NAVAL RESEARCH

REVIEWS

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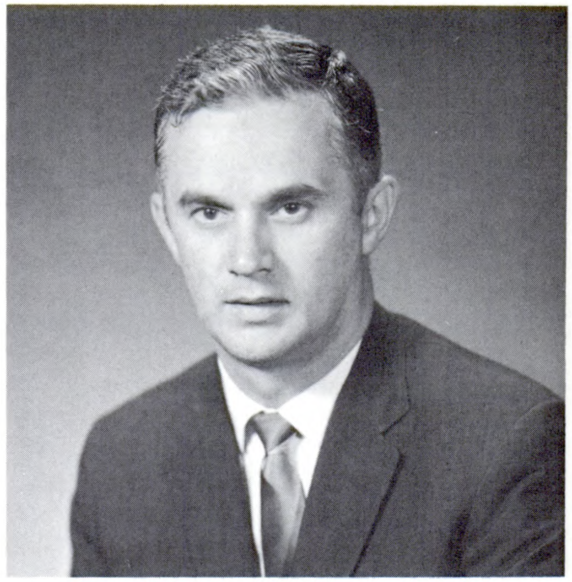
ONR's Dr. James Miller Wins Flemming Award



Dr. James Miller, the Head of ONR's Engineering Psychology Branch, was recently presented one of the 1967 Arthur S. Flemming Awards for outstanding public service. The Flemming Awards are granted annually by the Downtown Chapter of the District of Columbia Junior Chamber of Commerce, Washington, D.C. to the ten young men in the Federal service who have performed unusual and outstanding work of distinct benefit to the government. Five honorary awards are granted for exceptional achievement in the scientific or technical fields, and five are granted for exceptional achievement in the executive or administrative fields. The awards were presented at a luncheon honoring the winners on February 16 in the Grand Ballroom of Washington's Willard Hotel. Earlier, the winners were presented to President Johnson at the White House.

Dr. Miller directs a program of research support in the general area of human factors engineering and man-machine relationships. He is the principal consultant in engineering psychology to the Chief of Naval Research, and advisor to the Chiefs of the various Navy Systems Commands.

In the Navy's Man-in-the-sea or Sealab program, Dr. Miller has the primary responsibility for studying and solving the problems of man's performance while living and working for prolonged periods on the ocean floor. He played a prominent role in the 1965 Sealab II experiment in which 28 men lived for a total of 45 days at a depth of 205 feet off the coast of La Jolla, California. Although a previous experiment, Sealab I, demonstrated that men can live for prolonged periods under water, no one had found whether men could perform useful work, ranging from collecting scientific data to conducting salvage operations, in such an environment. To answer this question, Dr. Miller developed a pioneering research program for testing and measuring the behavior and performance of the men taking part in Sealab II. This program, which included tests designed to measure mental alertness, manipulative skill, tactile sensitivity, and visual and auditory acuity while working in the ocean, had to be administered remotely since the psychologist himself could not be present. The results of the program have encouraged the planning of future Sealab experiments, in which Dr. Miller will conduct further studies, and have provided knowledge essential to the design of tools and equipment required for undersea operations of the future.

A major factor in Dr. Miller's success is his deep concern with the need of bringing together scientists, engineers and operational personnel to achieve mutual understanding of problems to be solved. This concern has led him to initiate a special type of working seminar in which small groups (60-70 people) meet to discuss theory and practice simultaneously. Such meetings were held in connection with the Sealab project.

Dr. Miller, as the Navy representative, has been elected Deputy Chairman of the National Academy of Sciences-National Research Council Committee on Vision. He is also the principal coordinator of the Department of Defense project of preparing a current guide in utilizing human factors.

ONR London - The Navy's International Scientific Exchange

The Office of Naval Research Branch Office, London, operates a unique service not only for the Navy research community but also for the broader American scientific community. The professional staff of ONR London, which includes Navy officers as well as civilian scientists, provides a direct link between European and U.S. scientific research. Through regular visits to scientific and technical establishments in Great Britain and Europe, and through attendance at international scientific meetings, ONR London personnel maintain communication pipelines which provide a steady two-way flow of information on scientific progress between this country and abroad.

ONR London, like its parent, ONR Washington, is a descendant of the World War II Office of Scientific Research and Development, which during the war forged a new partnership between the Federal Government and the American scientist. The success of OSRD stimulated the Navy to establish its own permanent organization which would continue this partnership and insure the technological evolution of the Navy beyond the end of the war. The Navy was considerably aided in this effort by the publication of Vannevar Bush's influential report, "Science, the Endless Frontier," in July 1945 in which he urged that government support and participation in science be continued beyond the end of the war. The Office of Research and Inventions, which had already been set up by the Navy in May 1945, was transformed by Act of Congress into the Office of Naval Research in August 1946 when it became the first Federal agency with the primary mission of supporting scientific research.

The need for international exchange of scientific information was also noted by Dr. Bush in his report. He stated that "increasing specialization of science will make it more important than ever that scientists in this country keep continually abreast of developments abroad." This was spelled out even more cogently by the Steelman Report, "Science and Public Policy," published in 1947. This report stated: "Even when conditions of free scientific publication exist, there is often a considerable time lag between completion of the research and publication. Moreover, it is important that research workers be aware of similar or overlapping interests at an early stage in the work in order to make plans for cooperation or for cross-checking results."

As it happened, OSRD had established a London Mission in 1940 for the exchange of war research information. It was logical to continue this function under ONR. In fact, the jurisdiction of OSRD London was transferred to the Navy in March 1946 before ORI had become ONR. The transition was made even smoother when Dr. Holbrook M.

MacNeillie, who had headed the OSRD London Liaison Office, was appointed the scientific director for the new Navy London office. The first Commanding Officer following him was Commodore Robert E. Robinson, Jr. The Commanding Officers following him were Captains James P. Clay, Phillip D. Lohmann, Phillip S. Creasor, Bernard H. Meyer, Bradley F. Bennett, John K. Sloatman, Jr., William W. Schaefer, and the present incumbent, Captain C. T. Froscher.

The scientific directors who followed Dr. MacNeillie were Doctors Daniel B. Clapp, Charles E. Sunderlin, Maurice E. Bell, Samuel R. Aspinall, Gerard F. W. Mulders, David M. Gates, Howard E. Page, Immanuel Estermann, Peter King, and the present incumbent, Mr. Aubrey Pryce.

The initial objective of ONR London was to collect information on European research. Its mission, as originally stated, was to establish and maintain liaison with all scientific research agencies in free Europe and adjacent areas outside the Iron Curtain in order to keep the Navy Department, and especially the Chief of Naval Research, informed of all scientific endeavors in those areas. Right from the start ONRL realized that it must develop an image of a truly scientific activity rather than an intelligence arm of the U.S. government. Such an image was of crucial importance to the success of its mission.

A key element in achieving this success was the establishment of a policy of employing scientists highly respected in their fields. About 12 members of the professional staff are civilians from academic positions of the rank of full or senior associate professor or from government positions of corresponding professional standing. About 60 percent of this group are from universities and non-government research agencies. In most cases they have already established reputations in Europe, which gives them ready access to the academic community of Europe. Since they are not associated with military activities, they are in a good position to have a free exchange of scientific information with their colleagues. The remaining 40 percent of the civilian staff comes from ONR or other government activities. In addition, there is an 11-man military contingent which consists of technically trained officers, either from the medical and related fields supplied by the Medical Service Corps or from the general or restricted line.

None of the civilian scientists remains for more than two years, with the usual stay from one year to 18 months. This rapid turnover is deliberate to permit the hiring of outstanding professors who can stay away from their universities for only one academic year plus two summers. The usual practice is to accept employment at ONRL during a sabbatical. Another reason for the short-term employment is that ONRL wants scientists who are actively engaged in research. If such scientists remained away from their work for an extensive period, they

CAPT C. T. Froscher, Commanding Officer, ONR London (left) and Mr. Aubrey Pryce, Scientific Director, ONR London

would be removed from the main stream of research in their fields and their effectiveness in the exchange of information would rapidly decrease.

The qualifications for a scientific officer on the staff of ONRL were probably best set forth by Dr. C. E. Sunderlin, one of the early scientific directors of ONRL. As Dr. Sunderlin described him, the successful scientific liaison officer must, of course, be competent in his own special field. This means he must have intimate knowledge of all important research in his field in the United States, for otherwise he cannot judge the importance and timeliness of research in Europe. He must possess sound judgment as to the relative importance of new developments. Dr. Sunderlin saw the scientific liaison officer as a man riding twin horses—eager to do research himself but confining himself for the moment to the research of others.

In the early years of ONRL, the work of the office centered on Great Britain. This was due not only because it took over the work of OSRD London Mission but also because Great Britain, unlike most of the European countries, had not been occupied by foreign troops. Many of its research laboratories continued important fundamental research in spite of night bombing, V-1's and V-2's and the usual rigors of war. Research work rapidly assumed a peacetime character in that country, and university enrollment practically doubled during the first three postwar years.

