NAVAL RESEARCH REVIEWS

NOVEMBER-DECEMBER
1968

Portraits in Science

Dr. Robert Hofstadter

Dr. Hofstadter was the first to realize that Protons and Neutrons are complex bodies not point-like and elementary as previously supposed.

Under the sponsorship of the Office of Naval Research he measured sizes and distributions of electric charge and magnetic moment in the Proton and Neutron and found that each particle has one electric and one magnetic form.

The discovery of the form factors led to measuring nuclei and eventually to understanding the construction scheme of the fundamental nuclei of atoms. For his work on the Proton, Neutron and Atomic Nuclei, Hofstadter shared with Rudolph Mossbauer the 1961 Nobel Prize in Physics—

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Probing the Birthplace of American Weather

John D. Isaacs*
Scripps Institution of Oceanography

In the 1930's, a great drought turned a normally luxuriant part of the United States into what came to be known as the "Dust Bowl"; again in 1953, the southwestern part of the nation experienced a disastrous dry season; recently, an abnormal lack of rainfall in the Northeast dried up streams and ponds and seriously threatened even the supply of drinking water of many communities, while normally drier areas of the country were soaked by downpours; periodically, after intervals lasting a decade or longer, bank-to-bank floods have been known to sweep down the canyons and arroyos of the Southwest.

What factors are responsible for these phenomena? Could they be predicted?

The answers to these intriguing questions may lie in the little-understood large-scale temperature fluctuations in the surface layers of the waters of the North Pacific Ocean. It is in these vast ocean reaches that many of the features of the North American weather receive their final identity.

The centers of strongly abnormal surface-water temperatures occur most frequently in the region of 35° to 45° N and 150° W and 150° E. These "abnormal" or anomalous conditions are large in area and persist for long periods of time. They are known to be associated with changes in the propagation of underwater sound, shifts of ocean and atmospheric circulations, changes in the migration patterns of important commercial fishes, alterations in the distribution of pelagic organisms (including members of the sound-scattering layers), and with unusual weather over the North Pacific Ocean and the continental United States and perhaps the entire northern hemisphere.

The University of California's Scripps Institution of Oceanography (SIO), under contract to the Office of Naval Research, has initiated a long-term study in the North Pacific. This study is designed to understand the nature of the relationship between the large-scale sea-surface temperature anomalies, and the subsurface events, and both of these as they relate to meteorological events in the atmosphere.

Data now available from the North Pacific indicates that:

• The departure of the sea-surface temperature from the normal is the rule rather than the exception.

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• The average dimension of the temperature anomaly is about one fifth of the width of the North Pacific Ocean. Larger anomalies frequently occupy one third to one half or more of the North Pacific.

• Large-scale anomalies usually persist for longer than three months and sometimes as long as 30 months.

• Anomalous areas often appear to progress from west to east over a period of two to three years at an apparent speed of about 200 miles per month (or seven miles per day).

• The intensities of the warm and cold sea-surface temperature anomalies range as high as 10° to 12°F. Cold anomalies tend to be less intense than the warm ones. As an example, in the central North Pacific, anomalous temperatures less than 3.5°F are more often cold than warm, whereas warm anomalies are more frequent than cold ones for temperature differences above 3.5°F.

• The monthly mean temperature gradient, that is, the mean spacing between isotherms, is most closely associated with the gradient of the more intense anomalies. In other words, the areas that display the greatest departure from normal temperatures surprisingly show the most slavish adherence to the long-term mean temperature gradients.

• Warm anomalies may be the result of shallow stability, whereas cold anomalies may be the result of mixing. There is thus an anisotropy of heating and cooling processes. By a suitable succession of events, an anomalously warm layer can form on an anomalously cool one and the conditions can persist for months, with the cold water eventually reappearing at the surface.

• The normal seasonal temperature changes of the central North Pacific very closely follow the apparent north-south seasonal solar cycle.

The records of the weather of the Pacific Coast reveal almost continuous fluctuations since their inception. Variations in the temperatures at such coastal stations were long thought to be very local effects, but in the last decade or so they have been shown to be correlated over dimensions of 1000 km or more. Further, some years ago, it was noted that the more extreme departures from the mean ocean temperatures were roughly synchronous at such widely-separated regions as Peru, Japan and California. These extreme fluctuations were sometimes in the same sense and sometimes in the inverse sense; that is, the intensity was correlated, but not the phase. Considered as a correlation of widely separated local changes, these were thought to be cases of teleconnection. However, it now appears that these correlations are very often simply an expression of the great spatial extent of the ocean-atmosphere variations.

Perhaps a brief review of the case history of a well-studied variation in the Pacific will bring some of these matters into focus. The mean sea-surface temperature over the North Pacific during the years 1955 to 1958 underwent an intense change. During this period a great warm anomaly appeared to progress across the Pacific from Japan to the west coast of North America. This was associated with at least two periods of highly anomalous surface-wind patterns. In the winter seasons of 1956-57 and 1957-58 anomalous low-pressure areas were centered roughly over the warm surface waters. Qualitatively this should have the effect of propagating and intensifying the warm anomaly toward the north and east, by advection and simple thermal exchange at least. The 1957-58 winter season was typified by an intense development of a low pressure area over the eastern North Pacific. The effects of these anomalous southerly winds off the Pacific coast were marked. The southerly-directed California Current weakened and swung offshore, warm subtropical water invaded the coast as far as British Columbia, and Central Pacific water moved strongly to the east. In this change abnormal advection from abnormal winds has been implicated. Indeed, it appears that simple advection is partially successful in explaining these events and several scientists have developed and tested a series of increasingly sophisticated weather models based on this process.

In order to understand better the nature of the fluctuations in weather, it is necessary to know and to relate the weather behavior in the past to the known characteristics of today.

Scientists at Scripps have been accumulating much of the continuous and fragmentary data on the Pacific Coast conditions. This data consists of Spanish mission rainfall records, observations contained in whalers' logs, logs of Spanish galleons, letters of pioneers, *etc.* Data showing years when snow fell on the southern California and Mexican offshore islands, years of floods and displacements of tropical or northern fauna may eventually be fitted into a more thorough knowledge of the climatic variations in the Pacific and their etiology. Little-known expeditions to the Pacific have provided some very useful information. The logs of the Malaspina expeditions of 1786-94, which have long languished in Spanish archives, will soon be examined. These remarkable documents, which contain hundreds of excellent large color drawings of marine and terrestrial animals and plants, are a treasure trove of information. More ancient data has been gleaned from observations of what are the remnants of social habits of the inhabitants of Pacific coasts. Studies of the kitchen middens of coastal Indians have shown that the winds and currents must, in general, now be of the same nature as for the last four or more millennia.

At Scripps another and inexhaustive source of data on past variations in the Pacific is being developed. These are the rare and curious varved sediments laid down in certain coastal basins extending from British Columbia to Peru. These sediments are deposited at depths under water that is essentially devoid of oxygen. The sediments are not reworked by either currents or benthic organisms and are preserved as layers representing the annual fall of detritus from the overlying waters. These sediments, therefore, are virtually annual pages in the history book of the ocean-atmosphere system, that provide an extremely valuable entree into an understanding of the nature of oceanic fluctuations of the past, the frequency, the nature of the changing circulation, the relationships with rainfall, and the synchrony of changes between widely-separated areas. To decipher the message, we must know the range of distribution of the organisms whose remains contribute to the sediments. For example, the presence of a subarctic pteropod, the microscopic pelagic mollusc *Limacina helicina,* in the sediments of the Santa Barbara Basin must be a measure of the strength of the California Current.

Diatoms and foraminifera are also being tabulated. The results should give a great insight into the history and conditions of short- and long-term fluctuations in the Pacific, extending through the historical period for several thousand years before the present with a high time resolution. An attempt will be made to correlate this data with that of other basins and also with data from glaciers, tree rings, the historical record and other sources. Just the qualitative correlations of this pteropod data with known climatic change is intriguing. For example, periods of glacial advance in British Columbia appear to be associated with rapidly increasing numbers of *Limacina* and presumably with increasing strength in the California Current.

The information gathered this way, intriguing as it may be, is often empirical in nature and difficult to quantify; it gives only a vague insight into the nature of the sea-surface temperature anomalies and can only attempt to explain, in general terms, the atmospheric interaction of these features. To begin to understand the phenomenon, more accurate, extensive and synoptic measurements are needed. At the present, the only synoptic information on ocean temperature fluctuations is of the surface temperatures. We need to know more than this. We need to know what is transpiring below the surface of the sea during these fluctuations, so that we can determine such critical aspects as the fluctuation in heat content, the relationships of the large-scale changes and high-frequency events, the nature of diurnal heating and cooling, *etc*. Also needed is a better quantification of the insolation, wind drag, humidity and other atmospheric conditions associated with large-scale sea-surface temperature fluctuations. A new phase of study to gather accurate and extensive information is needed.

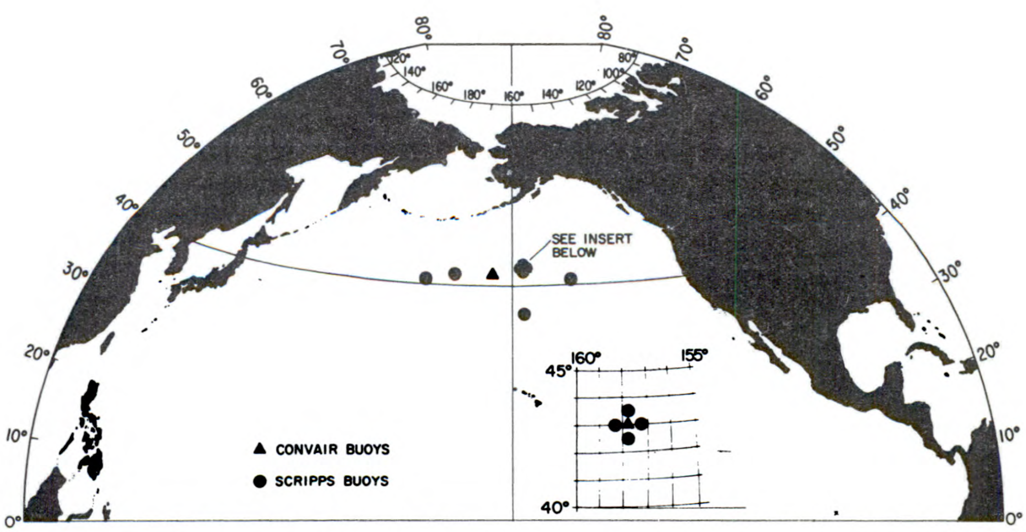
STUDY ENTERS NEW PHASE

To obtain a clear picture of the nature of the processes, Scripps is turning to deep-moored, unmanned, catamaran-type floating instrument (buoy) stations to study the physical changes of the waters of the North Pacific. In this new phase of the study, the buoys will remain on location for a year or longer. The area under observation will be a vast expanse four million square miles in area and extending some 1000 miles south of the Aleutian Islands. In this area Scripps scientists have installed one cluster of four of these buoys north of Hawaii at 43°N. In the center of the cluster is a 40-foot "Monster Buoy" developed for the Office of Naval Research by the Convair Division of General Dynamics (see *Naval Research Reviews* of February, 1967). Other SIO buoys are anchored in other areas of the North Central Pacific. A second Convair buoy is to be anchored soon. Scripps and Convair buoys have both been tested extensively in the ocean and have survived at least 100-mile winds and 45-foot waves.

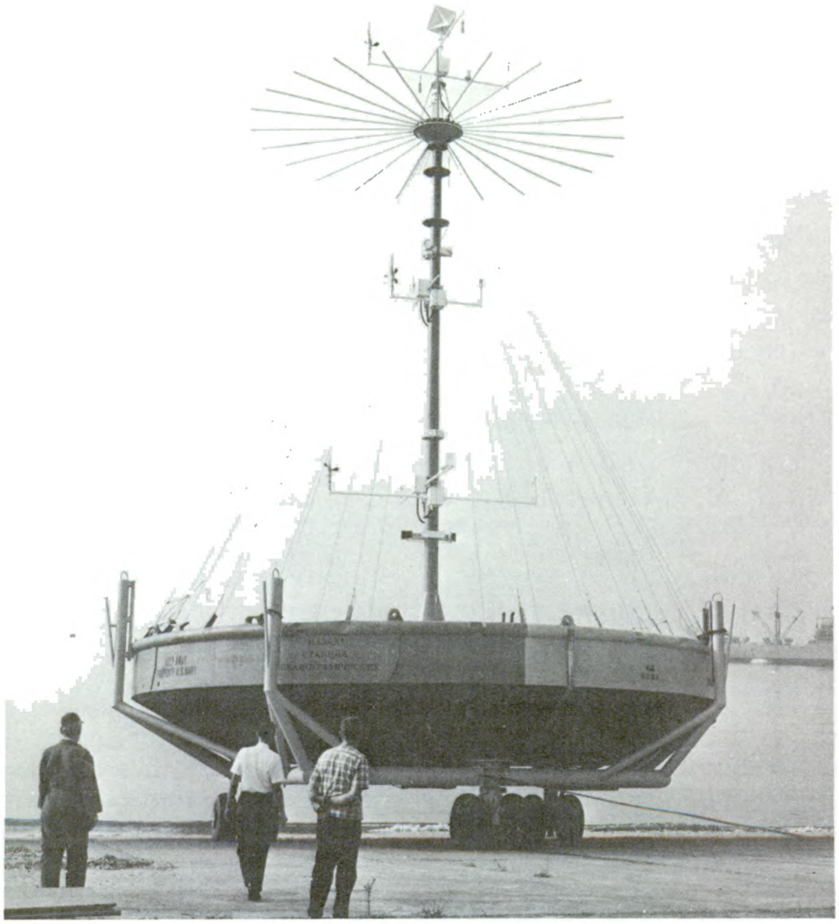
In addition to the data collected by the deep-moored buoys, scientists will collect other information such as satellite photographs of cloud cover from NASA and ESSA weather satellites, and hydrographic casts from sources such as ESSA, Bureau of Commerical Fisheries, U.S. Coast Guard, University of Washington, National Oceanographic Data Center, Oregon State University, University of Hawaii, Navy Oceanographic Office, Canadian ship observations, observations made by other countries and Scripps expeditions and mooring servicing cruises.

