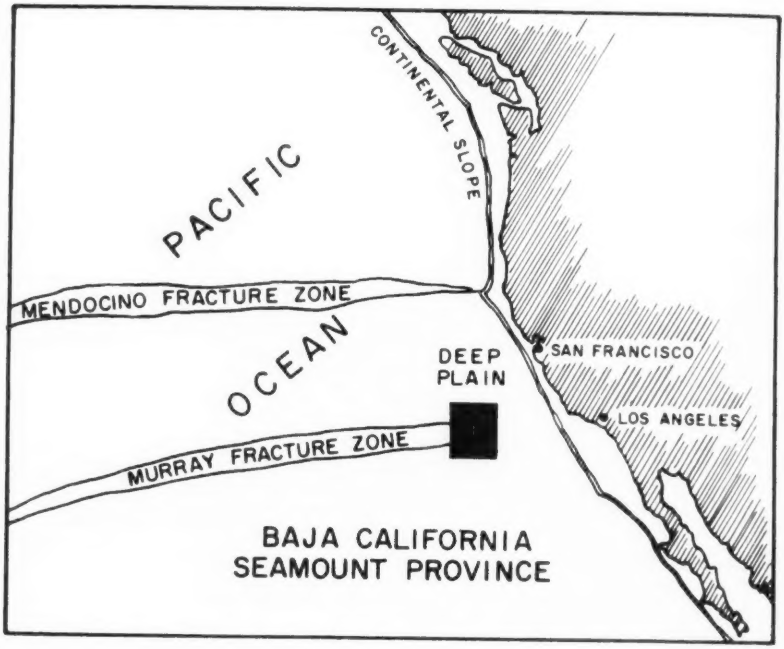

Figure 1 - Index map of a part of the northeastern Pacific Ocean and West Coast of United States, showing location of area covered by magnetic survey (black rectangle).

Figure 2 - The USC&GS ship PIONEER.

Magnetic Survey of Part of the Deep Sea Floor Off the Coast of California

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Measurements made of the depths of the ocean by echo-sounding devices have revealed the existence of many mountains, valleys, and plains on the ocean floors. Because these features have been protected by the sea from powerful erosive agents, and therefore have been preserved for much longer periods of time than similar features on exposed surfaces of the earth, they have aroused much interest among marine geologists and other investigators (see Research Reviews, August 1957). Primarily, this interest has centered on the geologic structures in which the record of the forces responsible for the topography is "written." These structures have been well preserved also, but as they are inaccessible, indirect means of identifying and mapping them have had to be utilized.

One of these approaches relies on geophysical techniques—the same ones used so widely in prospecting for oil and minerals over the land surfaces of the earth. For example, by timing the travel of elastic waves generated by earthquakes and explosions, seismologists have shown that the earth's crust, which is about 20 miles thick under the continents, thins out to about three miles under oceanic basins. This establishes the fundamental difference between continents and ocean basins and suggests that continental and oceanic areas of the world have retained their identity throughout geologic time.

Another method for investigating the ocean floor utilizes sonic waves. By measuring the velocities of these waves after they have been reflected from the ocean bottom to listening stations, it is often possible to determine the approximate thickness of the crustal layers and the kinds of rock that constitute them.

A third method involves the collection of magnetic data. This information is applicable to the study of geologic structures because of the fact that the crustal rocks, both of the land and the ocean floors, are magnetized by the earth's magnetic field. Thus, contacts of rock bodies of different mineralogical composition and surface and subsurface topography create measurable anomalies of the field at the surface of the ocean. By measuring these anomalies, important clues as to the nature of the crustal rocks can often be found.

Utilizing the latter method of study primarily, but applying data collected by the other methods to interpret the results obtained, the authors recently made a survey of a portion of the floor of the Pacific Ocean (Figure 1). One of the objectives was to learn more about a very prominent structure called the Murray fracture zone—a break in the earth's crust extending 1,800 nautical miles from a point near the

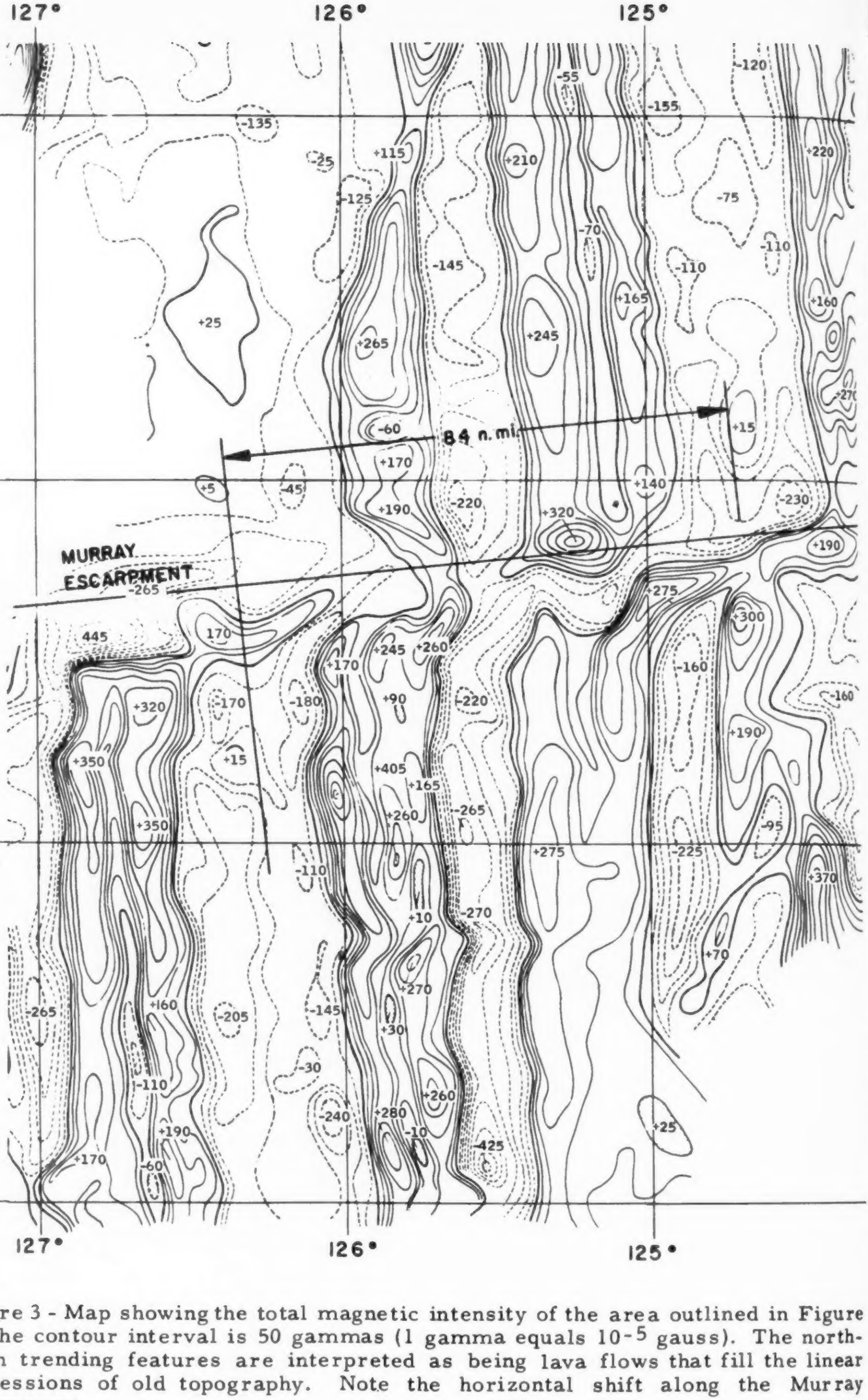

Figure 3 - Map showing the total magnetic intensity of the area outlined in Figure 1. The contour interval is 50 gammas (1 gamma equals 10^{-5} gauss). The north-south trending features are interpreted as being lava flows that fill the linear depressions of old topography. Note the horizontal shift along the Murray escarpment.

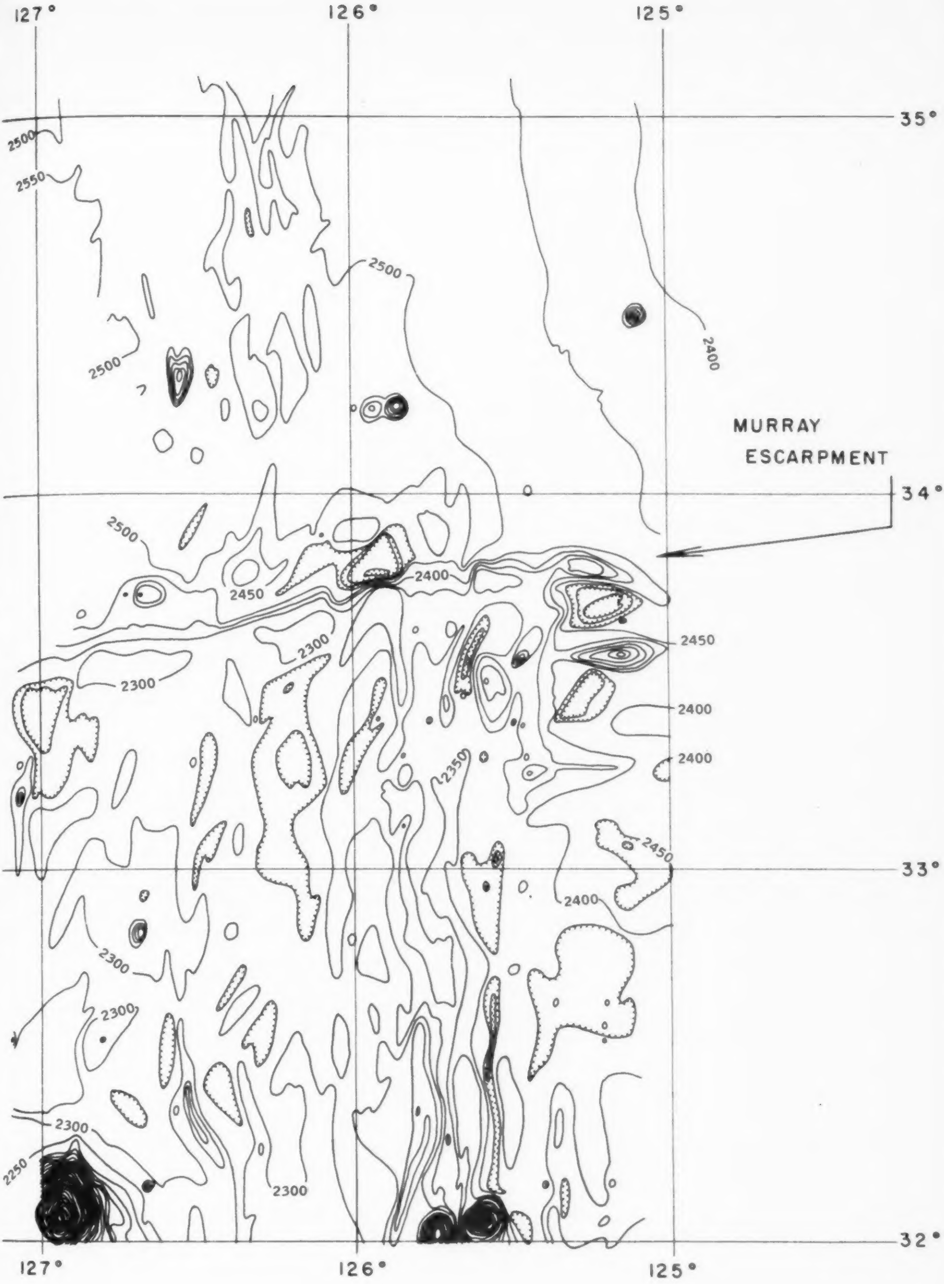

Figure 4 - Map showing generalized bottom topography of the area of Figure 3. The contour interval is 50 fathoms. Except for the northeastern corner of the map, where the ocean floor consists of sediments derived, apparently, from the continent, most of the topography shown is oriented north-south.