ONR London scientists spend 30 to 40 percent of their time attending scientific meetings and visiting laboratories outside of the London area

Gradually, however, the other countries of Western Europe rebuilt their programs of fundamental research and began to restock their supplies of scientific and technical knowledge and personnel. National scientific organizations began to appear in these countries. In France it was the Centre National de la Recherche Scientifique (CNRS). Belgium, Holland, Italy, and Spain established similar organizations.

German science was a special case. It had to be revitalized under military government and within the restrictions of inadequate laboratories, libraries, and personnel. Nevertheless, ONRL discovered that in the early postwar years five to ten thousand scientists in Germany were engaged in some kind of research, and that the results of this research were largely unpublished. Such research would have gone unnoted for a long period without the scientific liaison work of ONRL.

European science made a remarkably rapid recovery and by the early 1950's was back on its feet. It was now ready and eager to absorb data on U.S. research. This meant that ONR London not only had to collect material but also impart information on American progress to the European scientific community as well. This made the ONRL scientific staff even more welcome when they visited European institutions and laboratories.

Several years ago when the Mutual Weapons Development Program was initiated, ONRL was given an additional assignment. This was to provide a contact between the laboratories of the British and other military establishments and the Navy's research and development programs. ONRL established a Naval Applications Section staffed by technically trained naval officers to carry out this function. They have become the major liaison between the Navy and European defense establishments. A certain amount of these officers' time is spent on assisting with the administration of U.S. overseas research and development programs. In addition, ONR London naval officers often act as U.S. observers or members on NATO committees or in other international negotiations.

The principal justification, however, for the existence of ONR London and the major focus of its attention is the scientific exchange program. ONRL has developed a technique which is as far removed as possible from the bureaucratic way of doing things. Everything is based on the personal touch.

The ONRL scientific liaison officer, as indicated earlier, obtains information by visiting laboratories and attending scientific meetings. In a year, approximately 300 laboratories in Europe are visited by the ONRL scientists. The amount of time spent on these visits depends on the needs of the Navy and the energy of the scientist. Actually, he spends between 30 and 40 percent of his time in attendance at meetings and visiting laboratories outside the London area. While in London, in addition to his necessary routine correspondence, he prepares his reports for transmittal to scientists in the States, visits the local university and government laboratories and attends local scientific meetings and university seminars.

About 270 cities outside of London have been visited at least once. Eleven cities receive the bulk of the visits, with the greatest density in Great Britain. In addition to the major Western European countries, ONRL scientists visit the countries of southeast Europe and the Middle East as far as Israel. They also visit Poland, Czechoslovakia, Rumania, Yugoslavia, and Moscow. They come to call on the individual European scientist, not to visit the institution where he happens to be employed. The ONRL visitor makes it plain that his activities are overt and that the information he receives will be reported to the Navy Department and its contractors but that it will not be distributed further or made part of the scientific literature. This conforms to the ethics of scientific reporting which follows the rule that the communication of scientific results for the purpose of publication can properly be done only by the research scientist himself.

When an ONRL scientist obtains information which he believes is of value to the scientific program of the Navy, he reports his findings in one or more of a variety of ways depending upon the nature of the information. In some instances a letter will be sent to individual scientists, especially within ONR or to the Navy laboratories. When he wishes to send information of specific interest to a small group of specialists in the area, he prepares a Technical Memorandum which goes to approximately ten addressees. This form may also be used to fulfill a specific request of one of the Navy technical groups or contractors. Usually about 40 or 50 of these memoranda are issued per year.

If the information is of much more general interest, such as to all those involved in the metallurgy program of the Navy, the more formal Technical Report is used, which might receive a distribution of two or three hundred copies. Examples of these reports are, "The UNESCO International Conference on Radioisotopes in Scientific Research" and "Zoology and Physiology at the University of Bergen." The number of these reports averages about 150 per year and has been quite constant since 1950.

Finally, material which is of general scientific interest is published in the inexpensively produced *European Scientific Notes* published 10 to 12 times per year. This highly readable publication, which is as informal as two scientists chatting over a cup of coffee, has steadily increased its circulation in recent years, a significant indication of the major service performed by ONR London for the American scientific community. In 1955, this publication went to about twelve to fourteen hundred addressees. Presently ESN goes to 7000 individuals in government agencies and research laboratories, ONR contractors and scientists in the U.S. The publication is not distributed to the press in order to prevent reprinting or dissemination of the material contained in it beyond the scientific community. Each issue carries a statement that the material is "not part of the scientific literature."

European Scientific Notes, which contains a minimum of ten scientific articles in each issue, has been edited for some time by Victoria Hewitson assisted by another member of the London staff who takes on the duty for six months at a time. There is no question that it contains valuable scientific data and shrewd analysis of European research capabilities available in no other publication. As a check to see whether ESN is consistently useful to its recipients, a survey was made a few years ago in which each recipient was required to state whether he wished to continue receiving it. More than 96 percent of the addressees replied in the affirmative.

One reason for the popularity of ESN is that ONR London is the only agency of the U.S. government engaged in foreign scientific liaison on such a broad basis. The State Department science attache office is not generally staffed with a large number of experts in various scientific fields, and in addition it is somewhat restricted by national boundaries, which limits its coverage. The overseas offices of the other two military services do not engage in scientific liaison in the same nature and scope as that provided by ONR London. There has been no need since all of these agencies receive the reports from ONRL.

In addition to the reports prepared by the ONR London staff, the office transmits to the U.S. copies of scientific documents published in Europe. About 2500 titles per year are sent out, although only a few copies of each report are sent. About 75 percent of these documents originate in the United Kingdom, with other countries providing only a very small number. The reason for this is that the research report appears to be an Anglo-American invention and has not yet been adopted on a large scale by other countries.

Expediting the flow of technical information from the U.S. to Europe is an equally important function of ONRL. Many of the European publications available to ONRL for distribution to the U.S. are being received in exchange for U.S. documents distributed by ONRL. Moreover, the U.S. documents serve as a "ticket of admission" to European laboratories and facilitate the acquisition of the scientific information which forms a basis for the compilation of ONRL's own technical reports.

About 7000 research reports are received by ONRL each year from ONR contractors and a number of government agencies. These are generally technical and annual reports which the scientist has prepared for the agency which sponsors his research, and other reports which the responsible agency considers appropriate for European distribution. Since an average of 15 copies of each report is sent, this means that ONRL receives more than 100,000 documents a year for distribution to European scientists. Only a small fraction of this number is sent to an established distribution list. In the great majority of cases each document is scanned by an ONRL scientist who determines its distribution on the basis of his knowledge of the scientific interests of the recipient. Often these reports are sent to scientists who the ONRL liaison officer knows will have immediate use for the information because of its relationship to the research they are conducting. Such personal and timely distribution of information is greatly appreciated by European scientists and is a major factor in the large amount of good will built up by ONR London. ONRL also handles requests from European scientists for specific reports usually referenced in the publications they have received. In one year 300 requests for reports were received from European scientists and virtually all were filled.

ONR London also assists scientists working under the ONR program in their visits to Europe and European laboratories. This takes various forms such as suggesting laboratories of interest and assisting in making appointments. Many other scientists find it of value to discuss their plans with staff members and to exchange information on research activities in Europe. These visits are welcomed by ONRL. Where possible, the same kind of assistance is given to European scientists planning to visit the U.S. In effect, ONRL has become a focal point for American scientists visiting Europe and vice versa.

ONR London also operates the Navy European Patents Program. This consists of providing the services of a Patent Counsel who can act for Navy systems commands and offices on patent matters arising in Great Britain and other European countries in connection with their foreign programs. He also advises on requirements and procedures in accordance with the laws of the various countries. This involves evaluating patent disclosures from contractors who have made inventions during the course of their work and liaison with officers of foreign governments regarding the security classification of patent applications filed in foreign countries. The Patent Counsel also receives and screens disclosures of inventions submitted by foreign inventors and assists interested agencies in negotiations with such inventors.

Although ONR London does not operate like any other ONR branch office and is separated from ONR Washington by 3000 miles of ocean, it does not work in a vacuum. ONR London has already responded to the increasing emphasis in ONR of supporting research which has direct naval relevance. Until a decade ago, ONRL was interested almost exclusively in basic science, since European scientific research is most important in basic and fundamental areas rather than in engineering and development. Now ONRL is giving increased attention to more immediate naval developmental programs.

This actually began about 1955 when ONR London was assigned the responsibility for monitoring the MWDP weapons development programs under Navy cognizance and the Naval Applications Division was established. The officers who carry out this function also represent the Chief of Naval Operations and the material commands.