The Scripps-developed catamaran buoys, moored in water 12,000 to 18,000 feet deep, will record near-surface wind speeds and directions, and water temperatures at depths extending to 1000 and 1500 feet below the surface. A separate station in the cluster will monitor near-surface ocean currents. The buoys will also record barometric pressure, solar radiation and relative humidity.

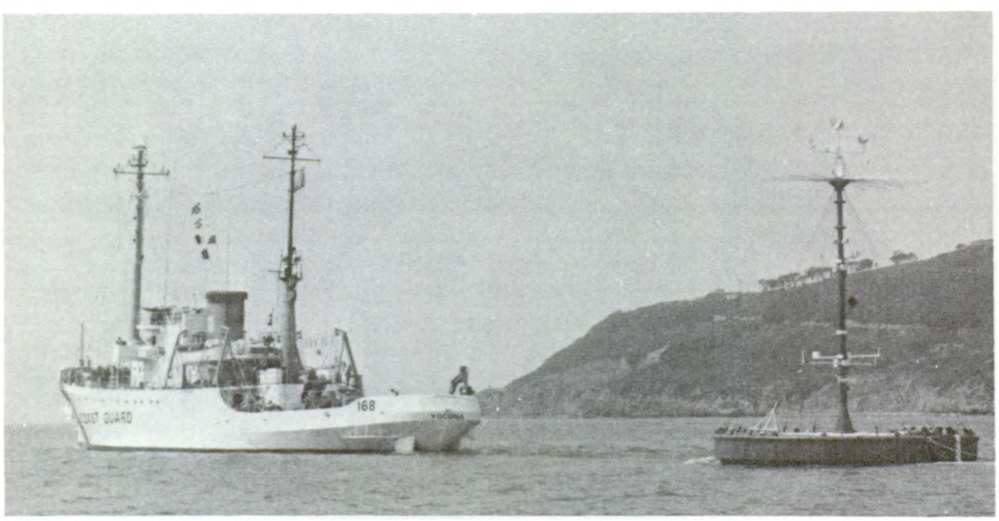
The two Convair-developed buoys will record wind speed, wind direction, air temperature relative humidity, rainfall, solar radiation,



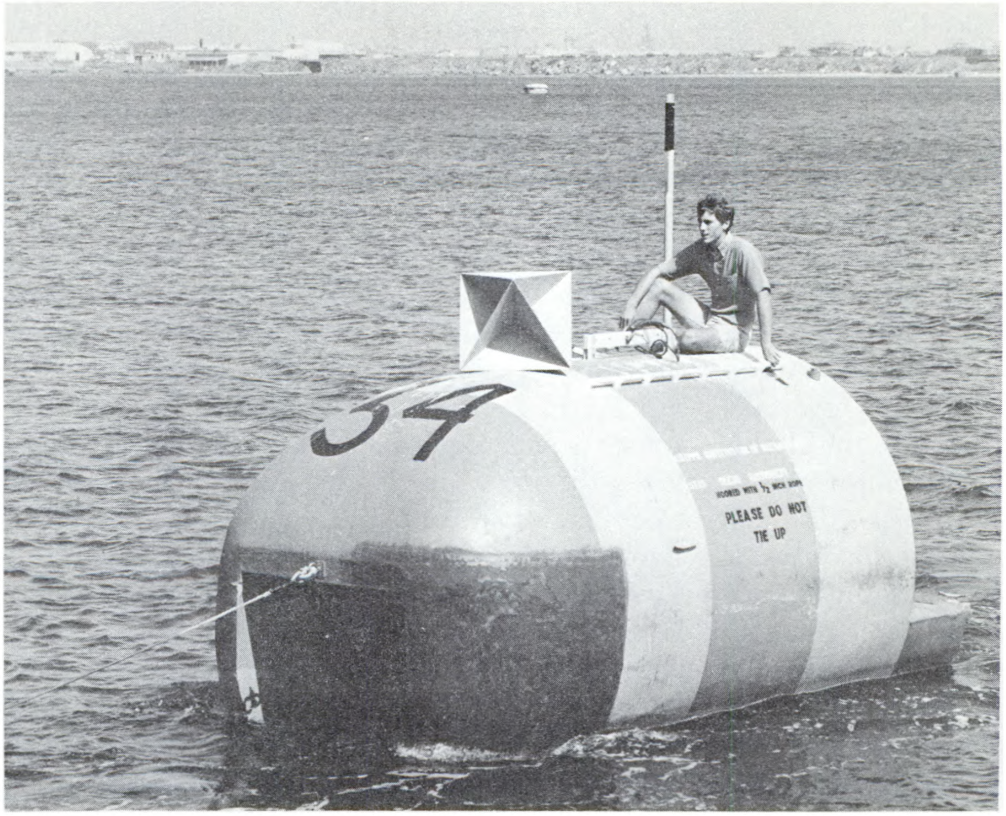
Approximate locations of the deep-moored stations



Convair-developed "monster buoy" is 40 feet in diameter and 7-1/2 feet deep



Coast Guard cutter YOCONA tows the Convair-developed ocean data station Bravo to position in the North Pacific Ocean



Scripps-developed bumblebee buoy being towed for loading onto the Coast Guard cutter ACUSHNET

barometric pressure, compass heading, surface current speed and direction, ocean temperature and salinity to 1500 feet and some engineering data.

In the Convair buoy, the data stored on magnetic tape is telemetered upon command to a shore-based control van operated by Convair engineers. The data collected by the Scripps buoys is photographically stored on board and will be periodically collected by the Coast Guard cutter ACUSHNET, which has been assigned to this project.

With the collection of the data, scientists at Scripps will be able to began tackling two of the most intriguing questions the North Pacific Study is attempting to answer:

- Are the anomalies the result of advection—wind transport—alone, or do the abnormal temperatures commonly interact with the atmosphere to perpetuate and accentuate the features under certain circumstances and interact to suppress them under other conditions? Stated differently, what feedback mechanisms act between abnormal weather and abnormal sea-surface temperature and under what conditions are these positive or negative feedbacks?
- What large-scale initial instabilities or oscillations of the ocean appear to occur in the North Pacific?

THE FIRST QUESTION

Advection will be measured in four independent ways. The ships' hydro-casts will provide data for the analysis of geostropic currents. Since the abnormal currents may not be in geostropic balance, catamaran buoys will provide measurements for comparison with the known water masses to observe changes in water masses and to provide indication of their direction of motion. The current meters will directly record the advective motion in the surface layers. The plankton samples will provide critical evidence on the sources of water masses even though they may have undergone considerable temperature changes. The measurements associated with thermal energy will be used to ascertain the nature of the changes in the thermal reservoir and to obtain knowledge of the nature of the fluxes that give rise to the changes. Data about changes in the general circulation will provide information about the possible feedback effects on the atmospheric conditions. Such data will by gathered from the general weather maps, from the wind direction measurements at the moored buoys, and from the changes in cloud cover noted from satellite photographs and quantified by the insolation measurements at the moored stations. These various sources of data will also provide information on secondary changes in the conditions of the atmosphere, such as humidity, stability, and precipitation.

Although many descriptive and quantitative analyses and comparisons will be involved, much effort will be devoted to ascertain whether changes in ocean conditions lag or lead the related changes in the atmosphere as an indication of the source of primary excitation and the nature of feedback. This will involve a comparison of the atmospheric pressure distribution, averaged over different periods of time, with the observed changes in ocean conditions.

THE SECOND QUESTION

All data collected for the first question can be used to analyze the second one—what large-scale initial instabilities or oscillations of the ocean appear to occur in the North Pacific? The moored temperature profiling stations that make continuous records of temperatures from the surface to 1500 feet will be essential in detecting large-scale instabilities.

It is suspected that three mechanisms may be involved in the possible occurrence of initial instabilities or oscillations. There is first the possibility that large-scale Rossby-type waves, similar to the planetary waves in the atmosphere, may occur along the West Drift Current and, second, that large-scale long-period internal oscillations of the entire North Pacific thermal structure may occur. A third possibility is that energetic internal waves from some distant generating source contribute to the thermal mixing of the North Pacific. This would result from the instability of these waves as they encounter the discontinuity of thermal structure at about 42° N latitude. This region may be a sort of "internal wave surf zone." In this case, changes in the intensity of incident internal waves generated by remote events elsewhere could result in the production of abnormal sea-surface temperatures.

Although the primary objective of the North Pacific Study is to answer these vital questions, it is expected that the study by-products will undoubtedly be of general importance in furthering knowledge of ocean processes such as heating-cooling cycles, response of layer thickness to low and high-pressure areas, effect of turbidity on radiant energy absorption, and distribution of certain plankton organisms.

Heating-Cooling Cycles

From previous moored-station data, we learned that the diurnal heating of a thin surface layer is a characteristic of relatively calm weather and an increasing general stability of the water column. In the present study, we will further understand the nature of this diurnally-heated layer and the manner in which it is dissipated by winds and at night. We will also understand the rates at which these processes take place. Diurnal cooling of the surface layers is probably associated with periodic convergence and sinking. We will be able to understand this process and the distribution of the convergence cells in space.

Response of Layer Thickness to Low and High Pressure Areas

The moored-station data will shed light on the rate of response of the surface layer thickness to meteorological pressure changes, of differing derivations of these changes and their velocity of motion. For example, certain critical velocities of motion of high or low-pressure features may result in a high coupling with internal motions and lead to high internal "bow" waves and wakes that are propagated within the density structure. These may be propagated and cause sea-surface temperatures changes elsewhere.

Effect of Turbidity on Radiant Energy Absorption

Upwelling and mixing processes give rise to increased light absorption because of plankton growth. In some cases, this then profoundly alters the depth at which radiant energy is absorbed and, hence, the depth over which solar heating is distributed and increase the rate of heating of the upper layer. In opposed fashion, convergence and downwelling suppress turbidity, increase the layer of heating, and decrease

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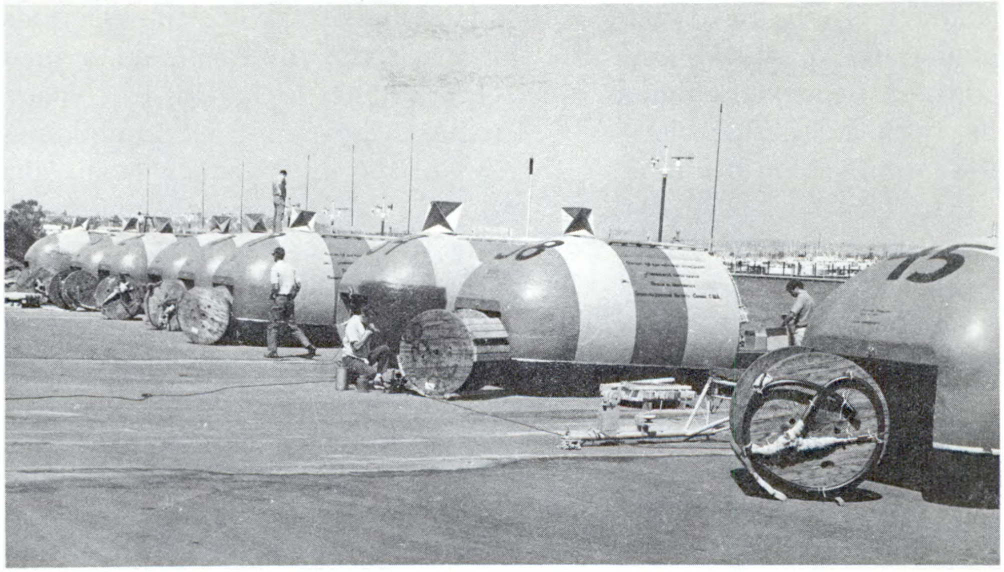
the rate of upper-layer heating. It is quite possible that such processes are important feedback mechanisms in the air-sea interaction processes. Absorption measurements will be conducted during the ship surveys.

Distribution of Certain Plankton Organisms

The presence or absence of certain planktonic organisms is frequently one of the best water-mass indicators. We will thus obtain plankton

Bumblebee buoys and monster buoy Alpha awaiting to be transported to the North Pacific Ocean. Both types of buoys have been tested in the ocean and have survived 100-mile winds and 45-foot waves.



Bumblebee buoys at Scripps' Nimitz Marine Facility in San Diego being readied for loading of cutter ACUSHNET

samples as the fourth entree into the determination of abnormal advection. In addition, this information is one of the few keys to the nature of past fluctuations, through the special sediment deposits, and, hence, a key for the establishment of the past ranges of conditions.

The first to benefit from the North Pacific Study will be the Navy. The data gathered will be of great importance in its program of oceanographic research and its Anti-Submarine Warfare Environmental Prediction System (ASWEPS) program. Since ASWEPS forecasts are largely based on up-to-date oceanographic information, the development of a system of highly-reliable deep-moored buoys that could provide real-time data on the ocean is vital. The data will also aid in the development of a more effective detection and weapon systems. Included among the other beneficiaries are U.S. Weather Bureau forecasters, the U.S. Bureau of Commerical Fisheries, the World Weather Watch, expected to go into effect in the 1970's, commercial fishermen, farmers, ship operators and other people whose livelihood and lives may be affected by the climatic changes associated with profound fluctuations in ocean conditions.

And these fluctuations in the conditions of the world oceans have often drastically affected the lives of many people. Fisheries have appeared and disappeared; hurricanes have visited coasts during some periods and shunned them at others; great quasi-cyclical alterations of rainfall and drought have successively stimulated and destroyed agriculture. The fluctuations of the conditions of the ocean and atmosphere cover broad spacial and temporal scales ranging from local changes lasting only minutes to changes that involve time periods of months to decades and affect large parts of the earth. While man adjusts to seasonal changes and to the long-term changes in climate, his resources and habits are frequently incapable of accommodating the intensity and duration of changes of the intermediate time scale. Agriculture and fisheries, for instance, cannot survive successive years of drought or dearth, nor can the food reserves of many societies be stretched across long periods. The biblical tale of the seven fat and seven lean years predicted by Joseph emphasize the vital nature of changes of such duration. (Joseph's prediction may well be considered the longest long-range weather forecast—a forecast covering 14 years!)