Pacific Coast almost to the Hawaiian Islands. The original observations were made mostly along east-west lines, about 5 nautical miles apart, with a magnetometer towed behind the USC&GS ship PIONEER (Figure 2), which was then engaged in a detailed hydrographic survey. The work was done under the sponsorship of the Office of Naval Research and with the cooperation of the Coast and Geodetic Survey.

Figure 3 is a map of the area surveyed, showing contour lines of equal magnetic intensity. The lines have been adjusted so that they do not reflect the increase in intensity of the earth's magnetic field that occurs from south to north across the area.

In Figure 4, the general ocean-bottom topography of the area is shown. The most conspicuous feature on this map is the escarpment of the Murray fracture zone. It trends east-northeast across the whole area. Not only does the escarpment have prominent relief of its own, but it also marks the boundary between two topographic provinces—a shallow, irregular one to the south and a deep, smooth one to the north. In this particular area, which is near the eastern end of the fracture zone, the maximum relief of the escarpment is only about 2,400 feet, and the average relief is only 1,200 feet. West of the area the relief of the escarpment is as great as 6,840 feet.

South of the Murray escarpment is the Baja California Seamount Province, a vast region consisting entirely of seamounts and hills. The seamounts in this province that have been dredged are volcanoes, and all the other large peaks appear to be volcanoes because of their typical conical shape (a few can be seen at the bottom of Figure 4). The origin of these countless hills is not well understood. Most of those in the area of Figure 4 do not resemble small, low volcanoes, but instead are long and narrow like the topography one would expect to be produced by folding and faulting.

Extending northward from the Murray escarpment to the Mendocino escarpment, and a few hundred miles westward from the continental slope off the coast of central California, is an abyssal plain called the Deep Plain (see Figure 1). At its western edge, the plain is interrupted by an increasing number of low hills (see Figure 4). These are part of the transition zone between the Deep Plain and the more rugged topography to the west. Most of the low hills north of the Murray escarpment have the same northerly trend as the hills to the south. However, some comparatively small volcanic cones rise above even the smoothest parts of the plain.

The magnetic expressions of the volcanoes vary greatly. This suggests that the more magnetic ones contain larger amounts of massive lavas than the less magnetic ones, most of which are probably cinder cones. The map of Figure 3 is drawn to too small a scale to permit adequate study of the volcanoes.

The northerly trend of the topography is reflected prominently by the larger magnetic features shown on Figure 3. Some of these magnetic features are known to extend 370 miles north of the Murray escarpment. They are also present over the smooth abyssal plain of the northeastern quarter of the topographic map of Figure 4, indicating that in that area the north-south ridges are covered by a layer of sediment which was deposited, in all probability, by turbidity currents—high-density mixtures of water and suspended sediment that flow down ocean-bottom slopes.

The sharpness of some of the large magnetic anomalies that trend north-south, coupled with the knowledge of the depth of the ocean and the thickness of sediment indicated by seismic shooting, suggests that the anomalies are caused by lava sheets which fill the valleys of the old topography. The total thickness of the lavas must be at least 2,000 feet in order to be consistent with the likely value of the magnetic polarization of such rocks. The lavas may be less magnetic if one assumes that some of the anomalies are due to intrusive bodies several miles thick, rather than thin lava flows piled one on top of another. However, the absence of erosional agencies, and the lack of correspondence between magnetic and topographic features, except for trend, suggest that the lava-flow hypothesis is the more likely one.

The Murray escarpment is reflected clearly on the magnetic map of Figure 3. It interrupts the great north-south trending features. The continuity of the latter is reestablished by slipping the area north of the Murray escarpment 84 nautical miles to the west along the line of the escarpment. The magnetic survey thus shows that, in addition to the vertical displacement of 1,200 feet, there is a right lateral displacement along the Murray escarpment which occurred after the pouring out of lavas on the ocean floor.

This evidence of recent relative motion in the sub-oceanic crust some 200 miles off the continental shores raises interesting questions with regard to the relationship between the deformations of the oceanic crust and adjacent continental margins in response to mountain-building forces in the depths of the earth.

The Material Sciences Division at ONR has a new Director--Dr. J. H. Shenk, formerly Head of the Research Department of the Naval Ordnance Test Station. He replaces Dr. I. Estermann, who will now give full time to his duties as Deputy Director of the Research Group for Coordination.

Dr. Shenk graduated from Kansas State College in 1929 with a degree in chemistry. Later, he obtained a Master's degree from that school and a Doctor's degree from the University of Illinois. He has been on the faculty of Kansas State College, University of Illinois, and Ohio State University. Before going to NOTS in 1946, he was a Research Associate with the Ohio State University Research Foundation.

More than 4,500 Navy personnel have taken part in the Navy's two Antarctic operations, DEEPFREEZE I and DEEPFREEZE II. Through their efforts, an area the size of the United States and Western Europe combined has been explored, much of it never before seen by man.

Accommodating the Space Man

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Special Assistant, Medical and Allied Sciences
Office of Naval Research

That man will some day send space ships to the far corners of the heavens is now taken pretty much for granted. And that he will, in time, ride in these ships is also regarded as matter of fact. Confidence in the ability of scientists to do these things runs high, in spite of the fact that tremendous problems stand in their way, particularly in carrying out the latter venture. Putting a ship into space is not too difficult. But putting a man there, and keeping him there for any length of time, is quite another problem. Indeed, making adequate provisions for his safety and comfort outside the earth's atmosphere is perhaps the most formidable obstacle we face as we chart our course on the new frontier.

In contemplating putting man in space, it becomes immediately clear that there is no reason whatever for doing so (if one can except the innate urge to explore the unknown) other than to make the best use of his unique capabilities. This premise dictates that manned vehicles be designed around the man and his requirements rather than that man be modified to fulfill the needs of the vehicles. It is evident that any stop-gap procedures attempted to adapt man to an environment or situation not designed to meet his requirements will be inadequate.

Man's needs in space will vary with the type of vehicle considered, the mission to be performed, and his time in space. Of these variables, the latter is the most significant, for it dictates the breadth of the aeromedical problems involved in both of the others. The importance of the time factor becomes apparent when one realizes that there is literally nothing in space of a material nature which can be used to sustain life. Thus, the space vehicle must carry with it everything needed for man's existence.

In view of these facts, it does not appear to be beyond present-day capabilities to put a manned space vehicle into orbit around the earth for a few hours. And if the development of the proper techniques is pursued vigorously, it is even probable that before very long a flight lasting for a week or two can be made. But when one contemplates keeping a man in space for many weeks or months, he finds himself up against a stone wall. The only way around it is through extensive long-range research and development.

As large as this obstacle is, some progress has already been made in whittling it down to size. For some time now the Navy has been dealing with certain aspects of it in regard to another type of vehicle designed for another medium—the submarine. At present our submarines are being built so as to be able to stay underwater for many weeks. And through research now underway, it is hoped that they will be able to remain submerged indefinitely. We shall do well, then, to consider the human factor in space travel in the light of what we already know, or are studying, with regard to the submarine.

THE INTERIOR ATMOSPHERE

Man can adapt himself in many ways to his environment. However, he displays very little natural flexibility in meeting his respiratory needs. An adequate amount of oxygen must be made available, and it must be fed to him under adequate pressure. In addition, the carbon dioxide which his body produces as metabolic waste must be removed from the atmosphere. We know that a man can accpet more carbon dioxide than is commonly found in the open air, but we do not know precisely how much he can tolerate indefinitely, particularly in an atmosphere containing other contaminants. For safety reasons, we have fixed upon a concentration of 1-1/2 percent as the level which should not be exceeded.

The role of nitrogen as a diluent in the atmosphere man breathes has received little attention. Whether or not it must be included is not known for certain, but it is believed that over long periods of time, man will run the risk of oxygen poisoning if nitrogen, or some suitable substitute, is omitted from the atmosphere.

There are other insidious substances, in addition to carbon dioxide, which enter the atmosphere. Small amounts of noxious gases are not a great problem as long as the atmosphere can be flushed out periodically and exchanged for a clean one. When this is not possible, one must consider the effects of such organic contaminants as plastics, paints, ozones, aerosols, and even the gases given off by such commonplace supplies as soaps, shaving creams, tooth pastes, and hair lotions. How detrimental these gases might be is not yet known.

We must also give thought to inorganic contaminants, such as chlorine, the breakdown products from the operation of machines, and refrigerants, such as freon. And we must study the problems posed by the presence of human wastes, cooking odors, and the carbon monoxide produced by smoking. We have long known that persons with halitosis and strong body odors are intolerable to their fellow crewmen; thus, the selection of men for duty in a continually closed environment, such as that of a submarine or space ship, must be made on this basis as well as many others.

Up to the present time, we have been able to avoid most of these problems in submarines by utilizing bottled oxygen, by scrubbing carbon dioxide out of the atmosphere, and by flushing out the whole system periodically through surfacing or snorkelling. But for indefinite submergence, these measures won't suffice. Bottled oxygen is undesirable because of the bulk and weight required to produce sufficient oxygen for long periods of time; carbon dioxide scrubbing is hazardous owing to the toxicity of the amines used in the scrubbing systems; and it is as yet impossible to flush out the whole system when submerged.