As ONR London became more involved with reporting on applied research and development as well as basic research, its usefulness to Navy laboratories and the material commands became more apparent. It was also obvious that to fulfill this function ONR London must have on its staff officers and civilians with a broad range of technical and scientific specialties. This led to a new recruiting program established in 1965 by the Secretary of the Navy, in which scientific and technical personnel (GS-14 and above) throughout the entire Navy R & D community were encouraged to apply for short-term employment (one to two years) at ONR London. It is believed that this program will not only provide career development opportunities to laboratory scientists and engineers and enhance their scientific potential, but also benefit their parent organizations and the Navy. (Employees remain on the rolls and payroll of their parent organizations and return there upon completion of their tour in London.) The background of personnel hired in this program ranges from basic research to systems engineering.

ONRL now has on its staff scientists whose background will permit them to devote their time to such fields as power and fuels in all their applications, vehicles and missiles, underwater acoustics and its relation to undersea warfare, electronics particularly as applied to weapons, weapon systems, infrared, and radar. When Dr. Peter King was appointed chief scientist for ONR Washington last August, after serving two years as scientific director for ONR London, his replacement was Aubrey Pryce, who has served for the past several years in the Naval Applications Group in ONR Washington.

The interest of the U.S. in European science has certainly not abated. In certain areas European laboratories have clearly demonstrated superiority both in talent and facilities. Therefore, ONR London can be expected to maintain its value as a scientific listening post. *Science* magazine, recently describing the operation of ONR London, stated it this way: "The very vitality of European science today puts ONR London's services at a premium, since in practical terms it is impossible to assess scientific developments from a vantage point 3000 miles away."

Dr. Kathryn Shipp, Winner of Federal Woman's Award

Dr. Kathryn G. Shipp, research chemist at the Naval Ordnance Laboratory, White Oak, Md., has been selected as a winner of the Federal Woman's Award.

She was selected for her high scientific achievement in the discovery and development of new explosive chemical compounds and her leadership in training newcomers in difficult and hazardous research.

Dr. Shipp is one of six women to receive the 1967 award, which was established in 1960. Its purpose is to provide special recognition for women who have made outstanding contributions to the efficiency and quality of the career service of the Federal Government; for their influence on major Government programs; and for their personal qualities of leadership, judgment, integrity, and dedication.

Since coming to the Naval Ordnance Laboratory, Dr. Shipp has made outstanding contributions to the chemistry of high explosives. She has received several awards from the Navy Department and has six chemical patents to her credit.

Dr. Shipp's most recent achievement was the discovery of hexanitrostilbene, a high explosive. Called HNS for short, the explosive will be used in NASA's active seismic experiments, when American astronauts first land on the moon. HNS is a stable explosive that can be handled without undue hazard and can withstand the severe temperature changes on the lunar surface.

The Why of Marine Microbiology

Dr. Robert F. Acker
Head, Microbiology Branch
Office of Naval Research

We are all attuned, as citizens and scientists, to developing scientific trends. We are aware of our country's exploits in outer space and of the new emphasis it has placed on oceanography. Such developments occur, not by accident, but in response to stimuli of various sorts. We will readily agree that the first sputnik marked the beginning of the race in space. Until that time there had been interest in this country in rocketry and exploration of the vast worlds beyond the earth's atmosphere, but sputnik brought a sudden realization to our country of the *potential* in new environment. A coalescence followed and a unification of effort began through the agency of the National Aeronautics and Space Administration.

Now we are responding to the challenge of the oceanic environment and its "inner space" where two successful "man-in-the-sea" experiments already have been carried out. Sealab I demonstrated that chambers located 200 feet beneath the ocean's surface could be made habitable for man—that man could not only survive within the confines of such chambers, but that he could carry out important tasks. Sealab II constituted an extension of these experiments at greater depth and under less ideal circumstances. The habitat was placed in the cold and murky waters off the coast of LaJolla, California, instead of the sparkling clear and warm environs off Bermuda, the locale for Sealab I.

The Sealab studies indicated the Navy's accelerating interest in deep-sea exploration. The ocean surface has been parted by maneuvering Navy ships for centuries, and the ocean depths have been the domain of submarines for nearly fifty years. The new excitement comes from knowledge that the ocean is the last of the earth's major dimensions to be explored. It is the last frontier, full of mystery, danger, and intrigue—full of knowledge waiting to be released, power waiting to be tapped.

Much of the ocean's knowledge and power is locked in biological phenomena. According to Dr. Claude ZoBell, of Scripps Institution of Oceanography: "The sea has been described as a gigantic biochemical laboratory or chemostat in which a great diversity of organisms function together and in competition with each other for the sparsely concentrated nutrient substances. The kinds of organisms present, their abundance, characteristics and activities are influenced by each other as well as by environmental conditions. As contrasted with other major habitats, the marine milieu is distinctive in its vast area and volume, its low content of organic matter, relatively high salinity, low temperature, and high pressure at great depths.

"The marine microbiologist is concerned with the qualitative and quantitative evaluation of the physiological activities of microorganisms that influence the state of carbon, nitrogen, sulfur, phosphorus, hydrogen, oxygen, and other elements in the sea and its bottom sediments. Besides the basic task of studying microorganisms for their own sake, the marine microbiologists must also be concerned with (a) the effects of microorganisms on higher plants and animals and the productivity of the sea; (b) stimulating and inhibitory effects of microbial metabolites; (c) microbes as agents of disease; (d) their role as geochemical agents and in the diagenesis of marine sediments; (e) microorganisms as indicators of the origin, movement, and properties of water masses; (f) study of the unique properties of marine microorganisms which might contribute fundamentally to a better understanding of the origin and processes of life; (g) problems of microbial corrosion, deterioration, fouling, and spoilage of materials of economic significance; (h) fate in the sea of microorganisms of sanitary significance; and many other problems.

"Unquestionably the most important function (of microorganisms) has to do with the modification of organic matter, its formation as well as its mineralization. Virtually all kinds of organic matter are susceptible to microbial attack under certain conditions. The end products of decomposition directly or indirectly provide essential plant nutrients (ammonium, nitrate, phosphate) and carbon dioxide. Under ordinary conditions of decomposition, from 60 to 80 percent of the carbon in organic matter assimilated by bacteria is liberated as CO_2 (complete mineralization). The remaining 20 to 40 percent is converted into bacterial cell substance. This is the major source of bacterial biomass, much of which is devoured by animals. Heterotrophic bacteria contribute substantially to the nutrition of aquatic animals. On the deep sea floor, animals may get much of their food from bacteria which develop there at the expense of dissolved, colloidal, and detrital organic matter conveyed there by ocean currents or sedimentation."

Fundamental Questions

Among the most fundamental questions to be answered by the marine microbiologist are those relating to the differences between marine and terrestrial species. In brief, the question is simply "What is a marine bacterium?" To answer this, we must learn why and how the marine bacterium became a part of the marine environment. Did it wash from land into the ocean as the waves lapped the shore, as the mud washed in from the banks, as the rivers emptied tons of silt and sediment? Or is the marine bacterium a native of its environment, evolved from some primordial stuff like its counterparts ashore? The marine bacterium is different from those counterparts because it is tolerant of the salt water environment. It is capable of tolerating an "osmotic pressure" which exists because its cell substance (cytoplasm) is relatively low in salts while the environment outside is high in salt concentration. Cells unadapted to such an environment lose interior water to the suspending medium outside. The cell shrinks (plasmolysis) and dies.

Bacterial cells are found in the ocean at depths of 7,000 to 10,000 meters. Many of these can be brought to the surface, transferred to laboratory nutrient media, and grown at pressures of 700 to 1000 atmospheres in specially-designed pressure cells. Some of the deep sea bacteria will grow *only* under high pressures; others grow equally well at ambient pressures or at one atmosphere. The question as to why this is so has not yet been answered. No one knows where either the barophilic (pressure requiring) or eurybaric (pressure tolerant) microbes have come from—whether they have been selected by genetic mutation for survival in the depths, or whether they simply drifted down from surface layers, adapting on the way.

Another characteristic of many marine bacteria is their tolerance for low temperatures. We find that they thrive in the depths of the ocean at temperatures lower than 5°C. More than 90% of the marine environment is, in fact, colder than 5°C.

We see, then, the need for a "comparative" approach to marine microbiology. It is important to know why and how marine microorganisms are adapted to the marine environment and how they differ from their terrestrial counterparts. Finally, we wish to know whether they have sprung *de novo* from the marine milieu or whether they have adapted to it, following an earlier history in the terrestrial environment.