But there is no need to go back so far in time and place to illustrate the effects of shifts in ocean conditions. The great American drought of the 1930's caused incalculable loss throughout a vast area of the United States. The economic catastrophe and human tragedy caused by that event are well illustrated in Steinbeck's "Grapes of Wrath." Again in 1953 a drought of disaster proportion occurred throughout Arkansas, Kansas, Colorado, Oklahoma, Missouri, Texas and New Mexico. We may now safely surmise that these droughts are related to persistent sea-surface temperature anomalies.

There are also many maritime expressions of these anomalies. From the middle of 1957 through about 1960, over much of the eastern North Pacific, water temperatures were much higher than the long-term mean. As a result, tropical and subtropical fishes migrated as far as southern Alaska. A related phenomenon is presented by El Niño of the Peruvian coast. Here masses of warm water periodically and inexplicable flow over the cold coastal current, with considerable changes in the fisheries and disastrous results to the birds and sometimes to the local inhabitants. On the Pacific coasts of North America the effects of past shifts in ocean conditions are conspicuous in guise of verdant forests of eucalypti planted at the 1913 onset of wet period, and abandoned remains of large agricultural colonies in Baja California stimulated by similar periods.

Ignorance or disregard of these repetitive effects results in activities fraught with potential for disaster. An example of such activities are the new housing developments on potential slide areas and particularly in the canyons and arroyos of the Southwest. Here, in the last twenty years, civic conscience has not taken into account the danger of bank-to-bank floods, though such floods occurred once in a decade in the first half of this century.

Someday, data similar to that to be collected by the North Pacific Study will enable scientists to predict the recurrence of drastic long-term weather and climate fluctuations and anticipate their effects. In the not-too-distant future a large network of buoys could supply simultaneously information about hundreds of oceanographic factors throughout the oceans. Land-based scientists could interrogate these buoys and receive an hour-by-hour picture of what is going on throughout the total marine environment. Unlike Joseph, who must have had divine assistance to make his prediction, once the basic mechanisms of change are understood, they will only have to analyze this data to make accurate and long-term predictions of fat and lean years—rainfall or drought, or other vital changes in the weather and climate.

Frozen Blood Program

The Research Division of the Navy Bureau of Medicine and Surgery is conducting a feasibility study in South Vietnam to evaluate the use of frozen blood banks in combat areas ashore and afloat. Four banks are currently operating at the Navy Station Hospital, DaNang, South Vietnam, aboard the hospital ships USS REPOSE and USS SANCTUARY, and at the U.S. Air Force Hospital, Clark Air Force Base, in the Philippines. Over 3000 units of processed frozen red cells have been transfused into carefully monitored battle casualties.

Principal responsibility for this study lies with the Naval Blood Research Laboratory, Naval Hospital, Chelsea, Massachusetts, where evaluations of various methods in the preservation of red blood cells at low temperatures have been made. Currently being analyzed are newly developed techniques and equipment which have the potential of substantially improving the system used in Southeast Asia. Also, efforts are underway at the Naval Medical Research Institute, Bethesda, Maryland, to improve shipping containers and freezer storage. The entire feasibility study includes a determination of the transportation, storage, and logistics support problems involved in operating a frozen blood bank in a combat area.

Frozen blood processing centers have been established at the U.S. Naval Hospital, Oakland, California, and the Naval Medical School, Bethesda, Maryland. From there, the frozen Group "O" Rh negative red cells are air-shipped to Southeast Asia in polystyrene-foam containers using dry ice as the refrigerant; they are then stored in low-temperature freezers. Prior to use the frozen red cells are thawed and washed free of the protective additive glycerol by the Huggins cytoglomerater.

While whole acid citrate dextrose (ACD) blood has a shelf life of only twenty-one days, frozen red cells will potentially last indefinitely, thus assuring hospitals of a reserve supply of back-up blood. Trials with patients who previously had adverse reactions to multiple ACD blood transfusions have shown that they can tolerate processed frozen red cells. Frozen blood cells are intended to supplement ACD blood rather than supplant it; and frozen blood cells have proven valuable as a readily available source of compatible blood. In one instance a Marine casualty at DaNang received 93 units of blood, 41 units of which were frozen blood, and survived.

International Solid-State Circuits Conference to be held at the University of Pennsylvania, Philadelphia, Pennsylvania, February 19-21, 1969. Additional information may be obtained from Dr. R. S. Pepper, Chairman, ISSCC International Arrangement Committee, Sprague Electric Company, North Adams, Massachusetts. Phone: Area Code 413-664-441. Co-sponsored by the Institute of Electrical and Electronics Engineers, University of Pennsylvania, Army Electronics Command, Air Force Systems Command, and the Office of Naval Research.

Human Factors Evaluation of the Vertical Contact Analog Display

Kenneth D. Cross
Naval Missile Center
Point Mugu, California

The Vertical Contact Analog Display (VCAD) concept is a computer-generated display which is analogous to the view a pilot in flight would see if he could look at the ground below through an opening in his instrument panel. VCAD evolved ten years ago from the efforts of the Joint Army-Navy Aircraft Instrumentation (JANAIR) Program and its antecedent, the Army-Navy Instrumentation Program (ANIP).

Pilots become overburdened with cockpit devices as they keep constantly informed of their aircraft's position, orientation, and operating status through the use of the many displays appearing on the conventional instrument panel. As aircraft capability continues to increase, pilots need more and more parameters of information. The typical remedy for displaying additional information has been to add more clock and stem gauge devices to the instrument panel. Now the average instrument panel is so crowded that the most highly trained pilot has difficulty using it. VCAD could improve this situation.

Much work has gone into developing and standardizing more readable displays and more efficient instrument layouts. But the concept of one information parameter per display (uniparameter display) has unfortunately survived. Even though early research did decrease scan time, reading time, and reading errors, the pilot was still overburdened. Reading time could not be reduced below some minimum value regardless of the efficiency of the display design. The time saved by reducing scan distance between displays was small in relation to total scan time. The pilot was still faced with the difficult and time consuming task of integrating the numerical values from numerous uniparameter displays into a unitary concept of aircraft position, orientation, and operating status.

As aircraft became faster, it became necessary for the pilot to update his information more frequently in order to maintain current knowledge of the flight situation. The reduction in the time available to recycle through the human scan-read-integrate sequence was accompanied by an ever increasing number of displays, with the result that less and less time was available for the processing of more and more information. It was concluded the the only way the pilot could be significantly unburdened would be to abandon the uniparameter display concept and develop display systems in which the necessary information parameters are presented in a more integrated format.

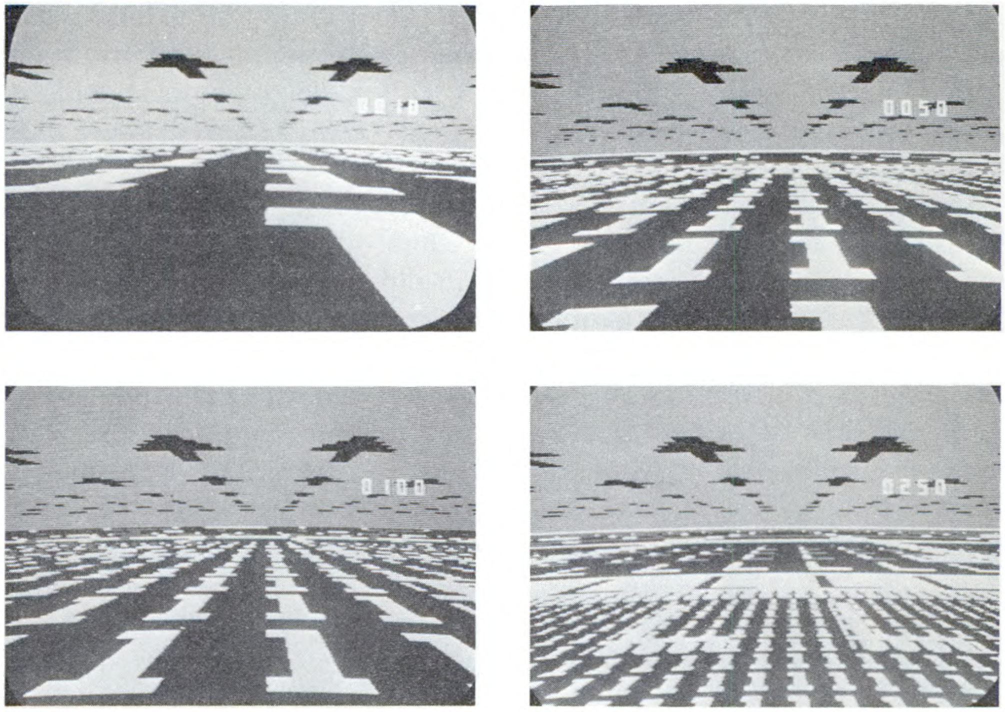


Figure 1 — View of a VCAD configuration showing changes that occur as altitude is increased from 10 to 250 feet

One type of display that is truly integrated is an unobstructed view of the world about the aircraft. A cockpit display which simulated those visual cues which are available when viewing the real world should prove effective in lessening the pilot's job. A study of these cues led to the conclusion that such a display should contain a textured sky and ground plane and an easily differentiable horizon line. The textured ground plane should reflect real world perspective and motion parallax. An example of just one of an almost limitless number of possible VCAD configurations which fulfill these requirements is illustrated in the sequence of photos in Figure 1. This sequence illustrates the manner in which the features of this particular display configuration changes as altitude is increased from 10 to 250 feet, and shows the close connection between changes taking place on the VCAD and those encountered in the real world.

From the beginning, the VCAD concept has been subject to considerable controversy, about the self sufficiency of VCAD. Although most people agree that information other than the VCAD will be required in the cockpit, few agree as to the type of supplementary information necessary or the format in which this information should be presented. One view is that VCAD should simply be added to the conventional cockpit. Another view is that a certain conventional instruments should be eliminated from the instrument panel and this information be superimposed on the VCAD in the form of alpha-numerics or numerical scales. Others believe that any supplementary information presented on the VCAD should be in strictly symbolic form, and they proposed using such symbols as aircraft reticles, command symbols, and flight paths. Because these problems have never been resolved, there has been dwindling interest in the VCAD concept.

During the past ten years, various VCAD configurations have been investigated in the laboratory and in flight situations generally with favorable results. Only recently have facilities become available which permit a systematic study of the VCAD concept. The vital part of this facility is a highly versatile VCAD generator. The device was specifically designed as a laboratory research tool and can systematically vary a large number of design features. The generator not only provides variable display features but can present supplementary information in a variety of forms, including both alpha-numeric and symbolic forms. A view of the VCAD generator is shown in Figure 2.

Figure 2 — Front view of the VCAD generator as installed in the Naval Missile Center's Advanced Display/Control Evaluation Laboratory

The VCAD generator has been installed at the Naval Missle Center's Advanced Display/Control Evaluation Laboratory. When completed, the laboratory can evaluate the utility of the VCAD concept for a wide range of different aircraft and mission segments. Other components of the laboratory include a fixed-base and a dynamic-base cockpit, a versatile control loading system, an extensive performance measurement system, and analog computers which simulate various aircraft flight dynamics. Figure 3 shows an overview of the laboratory, including the fixed base cockpit, and Figure 4 shows a view of the dynamic base cockpit. Under the program, the VCAD configuration is almost

Figure 3 — Overview of the Naval Missile Center Advanced Display/Control Evaluation Laboratory

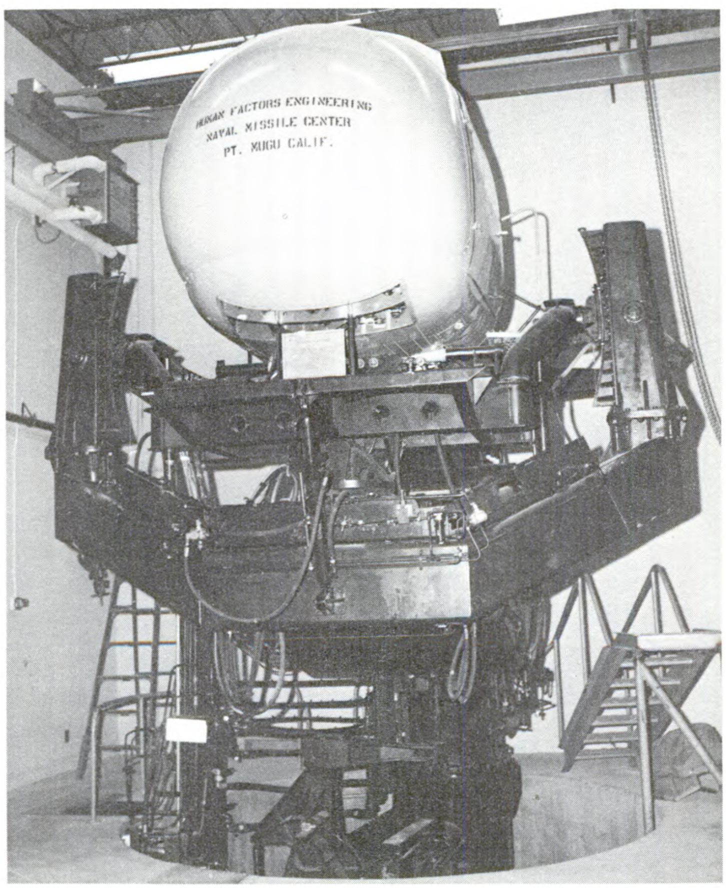


Figure 4 — View of the dynamic-base cockpit used in the VCAD Evaluation Program

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ready for a number of representative aircraft and mission segments. Later it will be determined whether this display configuration can be used with sufficient speed and accuracy to meet operational requirements. Implicit in this stated objective is the assumption that:

- No single VCAD configuration will prove optimal for all aircraft types and all mission segments.
- The VCAD concept should be evaluated by operational requirements rather than comparing it with any other existing display systems.

Program objectives, as now stated, give special emphasis to defining the need for supplementary information in a systematic way. In the past, there has been a strong tendency to add supplementary information because it has been available or because someone thinks it is needed. Giving in to this temptation would result in a VCAD configuration that would be as cluttered and difficult to use as the one available now. It is anticipated that considerable research effort will be expended in defining the minimum supplementary information that is necessary for each of the different mission segments selected for study.