For short space flights, where weight is not an insurmountable obstacle, a balanced atmosphere can probably be maintained by carrying along the entire amount of oxygen needed, and by removing carbon dioxide from the air by a chemical or mechanical means. But for longer flights, a self-contained regenerative system which will produce enough oxygen and remove the carbon dioxide, will be required. At present, photosynthetic gas exchangers seem to offer the best prospects for doing this.

FOOD AND WATER

Providing satisfactory food for sailors slated to remain at sea for a few weeks or months is a chronic problem, but it is as nothing compared with the one arising when we consider feeding the crews of submarines destined for indefinite submergence. Part of this headache arises through the relationship of food and morale, and food and performance. Here, too, time is the obstacle. There is a limit to the amount, diversity, and quality of fresh and dry stores that can be carried by a submarine for long periods of time.

The same problem applies to space ships. For a short flight, the nutritional requirement is rather simple. It is about the same as that existing at present in airplanes and can be handled in the same way. For longer flights, however, it is more complicated, because of the bulk and weight of the food and water required.

A normal individual in an average environment has a minimum water turnover of about 2-1/2 liters (5 pounds) per day. Additional water will be needed for sanitary purposes, such as bathing, laundering, and waste disposal. Consideration must also be given to the fact that our spacemen will probably want to shave and brush their teeth. It could become extremely important to devise a system for recycling water through the spaceman and his ship, not only to conserve the water, but to avoid the discomfort of continuous existence in an atmosphere saturated with water vapor lost through perspiration and respiration.

The food needed for a long flight will amount to at least 2,500 calories per day per man, which in terms of pure carbohydrate, protein, and fat weighs about one pound. Such concentrated food is not tolerable, however, because of its low palatability. To make it appealing, its weight must be increased to well over two pounds per day.

We do not completely understand why, but we have found in dealing with submariners that the mere provision of enough calories, bulk, vitamins and minerals, and other essentials is not enough to keep a man physically and mentally healthy. It is very important that some of these needs be supplied in the form of fresh food, that the types of foods and the cooking techniques be varied, that the diet be balanced, and that the food be as tasty as that served at home. If it is not, the crew's performance and morale will not be at their best. These food and water problems are not as pressing as the atmospheric one, but they do require attention.

RADIATION

So much work has been done to eliminate harmful radiation from the atmosphere of nuclear-powered submarines that this hazard is now of less concern than that of the other more commonplace toxins. But in the space ship, the radiation problem is not so simple, for here, the radiation to be guarded against emanates from much more powerful nuclear "engines"—the sun and stars.

In view of the fact that a space vehicle must shield its occupants from the surrounding space for them to function satisfactorily, many possibly harmful rays will be kept from entering it. Certainly, this shield will guard against ultraviolet, infrared, and soft X-rays. However, it will not keep out cosmic radiation, neutrons, and gamma rays. The hazards of these forms of radiation have not, as yet, been completely evaluated. It would appear, however, that the significant factor will be the dosage; this, in turn, is coupled with the time problem. Certainly, man can withstand small amounts of these radiations for short periods of time. The intensity of the field, and the time the ship will be in it, will determine the ultimate effects. Conventional shielding cannot, of course, be used in a space vehicle, because of its weight.

PSYCHOLOGICAL FACTORS

As they concern the submarine, the problems mentioned so far have been studied, and work is now underway aimed at their solution. So there is reason for cautious optimism that acceptable solutions will be found. But as we move on to a consideration of psychological factors, our outlook grows somewhat pessimistic. I do not mean to infer that work has not been or is not being carried out in this area, but rather that the problems are not as easily defined and the solutions are harder to come by.

For example, is it really possible for a crew to remain caged in a "steel box" for a long time without contact with the conventional world? Individuals vary widely in their ability to tolerate confinement. What is easily tolerable for a matter of hours may become annoying in a very few days and unbearable after weeks or months. How does this situation affect the leadership hierarchy? Will undesirable psychological changes occur in the crew without being recognized? It has been shown, for example, that as a result of confinement, pilots of high-flying aircraft have experienced difficulty in orienting themselves to the world and to their operational missions. Similarly, during Operation DEEPFREEZE, we found that isolation sometimes resulted in strange behavioral patterns. We do not yet understand these phenomena, but some recent work has shown that, contrary to our previous beliefs, the extrovert can in many ways stand loneliness and isolation better than the introvert (Research Reviews, April 1958). Obviously, we need to gather a lot more information on this subject to enable us to recognize desirable and undesirable traits in men assigned to the submarines and space ships of the future.

Numerous other questions are waiting to be answered, too. How does one maintain motivation and morale in the "steel cage?" How will prolonged submersion or flight affect the normal diurnal requirements of man? What about sleep, rest, and recreation? What new criteria of social acceptance will crop up in the crews? Where does fear enter the picture? How about the problem of sex and homosexuality? How will long confinement affect the crew's vigilance? What problems of display, lighting, and noise (or lack of it) need solving? At any rate, it

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is clear that as far as underwater weapons systems are concerned, we can no longer simply stuff men into them and expect top performance. Of course, the same will be true of space ships.

HUMAN ENGINEERING

Human engineering techniques have been vigorously pushed in the development of most of our newer submarines. It is believed, for example, that the methods of simplified information display that are now being designed for airplanes through the Army-Navy Instrumentation Program* can be applied to submarines as well. By means of them, answers to the questions "where am I?", "how am I doing?", and "what should I do next?" will be displayed optimally to crew members. Research on this application is now being carried out by the Office of Naval Research through Project SUBIC. Similar human-engineering effort must, of course, go into the development of manned space ships.

THE CREW

In the past, the men comprising submarine crews have been selected on a somewhat more critical basis than those making up the crews of surface ships. Now that these vessels are being designed for longer periods of submergence, even more exacting standards are being set. And in the future, when submarines are able to remain underwater indefinitely, still stiffer requirements will be established. Thus we are learning now, and will continue to learn more as time goes on, about the types of men best suited for long periods of confinement and the training and conditioning needed to enable them to perform optimally.

This knowledge will give us important leads concerning the ideal composition of, and the training and conditioning essential for, the crews of space ships. Our spacemen will have to be trained not only for the jobs they will perform, but also for living in the space ship's unusual environment. Much of this training will probably take place in simulated spaceship interiors. As part of their conditioning, prospective crews might also be required to live on special diets and to take selected drugs.

ACCELERATION AND DECELERATION

In addition to the problems described so far, with which we have already had considerable experience in the development of submarines, there are others that will be unique to the space ship. The foremost among these is posed by the acceleration and deceleration forces to which man will be subjected as he leaves and returns to Earth.

In accordance with American national philosophy and policy, it is unthinkable that we would send a man into space unless we were reasonably sure of getting him back alive. We can send him off with pretty good assurance that he will survive the acceleration forces experienced during launching, for it is believed that he can be properly positioned

*This project was originated by the Office of Naval Research and is now being supported cooperatively by ONR, the Bureau of Aeronautics, and the Army Signal Corps.

and otherwise protected against them. Also, during this stage of flight, automatic means of control can probably be provided so that he need exercise little control of the ship, himself. But upon his return, during reentry, his performance capabilities will be taxed to the utmost and must not be impaired by the deceleration forces that will exist. Devising ways of protecting the spaceman from these forces is the most critical problem of immediate concern to us. Until it is solved it is evident that man cannot venture into space.

ENVIRONMENTAL TEMPERATURES

Another new obstacle we shall encounter in developing space ships is keeping the "cabin" temperature at an optimum level for man. In theory, this does not appear to be an overwhelming task. After all, we have had experience already in air-conditioning many types of vehicles. But in practice, we will run into trouble, because the precise environmental conditions are not known, and because the weight, bulk, and power requirements are formidable. The magnitude of the problem is apparent when one considers that extreme temperatures will probably be encountered during the escape and reentry of the ship, and that even if these extremes are survivable, the ambient temperature within the vehicle must be kept at 70° F, plus or minus 10°, during the "cruising" part of the voyage to assure that the crew will be performing at its best.

WASTE DISPOSAL

Unique also to space ships is the problem of waste disposal. This requires consideration for flights lasting only six hours, and it becomes critical when we contemplate long flights. The ideal solution would be to recycle the wastes in such a way that some benefit could be derived from them. As yet, however, ways have not been devised for doing this.

WEIGHTLESSNESS

The prospect of space flight brings us to grips for the first time, also, with the problem of weightlessness. It is believed that man can tolerate the no-gravity state for brief periods. But can he tolerate it for days, weeks, or months? What effect will it have on circulation, digestion, orientation, performance, and equilibrium? In any event, weightlessness is unnatural for man and must be eliminated from his environment if he is to perform at his best. There are several possible techniques for doing this. The best one seems to be to provide an artificial gravity medium through centrifugation. It is quite likely that only a fraction of the terrestrial g force need be supplied to enable man to perform his tasks; in fact, this fractional g force may permit him to work far better than he does normally, because his metabolic requirement will be lower as his energies are employed. However, this last is speculation and must be studied before the facts are known.

These, then, are the major barriers to manned space flight. There are many smaller ones, of course, and it is likely that our advancing technology will uncover others, now unknown.

The individual and collective magnitude of these obstacles makes it very clear that if we hope to get a man into space in the reasonably near future (or ever), we must pursue a vigorous program of research in the field of bio-medicine. Certainly, the Navy is well equipped to shoulder a large share of this burden. Through its extensive aero-medical studies and its research on man's requirements in submarines it has built up a large back-log of knowledge on the reactions of men living and working in confined spaces. The value of this knowledge lies in the fact that it is applicable not only to the closed-space environments of aircraft and submarines, but also to all other such environments, whether they be those of tanks, bomb shelters, or space ships. As a result of having gained this broad experience, the Navy now holds a lead among the Services in the study of the problems posed by man as he ventures forth on the new space frontier.

Texas A & M Research Ship Cruises Caribbean

On May 12, the Department of Oceanography and Meteorology of Texas A & M College dispatched its research vessel HIDALGO on a seven-week voyage into the northern Caribbean, the region of the Antilles Current, and the southern portion of the Gulf Stream system. The expedition, under the direction of Dr. Hugh J. McLellan, Texas A & M oceanographer, is being made as part of the IGY program in oceanography.

About 90 hydrographic stations will be occupied, and observations will be made as close to the bottom as practical. Each sample from several depths will be analyzed for temperature, salinity, dissolved oxygen, pH, alkalinity, inorganic and total phosphorus, nitrate, and nitrite. Some calcium and boron determinations will be made also.

While the ship is underway, continuous measurements will be made of temperature, electrical conductivity, dissolved oxygen, CO_2 partial pressure in the surface waters, and CO_2 in the air at different levels. Routine bathythermograph and weather observations will be made on an hourly schedule. Other observations will be conducted at selected stations. These include measurements of vertical profiles of CO_2 partial pressure in the upper 100 meters of the ocean, sampling of water from various depths for trace-metal analysis, and sampling of large quantities of water from great depths for C-14 age determination (organic and inorganic carbon).