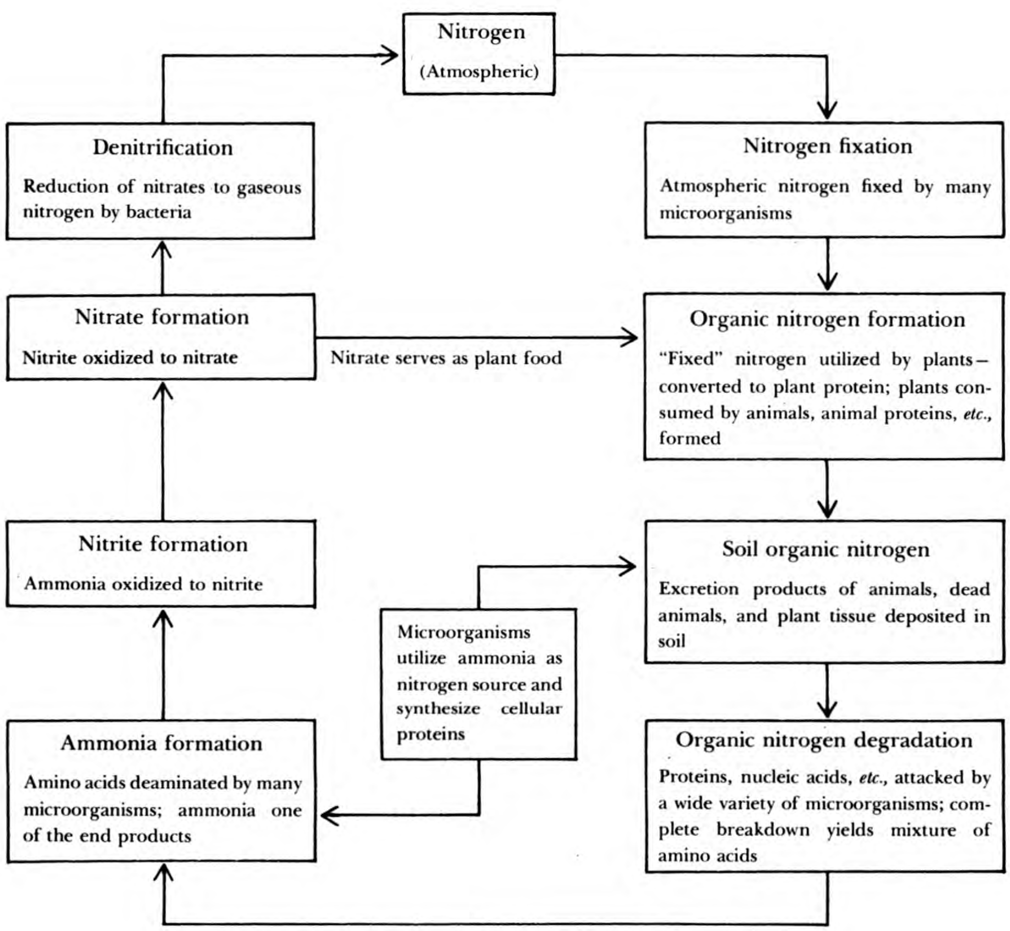
Microbial Transformations in the Ocean

Dr. Robert K. Jennings, Head of the Biochemistry Branch of ONR, has likened the ocean to a giant living tissue, in which may be found all the cellular forms, all the chemical elements and nutrients, and all the dissimilatory and assimilatory processes required to make the analogy valid. It is certainly true that fluctuations in flora and fauna in the sea follow patterns, sometimes seasonal and sometimes not. In the spring, for example, there is a recrudescence of life in the ocean not unlike that on land. The algae and protozoa proliferate in myriad numbers and produce a "bloom." The bloom of plankton forms a layer in the ocean, like a giant living shelf, which rises and sinks in rhythm as nature orders. Temperature shifts, wave action, and water motion determine at what level the layer will be, subject to additional thrusts imposed by radiation and tidal effects.

Following the blooms just mentioned, there is a dying-off of plankton, requiring that bacteria come to the rescue and dispose of nature's wastes. The dissimilatory processes of bacteria thus begin, breaking down complex organic materials to simpler compounds in a long chain of chemical events collectively called "mineralization." The end result, when mineralization is complete, is the production of CO_2 and H_2O.

The dissimilatory process is balanced by assimilatory processes involving the building of complex organic materials from simpler chemical building blocks. Thus, amino acids are linked to form peptides; peptides are connected to form proteins, and so on. The final product is more living bacterial cells and the establishment of a cyclic pattern of biochemical transformations. Such cycling, in the soil, contributes to soil fertility. The pattern of chemical events, in the case of soil-and-the-microbe is well known to the soil microbiologist. There is reason to believe that chemical events very much like the following take place in the ocean.

*Nitrogen Cycle in Nature



*Adapted from chart published in *Microbiology*, by Michael J. Pelczar, Jr., Professor of Microbiology, University of Maryland and Roger D. Reid, Director, Biological Sciences Division, Office of Naval Research. McGraw-Hill Book Company, 1965.

Electron microscope view of chitin digesting marine bacteria. Magnification—36,000X.

One of the oldest techniques devised by microbiologists to study bacteria-mediated transformations in a given ecology or environment is the technique of "enrichment." According to this technique, one simply exposes a preponderance of one kind of foodstuff, known to exist in the environment, to all the kinds of bacteria found there. For example, decaying plant materials on the earth or in the sea are rich in cellulose. Under controlled conditions, we can study the breakdown of cellulose by exposing this substrate (microbial food) to natural seawater. The microorganisms present in this environment which are capable of attacking and utilizing the substrate in question (in this case, cellulose) will be enriched, *i.e.,* they will thrive and proliferate and finally become the predominant microbial form.

Dr. John Liston, a prominent marine microbiologist under contract to ONR, is currently using this technique to study the breakdown of cellulose and chitin in the marine environment. These two materials were chosen for study by Dr. Liston of the College of Fisheries at the University of Washington because they represent materials which are abundant in decaying plants (cellulose) and animals (chitin). The latter is the hard, tough, horny kind of substance found in hooves of many four-legged mammals, nails on the hands and feet of man, and shells covering many insects and sea animals. The well-known horseshoe crab is an example of an amphibious animal whose shell is rich in chitin.

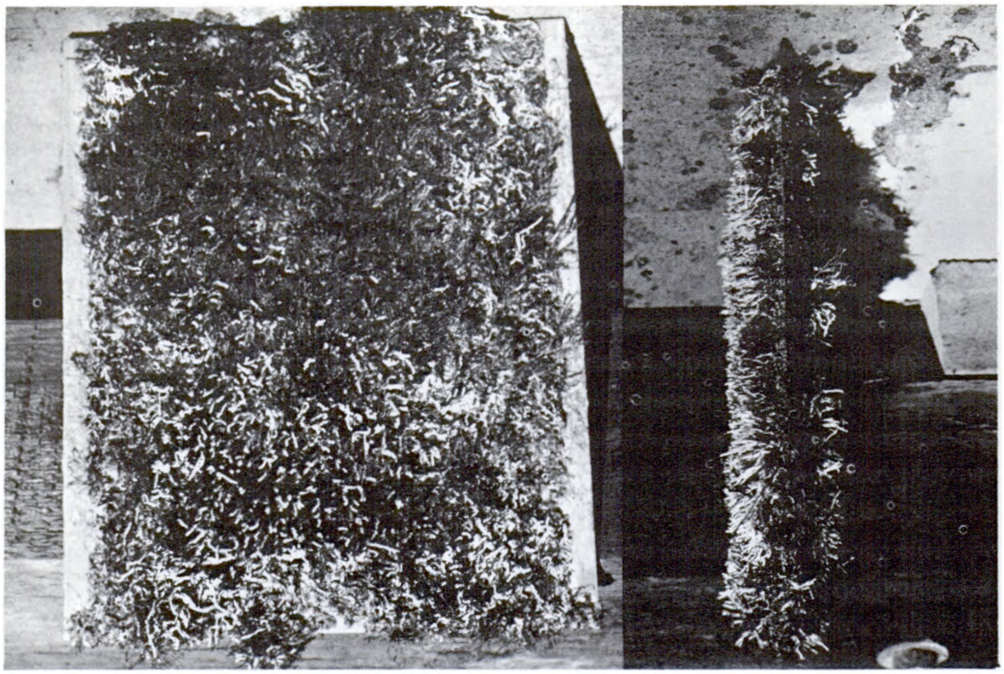
For his study, Dr. Liston has devised a model "sea bed" consisting of a glass vessel containing a layer of sea-bottom sediment over which travels a continuous flow of natural sea water. In the midst of this simulated sea environment are suspended pieces of solid cellulose or chitin. The chitin utilizing forms, in the latter case, become enriched and may be counted and identified by relatively simple laboratory procedures. When unusual forms develop by enrichment, they may be isolated on suitable laboratory media and studied separately. The study of marine microbiology is thereby advanced, new scientific knowledge is accumulated, and our understanding of the vast marine environment is improved.