The research to date has been encouraging. After a minimum amount of training, the trainee can judge such parameters as pitch-angle, roll-angle, and altitude with a much higher degree of accuracy than has heretofore been supposed. These experiments have also provided a great many insights into the cue structure of the VCAD (those VCAD features which must be studied in order to judge the value of the various flight parameters).

There are many critical questions to answer before the VCAD concept is given a comprehensive evaluation. The few answers that have been obtained are sufficiently encouraging to warrant the prediction that the VCAD will be important in future aircraft instrumentation.

New Comprehensive Technical Thesaurus Published

The first thesaurus to encompass in one volume the technical vocabulary used by the military services, industry, and the academic community has been published jointly by the Department of Defense (DOD) and the Engineers Joint Council (EJC). Manager of the DOD effort, known as Project Lex, was the Office of Naval Research.

The volume, entitled *Thesaurus of Engineering and Scientific Terms,* has been prepared to answer the problem of the variety of meanings given to major terms by different scientific disciplines, which has hampered the interchange of technical information. This has been further complicated by the number of new terms and phrases created in recent years. A standardized technical vocabulary was also needed to provide precise terminology for computer information systems, especially where they cut across interdisciplinary boundaries.

The DOD/EJC cooperative venture started as two independent projects in 1965. DOD initiated Project Lex to develop for the first time a comprehensive standard technical

—Continued on Page 41

Department of Ocean Engineering at WHOI

LT Paul W. Chapman USNR-R
Research Reserve Company 1-1

Major changes have been incorporated into the organizational structure at the Woods Hole Oceanographic Institution (WHOI) since the article on the Institution's history in the May 1966 *Naval Research Reviews*. To support continued growth of the Institution, a Department of Ocean Engineering was established in 1967.

The new department was prompted by two developments: the rapid growth of deep submergence activity and the fact that WHOI can now grant an advanced degree in Marine Sciences. ALVIN, an example of deep submergence activity, evolved from a basic submersible research platform into a highly sophisticated instrument system requiring unique sensors, data handling equipment, work aids, and a specialized navigation system. There are 30 students enrolled in the degree programs, nine of whom are in the field of Ocean Engineering. Next year, at least 10 students will start the WHOI and MIT doctoral program.

The new department has three types of activity: project assistance, project management, and institutional service in tasks involving development, research, education and services. The department is divided into four sections: Deep Submergence, Engineering and Operation, Buoy Engineering, Instrument System Engineering and Information Processing and Analysis.

Of the other four departments at WHOI, only the Geology and Geophysics Department has its own engineering group. In the Physical Oceanography, Chemistry, and Biology Departments, individual investigators often provide their instruments and hardware; however, the Ocean Engineering Department is now frequently called upon to support program engineering.

Deep Submergence Programs

In the Deep Submergence Section activity centers on the updating of ALVIN. ALVIN's modifications improve her operational flexibility and reliability. New operational tools are constantly being developed to aid in the scientific missions. A series of manipulative aids has been devised for physical, biological, and chemical sampling. The Deep Submergence Section is also involved with modifications to LULU, ALVIN's support catamaran and other support facilities (Figure 1).

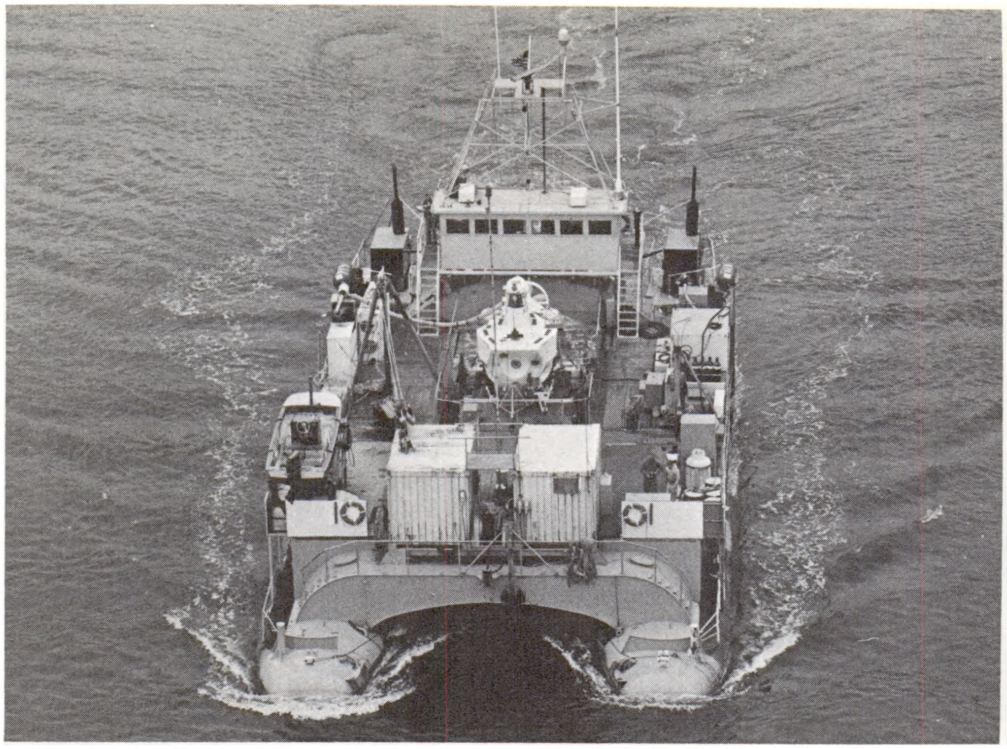


Figure 1 — LULU, ALVIN's support catamaran, is shown carrying ALVIN

The need for knowing the exact location of a deployed DSRV at all times has prompted the development of a comprehensive three-dimensional navigation system. Another development is an automatic data logging system, which relieves the scientists of tedious writing and the chance of losing data. A key feature of the combined Al-Nav/ Al-Log system is that both DSRV and support ships are passive acoustically.

This not only eliminates problems of multiple interrogation but also insures a minimum disturbance by scientific or search teams.

Oceanographic Buoys

The Buoy Engineering Section has almost completed a program involving 36 deep and 20 shallow engineering moors. Particular emphasis is being placed on torque balanced mooring cables and the fatigue life of various alloys. Exotic alloys may prove effective in extending on-station time from 60 to 180 days.

Buoy system dynamics as related to platform stability is being studied. Instruments are being devised and measurements taken to establish the suitability of various system configurations as sensor platforms. Line heave and vortex shedding can obliterate critical acoustic measurements. Pitching and bobbing of a buoy platform can confuse sea-state measurements as well as cause undue fatigue to mooring systems.

Instrumentation

The Instrument Section is active in many programs including several instrument probe projects such as whale tracking and vertical current measurement.

Under the Instrumentation Section is the Data Logging system for DSRV's, which involves the sensing, formating, and storage of four parameters, salinity, temperature, depth, and velocity. A unique technique has been developed by the Instrument Section which periodically scans these four sensors and formats the data so that it can be read directly in correct units on a standard one-second counter. Eleven spare channels allow for future system expansion and addition of other scientific sensors. More sophisticated processing and displays will be developed in later phases of the program.

Data Processing

Data Processing is primarily a service group; however, the group has established seaborne computers, satellite navigation, and a new information retrieval system. The group has significant expertise in analog/digital conversion and other computer problems.

In the shore based Computation Center, there is a Sigma-7 computer for big jobs and small PDP-5 for special tasks. Because an HP-2116A computer carries the load at sea, performing navigation and data logging functions in real time, scientists receive their processed data before they come ashore.

The new Ocean Engineering Department's main job is to support scientific and educational programs at Woods Hole. A good example of this support is the exploratory mapping program of the Atlantic Continental Margin of the United States.

The continental margin program is making a geological and geophysical survey of the ocean floor areas adjacent to the coast to a depth of 200 meters (Figure 2). The next two decades of biological and mineral exploitation of the sea will be in this region.

WHOI and the U.S. Geological Survey are working together to learn about the structure, origin, and general geologic setting of this submerged continental block. Profiles revealing in some detail the structure of the upper 1000 meters of sediment from Corsair Canyon to the Tongue of the Ocean have been constructed. Selected areas have been surveyed with side scan sonar and samplings of rocks, sediments, and biology have been obtained.

The challenges are many and varied and currently include instruments to measure insolation and monitor ocean meanderings over great distances. The untethered Auto Probe, can be preprogrammed to carry out a sequence of scientific observations *versus* depth and time. Freely moving with lateral currents, one version is capable of

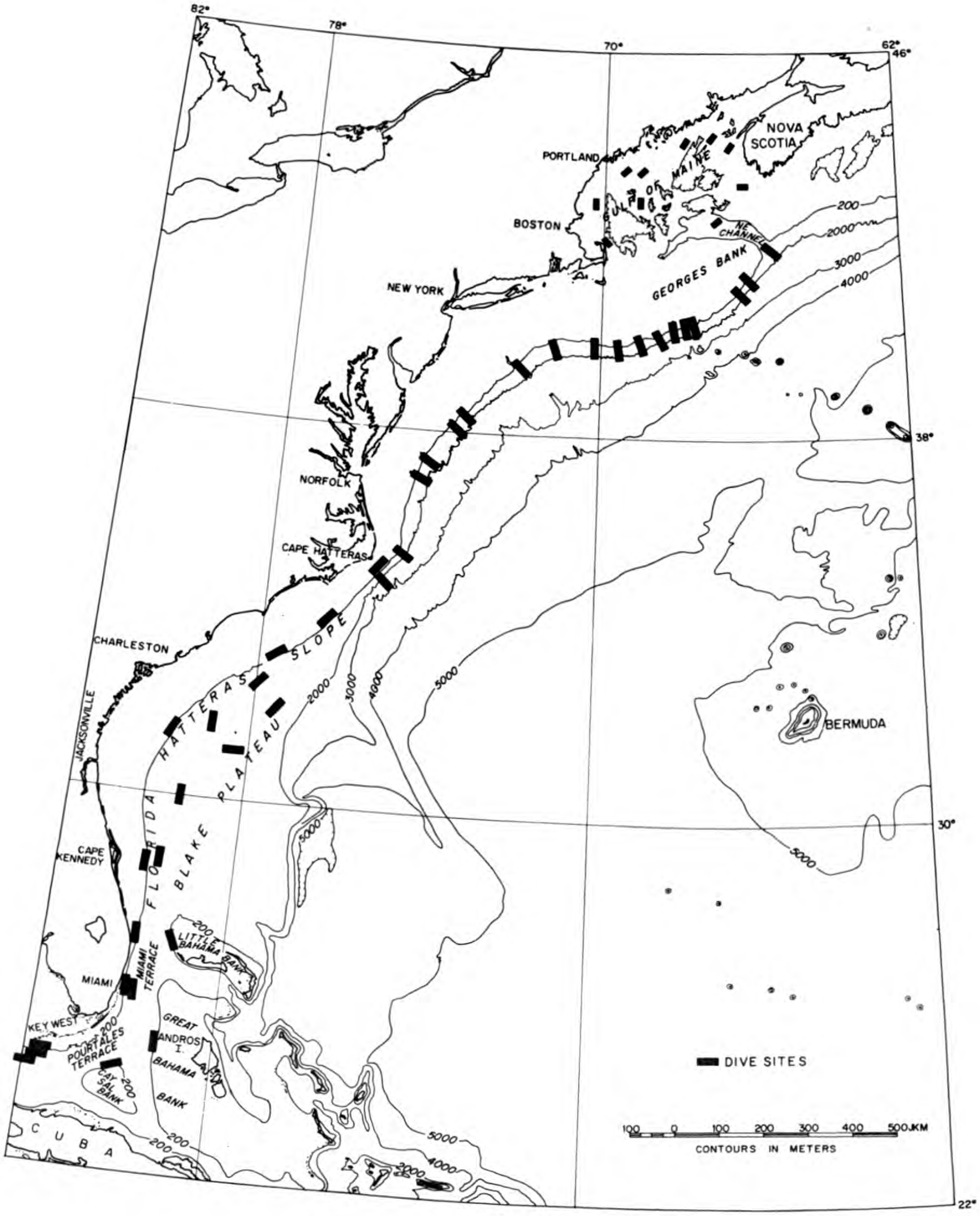
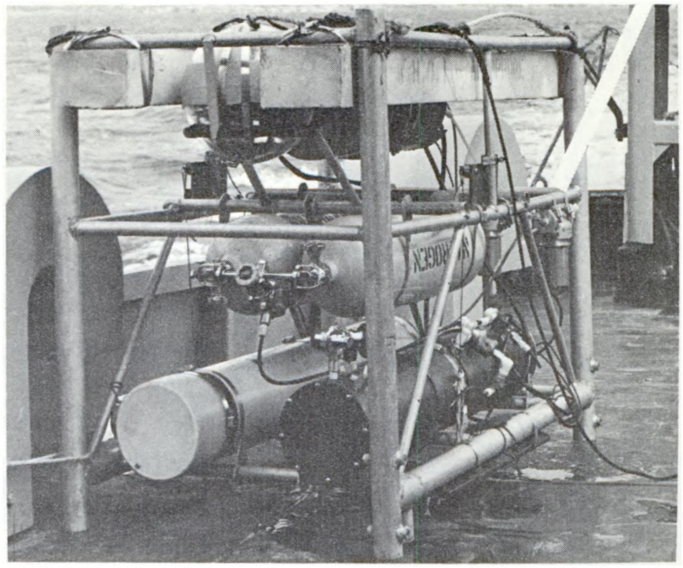


Figure 2 — Exploratory Mapping Program of the Atlantic Continental Margin. The Continental Margin program involves submarine areas adjacent to the coast to a depth of 200 meters.

tracking isotherms over a ten-day period. Another version records shear currents and temperature *versus* depth (Figure 3).

A recent Ocean Engineering Department prospectus outlines a Deep-Ocean Observatory Research (DOOR) Program. If adapted, the DOOR program would study benthic and volumetric processes within the sea from a number of unmanned observatories on the ocean floor. Measurements and observations would be recorded over long periods of time by instruments installed and removed by a DSRV. The observatories located at depths ranging from six hundred

Figure 3 — The untethered auto probe can be preprogrammed to carry out a sequence of scientific observations versus depth and time.