In addition to these studies, which are fundamentally the same as those being made by other ships involved in the IGY program, an attempt will be made to obtain precise gravity measurements continuously during the voyage. For this purpose, a new gravity meter, called a La Coste-Romberg, will be used. Unlike conventional gravity meters, it is believed capable of reliable operation in a ship underway, at least in moderate seas. If the technique is successful, it should open up new horizons in geophysical research. This phase of the scientific investigation is being sponsored by the Office of Naval Research.

The HIDALGO is a 136-foot twin-screw wooden-hulled vessel which was built in 1944 as a P.C.S. for the Navy. She has accommodations for a crew of eight and a scientific party of as many as 12. The ship is well suited for work in southern waters because it is air-conditioned throughout.

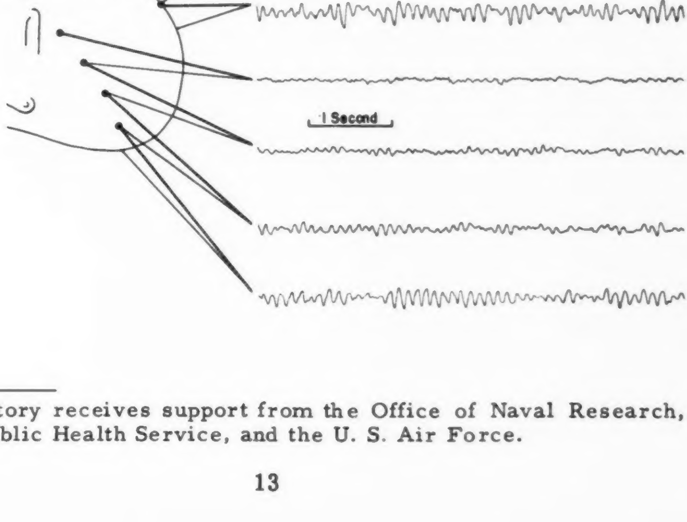
The Exploration of Correlation Analysis in the Study of Brain Mechanisms

Neurophysiological Laboratory*
Massachusetts General Hospital

Much of our present knowledge of how the infinitely complex nervous system carries out its role of communication and coordination has been accumulated from the study of the electrical changes associated with nerve action. Discrete recordings can be made directly from exposed nerves or individual nerve fibers or cells. For the most part such work is confined to experimental animals. The technique of electroencephalography, however, provides a means for collecting electrical data through the intact skulls of both animals and man. The electroencephalogram (EEG) is essentially a voltage-time graph of electrical activity of the brain, recorded from electrodes placed at various points on the scalp. (Figure 1.)

Unlike the peripheral nerves, which are either in a resting state or are conducting impulses set up by specific stimuli, the brain is in a state of continuous electrical activity. Superimposed upon and altering this persistent background activity are electrical changes evoked by sensory stimuli which bombard the brain constantly. The EEG, therefore, shows continuous fluctuating potentials at the surface of the head. The waveform recorded is a complex composed of waves of many

Figure 1 - EEG of a normal adult (awake).



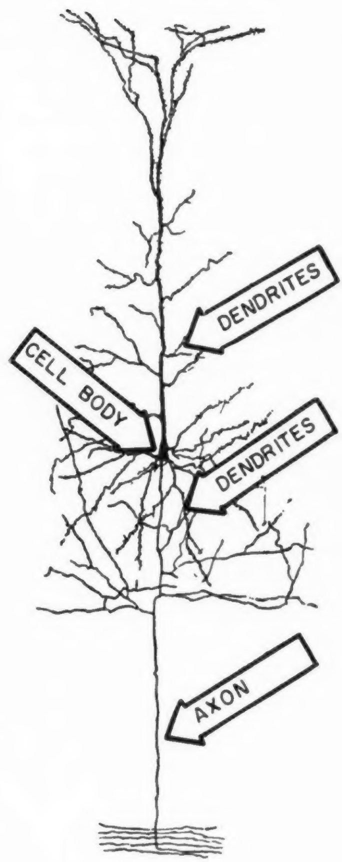
*The Laboratory receives support from the Office of Naval Research, the U. S. Public Health Service, and the U. S. Air Force.

Structure and Electrical Activity of the Nerv

As background for the discussion of correlation analysis appearing on these pages, a brief review is given here of the structure of the nervous system and the electrical component of its activity.

The primary unit of the nervous system is the nerve cell, or neuron. This cell is composed of three main parts: The cell body with its nucleus; the dendrites, finely branched processes whose electrical reactions modify the excitability of the cell body; and the axon, or fiber, which carries the impulse away from the cell. Axons range in length from several micra (1 micron = 1/1000 of a mm.) to 1 meter or more in some peripheral nerves, and in diameter from 1 to 20 micra. A motor nerve consists of bundles of axons, a medium sized one being comprised of several hundred strands.

The brain is constructed of many thousands of millions of neurons, each interconnecting by means of its dendrites and axons with hundreds of others. Great concentrations of cell bodies occur on the outer surface of the brain, known as the cortex, and in certain other brain centers. (The accompanying figure shows a neuron from the cerebral cortex.) These are referred to as "grey matter" because of the grey appearance of the cell bodies and their dendrites. In contrast, the underlying interconnecting bundles of fibers appear white because most individual axons are covered with white fatty sheaths.



Neuron from the cerebral cortex. The dendrites of this pyramidal neuron are unique to the nervous system in that they are of unusual length and are oriented toward the surface. There is mounting evidence that fluctuations in the potentials of these dendrites form the substratum of the electroencephalogram.

Information arrives at the brain from the external environment by means of impulses which are passed from the sense receptors along sensory nerves either directly to the brain or via the spinal cord. In reverse sequence, impulses pass from the brain and spinal cord to motor nerves and ultimately to the muscles and glands to provide appropriate adjustment to the environment.

of the Nervous System

When either a natural stimulus (one transmitted through a sense receptor) or an artificial stimulus (one transmitted by mechanical, thermal, chemical, or electrical means) reaches a nerve, the nerve, being irritable, reacts. In an inactive nerve there is a resting potential difference of about 50 millivolts between the inside and outside of the fiber membrane (the outside positive to the inside). An applied stimulus upsets this resting equilibrium and produces a wave of activity in the nerve. This wave, which moves rapidly along the fiber, is accompanied by a change in potential. The impulse is not, however, an electric current running straight down the nerve as though it were a conducting wire. The energy for the transmission of the impulse comes from the nerve fiber itself and not from the stimulus. Nervous conduction never takes place without this electrical change, which shows essentially the same characteristics in both sensory and motor nerves. During activity, the change in potential difference across the membrane is about 100 millivolts (therefore, it is greater than the resting potential) but lasts for only a few thousandths of a second. The speed with which the impulse travels can be very fast, depending upon the particular nerve (about 200 miles an hour in some nerves in man), the exact speed being related to the diameter of the fiber involved. In very fine fibers, conduction velocity may be as low as 2 meters per second.

The physico-chemical processes behind the maintenance of the resting potential and the production of the action potential are still not established beyond dispute, but there is little doubt that there is only one kind of propagated nerve impulse and that this is universal to the nervous system. The conduction of this nerve impulse is the principal function of the nerve fibers.

frequencies with shifting phase relationships and varying amplitudes. On general inspection of normal records, two apparently rhythmical components are seen (identified as alpha and beta rhythms), usually relating to certain areas of the cortex. Many theories have been set forth to explain how brain cells are able to exhibit rhythmically fluctuating potentials rather than discharge of a random nature, and a better understanding of this phenomenon is one of the objectives of electroencephalographic research.

There are considerable differences in EEG from person to person, but under standard conditions of relaxation and wakefulness there is little variation in that of a normal adult either from hour to hour or over a period of several months. It is this fact which has led workers to feel that the EEG is a reasonably constant measure of basic physiological importance. It should be emphasized, however, that even the resting EEG is not free of incoming sensory stimuli, so it too is a composite record. Figures 2, 3, and 4 illustrate the sorts of variations which appear in EEG tracings under different conditions. It may be seen that a clear relationship exists between EEG changes and different levels of consciousness.

The technique of electroencephalography was first applied to the human brain in 1924, but really significant progress has come about only in the past 25 years with the development of adequate means of amplification of small potentials. Recorded through the unshaved scalp, these potentials commonly show a difference between leads of only about 50 millionths of a volt; for such differences to be detected, the voltages have to be amplified as many as 10 million times. The problem of eliminating or reducing competing "noise" from extraneous potentials, such as those of the skin and bimetallic contacts, had also to be resolved. Once adequate records were obtainable, attention shifted to the further complication of sorting out and interpreting the various components contained in a single EEG tracing. Visual inspection yields some information; for example, the approximate frequency characteristics of brain potentials have been established in this way. More recently, automatic frequency analyzers have been designed which assess over a limited time (usually 10 seconds) the relative amounts of activity present at each of a number of frequencies (between 1.5 and 30 cycles per second).

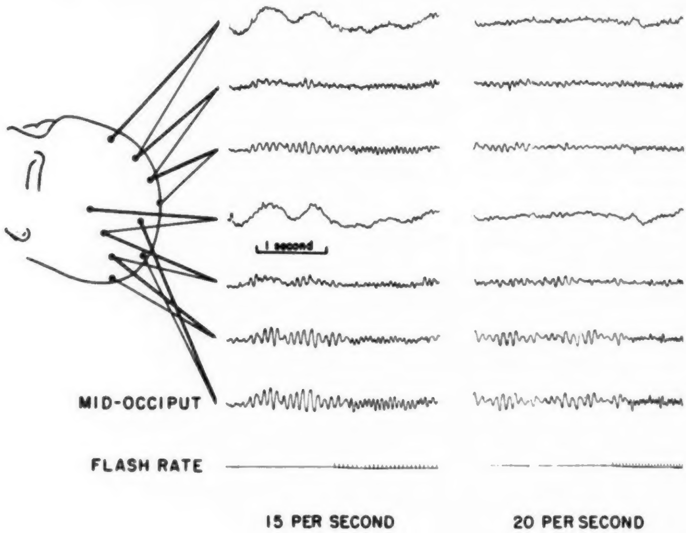


Figure 2 - Effect of repetitive visual stimuli on EEG.