Marine Corrosion

No discussion of marine microbiology would be complete without reference to some of the deleterious activities of microorganisms. We don't wish to imply that *all* activities of microorganisms are harmful or undesirable, because this is not true. Without the scavenger activity of microorganisms, we earthlings would soon be inundated by organic wastes. Cattle carcasses, corn cobs, tree trunks, rubbish, and refuse would accrue on this planet at a rate that would defy disposal. The whole chain of biblical events from "dust to dust" would be interrupted and all "dead" matter would be forever stabilized. An unhappy prospect, indeed.

It could be said, in the case of metals, that the opposite of stabilization is corrosion. Corrosion has been defined, in fact, as an "interaction" of a metal or alloy with its environment. The oceanic environment, because of dissolved salts and consequent electrolytic properties, is an ideal environment for corrosive action. Unless effective counteraction is taken, ferrous metals will corrode and waste in the sea at an accelerated rate.

Microorganisms play a significant role in corrosion because of their physical and chemical activities. In the first place, they cling to the surfaces of almost all objects placed in the ocean and form a continuous slimy film. The film provides a protective cover under which undesirable chemical or biochemical activities can take place. This represents the *physical* contribution of microorganisms to corrosion. Without going into complex electrochemical theory, we can see that microorganisms can contribute to *chemical* or electrochemical events by changing the environment beneath their own contiguous slimy shield. The concentration of oxygen between the metal surface and the bacterial film may be reduced, or the concentration of corrosive chlorides or sulfides may be increased. Some marine bacteria produce acidic substances which etch or pit the metal surface. Some can absorb partially oxidized sulfur compounds such as sulfur, sulfite, or thiosulfate and oxidize these to form sulfuric acid. The latter, of course, is highly corrosive.



Front and side view of fouling on panel—one month immersion in sea water

Other microorganisms reduce nitrate, absorb hydrogen, or carry out a myriad of other simple chemical reactions which contribute collectively to the corrosion of metals.

The control of corrosion and fouling is a major concern of the U.S. Navy and the U.S. Maritime Administration. Corrosion, as already explained, refers to the process whereby metal wastes away. Fouling refers to the accumulation of marine life on the surfaces of materials in the ocean. Barnacles, tunicates, hydroids, marine plants, and bryozoa contribute most heavily to the fouling phenomenon, but more than 2,000 different species of animals and plants have been found on fouled structures. The prevention of corrosion *and* fouling is most often a matter of applying protective paints to surfaces such as the hulls of ships. Because formulations for the prevention of corrosion are somewhat different from those devised for the prevention of fouling, the commonly used procedure consists of applying first a layer of anticorrosive paint and afterward a layer of antifouling paint. Chemists, engineers, and biologists strive constantly by experimentation and testing to improve the protectiveness of these much-needed coatings and to extend their span of effectiveness in actual use.

So great is the worldwide concern of maritime and navy interests in this problem that an international independent research group has been organized to carry out cooperative research and development studies. This organization, known as the Permanent International

Committee for Research on Preservation of Materials in the Marine Environment, was officially established in Paris, France, on December 2, 1966. Its formation was the outgrowth of previous successful cooperation in the same vein under the sponsorship of the Organization for Economic Cooperation and Development.

Preservation of Wood and Concrete

Damage to wharves, piers, fenders, and sea walls by biological attack has been estimated at $50,000,000 per year. The majority of the loss is attributed to the activities of marine borers, such as ship worms (teredo and limnoria), which weaken and destroy wooden waterfront structures by tunneling into the surface layers or even into the depths of wooden pilings. Microorganisms contribute to the process by digesting protective chemicals such as creosote, by softening the surface layers, or by contributing food for the borers themselves. The presence of microorganisms on wood is known to stimulate the activities of marine borers, but the mechanism for such stimulation is not known. It has been hypothesized, on one hand, that the microorganisms serve as food for the invaders. On the other hand, it is suggested that microorganisms are stimulatory because they form a symbiotic (mutually beneficial) relationship with the borer, becoming established in the alimentary tract and aiding in the digestion of wood.

The gaps in our knowledge point to the need for sound research. The research may be very basic in its objectives, but it must be oriented to the need and the problems at hand. Through a well planned and thoroughly integrated program, the Office of Naval Research will contribute to the effectiveness of our Modern Navy, enabling it to meet the challenges it faces in all parts of the globe—not only today, but through many tomorrows.

Book on Military Infrared Available

A book entitled *Handbook of Military Infrared Technology* has recently been compiled by the University of Michigan under contract with the Office of Naval Research funded by the Advanced Research Projects Agency. The book, which was edited by William L. Wolfe, University of Michigan, contains articles from 22 contributors—distinguished scientists and engineers actively engaged in infrared research and development. It presents state-of-the-art coverage as well as design and engineering data.

The book was published by the Naval Research Laboratory and printed by the Government Printing Office. Copies are available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 at $3.75 per copy. (Catalog No. D210.6/2:In3)

NRL Dedicates New Cyclotron Facility

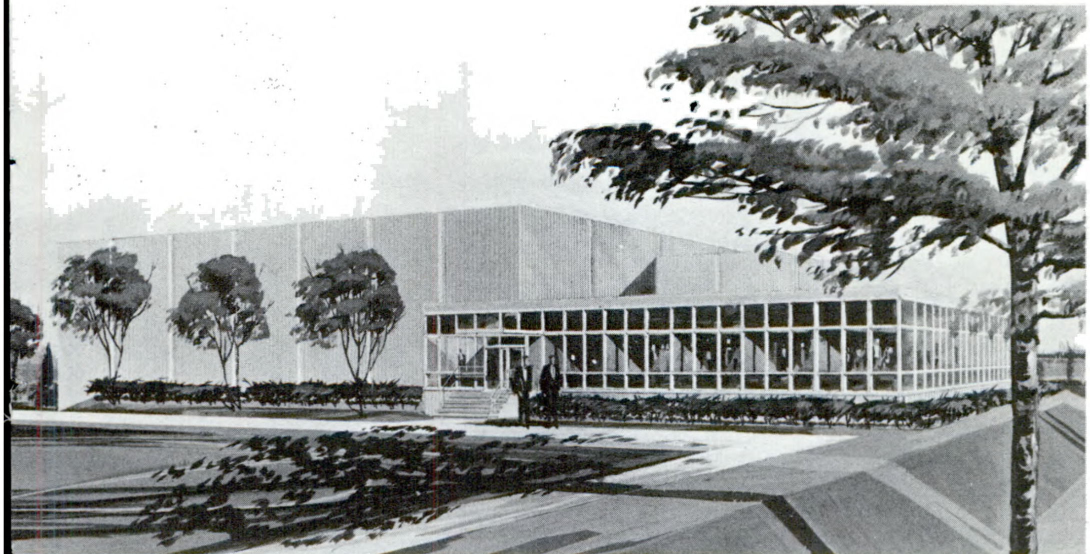
The Naval Research Laboratory dedicated its new nuclear physics research laboratory and sector-focusing cyclotron building on Tuesday, February 28. The cyclotron, which will accelerate protons over the energy range of about five to 75 Mev, will greatly expand the energy range now available to Navy scientists. The Honorable Robert A. Frosch, Assistant Secretary of the Navy for Research and Development, took part in the ceremonies by addressing the audience of military personnel, scientists, and engineers from laboratories throughout the nation.

The three-story facility has been designed to allow maximum utilization of the cyclotron, beam transport and experimental equipment for nuclear physics research and in producing radioisotopes and other service bombardments. The walls surrounding the cyclotron and experimental areas are nine feet and eight feet thick, respectively, thus providing adequate shielding from the radiation produced by the cyclotron ion beam.

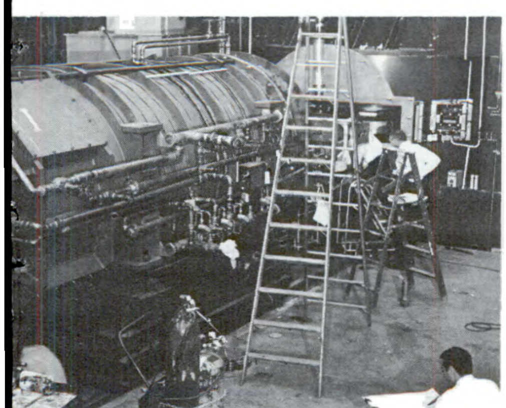
The cyclotron will enable scientists to conduct research in the field of heavy-ion nuclear physics. Studies of heavy-ion beams, which are capable of producing compound nuclei, will permit better understanding of laws governing fission. Also, studies of reactions resulting from neutron-producing accelerated beams will enable Navy scientists to probe heretofore unexplored neutron energy regions.