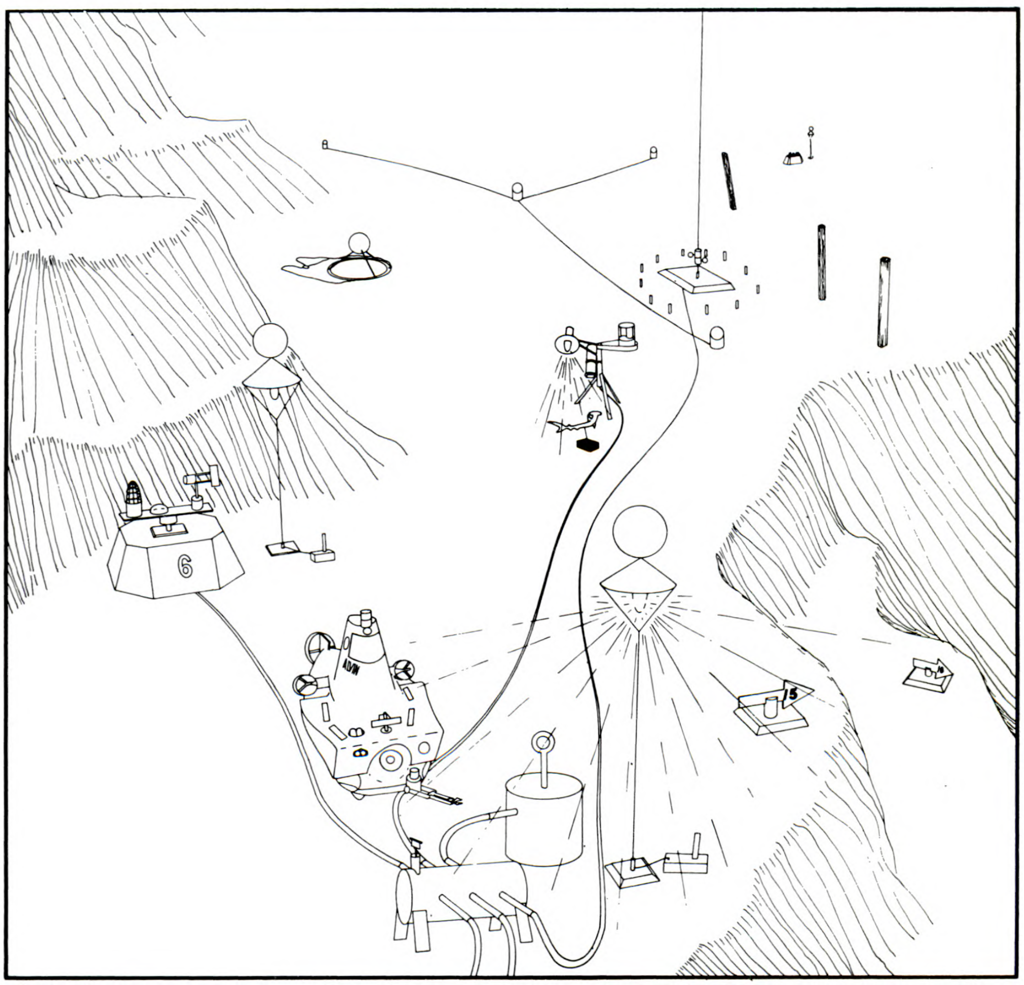


Figure 4 — A concept has been proposed for Deep-Ocean Observatory Research (DOOR) Program, which would study benthic and volumetric processes within the sea from a number of unmanned observatories on the ocean floor.

to six thousand feet would be immune from the severe environment of the ocean surface and would provide otherwise unobtainable long term time series data (Figure 4). The stations could provide excellent materials environmental sites. Also the stations would include specialized buoy types for vertical profile data, which would augment the continuing Continental Margin Mapping Program.

Dr. Zisman Receives the Captain Robert Dexter Conrad Award

Dr. William A. Zisman of the Naval Research Laboratory receiving the Robert Dexter Conrad Award from Secretary of the Navy Paul R. Ignatius.

Dr. William A. Zisman, Chief Scientist of the Laboratory for Chemical Physics at the Naval Research Laboratory (NRL) received the Navy's 1968 Robert Dexter Conrad Award for his notable research in chemistry during the past 29 years. The annual award which recognizes outstanding scientific and technical achievement by an individual in the field of research and development for the Navy, was presented by Secretary of the Navy Paul R. Ignatius.

Under Dr. Zisman's guidance NRL made numerous contributions in physical, inorganic and organic chemistry, electrochemistry, protective chemistry, surface chemistry, radiochemistry, biochemistry, and mycology. His own fundamental and applied interdisciplinary research in surface chemistry and physics has led to numerous civilian and military applications in such areas as corrosion prevention, wetting, adhesion, protective coatings, surface potentials, lubrication, friction, and wear.

Research Notes

Shock Study

The primary mission of Navy surgical research programs is to find means for providing improved medical support for the combat casualty. Present hostilities in Vietnam offer unparalleled opportunities for studying and documenting the field problems concerned with the care and management of the critically wounded. The Navy surgical research programs have adjusted to meet the immediate operational problems by establishing a Surgical Research Unit in DaNang, South Vietnam. Administrative, logistic, and technical support is provided by the Naval Medical Research Unit No. 2 in Taipei, Taiwan.

The investigations at DaNang are closely coordinated with the research program of the Experimental Surgery Division of the Naval Medical Research Institute, Bethesda, Maryland, and the Navy Blood Research Laboratory, Naval Hospital, Chelsea, Massachusetts. Problems and questions raised by the study in DaNang are being investigated by the Surgical Research Program at the Naval Medical Research Institute. This will also be coordinated with the investigations of surgical shock teams planned for the U.S. Naval Hospitals in Bethesda, Maryland, and San Diego, California.

The first project at DaNang was the clinical evaluation of the use of freeze-preserved red cells. The clinical shock study is a natural extension of the frozen blood feasibility study. This clearly indicated the need for an increased capability in monitoring the severely injured battle casualty as well as an improved understanding of the resuscitation of this type of patient. The Navy's current interest in both shock and blood preservation represents a convergence of these two important fields.

Initial emphasis has been placed on shock and resuscitation and the development of a portable shock and surgical unit. Rapid helicopter evacuation of battle casualties, sometimes within fifteen minutes of injury, to fixed medical facilities has given rise to a new type of surgical patient: One who is critically wounded and suffering from rapid blood loss from vascular or organ injury. Under any other circumstances, this type of patient would have died shortly after injury. The resuscitation of these patients requires much more sophisticated laboratory and treatment facilities than have ever been used in a combat area. The facilities and the location of the U.S. Navy Station Hospital at DaNang are ideal for the treatment and study of these cases. The Surgical Research Unit is equipped with instruments for determining blood gases, PH, lactate levels, electrolytes, cardiac output, and recordings of arterial and central venous pressure. Radioisotope capability is being provided by the U.S. Naval Medical Research Unit No. 2 in Taipei.

The general approach is to study in great detail those casualties who suggest the greatest challenge in shock management. Baseline values of hemodynamic, metabolic, respiratory, and renal parameters are obtained on admission, followed by serial observations during resuscitation, surgery, and recovery. The immediate impact of the shock study has been an improved level of bedside care for a selected group or high-risk patients by providing an increased range of physiological data necessary for the control of therapy. In addition to providing an essential adjunct to the care of this group, these data are available for systematic analysis to provide a better understanding of shock and its treatment in the combat casualty and a basis for recommendations on the optimal selection of resuscitative fluids.

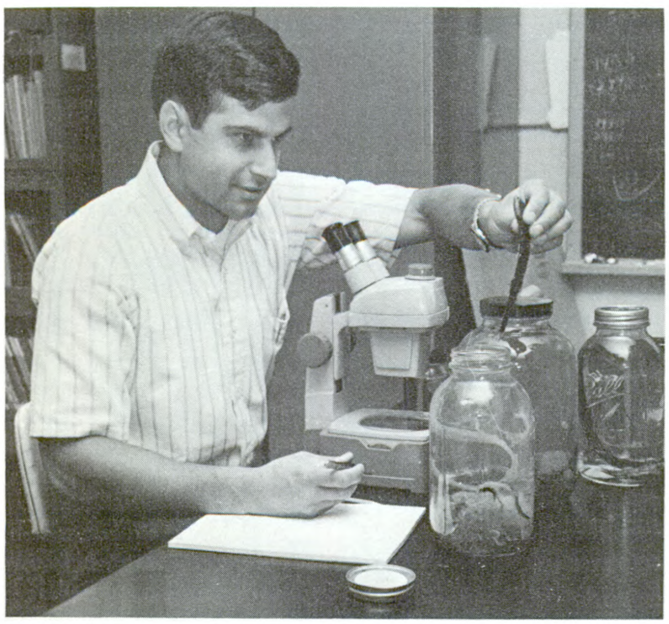
Plans for long-term projects include the further development of a computer-assisted bedside monitoring system for use aboard hospital ships or at fixed medical facilities in the field.

Deep Scattering Layers

Scientists from the U.S. Naval Oceanographic Office are working on the mystery of the deep scattering layers. On a seven-day cruise north of Hawaii the scientists netted marine organisms, which they analyzed in hopes of finding out something about the composition of the deep scattering layers.

The marine life samples caught on the Pacific cruise, will be compared with specimens collected since July of 1965 on similar operations in the Atlantic. The comparison may help scientists develop a world-wide view of the deep scattering layers.

Discovered by accident during World War II, deep scattering layers are horizontal, sound-scattering bands existing at various depths, generally in the upper 3000 feet over broad reaches of the world's oceans. These sound-scattering zones often produce false bottoms on the recording traces of echo-sounding devices. In the past, cartographers charted non-existent shoals because their sound equipment, used in delineating the ocean floor, traced a deep scattering layer instead of the actual sea bottom. In addition, deep scattering layers confused sonarmen looking for submarines because the target return from the submarine was obscured by the scattered sound energy of the layers. Scientists discovered that marine animals making up the deep scattering layers migrate to the surface at sunset and descend to the mid-depths at sunrise.



A marine biologist prepares to examine a bristlemouth. Other fish possessing swim bladders identified as inhabiting deep scattering layers are lantern fish and hatchet fish.

The problem now facing oceanographers is to determine the types of marine life inhabiting the deep scattering layers. Most scientists believe the most important organisms in the layers are fish possessing swim bladders, which act as air bubbles to scatter sound waves; however, they have identified only a few. Some fishes inhabiting the deep scattering layers are lantern fish, hatchet fish, and bristlemouths.

A fish swim bladder, acting as an air bubble, scatters sound extremely well; and the resonant frequency of the sound will vary depending upon the depth and the diameter of the bubble. A small bubble has a higher frequency than a large one. The swim bladder expands and contracts as the fish migrates up and down the water column. However, the organ poses a problem because biologists do not fully understand its mechanisms.

During the Hawaiian cruise, the gases in the swim bladders of the fish caught in the deep scattering layer were analyzed. Also the oxygen needs of the fish were determined. The high mortality rate of the delicate animals made the job extremely difficult.

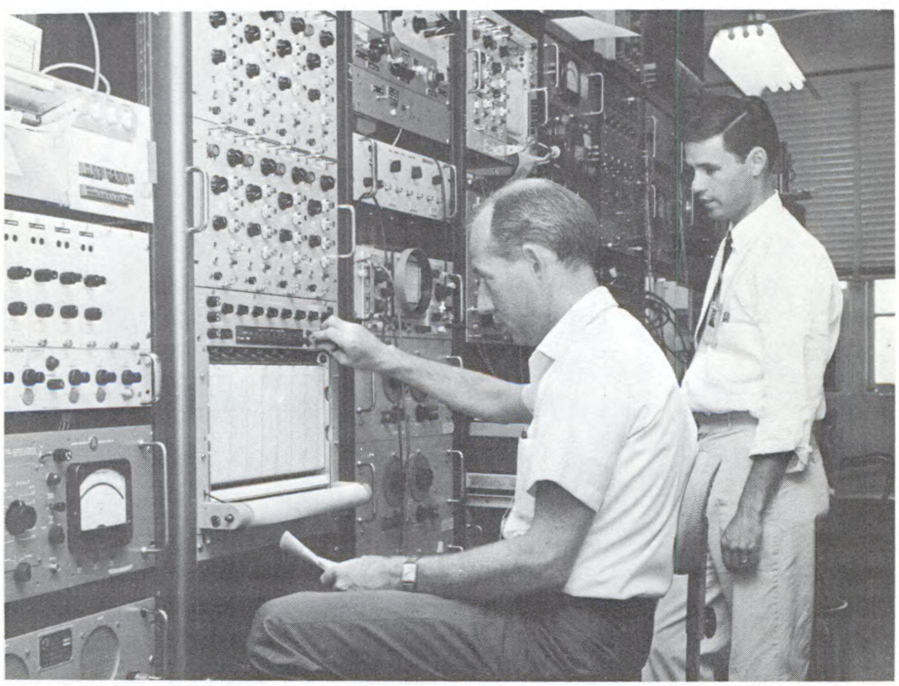
Catching the organisms in the 10-foot Isaacs-Kidd midwater trawl and the 6-foot Tucker net, lowered to depths as great as 360 fathoms, shocked the animals. They were either injured or killed as they thrashed against each other and the sides of the nets. The quick temperature and pressure change from the depth of capture to the surface also may have caused many of the organisms to die before they were landed on deck.

The scientists were able to make 36 collections or catches with the two tow nets during their four-day stay at the study site located 240 miles north of Oahu. Now marine biologists are sorting the preserved animals. The biologists will identify the organisms and will try to determine the depth at which they were caught and estimate the vertical distribution of the animals in the water column.

Catches with the Tucker net, which opens and closes at predetermined depths, will help the biologists to determine the vertical distribution of the animals. The Isaacs-Kidd trawl, and open net, caught marine life at all levels. On future trips, the biologists will use a four-chambered sampler attached to the end of a big trawl net. This sampler, which can be electrically triggered to close at any depth, will collect four separate samples.