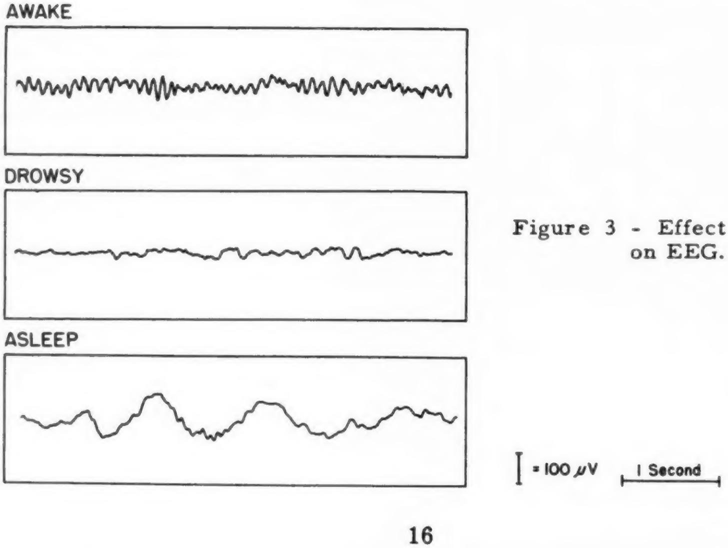


Figure 3 - Effect of sleep on EEG.

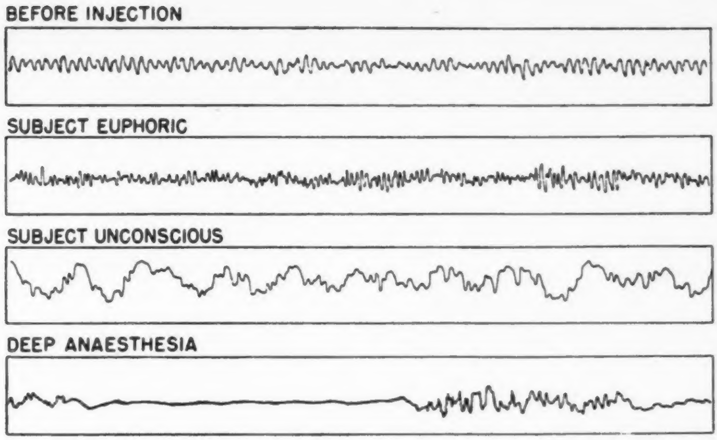


Figure 4 - Effects of barbiturate anaesthesia on EEG.

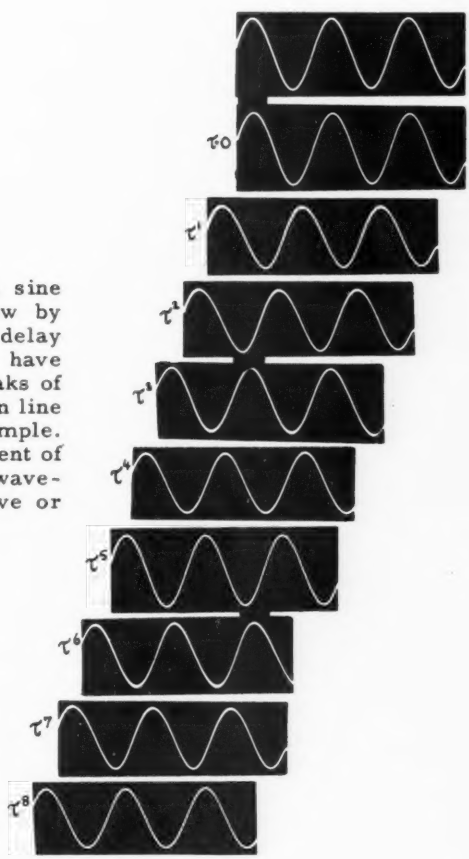


Figure 5 - Diagram of a sine wave (top) displaced below by nine different values of delay time (τ). Black marks have been placed above the peaks of waves which are directly in line with waves of the top sample. The amount of displacement of these waves is equal to the wave-length of the original wave or multiples of it.

Because it seemed evident that current methods for studying EEGs were capable of yielding only incomplete information, the Neurophysiological Laboratory of the Massachusetts General Hospital began, in 1950, to explore new ways of analyzing the records. In some preliminary pilot work done in collaboration with the Research Laboratory of Electronics* at the Massachusetts Institute of Technology, a digital system of correlation analysis was investigated. More recent work has relied very heavily on an analog correlator built by that Laboratory, whose cooperation has been an important feature of this work.

CORRELATION THEORY AND ANALYSIS

Since the electroencephalogram is a continuous graph of amplitude (voltage) against time, it comes under the category of phenomena that are called time series. Previous approaches to the analysis of EEGs have been made in what may be called the "frequency domain"; that is, attention was directed to the fluctuations per unit time. Correlation analysis, on the other hand, places emphasis on the "time domain." Briefly, it is a method of comparing a given time series with itself (autocorrelation) or with another time series (crosscorrelation) displaced by successive time lags or delays. The principle can be demonstrated graphically in simple form by illustrating a sine wave displaced progressively through a series of time intervals and observing the periods at which it shows high correlation with itself (see Figure 5). High correlation will exist even where the repetitive activity (the biological "signal") is of considerably lower amplitude than the competing activity (brain "noise").

Correlation analysis is computed mathematically by solving a correlation equation** for each delay time at which two time series are compared with each other (or the same series with itself). The correlogram or written record resulting from this comparison consists of successive pen excursions which indicate by their relative lengths the value for each computation of the correlation equation at successively increasing steps of delay. Autocorrelations of three EEGs are shown in Figure 6. The peaks indicate points of positive correlation; the valleys, points of negative correlation. The time between points of high correlation can be readily determined. Maximum correlation, of course, is at zero delay.

*This Laboratory is supported in part by the Office of Naval Research, the U. S. Army Signal Corps, and the Development and Research Command of the U. S. Air Force.

**Correlation equation:

$$\phi(\tau) = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{+T} f(t)\, g(t+\tau)\, dt$$

where $f(t)$ and $g(t)$ are two time series, $g(t)$ displaced with respect to $f(t)$ by delay τ. 2T is the interval of observation (or length of EEG sample). The equation becomes increasingly accurate as 2T approaches infinity.

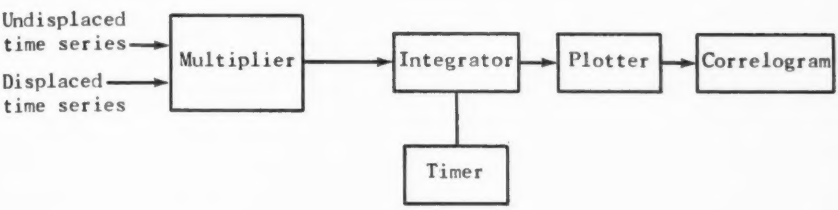
Correlation analysis is feasible, of course, only when the necessary calculations can be carried out automatically. Hence the instrumentation for this approach to the study of EEGs was most important.

THE CORRELATOR SYSTEM

A correlation system of the analog type has been specifically designed in collaboration with our colleagues at the Massachusetts Institute of Technology for the automatic computation of correlation functions of brain potentials. The electrophysiological phenomena are recorded on magnetic tape, and correlation analysis is performed during repeated playbacks of the tape. The following block diagrams illustrate the correlator system and the correlator itself.

Block Diagram of Correlator System:

Block Diagram of Correlator:



A specific problem in the design of this whole system has been the low frequency band within which the EEG lies (for the most part below 35 cps). The applications of similar techniques in communication engineering are usually concerned with much higher frequencies (principally in the audio and supersonic range); hence, considerable modifications have had to be made to suit the purposes of the correlator system. Frequency multiplication to bring the EEG into the frequency band of the computer is achieved by playing the tape into the delay stage of the analyzing system at several times the original speed of recording. Were we not to speed the playback we would be restricted to a maximum delay time of 185 milliseconds and a total sample time of 50 seconds. When we first started this work we expected to find regularly recurring phenomena only within extremely short stretches of the record. This expectation was based on our visual inspections of the alpha rhythm in the EEG traces. However, a few preliminary correlograms showed hidden periodicities of long persistence; hence, we had to develop our instrumentation so that delays of the order of several seconds could be introduced. By speeding up the playback of the recording fivefold, the maximum delay time obtained is 925 milliseconds for the delay and 250 seconds for the sample. Clearly, higher multiples of playback speed give us even greater ranges.

The entire process of correlating a given time series with itself or another series for a predetermined number of successive delays has been arranged so that it is automatic, the magnetic tapes recycling again and again until the maximum delay is reached.

CORRELATION ANALYSIS OF ELECTROENCEPHALOGRAMS

Our goal in applying correlation theories to the analysis of EEGs was to devise a system for distinguishing three possible levels of activity in the brain:

- An underlying periodic activity which might be called the "intrinsic electrical activity of the brain." This activity might be regarded as representing the homeostatic (stabilizing) interplay of brain stem and cortex in the awake brain, reflecting excitability levels.

- Activity brought about by transient sensory stimuli. This consists of rhythms which are not independent of impinging sensory stimuli but are in fact altered so that future samples cannot be extrapolated from the past.

- Activity evoked by controlled sensory stimuli. Distinguishing this level of activity calls for the somewhat artificial isolation by laboratory techniques of the effect of a sensory stimulus (such as light) directed overwhelmingly at a chosen sensory receptor.

These three objectives are being pursued by means of auto- and crosscorrelation; the first particularly by autocorrelation, the second by both auto- and crosscorrelation, and the last by a special form of crosscorrelation.

Autocorrelation seeks information about the EEG voltage-time series throughout the whole length of a given sample. It seeks to find whether any amplitude fluctuations occurring in the EEG are related in any consistent way to those that have come before—even at long intervals before. This question is important for it seems highly unlikely that in the brain the electrical signs, and the nervous activity causing them, are random in character. The EEG, on visual inspection alone, appears to have statistical properties characteristic of a stationary time series. In the simplest possible terms, autocorrelation is a method for comparing an electroencephalogram with itself displaced in time. If there is a repetitive event present in the EEG, the correlation of the EEG with itself will be strongly positive when it lags by a delay time equal to the repeating period of this event and at all multiples of this. At all other delay times the correlation will be less than maximal.