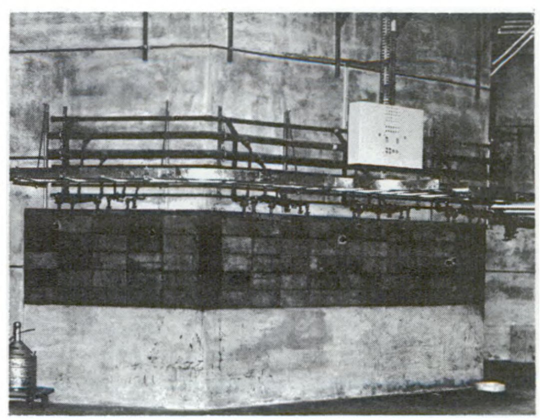
At present, NRL operates a 5 Mev Van de Graaff particle accelerator, several smaller Van de Graaff accelerators, a 60 Mev electron linear accelerator, a 1 Megawatt pool type nuclear reactor and a high level radiation laboratory in its nuclear physics program. The new cyclotron will extend to higher energies the research programs already under way at existing accelerators. One such program is the investigation of nuclear interaction mechanisms, a study which has been limited to low z elements because of Coulomb effects due to barrier and distortion problems. Increasing the bombarding energy will permit more accurate observation and interpretation of nuclear interaction mechanisms. These interactions include the so-called "direct" interaction, pickup and stripping; and compound nucleus formation.

In addition to supporting NRL's nuclear research program, the new facility will also be involved with a number of experiments of a more applied nature. These will include research in the areas of dosimetry and radiation measurement techniques, production of radio-active isotopes, applications to space research, shielding information, and biological applications.



Above: Artist's concept of NRL's new cyclotron facility. Left: Part of the control panels for the cyclotron and beam transport system. Lower left: The 250-ton magnet where particles are accelerated (right) and the resonator tank. The two units will be joined together when finished. Lower right: Experimental room #3, looking towards the beam slot. Some of the concrete blocks will be replaced by a steel shutter to allow the beam to enter. The cyclotron and beam preparation equipment are on the other side of the 9-foot thick wall.





Holography and the Third Dimension

LT Bruce A. Finlayson
Physical Sciences Division
Office of Naval Research

Man has wanted to make three-dimensional pictures ever since he first invented the camera. Until recently, however, the only means he had of achieving this effect was by a stereoscope—an optical instrument which combined the images of two pictures taken from two different points of view to give the effect of solidity or depth. The crude paper and celluloid viewer used in the once popular 3-D movies worked in a similar fashion. However, such devices were far from satisfactory.

Holography,* a relatively new approach, enables true three-dimensional recordings of visual scenes. Not only does it give the viewer a sense of depth but it allows him to look at either side or even around the object. Further, because of recent developments—notably, lasers—holography is being discussed for possible uses in measuring particles, x-ray microscopy, landing aids to pilots, analysis of thermal and mechanical strains, information storage, character recognition, and many other applications.

Principles of Holography

To illustrate the principles of holography, imagine a light wave as the ripple or wave on the surface of a pond after a rock has been thrown

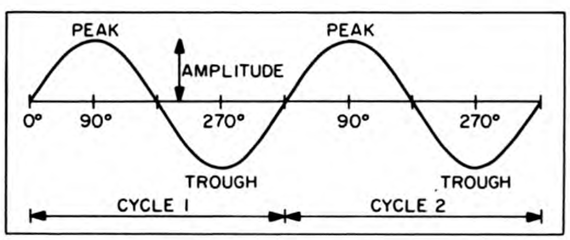


Figure 1

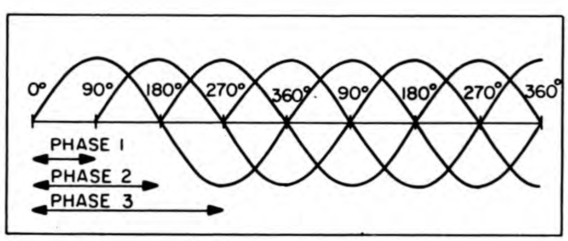


Figure 2

*Combining term, taken from Greek *holos,* whole or entire.

in (see figure 1). Half the distance from the wave's peak to its trough is called its *amplitude* or size. The intensity (amplitude squared) is what is recorded by an ordinary camera.

Now, imagine that a second and a third rock are thrown into the pond, causing more ripples to form, but at a different time or *phase* than the first one (see figure 2). When you look at the pool, you see not one wave, but many, each reflected or emitted from a different point of view. Analogously, it is the total or superimposition of many light waves which forms the visual image.

To further illustrate, examine the two pairs of waves—A and B, C and D—seen in figure 3. B begins 90° later or out of phase with A; D begins 45° later or out of phase with C. When A & B and C & D are added or superimposed, giving E and F, respectively, the results are different because the phases of the added waves are different. In a visual image, the light waves from different points of view have different relative phases. When the observer is at one position, the waves may add to give something like E. When he moves to one side, they may add to give something like F. Thus, a true three-dimensional image must record not only the amplitude, as conventional photographic film does, but *also* the phase.

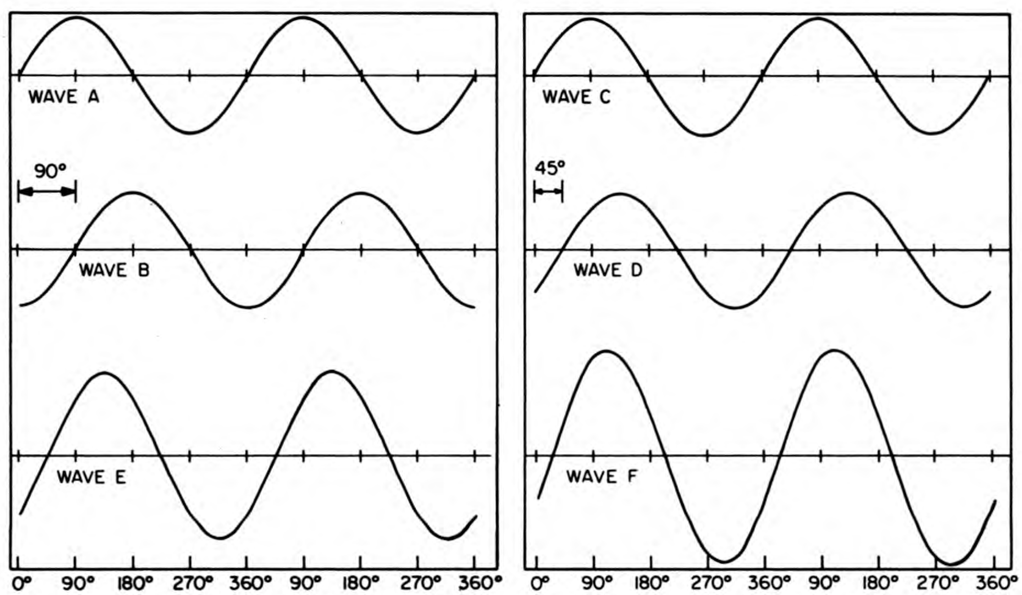


Figure 3

The first attempt to record both the amplitude and phase of waves was made by England's Dr. Dennis Gabor in 1948. He suggested superimposing an electromagnetic wave on a coherent or stable reference wave, and recording the interference on a sensitive plate, such as a photographic plate (see figure 4). If the processed transparency were

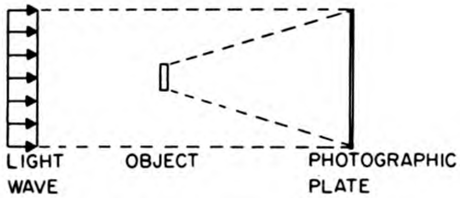


Figure 4 – Recording the hologram

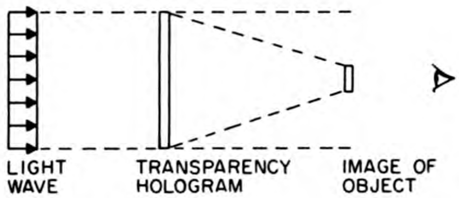


Figure 5 – Viewing the hologram

viewed with the same coherent reference wave, its effects could be subtracted out, leaving the original wave, including its amplitude and phase (see figure 5).

Going back to the pairs of light waves in figure 3, let us call A the coherent reference wave and B the object wave we wish to record. A and B interfere (some amplitudes are neutralized and others augmented depending on the phase) to give E which is photographed. The developed transparency is then viewed by shining A through it, except that A is *translated* 180°, making it exactly the *opposite* of the original A. Thus, when the transparency is viewed using the translated A as the illumination, its effect is subtracted out of E, leaving B. In this way, the wave has been recorded and retrieved, including both amplitude and phase. A real object would, of course, have many wave B's, each behaving in the same way. The image of a real object would, therefore, include relative phase information as well as the usual amplitude information.