In addition to finding improved methods of catching the organisms, scientists also are exploring better ways of locating the deep scattering layers and measuring the amount of acoustic energy they scatter. An ultimate aim of the scientists is to be able to chart the layers.

The present technique of making acoustic measurements of the layers is through the use of a bomb, a two-pound charge of TNT, which is detonated at a predetermined depth by a pressure-activated device. It was noted that the bombs provide valuable information on sound scattering, but they are not suitable for measuring individual layers. Experiments are now being conducted with a pulse sounding system, a directional, downward-looking instrument quite similar to the conventional echo-sounder used to chart the ocean floor. This system eventually will permit detailed measurements of individual layers at several different frequencies.



A technician watches as the sound of a two-pound charge of TNT is illustrated by a computer. The charge was detonated to help delineate the deep scattering layers at the test site.

Balloon-Borne Camera Aids Coastal Research

Scientists at the Coastal Studies Institute, Lousiana State University, have devised a novel aerial surveillance technique for monitoring the streamline movement of currents in the shallow water along the coastline.

The techinque makes use of a camera suspended from a helium-filled balloon above the coastline (Figure 1). The balloon-borne camera will provide a minute-by-minute photographic record of the diffusion of the dye used to track the movement of the water (Figure 2).

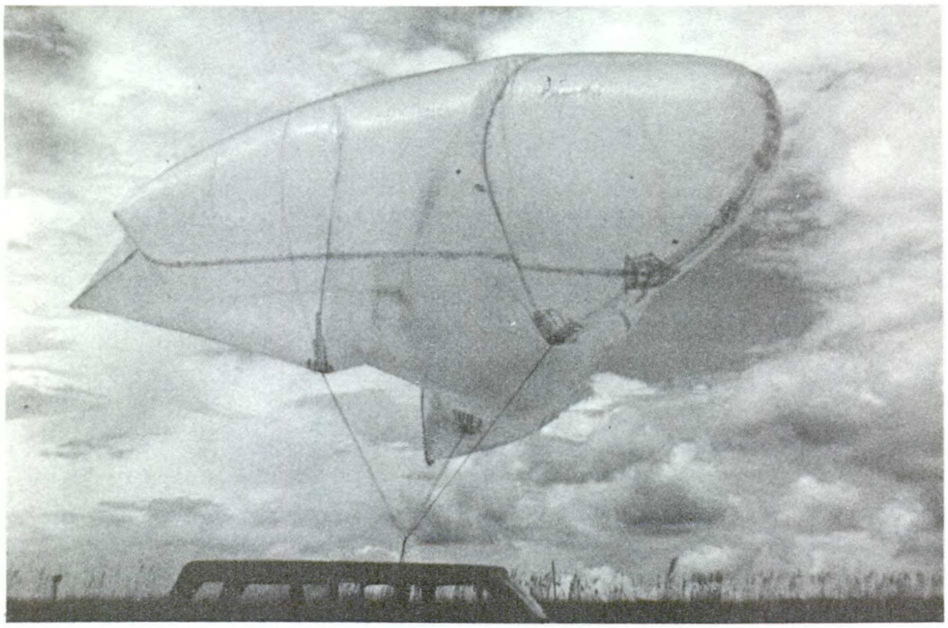


Figure 1 — Balloon being readied for experiment

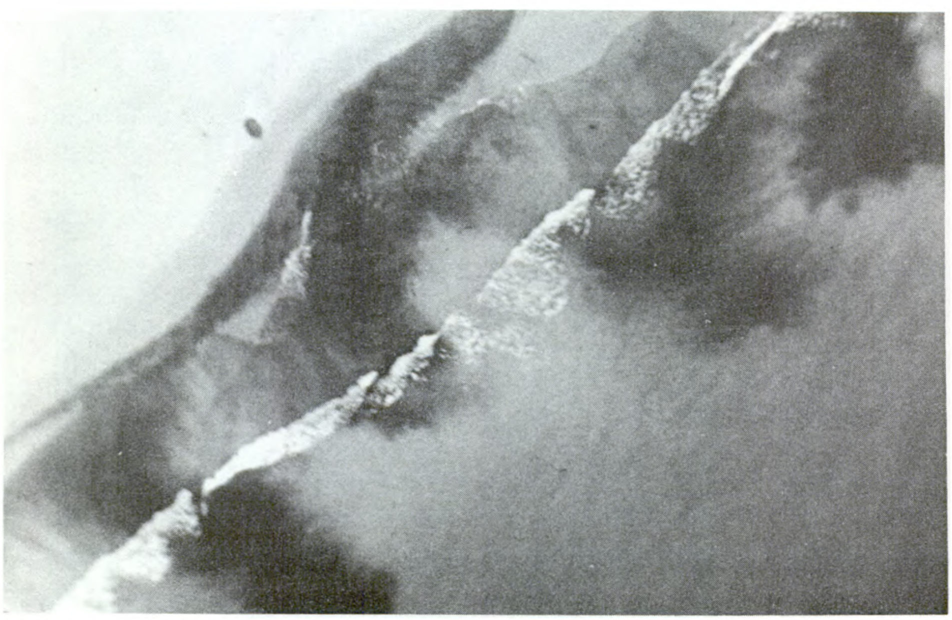


Figure 2 — Diffusion of dye photographed from balloon

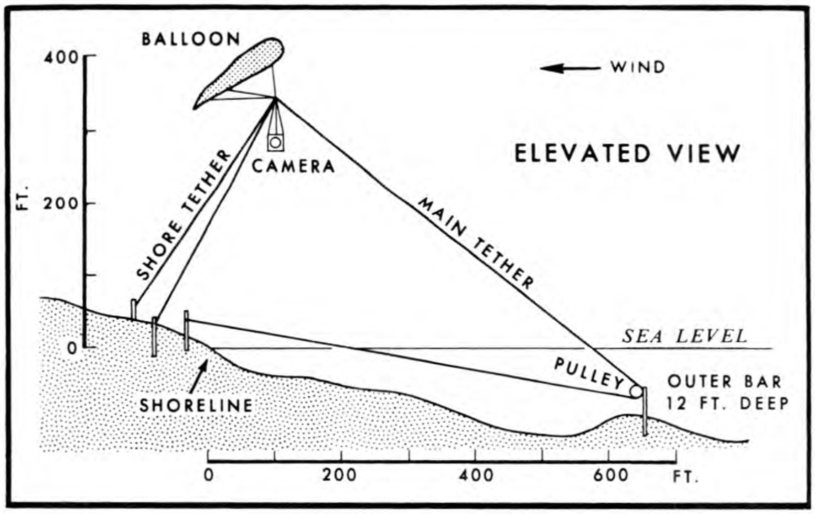


Figure 3

The camera, equipped with an automatic winding mechanism, can be triggered by a radio receiver or by a 450-foot long telephone wire connecting it to a ground-based switch. The plastic balloon, swept-winged in shape and with aerofoil cross section, is anchored by three tethers, one offshore and two shore-based. (See Figure 3.)

Photographs taken from an altitude of approximately 350 feet above the surf zone on Seagrove Beach, Fla., demonstrated the potentialities of this surveillance technique in shallow water research. They revealed not only a time history of rip currents operating in a series of three along shore, but also evidences of onshore mass transport between the rips, diffusion normal across the breaker line, individual wave crests, bottom relief, and even ripple marks in the feeder and rip channels.

Navy Begins Research on How Strains on Earth Affect Tides

The Navy has initiated research which could eventually permit it to predict accurately the rise and fall of tides all over the world, including the temporary covering of land areas with water.

A $25,000 study, to be conducted by the University of California at San Diego under contract to the Office of Naval Research, will examine the way the earth bends and yields when subjected not only to thousands of tiny earthquakes that occur every day but also to the pressures from tidal forces and ocean waves. These daily disturbances apply stresses and strains to the earth that greatly affect the movement of tides around the world.

Rear Admiral Thomas B. Owen, Chief of Naval Research, in announcing the study, stated: "The ability to make world-wide comprehensive predictions of tides could be vital to the Navy in planning amphibious operations in unknown areas as well as in unloading ships in those areas."

The research study will explore three major areas of earth strain and its yielding to disturbances. They are: (1) changes in earth elevations caused by the pulsing of the earth due to small earthquakes; (2) the downward flexing and upward rebounding of the earth's crust in response to tidal pressures; and (3) the earth motions due to low-frequency oceanic waves.

The pulsing of the earth in response to tiny earthquakes is so low that scientists in the past have been unable to obtain measurable data from conventional seismographic instruments. This is due to the relatively high noise levels in these instruments coupled with man-made noises and natural earth noise. UCSD researchers are developing special instruments designed to overcome this problem.

The UCSD group has devised equipment employing the latest concepts in geophysical instrument design. The investigations will utilize a long line of these instruments as a geophysical "antenna" to detect the pulsing, vibrating, and cracking of the earth.

The array of instruments includes gravimeters, tiltmeters, seismometers, and microbarographs. This antenna will eventually stretch across the Elsinore and San Jacinto faults in San Diego and Imperial counties, California.

The southwestern end of the antenna is located in Camp Elliott, some 15 miles east of La Jolla, while the northeastern end of the antenna is expected to terminate in the Colorado desert.

Already operating at Camp Elliott are two, 500-foot, liquid level tiltmeters one inch in diameter, buried six feet underground, and a 600-foot laser strain meter.

The tiltmeter measures the horizontal "tilting" of the earth. The laser strain meter measures small strains of the earth's surface. An accelerometer to measure the earth's vertical motion is being tested before it is installed as part of the antenna array.

The UCSD scientists hope to install enough of these stations to determine the characteristics of crustal blocks. There are massive sections of the earth's crust which are distinct from each other geologically and which respond differently to disturbances or stress. A large number of the stations on the antenna array will further insure that it will be sensitive to the earth's motion over a large area.

By periodically shifting the sites of the elements in the array and by reoccupying the old sites, the scientists believe they will obtain a systematic picture of the response of the region covered by the array.

Alvin Recovery Operations

Recovery operations began November 1 to bring back Alvin from the ocean bottom where it sank in 5000 feet of water on October 16, 120 miles south of Cape Cod. The two steel cables on the lowering cage snapped during a routine launch operation, plunging the 15-ton submersible forward in the water with its hatch open. She was being launched from the catamaran mother ship, Lulu, for a routine inspection of buoy moorings.

A three-man team, in the Alvin at the time of the accident, excaped with minor injuries. The pilot, Edward L. Bland, Jr., said that the sub carried them approximately 15 feet below the surface before bobbing to the top and staying afloat just long enough for an escape.

Six heavy nylon lines are normally attached to the sides of Alvin during launching. Crew members held onto these lines when the sub slid at a 45-degree angle into the water; this gave the men in the Alvin enough time to escape. Simultaneously, the Lulu's captain, Dale Butler, moved the catamaran forward to provide clearance for the men aboard Alvin. As the Alvin bobbed to the surface, the men scrambled onto the side of the Lulu without having to enter the water.

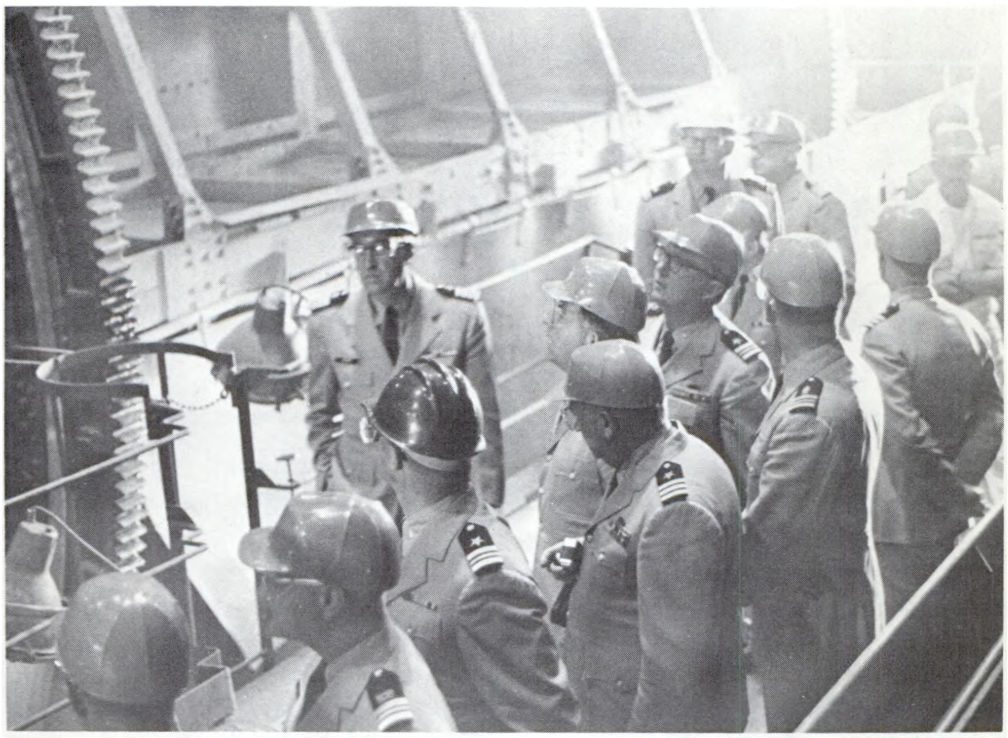
A forward observation window in Alvin's conning tower had broken. As a result, the ship was tilting forward and taking water fast through this port. The sphere below filled, the retaining lines snapped, and the 15-ton submersible plunged to the bottom.

The extent of damage to the Alvin as a result of its 5000-foot drop is unknown.

On the Naval Research Reserve

NRRC 9-6 Sponsors Two-Week Seminar

Ninety-one reservists attended the first Upper Midwest Naval Research Seminar at Minneapolis, Minnesota. During the Seminar there were field trips to Reserve Mining's taconite processing plant on Lake Superior, the Mayo Clinic, and the IBM plant at Rochester, Minnesota. Lectures at the University of Minnesota were alternated with visits to the local facilities of Honeywell, Control Data, 3M, UNIVAC, and FMC.