Crosscorrelation is an extension of the concept and principle of autocorrelation. It consists of comparing two simultaneously occurring EEG traces (that is, from different points on the cortex) with each other. Any event in one trace that has a time-locked relationship to an event in the other trace will reveal itself by the high value for correlation between them. In this way not only synchronously occurring events can be detected, but also those in which a neuronal discharge in one location travels by nerve pathways to the other location. From the values of

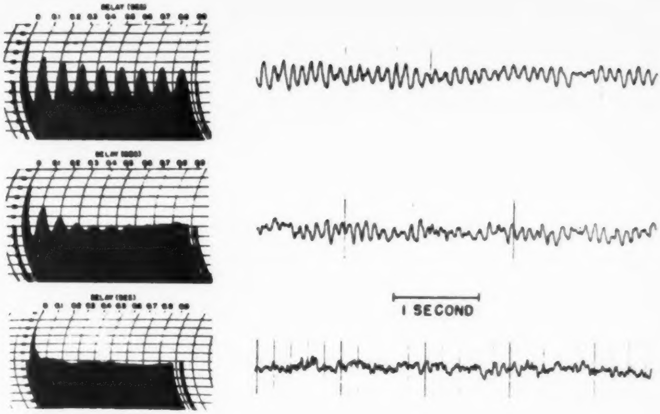


Figure 6 - Autocorrelations of one-minute samples of the EEGs of three human subjects recorded from bipolar electrodes (right parietal to right occipital) of the scalp.

the delay time at which maximum positive correlation occurs, the difference in time of the electrical events in the two places can be found, and hence the neuronal conduction time between the two points can be calculated. If the one is merely the electrical field of the other, they will have exact synchrony and correlate maximally at zero delay time.

Evoked Response Detection, a further application of the principle of crosscorrelation, enables the separation of responses evoked by sensory stimulation from the background EEG activity. It is well known that a stimulus applied to the sense receptors or to peripheral sensory nerves evokes an electrical response that can be recorded at the cortex under certain circumstances. One of the most important of these

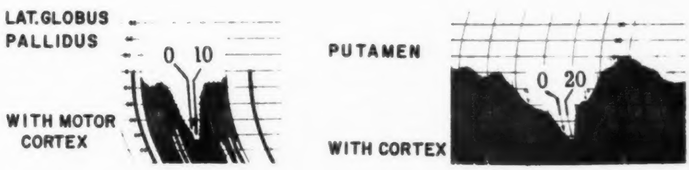


Figure 7 - The two correlograms above were obtained by crosscorrelating electrical events in the motor cortex of the brain with the activity in each of two cell masses of the basal ganglia (a portion of the forebrain lying just below the cortex). Simultaneous electrical activity of two structures being compared would be indicated by a maximum correlation at 0 milliseconds.

In the diagram at left, maximum correlation between the cortex and the globus pallidus (one of the basal ganglia) occurs at 10 milliseconds, indicating that activity in the cortex precedes, on the average, that in the globus pallidus by 10 milliseconds.

In the diagram at right, maximum correlation between cortex and putamen (another of the basal ganglia) occurs at 20 milliseconds, indicating that the cortex is active 20 milliseconds before the putamen.

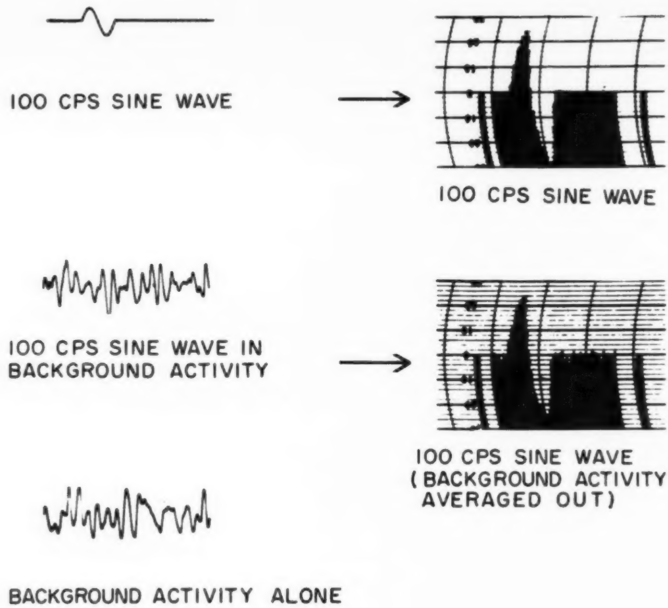


Figure 8 - Detection of a simulated evoked response by electronic averaging. Single responses are shown on the left, averaged responses on the right. The simulated response is a single cycle of a 100 cps sine wave with a repetition rate of five per second. The background activity consists of randomly fluctuating potentials with a frequency range of from 20 to 400 cps.

circumstances is that the relative amplitudes of the evoked potential and the background activity are not such that the former is hidden in the latter. In other words, it is a problem of signal-to-noise ratio, the "signal" in our case being the specific response to the stimulus, and the "noise" being the continuous brain activity. The method for this application consists of crosscorrelating brain potentials recorded during stimulation with an electric signal from the stimulus itself, so that only those potentials that have fixed time relationships to the stimulus are preserved in the analysis. All those that are unrelated (that is, not time-locked) to the stimulus are rejected. The circuits for this method are designed so that they not only detect the evoked response, but also reproduce and preserve its wave form. This is essentially an automatic averaging procedure.

Examples of these three types of analysis are illustrated in Figures 6, 7, and 8. Figure 6 shows autocorrelations of three normal subjects. In the top example there is a strikingly stable oscillation persisting without phase change for a considerable time; in the lower one almost no periodic activity is evident; an intermediate example is shown in the middle. To date, too few of the third type of EEG have been recorded to shed any light on the question of whether or not there is in these cases an underlying but severely attenuated rhythm at about 10 per second. Figure 7 shows the application of crosscorrelation to determine the time relationship between electrical events in adjacent structures. Figure 8 is a "mock-up" to illustrate evoked response detection. It may be seen that the wave form is reproduced in this type of analysis.

The application of correlation analysis to the study of electroencephalograms is now being carried out in the clinical setting on human subjects and in the laboratory with experimental animals. Although it is premature at this point to draw extensive conclusions, the data processed thus far indicate that the continuous underlying electrical activity in the brain is remarkably similar to a stable oscillator, both in phase and frequency characteristics. Whether this stable oscillation can be recorded from all individuals, thus providing "thumbprints" of each, remains for exploration. However, the fact that this activity can now be recorded separately from transient electrical activity of the brain suggests many lines of research. There is the possibility that this component of the brain's activity may reflect abnormalities in certain neurological diseases which yield an apparent "normal" alpha rhythm by standard techniques of analysis. A stable oscillation of potential suggests some kind of homeostatic (or stabilizing) mechanism, and future studies of diseases in which there is evidence for a homeostatic balance having been established at an abnormal level (such as drug addiction, alcoholic addiction, and some types of schizophrenia) may reveal some abnormality of this mechanism.

Dr. Suits Elected Chairman of NRAC

Dr. C. Guy Suits, President, General Electric Research Laboratories, has been elected Chairman of the Naval Research Advisory Committee (see Research Reviews, September 1957). He succeeds Dr. Frederick E. Terman, Dean and Director of the Electronic Research Laboratory, Stanford University. Elected Vice-Chairman was Dr. Frederick Seitz, Chairman, Department of Physics, University of Illinois. He assumes the Vice-Chairmanship previously held by Dr. Suits.

NRAC is the Navy Department's senior research advisory group. It advises the Secretary of the Navy, the Chief of Naval Operations, and the Chief of Naval Research with respect to research and its utilization by the Navy. The Committee considers questions of policy on Navy-wide scientific problems.

The members, all preeminent in science, include Dr. A. V. Astin, Director, National Bureau of Standards; Dr. R. F. Bacher, Chairman, Department of Physics, California Institute of Technology; and Mr. E. H. Heinemann, Chief Engineer, Douglas Aircraft Corp. The Massachusetts Institute of Technology has two members: Dr. J. A. Stratton, Chancellor, and Dr. J. C. Hunsaker, Department of Aeronautical Engineering. Other members are Dr. M. J. Kelly, President, Bell Telephone Laboratories, Inc.; Dr. R. A. Kern, Temple University Hospital, Philadelphia; Dr. A. B. Kinzel, Vice President for Research, Union Carbide Corp.; and Dr. E. R. Piore, Director of Research, International Business Machines Corp. Completing the list of members are Dr. I. I. Rabi, Department of Physics, Columbia University; RADM E. H. Smith, USCG (Ret); and Dr. E. A. Walker, President, Pennsylvania State University.

A 1,000-year-old Eskimo house is excavated at Birnirk, an old village located two miles from ONR's Arctic Research Laboratory at Point Barrow, Alaska.

Anthropology and the Navy

Joan Criswell
Group Psychology Branch
Office of Naval Research

One of the striking characteristics of the U. S. Navy is its need—in time of peace as well as in time of war—to roam the far corners of the earth. As a result of it, the Navy has been put in close contact with many different peoples of many different cultures. Important, of course, to the success of its relationships with these peoples is the understanding it has for them. This need to understand the ways of life of such a broad spectrum of humanity has given the Navy a special interest in the field of anthropology.

One of the first anthropological programs in which the Navy engaged was the Cross-Cultural Survey, started by Yale's Institute of Human Relations in 1937. The purpose of the Survey was to assemble, classify, and make readily accessible information on cultures all over the world. By 1943, data on 150 peoples had been collected. At that time, attention was being devoted particularly to building a body of information on the Pacific islands held by Japan. The Navy entered the program in 1943, when it asked the Institute to expand its work in this area. Accordingly, the staff was enlarged to set up files on Micronesia, the Ryukyus, Formosa, the Kuriles, Izus, and Bonins. On the basis of this work, which continued into 1944, a number of handbooks were prepared for the use of civil administrators. Among the topics considered were native methods of obtaining water on islands having no fresh-water streams, incidence of diseases, property rights, and social structures.

From 1946 to 1949, after taking over the administration of the Trust Territory in the Pacific, the Navy operated the School of Naval Administration at Stanford University and at Monterey, California, with the assistance of an anthropological consultant, Felix Keesing. Naval officers were trained at this school for administering the Trust Territory. The instruction prepared them for dealing with economic and social problems, with emphasis on cross-cultural situations likely to be encountered.

In December 1946, the Pacific Science Board was organized by the National Research Council to assist American scientists and to provide scientific information to government and other agencies concerned with the Pacific area. The first field program was called the Coordinated Investigation of Micronesian Anthropology (CIMA). Under its auspices, beginning in 1947, a number of scientists including 35 anthropologists were supported in research projects in the Marshalls, Carolinas, and Marianas. This work was supported by the Geography Branch of the Earth Sciences Division of ONR. Although the anthropologists were free to choose their own research topics, the resulting knowledge of island culture was of great value to the Trust Territory administrators in their attempts to rehabilitate natives having different customs, languages, and socio-economic structures. Support of this work was discontinued in 1951 when the Navy turned over the administration of the Trust Territory to the Department of the Interior.

The successor to CIMA was the Scientific Investigation of Micronesia (SIM), which included not only work in anthropology, but also in botany, forestry, geography, geology, zoology, and ecology. Several ecological studies supported by the Geography Branch were made of coral atolls, beginning in 1950. During the early years of this program a few anthropologists participated in the work.