There were two problems with Dr. Gabor's technique. First, because of the laws of optics, he obtained two images—real and virtual. The result appeared like two superimposed images—one in- and the other out-of-focus, with the out-of-focus image tending to obscure the in-focus one. Second, he was able to obtain only very weak coherent (when adjacent light waves are all in phase—like soldiers all in step) light beams, so the light intensity was quite low. These coherent beams were obtained by shining light through a pinhole. Thus, the only objects that could be "photographed" in this way were transparencies which transmitted a large amount of light. Gabor knew that there were methods available in light optics to split the reference beam and possibly separate the twin images. However, since he was interested primarily in electron optics, where no beam splitters were available, he pursued the idea no further.

The next important development in holography came in 1962 when Emmett Leith and Juris Upatnieks of the University of Michigan explored the possibility of splitting the twin images. They used a wedge or prism which caused the reference beam to make an angle with the light transmitted through the transparency (see figure 6). When the hologram is recorded in this fashion, the reconstructed images are not in the main beam but are deflected at angles, as shown in figure 7. Thus, they can be separated depending upon the observer's angle of observation of the illuminated hologram. Though the holograms produced by this method were of very poor quality, they did demonstrate the approach.

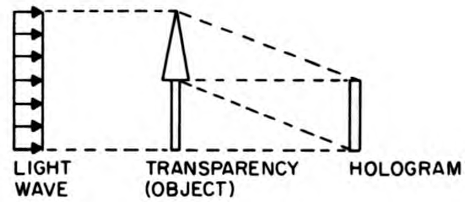


Figure 6 – Recording the hologram

A year later, the laser was introduced as the coherent light source. The main advantage of the laser is that it *is* coherent. Other advantages are that it is bright, nearly monochromatic and can be imaged to a fine point. Since the first laser holograms were made of two-dimensional transparencies, however, the resulting images could not contain three-dimensional characteristics. But they did demonstrate further the basic feasibility of holography.

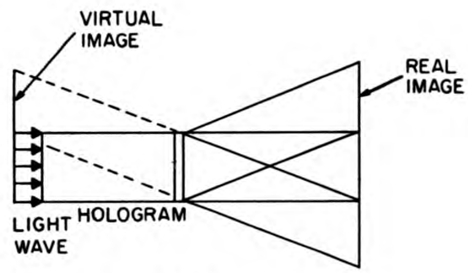
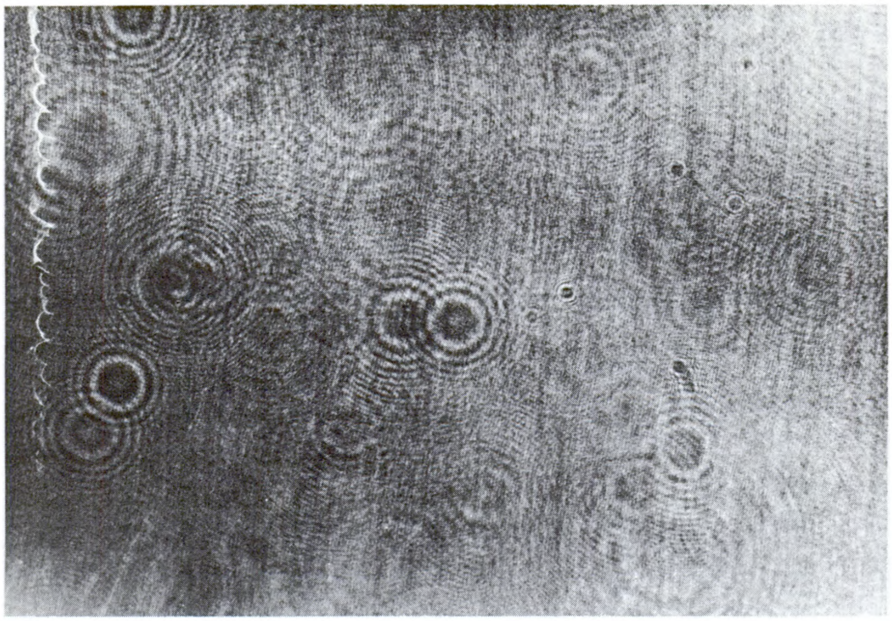


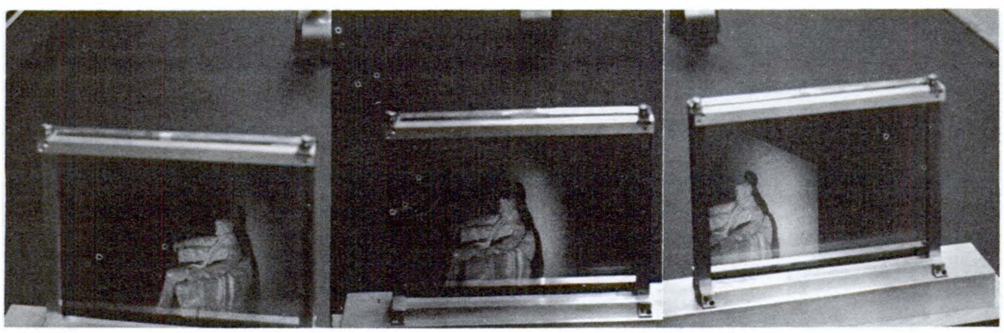
Figure 7 – Reconstruction

In 1964 Leith and Upatnieks succeeded in making holograms of three-dimensional objects. Using a darkened room, they turned on a laser and divided it into two beams. One beam was used to illuminate the object and the other to illuminate the photographic plate. Reflected light from the object, caused by the first beam, also shone on the photographic plate. In other words, they caused the reference or first beam to interfere with the reflected light from the object rather than the light transmitted through the object, as in a transparency. When the plate was completely exposed—a period of several minutes duration—the laser was turned off and the photographic plate removed and developed. By shining a laser through the negative or *hologram,* they were able to reconstruct the original three-dimensional view. Further, they photographed the image from several points of view. The results demonstrated that the observer could see one image in the hologram from one point of view, another from a second point of view, *etc.,* thus giving a true three-dimensional image.

To illustrate, the photograph on the following page shows what a hologram or negative looks like in ordinary (incoherent) room light. The circular patterns result from diffraction of light by dust particles in the optical path. The actual interference between the reference beam and the illuminating beam—which forms interference fringes—cannot be seen.

Now, look at the three views of the Lincoln statuette shown below the hologram. Actually, they are views of the same hologram. Only this time, a laser has been shined through the hologram, reconstructing the three-dimensional image. The different views correspond to different images we would see when moving our eyes to different





positions when actually viewing the illuminated hologram. The different positions and the shadows cast clearly show the three-dimensional character of the image.*

Limitations

In spite of the successful use of the laser, holography still has its limitations. Since the laser is limited both in power and in coherence, holograms can be made only of relatively small objects. The coherence length of lasers can be improved, but only with a sacrifice of power, which is also severely limited. Energy is required to expose even the most sensitive photographic plate; and, of course, as the area to be illuminated becomes greater, the amount of power or energy required to expose the photographic plate becomes greater. While very high power lasers have been achieved in a pulsed mode, the coherence

*Photographs provided by ONR contractor Professor George W. Stroke, University of Michigan.

length is usually not long enough to make a hologram. Rather, most holograms are produced by using a continuously operating gas laser, which, because of its very low power, takes several minutes. This means that the object, the light source, and the photographic plate must all remain relatively fixed in position for this length of time. A commonly stated criterion is that all elements must remain fixed in space to within 1/8 of a wavelength during exposure; and, since the wavelength is less than 1/1000 of a millimeter long, this requires *extreme* stability. These difficulties—coherence length, power and dimensional stability—have thus far limited holograms to relatively small, rigid scenes.

Applications of Holography

The first field use of holography is in determining the size of particles suspended in a liquid or vapor media. Whether the suspension is plankton in water or fog droplets and smog particles in air, information about the particle size and concentration must be gained before they can be effectively studied or treated.

In studying fog droplets, a hologram is made and the diffraction rings (the concentric circles in the photograph shown previously) studied to give a measure of the particle size. By using holography, information is gained about a three-dimensional volume without disturbing it—other than shining a light through it. Consequently, measurements can be made *in situ*—an important advantage. For studying plankton in water, the hologram could be made in the usual fashion (possibly *in situ*) and the three-dimensional reconstruction examined at leisure with a microscope to determine the type and size of the biological life.

Holography can also be used as an interferometer to detect small movements of an object—movements as small as 1/1000 of a millimeter. To determine how a body is stressed when heated, tiny gauges are strapped to the body to measure its strain and movement. By using holography, a hologram could be made of the unstressed object and the reconstructed three-dimensional image superimposed on the stressed object, causing the light waves from the unstressed image and stressed object to interfere. Thus, the light reaching the eye would represent the difference between these light waves. The advantage to this technique, of course, is that the object itself would not be disturbed with probes. The hologram interferometer is also applicable for the study of membrane vibration: the holographic image of the unvibrating object would be superimposed upon the real image of the vibrating object.