Attendees at the First Upper Midwest Seminar watch as a giant automated unloader clamps down on two hopper cars, then rotates them, dumping 175 tons of taconite ore to feed Reserve Mining's multimillion dollar Silver Bay, Minnesota, pelletizing plant.

Research and Development Seminar

The Office of Naval Research and the U.S. Atomic Energy Commission sponsored a Research and Development Seminar in August at Oak Ridge Tennessee. Fifty research reservists attended the meeting.

CAPT Hugh R. Murphy, USNR, of the Sixth Naval District was the lead off speaker. RADM T. B. Owen, USN, Chief of Naval Research discussed the objectives of the Naval research program and the problems facing the research community.

Other presentations were made by CDR G. J. Mischke, USN, Defense Atomic Support Agency, CAPT W. C. Raposa, USN, Strike Warfare Division of CNO, and CDR R. W. Keniston, USNR, Special Assistant to the Chief of Naval Research for Research Reserve.

The program emphasized the biological and ecological research and development being conducted in the Oak Ridge area. The reservists participated in the Conference on Application of Abundant Nuclear Energy.

Officially Activated Research Reserve Companies

There are 92 Research Reserve companies located throughout the United States. These companies are listed below by Naval Districts. The time and place of meeting, address, and name of the commanding officer are included.

FIRST NAVAL DISTRICT

NRRC 1-1
1930, 1st & 3rd Mondays, Room 4-270, M.I.T., 77 Massachusetts Avenue, Cambridge, Massachusetts 02138. (CDR Charles F. Davis, Jr., USNR, P.O. Box E, Concord, Massachusetts 01742.)

NRRC 1-2
1930, 1st & 3rd Wednesdays, Room 114, Naval & Marine Corps Reserve Training Center, Fields Point, Providence, Rhode Island 02905. (CDR Robert E. Hill, USNR, 26 Benevolent Street, Providence, Rhode Island 02906.)

NRRC 1-3
1930, 1st & 3rd Tuesdays. (No meetings during July and August.) Dickinson Hall, Room 214, University of Massachusetts, Amherst, Massachusetts 02103. (LCDR Edward A. Walsh, USNR, 194 Notch Road, North Adams, Massachusetts 01247.)

NRRC 1-5
1930, 1st & 3rd Mondays. (No meetings during July and August.) Higgins Laboratories, Seminar Room 107, Worcester Polytechnic Institute, Worcester, Massachusetts 01609. (LCDR Clarence D. Peterson, USNR, 1 Germain Street, Worcester, Massachusetts 01602.)

NRRC 1-7
1930, 1st & 3rd Tuesdays. (No meetings during July, August, and September.) College Hall, Room 312, Dartmouth College, Hanover, New Hampshire 03755. (LCDR Wesley (NMN) Pietkiewicz, USNR, R.R. No. 1, Box 537, Windsor, Vermont 05089.)

THIRD NAVAL DISTRICT

NRRC 3-1
1830, 1st & 3rd Thursdays, 820 United Nations Plaza, New York, New York 10017. (CDR Martin A. Rizack, USNR, 318 Warwick Avenue, Teaneck, New Jersey 07666.)

NRRC 3-2
1930, 2nd & 4th Mondays, U.S. Merchant Marine Academy, Kings Point, New York 11024. (CDR Frederick E. Roediger, USNR, Glenby Lane, Glen Head, New York 11545.)

NRRC 3-3
2000, alternate Mondays, Room G14A, School of Medicine, University of Buffalo, Buffalo, New York 14214. (LCDR Sheldon M. Markel, USNR, 206 Irving Terrace, Buffalo, New York 14223.)

NRRC 3-4
2000, alternate Mondays, Bausch & Lomb Hall, Room 106, University of Rochester, Rochester, New York 14627. (LCDR Edward R. Schickler, USNR, 990 Pear Tree Lane, Webster, New York 14580.)

NRRC 3-5
2000, alternate Thursdays, Hartford Electric Building, Wolcott Hill Road, Wethersfield, Connecticut 06169. (LCDR Edward C. Toops, USNR, 179 Westledge Road, West Simsbury, Connecticut 06092.)

NRRC 3-7
2000, 2nd & 4th Thursdays, U.S. Naval Reserve training Center, Scotia, New York 12302. (CDR Benjamin B. Lockett, USNR, 1804 Nott Street, Schenectady, New York 12309.)

NRRC 3-8
1900, 2nd & 4th Tuesdays, Young & Rubicam, Inc., 40th St., 16th Floor, 285 Madison Ave., New York, New York 10017. (LCDR Vincent J. Gentile, USNR, 100 B. Cedar Lane, Highland Park, New Jersey 08904.)

NRRC 3-9
1930, 2nd & 3rd Wednesdays, Brookhaven National Laboratory, Upton, L. I., New York 11973. (CAPT Victor P. Bond, USNR, Cedar Lane, Setauket, L.I., New York 11785.)

NRRC 3-14
1800, 1st & 3rd Tuesdays, U.S. Naval Reserve Training Center, 75 Oakley Street, Poughkeepsie, New York 12601. (CDR Richard J. Messina, USNR, Simmons Street, Saugerties, New York 12477.)

NRRC 3-16
2000, 1st & 3rd Thursdays, Sheffield Lab. of Engineering Mechanics, 51 Prospect Street, New Haven, Connecticut. (LCDR C. Marshall Davidson, USNR, 22 Lawrence Road, Hamden, Connecticut 06514.)

NRRC 3-17
1730, alternate Tuesdays, Sperry and Hutchinson Building, S and H Conference Room, Ninth Floor, 330 Madison Avenue, New York, N. Y. 10017. (LCDR Jordan C. Schreiber, USNR, 110 Bleecker Street, New York, New York 10012.)

NRRC 3-18
1945, 1st & 3rd Mondays, Marshall Hall, State University College of Forestry, Syracuse University, Syracuse, N.Y. 13210. (LCDR Curtis B. Wilbanks, USNR, 129 Bennett Road, Camillus, New York 13031.)

FOURTH NAVAL DISTRICT

NRRC 4-1
2000, alternate Wednesdays, 10 Buyot Hall, Princeton, New Jersey 08540. (CAPT David M. Jewett, USNR, 22 Sunset Boulevard, East Brunswick, N.J. 08816.)

NRRC 4-3
2000, alternate Thursdays, U.S. Naval & Marine Corps Reserve Training Center, 4902 Forbes Street, Pittsburgh, Pennsylvania 15213. (LCDR Helmuth H. Hansen, USNR, 301 Sharon Drive, Pittsburgh, Pennsylvania 15221.)

NRRC 4-4
1900, alternate Mondays, 316 Wagner Building, Pennsylvania State University, University Park, Pennsylvania 16801. (LT John D. Sink, USNR, 100 Oakmont Road, State College, Pennsylvania 16801.)

NRRC 4-5
2000, alternate Mondays, U.S. Naval & Marine Corps Reserve Training Center, 3920 Kirkwood Highway, Wilmington, Delaware 19808. (LCDR James S. Linderman, USNR, 1515 Brandywine Boulevard, Wilmington, Delaware 19809.)

NRRC 4-7
1930, alternate Thursdays. (No meetings during August.) Battelle Memorial Institute, South Conference Room, 505 King Avenue, Columbus, Ohio 43201. (LCDR Charles R. McLean, USNR, 47 Electric Avenue, Westerville, Ohio 43081.)

NRRC 4-8
1800, alternate Mondays, U.S. Naval & Marine Corps Reserve Training Center, 1089 East 9th Street, Cleveland, Ohio 44114. (LCDR Gordon D. Pred, USNR, 23401 Effingham Road, Euclid, Ohio 44117.)

NRRC 4-11
1900, alternate Tuesdays, U.S. Naval & Marine Corps Reserve Training Center,

Gilbert Ave. at Victory Pkwy, Rm. 37, Cincinnati, Ohio 45227. (CDR John E. White, USNR, 9757 Overview Lane, Cincinnati, Ohio 45231.)

NRRC 4-12
1930, alternate Tuesdays. (No meetings during July and August.) Technical Training Building, U.S. Naval Air Station, Willow Grove, Pennsylvania 19090. (CDR William H. Hazlett, Jr., USNR, Bit-a-Bux, River Road, Upper Black Eddy, Pennsylvania 18973.)

NRRC 4-13
1930, 1st & 3rd Mondays, Franklin Institute, 20th Street and Parkway, Philadelphia, Pa. 19112. (LCDR Donald J. Heron, USNR, 7717 Cedarbrook Street, Philadelphia, Pennsylvania 19150.)

FIFTH NAVAL DISTRICT

NRRC 5-2
2000, Mondays. (No meetings during July and August.) Room 310, Hutcheson Hall, Virginia Polytechnic Institute, Blacksburg, Virginia 24061. (LT William J. Kennedy, Jr., USNR, 210 Orchard View Lane, Blacksburg, Virginia 24060.)

NRRC 5-3
1930, 1st & 3rd Tuesdays, Building 560, Fort Detrick, Frederick, Maryland 21701. (LCDR Robert E. Boyle, MSC, USNR, Route No. 7, Eastview, Frederick, Maryland 21701.)

NRRC 5-4
1945, 1st & 3rd Thursdays, Board of Education Building, 3 East 25th Street, Baltimore, Maryland. (LCDR John M. Backer, USNR, 402 Cedarcroft Road, Baltimore, Maryland 21212.)

NRRC 5-8
2000, 1st & 3rd Thursdays, National Academy of Sciences, 2102 Constitution Avenue, N.W., Washington, D.C. (CDR Julian C. Nall, USNR, 4631 N. 27th Street, Arlington, Virginia 22207.)

NRRC 5-9
1630, 1st & 3rd Fridays (except during First Quarter meetings are alternate Wednesdays), U.S. Naval Research Laboratory, 4555 Overlook Avenue, Washington, D.C. 20390. (LCDR Herschel L. Smith, Jr., USNR, 6464 Hemlock Place, S.E., Temple Hills Park, Maryland 20031.)

NRRC 5-10
2000, 2nd & 4th Tuesdays, Naval Medical Research Institute, National Naval Medical Center, Bethesda, Maryland 20014. (CDR Sherman Ross, MSC, USNR, 24 Wessex Road, Silver Spring, Maryland 20910.)

NRRC 5-11
2000, 2nd & 4th Tuesdays, Annapolis Division Ships Research & Development Center, Annapolis, Maryland 21402. (CDR Roy F. Dodd, USNR, 2 Oak Lane, S.W., Glen Burnie, Maryland 21061.)

NRRC 5-12
1900, 2nd & 4th Mondays, Building 1200, Room A135, U.S. Naval Weapons Laboratory, Dahlgren, Virginia 22448. (LCDR Don J. Ammerman, USNR, P.O. Box 501, Dahlgren, Virginia 22448.)

SIXTH NAVAL DISTRICT

NRRC 6-1
1930, 1st, 2nd & 3rd Thursdays. (No meetings during First Quarter.) U.S. Naval & Marine Corps Reserve Training Center, 274 Fifth Street, N.W., Atlanta, Georgia 30318. (LCDR Donald A. Reddicks, USNR, 5320 Roswell Road, N.E., Apt. J-2, Atlanta, Georgia 30305.)

NRRC 6-3
1930, 2nd & 4th Wednesdays, U.S. Army Reserve Armory, Elza Gate, Oak Ridge, Tennessee 37830. LCDR John L. Redford, USNR, 131 Andover Circle, Oak Ridge, Tennessee 37830.)

NRRC 6-4
1915, 1st & 3rd Tuesdays, U.S. Naval Reserve Training Center, 1300 N.E. 8th Avenue, Gainesville, Florida. (LT Charles E. Engel, USNR, 925 N.W. 52 Terrace, Gainesville, Florida 32601.)

NRRC 6-5
1930, 1st, 3rd & 5th Mondays, U.S. Naval & Marine Corps Reserve Training Center, P.O. Box 1180, Broad Avenue, Gulfport, Mississippi 39502. (LCDR Walter R. Congdon, USNR, 113 Beach Drive, Pass Christian, Mississippi 39560.)

NRRC 6-6
1800, Mondays. (No meetings during First Quarter.) NROTC Building, University of North Carolina, Chapel Hill, North Carolina. (LCDR William E. Hammond, USNR, 10 Forrest Dale Drive, Durham, North Carolina 27705.)

NRRC 6-8
1930, 1st & 3rd Tuesdays, U.S. Naval Reserve Training Center, Livingston & Parramore Streets, Orlando, Florida. (CDR Clarence R. Bachmann, USNR, 1121 Willowbrook Trail, Maitland, Florida 32751.)

NRRC 6-9
1900, 1st, 3rd & 4th Mondays, Smith Hall, U.S. Navy Supply Corps School, Athens, Georgia. (CAPT William T. Chambers, USNR, Cabin Lane Drive, Athens, Georgia 30601.)

NRRC 6-16
1700, 1st & 3rd Tuesdays, PAFB Chapel Annex, B Street, Patrick Air Force Base, Florida. (LCDR Carroll A. Schory, USNR, 125 Eighth Avenue, Indialantic, Florida 32901.)

NRRC 6-17
1900, Tuesdays, U.S. Naval Reserve Training Center, 203 Leeman Ferry Road, S.W., Huntsville, Alabama. (LCDR Alfred R. Morse, USNR, 2613 Vista Drive, S.E., Huntsville, Alabama 35803.)

NRRC 6-18
2000, 1st & 3rd Mondays, School of Engineering, Vanderbilt University, Nashville, Tennessee. (LCDR Hugh G. Eldredge, USNR, Glendale Apts., Apt. 14, 1112 Clifton Lane, Nashville, Tennessee 37204.)

NRRC 6-19
1930, 1st, 2nd & 3rd Thursdays, U.S. Naval Reserve Training Center, 12 Meadow Street, Chattanooga, Tennessee 37405. (LCDR Oscar M. Wilson, Jr., USNR, 12 Fairhill Drive, Chattanooga, Tennessee 37405.)

EIGHTH NAVAL DISTRICT

NRRC 8-1
1930, alternate Tuesdays, Richardson Memorial Building, Room 213 Tulane University, 6823 St. Charles Avenue, New Orleans, Louisiana 70188. (LCDR C. W. Unangst, USNR, 1758 Pressburg Street, New Orleans, Louisiana 70122.)