The Geography Branch has also supported anthropological research in the Arctic. This was done as part of an investigation of the ecology of the region around ONR's Arctic Research Laboratory at Point Barrow. The social behavior of two groups of Eskimo was compared, one living on the coast at Point Barrow and the other, a nomadic tribe, based at Anaktuvuk Pass in the Brooks Range. A major point of interest in the study of the Eskimo near Point Barrow was his employment at the Naval Petroleum Reserve IV base. This had accustomed him to a much more "civilized" standard of living than he had had before the base was established. It was feared that the natives would not be able to support themselves when employment by the Navy might cease. The investigators' conclusion, reached in 1953, was that enough of the original culture remained intact so that the transition could be made successfully. This study is still being written up, at present under the auspices of the Smithsonian Institution.

ONR has also supported anthropology through its psychological sciences program. In 1946, when ONR began financing research in the social sciences, a nine-member Advisory Panel on Human Relations was appointed to assist in planning the studies. Members were drawn mainly from the field of psychology but also from anthropology, economics, political science, sociology, and psychiatry. Ruth Benedict represented anthropology on the Panel. It was planned that anthropological research would be made in two areas—psychological warfare and peoples in areas of military importance. At that time, the Psychological Sciences Division was known as the Human Resources Division, and the branch having cognizance over research in social science was called the Human Relations and Morale Branch.

The first anthropological contract let by this branch was titled "Research on Contemporary Cultures." It called for an extensive study of seven different cultures—pre-Soviet Russia, China, Poland, Czechoslovakia, France, Syria, and Eastern European Jews. Information was to be gathered through representatives of these cultures living in the United States and through the literature and other cultural products of the people involved. The aim was not only to learn more about the cultures themselves, but also to develop a methodology for studying countries not directly accessible to the investigator. This project was originally under the direction of Ruth Benedict, but after her death it was carried on by Margaret Mead, who also succeeded her on the Advisory Panel on Human Relations.

On the basis of the methodological study, Margaret Mead and Rhoda Metraux wrote a book called "The Study of Culture at a Distance" (Chicago: University of Chicago Press, 1954). Another book resulting from the contract was "The People of Great Russia, A Psychological Study," by Geoffrey Gorer (London: Crosset Press, 1949). Accounts of some of the work done on the contract appear also in "Childhood in Contemporary Cultures," edited by Margaret Mead and Martha Wolfenstein (Chicago: University of Chicago Press, 1955). In addition to these books, the contract provided material for numerous articles that have appeared in journals.

From time to time, special studies were undertaken through this project for use by the Navy. One of these was a study of the relationship of Chinese Communist ideology to contemporary Chinese culture, and the impact upon Chinese culture of Soviet Russian ideology as indicated by its assimilation in utterances of top Chinese Communist leaders, in Chinese Communist documents, and in school text books and proposed school curricula. This study has been of use also to the State Department and quite recently to the Department of the Army.

The second anthropological contract supported through the psychological sciences program concerned a part of the Human Relations Area Files, under the direction of Clellan Ford. These files, started in 1949, were a sequel to the Cross-Cultural Survey. By the time the Navy began to participate in their development, duplicate files had been set up in a number of universities. In 1951, the Human Relations and Morale Branch began to support the building of a part of the file devoted to Southeast Asia and related areas. A complete set of the file cards assembled as a result of this work was installed for use in the Office of Naval Intelligence. Shortly before this contract was terminated in 1953, it was administered by the Geography Branch.

The last anthropological project supported by ONR was called "Japanese and Far Eastern Economic Structures." This investigation, made from 1951 to 1953, was directed by John Bennett. Considerable socio-economic data had been collected by Dr. Bennett during his stay in Japan as a participant in the studies made by the Supreme Commander for the Allied Powers (SCAP) from 1946 to 1950. These studies were made by the occypying nations to provide a basis for introducing various changes into the Japanese culture or for evaluating changes already effected. Although the investigation was made in order to solve immediate problems, much data relating to fundamental aspects of social behavior were gathered. ONR asked Dr. Bennett to analyze this data in order to learn more about (1) the Japanese labor-boss system, (2) the structure of the Japanese forestry industry, through which a major economic reform had been made, and (3) freedom and control in the rural family system.

In 1953, the psychological sciences program of the Office of Naval Research was reorganized, the Human Resources Division becoming the Psychological Sciences Division and the Human Relations and Morale Branch becoming the Group Psychology Branch. The latter revised its program to concentrate more on studies of small groups in a laboratory setting. The Advisory Panel on Human Relations was discontinued, and contracts concerning psychological warfare and peoples in strategic areas were no longer supported. Since that time, no anthropological contracts have been financed by ONR.

It is possible that anthropological research will again be supported by ONR, although none is planned at present. For example, the Geography Branch might again use anthropologists as members of interdisciplinary teams engaged in ecological studies. The Group Psychology Branch would also profit from more anthropological research, particularly that undertaken as a means of freeing psychological findings from cultural bias. Generalizations made in such areas as (1) leadership and (2) cooperation versus competition need to be checked for peoples having different concepts of such behavior and for peoples living in different environments. Another form of bias that needs to be investigated is that arising within the psychological laboratory, for the laboratory, like all other institutions, has its own culture. This culture needs to be studied because its influence on experimental results is not well understood. We might also study the culture of the Navy itself, for through an understanding of it we would be in a better position to apply studies of group behavior to Navy situations.

The value of anthropological investigation is evident, for the more man understands about the background and framework of reference of his fellow man, the better are his relationships with him likely to be. At the present time, however, we can only speculate on the future of anthropology in the Navy.

On the Naval Research Reserve

Training Device Seminar Held

Guided-missile training and other naval training programs were among the topics discussed recently at the Eighth Annual Training Device Seminar held from April 13th to 26th at the U. S. Naval Training Device Center, Port Washington, Long Island, New York. Thirty leading civilian scientists, engineers, executives, and science instructors, representing Naval Research Reserve groups from all parts of the United States, were called to active duty for two weeks to attend the Seminar. The purpose of the program was to help the Reservists become familiar with the scientifically designed equipments and techniques used in the training of naval personnel.

An impressive list of speakers took part. Among the visiting lecturers were RADM Chester C. Wood, USN, Commandant, Third Naval District; RADM Rawson Bennett, USN, Chief of Naval Research; RADM Luis de Florez, USNR (Ret); Mr. Ansel Talbert, Military and Aviation Editor, New York Herald Tribune; RADM L. D. Coates, USN, Assistant Chief for Research and Development, Bureau of Aeronautics; Mr. Willy Ley, space-rocket consultant and author; and RADM J. T. Hayward, USN, Assistant Chief of Naval Operations (Research and Development); CAPT John P. Aymond, USN, from the Office of Naval Research; and VADM Charles E. Rosendahl, USN (Ret).

Some of the vital subjects covered by talks given at the Seminar are indicated by these titles: "Advanced Weapons Training Equipment,"

A model of the TERRIER missile holds the attention of RADM J. T. Hayward, USN, Assistant Chief of Naval Operations (Research and Development) and CAPT E. C. Callahan, USN, Director of NTDC.

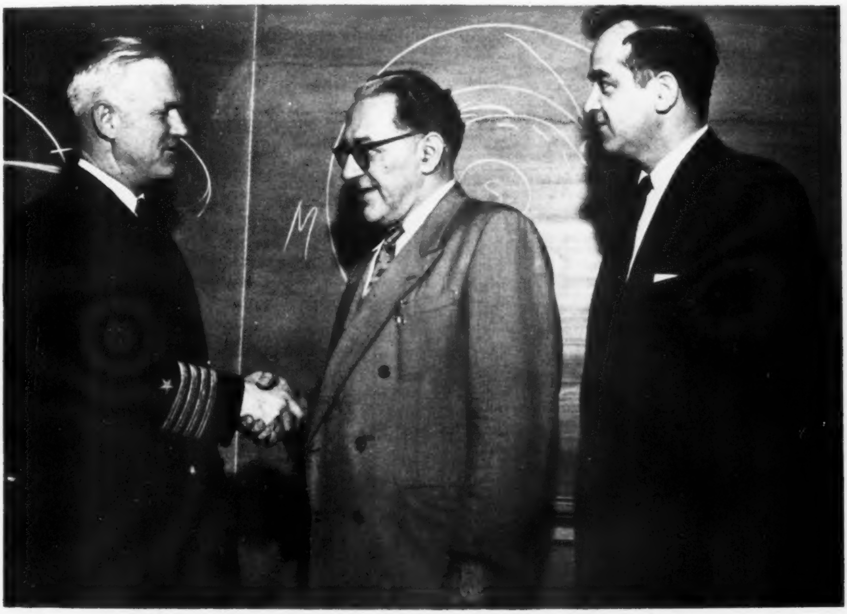
CAPT Callahan thanks Mr. Willy Ley, space-rocket consultant and author, for his talk on "Theoretical Problems of the Space Age." Mr. Joe Pecoraro, Head of the Center's Equipment Research Division, looks on.

"Naval Research and Development," "Missiles, Rockets, and Astronautics," "The Polaris Program," "Nuclear Propulsion," "Theoretical Problems of the Space Age," "Recent Developments in Naval Aviation," and "The Navy in the Nuclear Age."

In his lecture on "Theoretical Problems of the Space Age," space-expert Willy Ley stated that space-flight trainers will be needed soon to aid in the selection and training of the first men that go into space. The human centrifuge and high-speed aircraft are now available and will be used to indoctrinate individuals to high G forces and to select those who respond efficiently in a weightless environment. However, according to Willy Ley, the major trainers needed to complete the training of crews in the operation and navigation of space craft will have to wait for major policy decisions to be made on the type of hardware to be put into space.

Leading authorities on synthetic and audio-visual training equipments and methods employed by the U. S. Naval Training Device Center discussed the Center's important mission in developing training aids and devices to keep pace with the rapidly developing techniques of modern warfare.

CAPT E. C. Callahan, USN, Commanding Officer and Director of the U. S. Naval Training Device Center, summed up the purpose of the Seminar in an address to the Research Reservists. He said, "In these days of complex weapons and weapon systems, training of personnel plays an increasingly significant role. The machine is vital, but the man who operates the machine is even more important. . . .The Research Reserve will play a vital role in our country's defense in the case of mobilization, and I sincerely hope that the program we have arranged for you will add to your knowledge of the duties you may be called upon to perform, thereby contributing in some measure to the Navy's part in combat readiness.



Department of Defense Reserve Awards Presented

Two Department of Defense Reserve Awards were presented recently as a result of nominations made by members of the Research Reserve, one to an educational institution and the other to an insurance company.