NRRC 8-3
1930, Mondays, Biological Science Building, Texas A&M College, College Station, Texas 77843. (LCDR Robert M. Olson, USNR, 4005 Nagle Street, Bryan, Texas 77801.)

NRRC 8-4
1930, 1st & 3rd Wednesdays, U.S. Naval Reserve Training Center, Houston, Texas 77025. (LCDR Gerald L. Glahn, USNR, 301 Tose Lane Drive, Baytown, Texas 77520.)

NRRC 8-5
1900, Mondays, Experimental Science Building 115, University of Texas, Austin, Texas 78712. (LCDR Loy E. England, USNR, 1101 Anderson Lane, Austin, Texas 78757.)

NRRC 8-7
1930, Wednesdays, NROTC Building, University of New Mexico, Albuquerque, New Mexico 87106. (LCDR Robert P. Baker, USNR, RR Box 150-1, Alameda, New Mexico 87112.)

NRRC 8-8
1930, 1st & 3rd Tuesdays, Post Office Building, Bartlesville, Oklahoma 74003. (LCDR Vernon A. Cawi, USNR, 5815 S.E. Harvard, Bartlesville, Oklahoma 74003.)

NRRC 8-9
1700, 1st & 3rd Tuesdays, Lecture Room Administration Building, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544. (LCDR Charles A. Linder, USNR, 232 Dos Brazos, Los Alamos, New Mexico 87544.)

NRRC 8-12
2000, 1st & 3rd Tuesdays, Santa Fe Building, 114 Commerce Street, Dallas, Texas 75202. (LCDR Charles P. Grier, USNR, 9818 Fitzroy Drive, Dallas, Texas 75238.)

NRRC 8-13
2000, 2nd, 3rd & 4th Mondays, Room 358, Union Building, Oklahoma State University, Stillwater, Oklahoma 74075. (LT Eldon C. Nelson, USNR, 401 N. Donaldson Drive, Stillwater, Oklahoma 74074.)

NINTH NAVAL DISTRICT

NRRC 9-1
1900, 2nd & 4th Tuesdays, Naval Armory, Randolph at The Lake, Chicago, Illinois 60601. (CDR John D. Davidson, USNR, 831 Santa Maria Drive, Naperville, Illinois 60540.)

NRRC 9-2
1930, Mondays, Law Building, University of Illinois, Urbana, Illinois 61803. (LCDR Frederick L. Neumann, USNR, 502 East Washington Street, Urbana, Illinois 61801.)

NRRC 9-3
1930, Mondays. (Varied dates July, August and September.) 62 North Hall, University of Michigan, Ann Arbor, Michigan 48104 (LCDR Loren L. Wilcox, USNR, 3360 Pontiac Lake Road, Pontiac, Michigan 48054.)

NRRC 9-4
2000, 2nd & 4th Tuesdays, U.S. Naval & Marine Corps Training Center, Milwaukee, Wisconsin 53207. (CAPT Robert E. Best, USNR, 3124 North 103rd Street, Wauwatosa, Wisconsin 53213.)

NRRC 9-5
1900, 1st, 2nd & 3rd Wednesdays, USN-ROTC Building, Iowa State College, Ames, Iowa 50010. (LTJG Robert P. Staggs, USNR, 312 Abraham Drive, Ames, Iowa 50010.)

NRRC 9-6
1930, 2nd & 4th Mondays, Room 308, Mechanical Eng. Building, University of Minnesota, Minneapolis, Minnesota 55414. (LCDR Theodore E. Molitor, USNR, 1286 Burde Avenue, St. Paul, Minnesota 55113.)

NRRC 9-7
1900, Tuesdays, c/o NROTC Unit, AES Annex, Purdue University, Lafayette, Indiana 47907. (LCDR George J. Koehler, USNR, 3431 State Road 26 East, Lafayette, Indiana 47905.)

NRRC 9-8
1900, 2nd & 4th Wednesdays, Air Force ROTC Facilities, Washington University, St. Louis, Missouri 63130. (LT William F. Schallert, USNR, 8923 Larchwood Ct. Crestwood, Missouri 63126.)

NRRC 9-10
1800, alternate Tuesdays, Sargent Hall, Northwestern University, Evanston, Illinois 60201. (CDR Benedict J. Jaskoski, USNR, 6336 Magnolia, Chicago, Illinois 60626.)

NRRC 9-12
1930, Thursdays, Wood Utilization Laboratory, Colorado State University, Fort Collins, Colorado 80521. (CDR Harry Troxell, USNR, 624 Armstrong Avenue, Fort Collins, Colorado 80521.)

NRRC 9-14
1930, alternate Mondays, State Lab of Hygiene, University of Wisconsin, Madison, Wisconsin 53706. (LCDR Fred H. Koenecke, USNR, 1640 Capital Avenue, Madison, Wisconsin 53705.)

NRRC 9-15
1900, 2nd & 4th Wednesdays, Midland Community Center, Midland, Michigan 48640. (LT William E. Pearson, USNR, 1200 Glendale Street, Midland, Michigan 48640.)

NRRC 9-16
1930, Tuesdays, 221 Computing Center,

Michigan State University East Lansing, Michigan. (LCDR Armon F. Yanders, USNR, 1311 Bayshore Drive, Haslett, Michigan 48840.)

NRRC 9-19
1930, Mondays, Room 61, Chemistry Bldg., State Univ. of Iowa, Iowa City, Iowa 52240. (LTJG Thomas R. Breese, USNR, 227 Mahaska Drive, Iowa City, Iowa 52240.)

NRRC 9-20
1930, Tuesdays, 104 Military Science Building, University of Kansas, Lawrence, Kansas 66045. (LCDR Owen F. Wagner, USNR, 12001 West 60th Terrace, Shawnee, Kansas 66216.)

NRRC 9-21
2000, 1st & 3rd Thursdays, Student Union, Univ. of Denver, Denver, Colorado 80210. (LT Allen L. Miller, USNR, 843 South Vivian Street, Lakewood, Colorado 80228.)

NRRC 9-23
1930, 2nd & 4th Wednesdays, Argonne National Laboratory, Argonne, Illinois 60439. (LCDR Donald J. Keefe, USNR, 127th & Archer, Lamont, Illinois 60439.)

NRRC 9-25
1930, 1st & 3rd Wednesdays, U.S. Naval Reserve Training Center, Indianapolis, Indiana 46208. (CAPT Robert O. Jackson, USNR, 1 East 73rd Street, Indianapolis, Indiana 46240.)

NRRC 9-26
1930, Tuesdays, U.S. Naval Reserve Training Center, Colorado Springs, Colorado 80906. (LCDR Henry W. Elkins, USNR, 1214 Mount View Lane, Colorado Springs, Colorado 80907.)

NRRC 9-27
1930, Thursdays, Bldg. 1, Great Lakes, Illinois 60088. (CDR John O. Karstrom, USNR, P.O. Box 855, Lake Forest, Illinois 60045.)

NRRC 9-28
1900, Wednesdays, NROTC Armory, 6th Street & Stewart Road, Columbia, Missouri 65201. (LCDR Donald H. Hazelwood, USNR, R.D. 5, Columbia, Missouri 65201.)

ELEVENTH NAVAL DISTRICT

NRRC 11-2
2000, 1st & 3rd Thursdays, U.S. N&MCRTC, 2727 Paloma Street, Pasadena, California 91107. (CAPT Charles V. Armstrong, USNR, 2316 Las Lunas, Pasadena, California 91108.)

NRRC 11-5
1930, 2nd, 3rd, & 4th Tuesdays, U.S. Naval Reserve Training Center, Camp Decatur, San Diego, California 92133. (LCDR Craig R. Allen, USNR, 1985 Alameda Terrace, San Diego, California 92103.)

NRRC 11-7
2000, 1st & 3rd Thursdays, U.S. Naval & Marine Corps Reserve Training Center, 1100 South Avernon Way, Tucson, Arizona 85711. (LCDR Robert L. Voigt, USNR, 2131 East La Madera Drive, Tucson, Arizona 85719.)

NRRC 11-8
1645, 2nd & 4th Wednesdays, Pacific Missile Range, Conference Room, Bldg. 1, Point Mugu, California 93041. (LCDR Donald D. Paillette, USNR, 1026 Via Arroyo, Ventura, California 93003.)

NRRC 11-9
2000, 2nd & 4th Wednesdays, Pitzer College Conf. Room, Administration Bldg., 8 Mills Road, Claremont, California 91712. (LCDR Harry E. Waldorf, USNR, 7238 North Ben Lomond Avenue, Glendora, California 91740.)

NRRC 11-11
2000, 1st & 3rd Mondays, U.S. N&MCRTC, 3400 Airport Avenue, Santa Monica, California 90405. (LCDR Freeland F. Stecker, USNR, 5549 Scotwood Drive, Palos Verdes Peninsula, Calif. 90274.)

TWELFTH NAVAL DISTRICT

NRRC 12-2
1700, 1st, 2nd & 3rd Mondays, Room A, Bldg. 111, Lawrence Radiation Lab., Livermore, California. (LCDR Robert L. Chapman, USNR, 174 Midland Way, Danville, California 94526.)

NRRC 12-3
1930, 1st & 3rd Wednesdays, Room 101, Physics Lecture Hall, Stanford University, Stanford, California. (LCDR Hugh M. Satterlee, USNR, 2399 South Court, Palo Alto, California 94301.)

NRRC 12-4
2000, Wednesdays, Room 119, Agricultural Bldg., Fresno State College, Fresno, California. (LCDR Robert "J" Selkirk, USNR, 5579 North Sixth Street, Fresno, California 93726.)

NRRC 12-5
1930, 2nd & 4th Wednesdays, Room 247, Cory Hall, University of California, Berkeley, California. (LCDR Harold B. Curtis, USNR, 501 La Vista Road, Walnut Creek, California 94598.)

NRRC 12-6
1930, 1st 2nd & 4th Thursdays, Room 108, Young Hall, University of California, Davis, California. (CDR Hubert M. Reisenauer, USNR, 828 "A" Street, Davis, California 95616.)

NRRC 12-8
2000, 2nd & 4th Wednesdays, Room S-136, USN Postgraduate School, Monterey, California. (CDR Sydney H. Kalmbach, USNR, P.O. Box 727, Pebble Beach, California 93953.)

NRRC 12-9
1715, Tuesdays, Main Conference Room, Building 2001, Aerojet-General Corporation, Sacramento, California. (LCDR Robert B. Lynch, USNR, 10219 Malaga Way, Rancho Cordova, California 95670.)

THIRTEENTH NAVAL DISTRICT

NRRC 13-1
1930, 1st, 2nd & 3rd Mondays, USN ROTC, 860 Terry Avenue North, Seattle, Washington 98109. (CDR Albert S. Hanson, USNR, 3215 98th N.E., Bellevue, Washington 98004.)

NRRC 13-4
2000, 2nd & 4th Tuesdays, USN&MCRTC, Swan Island, Portland, Oregon 97217. (CDR Delmer L. Kuns, USNR, 14465 S.W., 119th Avenue, Tigard, Oregon 97223.)

NRRC 13-5
1930, 2nd & 4th Mondays, USN ROTC Armory, Oregon State University, Corvallis, Oregon 97330. (LCDR Richard E. Moffitt, USNR, 7635 N.W. Mount View Drive, Corvallis, Oregon 97332.)

NRRC 13-6
1930, 2nd & 4th Thursdays, Reserve Center Armory, Tautphaus Park, Idaho Falls, Idaho 83401. (CAPT Thomas J. Wadsworth, USNR, 256 Third Street, Idaho Falls, Idaho 83401.)

Ocean Engineering Symposium

Preliminary planning has been completed for the first joint symposium of universities doing deep ocean engineering under the auspices of Project THEMIS. The symposium will be conducted 13-14 December 1968 at Notre Dame, Indiana. The University of Massachusetts and University of Norte Dame will conduct technical and general sessions. Representatives from other universities interested in this field will be invited. Additional information may be obtained from Dr. Harry C. Saxe, THEMIS Program Manager, College of Engineering, University of Notre Dame, Notre Dame, Indiana 46556.

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*Articles are arranged under the ONR division having cognizance of the research described.

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Donnelly, J. D., LCDR, USN, January
Fiedler, Fred E., July
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Goffman, Jerry M., June (coauthor)
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Hagey, Grahm L., February
Helmreich, Robert, February
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Horning, Donald F., July
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Macander, Aleksander, May, (coauthor)
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Owen, Thomas B., RADM, USN, January and October
Plag, John A., June, (coauthor)
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Roberts, Ralph, August
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Weinrauch, Alfred, April
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thesaurus. When the Engineers Joint Council began work on revising its 1964 *Thesaurus of Engineering Terms,* it was decided to pool resources and professional help.

The 690-page thesaurus lists more than 23,000 main terms with generic relationships, cross-references and indexes for a total of more than 245,000 line entries. The DOD edition, consisting of 10,000 copies, was printed at the Government Printing Office using its newest computerized typesetting system known as the Linotron. This equipment performed the task in about two working days compared to some six man-months that might have been required by conventional typesetting methods.

Following primary distribution by the Office of Naval Research, further distribution within the Federal Government and to its contractors will be made through the Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314. The engineering community and the general public can purchase copies of the EJC edition from the Engineers Joint Council, 345 East 74th Street, New York, New York 10017. A magnetic tape version of the thesaurus with programs for computer manipulation will be made available.

Selected Contract Research Reports

The contract research reports listed below have been extracted from U.S. Government Research & Development Report 68, No. 12 of 25 June 1968, No. 13 of 10 July 1968, and No. 15 of 10 August 1968. Government agencies and their contractors who are registered with the Defense Documentation Center of the Defense Supply Agency may obtain copies from the Center at Cameron Station, Alexandria, Virginia 22314. Abstracts of the reports are found in USGRDR 68, Nos. 12, 13, and 15.

For non-DDC users, most reports may be purchased from the Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, Springfield, Virginia 21151.

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Upper section of the mast of the ocean data station Alpha, showing part of its array of environmental measuring instruments. Alpha and its sister buoy Bravo are two of the deep-moored stations used to gather data in the North Pacific Study. See page 1.

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