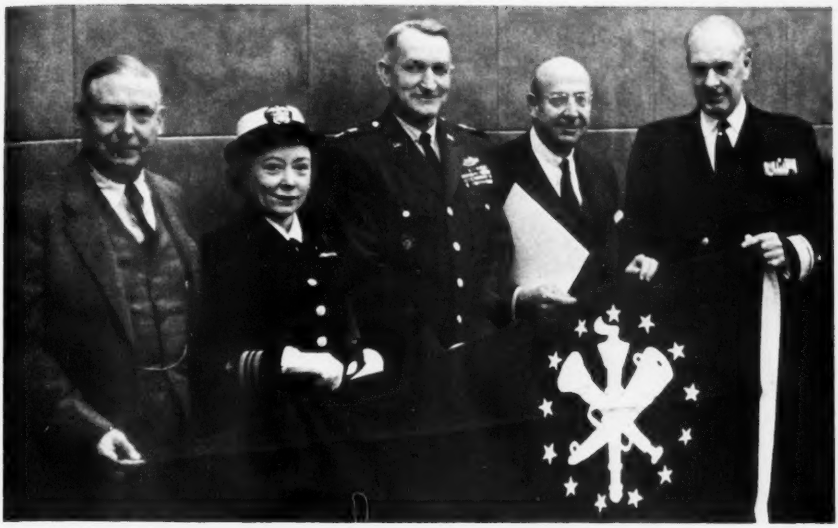
● Naval Reserve Research Company 12-7, Logan, Utah, initiated the nomination which resulted in Utah State University receiving the Award on April 18, 1958. CDR Oliver B. Cope, USNR, Commanding Officer of the company, arranged for both the nomination and the presentation.

CAPT F. B. Risser, USN, Commanding Officer, Naval Supply Depot, Clearfield, presented the award for VADM G. L. Russell, USN, Commandant of the Twelfth Naval District. The occasion was the banquet preceding the Governor's Military Ball. Dr. Daryl Chase, President of Utah State University, accepted the certificate of award and pennant. The Honorable George D. Clyde, Governor of Utah, also attended, as did officers of the Navy, Air Force, and Army.

CAPT Risser praised the encouragement and substantial aid which USU has given reserve activities over a long period of time, but particularly since World War II.

"To the credit of Utah State University is added this award, presented for the preservation of high standards of reserve performance rather than mere quantity of reserve activity," CAPT Risser declared.

CAPT F. B. Risser, USN (right) and CDR Oliver B. Cope, USNR (left) present the Department of Defense Reserve Award to Dr. Daryl Chase, president of Utah State University.



Displaying pennant presented to the Metropolitan Life Insurance Co. are (left to right) Mr. C. J. North; LCDR Elsie U. White, USNR; Major General R. E. Bell, USA; Mr. F. W. Ecker; and RADM C. C. Wood, USN.

"The facilities of USU have been available to reserve units, usually without cost, within limits of state regulations.

"The cooperation extended by the university to the armed forces has included a liberal policy for leave extended to faculty members so that they may fulfill their active duty training commitments." CAPT Risser then detailed other ways in which the institution had helped foster reserve programs.

● The Department of Defense citation for "outstanding cooperation with the Armed Forces Reserve" was conferred upon the Metropolitan Life Insurance Company by RADM Chester C. Wood, USN, Commandant of the Third Naval District.

LCDR Elsie U. White, USNR, member of Naval Reserve Research Company 3-1, New York, was the Metropolitan employee who nominated the company for the Award. Mr. Frederick W. Ecker, President of Metropolitan, accepted the Award on behalf of the company, the nation's largest life insurance company. Among others present at the ceremony were Mr. Cecil J. North, Metropolitan Executive Vice-President, and Major General Raymond E. Bell, USA, Commanding General of the Second United States Army Corps Reserve.

Another Promotion List

One hundred and three Lieutenants of the Research Reserve Program were among the 2293 officers of the Naval Reserve selected for promotion to the grade of Lieutenant Commander by the Fiscal Year 1958 line selection board which convened March 11, 1958. These officers and their Research Reserve companies are listed on the following page.

RESEARCH RESERVISTS SELECTED FOR PROMOTION:

BOULTER, Edward A.	1-1
DANA, Richard B.	1-1
HENIZE, Karl G.	1-1
MARTIN, Louis H.	1-1
RAFFI, James C.	1-1
TRENHOLME, William M.	1-1
LUDTKE, James B.	1-3
ANDERSON, Frederick A.	1-5
GROGAN, William R.	1-5
BARRY, James W.	3-2
FERRANDINO, Peter A.	3-2
STRIKER, Robert G.	3-2
HORRIGAN, Robert V.	3-3
JACOBSON, Albert H.	3-4
DESSEL, Arnold M.	3-5
MAHER, John E.	3-5
BAKER, Leonard L., Jr.	3-9
GIDEZ, Lewis I.	3-9
SCHLAFKE, Alber P., Jr.	3-9
HICKEY, Albert E., Jr.	3-12
JEFFREY, Arthur D.	3-12
REIHL, John J.	3-12
HASKELL, Arthur J.	3-13
SANDERSON, Benjamin S.	4-1
THURSTON, Robert N.	4-1
ATHERTON, Richard	4-3
BOLLINGER, Edward H.	4-7
DIPNER, Wayne E.	4-7
LEVINE, Raphael B.	4-7
BAIRD, Blake O., Jr.	4-8
TUPA, Robert C.	4-8
BROWN, John L.	4-12
SMITH, Frederick E.	4-12
KANE, John J. W.	5-8
BISSETT, Eldon B.	5-9
BUTLER, James W.	5-9
COLE, James M.	5-9
LEIPHART, John P. C.	5-9
STROUP, Eugene R.	5-9
ELLIOTT, Denton W.	5-10
FERGUSON, Don E.	6-3
HOLZ, Peter P.	6-3
PRYOR, William A.	6-3
HOWKINS, John S., Jr.	6-5
HINNERS, Arthur H., Jr.	6-12
McGRAW, William J.	6-15
FRICKS, Clyde D.	6-16
PETTERS, James R.	6-16
GRINER, Roland F.	6-17
ZAROVSKY, Jacob	6-17
GASSER, Irvin L.	8-7
HOSKING, George W.	8-7
DUNN, Theodore A.	8-9
McMILLAN, William D.	8-12
SIRNY, Robert J.	8-13
BOHAN, Walter A.	9-1
SWAGO, Andrew W.	9-2
DOOLITTLE, Robert F.	9-3
STATON, Wesley M.	9-3
TRUCKENMILLER, W. C.	9-3
SIMMERING, Lawrence F.	9-5
IBELE, Warren E.	9-6
VANPILSUM, John F.	9-6
FILLMORE, Walter J.	9-11
KNIGHT, Frederick B.	9-12
MALER, George J.	9-12
SHERMAN, Jerome K.	9-14
VLIET, Daniel H.	9-14
McDOW, John J.	9-16
FAHR, Samuel E.	9-19
BALL, Harold J.	9-22
FISCHER, Loyd K.	9-22
McFERON, Dean E.	9-23
YOUNG, Gordon E.	9-23
SHAFER, Robert L.	11-1
ELKO, Edward R.	11-2
THOMAS, Ralph L.	11-2
GOOD, Robert L.	11-3
YOUNG, David M.	11-3
PHELPS, George M.	11-4
ZEH, Richard J.	11-4
LEVY, Robert A.	11-6
WILSON, Richard W.	11-6
BROWN, Ralph H.	11-8
RUBENS, George J.	11-8
KEMPTER, Rudolph H., Jr.	11-9
McGEE, Howard A.	11-9
MORROW, Willbert J.	11-9
RYAN, James D.	11-9
FIELD, Vernon M.	12-2
KERMEEN, Robert W.	12-3
MALLORY, Kenneth B.	12-3
RICHARD, George J.	12-3
VAIS, Lawrence A.	12-3
WELSH, Luther	12-3
SELKIRK, Robert J., Jr.	12-4
CHILDS, Walter T.	12-5
COLDREN, Clarke L.	12-5
SCALISE, Dominic T.	12-5
TODD, David B.	12-5
WARREN, Jonathan R.	12-5
WEISS, Haskell	12-5
DEHOFF, Harold L.	13-6

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LAST MONTH WITH "VANGUARD"

• "At 10:46 PM EST May 27, scientists and engineers of the Navy's Project Vanguard, as announced earlier by the National Academy of Sciences, made an attempt to place another IGY satellite in orbit.

"The 72 foot Vanguard rocket appeared to function well through the firing of all three stages but still did not result in an orbit for the 20 inch sphere. When the satellite's radio signal was received by the Navy's Down Range Minitract station at Antigua, BWI, indications were that the satellite had assumed an arc-like upward attitude which prevailed as it continued downrange, and according to initial calculation, reached a peak altitude of about 2 thousand miles at its zenith and fell back to earth.

"While no orbit was achieved, the Vanguard scientific package reached a great altitude and it is expected that the large quantity of telemetry data which was received from the 20 inch sphere will provide much valuable scientific information."

The experiments which were planned for the SLV-I satellite concerned Lyman-alpha solar radiation, meteoric particles striking the sphere, and internal and external temperatures.

• One of the VANGUARD rockets that are being used by the Navy to place IGY earth satellites in orbit around the earth is now on permanent display at the Smithsonian Museum in Washington, D. C. The towering rocket, a gift to Smithsonian from the Navy Department, was presented to Dr. Leonard Carmichael, Director of the Smithsonian Institution, by RADM Rawson Bennett, Chief of Naval Research, on May 26.

In presenting the rocket, RADM Bennett said, "I believe that the display of the VANGUARD rocket sets an excellent precedent for the Smithsonian Museum, which is generally concerned with momentos of America's past technological achievement. In this case, VANGUARD, the most sophisticated vehicle for space research that America has yet produced, does not represent our past but our future. There will, of course, come a time when VANGUARD, too, will join the past and become no more than an historical milestone in the fabulous scientific progress of this nation. For the present, however, it will stand here proudly, literally pointing the way to the most ambitious goal man has yet attempted — the future conquest of space."

In This Issue

COVER PHOTO: The 50-foot human centrifuge at the Navy's Aviation Medical Acceleration Laboratory, Johnsville, Pa. The gondola and the long "arm" that whirls it around at terrific speeds, were built to study man's reactions to acceleration forces. See article beginning on page 6.

RESEARCH REVIEWS endeavors to report briefly highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. Articles which meet these broad criteria and possess a good degree of readability are welcomed. Manuscripts and changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. ... Research Reviews 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. Use of funds for printing this publication was approved by the Director of the Bureau of the Budget, February 12, 1958.