Holography has also been discussed as a landing aid to airline pilots. The hologram would provide a three-dimensional view of the landing strip during approach, replacing the actual view when obscured by bad weather or other poor visibility conditions. After the position of the plane had been determined by radar, the correct view could be determined. A prearranged set of holograms would have to be on board the airplane and the proper one selected. As the airplane approached the landing field, the hologram would be changed to correspond with the changing "real" view. Such a scheme would be a form of 3-D movie—only in very slow motion and with prearranged instructions. However, much work remains before such a system can be tested in operation. One of the important problems—the need to store thousands of holograms in the airplane—may be resolved by the system described below.

It has been found that a hologram can be used to record many views which can be read out separately in the reconstruction. Each separate view is recorded at a different angle between the light reflected from the object and the reference beam. When the hologram is viewed, the several images can be seen in succession by rotating the hologram in the illuminating light. The same principle could be used to record several pages of a book on a single hologram. Each page could be read simply by rotating the hologram during reconstruction. Thus, a good deal of information could be stored in a very small area.

Professor George Stroke, an ONR contractor from the University of Michigan, and others have viewed holograms by using white light rather than monochromatic laser light. The reference beam is introduced from the reverse side, *i.e.,* the light from the object approaches the hologram from one direction and the reference beam approaches from almost the reverse direction. This scheme has been extended to include multicolor holograms. The hologram is made by illuminating the object with three different colored laser beams and viewed in white light, resulting in a full color three-dimensional rendition of the original scene. An interesting note is that the hologram itself is black and white but the reconstructed image is in color.

Professor Stroke has also succeeded in making holograms by means of a computer. The physical arrangement is similar to the usual one, except that a small pinhole of light takes the place of the object. This pinhole of light represents the reflected light which would normally come from a point on the object if it were really there. The position of the pinhole is changed in accordance with instructions from a computer, thus forming successive images on the photographic plate. This scheme has been used to date only for making two-dimensional transparencies.

Another possible application for holography is x-ray microscopy. Magnifications are achieved in holography by using a different wavelength illumination for recording and reconstructing the hologram. If the hologram is recorded with x-rays with a 1 angstrom wavelength and illuminated with light with a 6000 angstrom wavelength, the resulting magnification would be 6000. Further increases in magnification could be achieved by changing the distance from the object to the hologram. Ultimate magnifications of 1,000,000 are being discussed.

The advantages of a holographic x-ray microscope are that a three-dimensional picture could be obtained, less sample heating would be encountered than in electron microscopes, and the fact that samples might not need to be in a vacuum. Perhaps even living tissues could be examined. One of the major problems is the lack of an intense coherent source at x-ray wavelength. Just as holography in the visible spectrum had to await the introduction of the laser before good results were obtained, holography in the x-ray region may have to await an x-ray laser. Unfortunately, the shortest wavelength laser is in the ultraviolet with a wavelength many orders of magnitude greater than desired. Professor Stroke has provided many important advances towards holographic x-ray microscopy by his work on high-resolution holography and spatially-extended sources, *i.e.,* not pinhole sources. Although no x-ray holograms have been produced thus far, the benefits of such an achievement are so attractive that research continues towards this objective.

The Navy is, of course, interested in phenomena occurring underwater. Holography has been demonstrated there, too, except that acoustic waves are used in lieu of light waves. An acoustic wave is reflected from an object and combined with another acoustic reference wave. The combined beam is then recorded and the resulting hologram is illuminated, using visible light for the reconstruction. The image is demagnified because the wavelength of the acoustic waves is much longer than that of the light waves. Thus, one problem in this type hologram is to use as high a frequency acoustic wave as possible in recording the hologram so that its wavelength will be as small as possible. Results to date have not been spectacular. Much work remains before this type of holography can become useful.

While the applications of holography described above have been demonstrated in the research laboratory, the field is still too new for many of them to have been tried in the field. The feasibility of widespread use of holography will depend upon further developments and whether or not it can compete with other techniques. We have examined only a few of the many exciting possibilities for using holography; many others will be discovered in the future.

Members of the Washington Chapter, American Ordnance Association were briefed on specific programs of Washington area Navy laboratories during a recent meeting at the Naval Research Laboratory.

Dr. G. W. Johnson, Director of Navy Laboratories, opened the one-day session with an outline of the role of Navy laboratories in the Navy RDT&E program.

Other presentations were made by representatives of the Marine Engineering Laboratory, the Naval Weapons Laboratory, the David Taylor Model Basin, the Naval Ordnance Laboratory, and the host Naval Research Laboratory.

On the Naval Research Reserve

New Research Reserve Units Established

Welcome is extended to the two new Research Reserve Companies in the Third Naval District. The Bureau of Naval Personnel authorized the establishment of NRRC 3-16 at New Haven, Connecticut and NRRC 3-17 at New York, New York effective September 1, 1966.

Newly formed NRRC 3-16 has strong ties with Yale University since six of its members are Yale graduates. The group meets alternate Thursdays on the Yale Campus. The Commanding Officer, LCDR Charles Marshall Davidson, USNR, a 1950 Yale graduate, is a WEDO (Weapon Engineering Duty Officer). He was formerly assistant head of Ballistics in the Bureau of Ordnance, and is currently employed by the Armstrong Rubber Company as a product engineer. There are three doctorate, two master and eight baccalaureate degree holders in 3-16.

NRRC 3-17 meets alternate Tuesdays in the Columbia University club, New York City, thus becoming the third Research Unit to hold its meetings in Manhattan. The Commanding Officer, CAPT Richard M. Cukor, USNR, a Dartmouth graduate, has been employed by Macy's for over 30 years, with time out to help fight World War II. He has held almost every product research, marketing and management job existing at Macy's, and currently manages Macy's Queens. In 3-17 there are one doctorate, seven master and fifteen baccalaureate degrees.

NRRC 5-8 Will Present Seminar in Washington, D.C.

The Office of Naval Research and Naval Reserve Research Company 5-8 of Washington, D.C., will present the 18th Annual Research Reserve Seminar in Washington from June 5 through June 16, 1967. The seminar, entitled "Today's Research and the Navy's Long Range Objectives," will be co-chaired by CAPT E. J. Zellmer, USNR, Commanding Officer of NRRC 5-8 and CAPT J. R. Patton, Jr., USNR, former Commanding Officer and now Senior Staff Advisor.

The seminar will review ONR sponsored and other Navy research in relation to their contribution to the long-range objectives of the Navy. The first week will consist of presentations by high-level officers in various offices of Chief of Naval Operations, Chief of Naval Material, and the Office of the Secretary of the Navy. During the second week, special days will be designated to discuss four important areas of research: Material Research, Human Factors, Energy and Electronics. A workshop will be held at the close of each day wherein selected groups will analyze, digest and criticize the day's presentations. The results of these daily deliberations will be presented to the entire group on Friday. Also on Friday, it is hoped to have several short presentations by high-level officers just returned from Viet Nam.

Field trips will be conducted on Wednesday, June 7 to the National Naval Medical Institute, Bethesda, Maryland, and on Friday, June 9 to the Navy Marine Engineering Laboratory and the U.S. Naval Academy, in Annapolis, Maryland.

Over the weekend, attendees will have the opportunity to visit the historic shrines located in and around Washington. These shrines include the famous Manassas Battlefield (Bull Run), Gettysburg National Monument, Williamsburg, and Old Fort McHenry, the home of the Star Spangled Banner.

On Tuesday evening, June 6, Research Reserve Companies 5-8, 5-9, and 5-10 will sponsor a joint meeting. A high-level speaker from the Navy or the Department of Defense will be invited to speak. All seminar participants will be invited to attend.

Promotion Selections

Two hundred and forty-seven Naval Reserve line officers were selected for promotion to captain by the Fiscal Year 1967 Reserve Selection Boards. Five were members of the Research Reserve Program. Congratulations to:

Gardner, Benjamin H., III	NRRC 11-5
McMurdo, Robert B.	NRRC 13-1
Reichard, Edmund C.	NRRC 4-1
Stoutenburgh, Joseph S.	NRRC 9-6
Wright, William F.	NRRC 6-18

Four of the officers selected were from the new field and one from the old. Other statistics based on the records of the Research Reservists selected for promotion are:

Year of Birth	Date of Rank	Designator
Earliest 1918	Earliest 7-1-54	1105:2
Latest 1926	Latest 6-1-62	1405:1
		1515:2

Seminars Planned for Fiscal Year 1968

Six Research Reserve seminars are planned by the Office of Naval Research for Fiscal Year 1968. The titles, places, and dates of the seminars are as follows:

Research Reserve Advanced Systems Warfare/Underseas Technology Seminar, Newport, Rhode Island	July 24, 1967
Fourth Research Reserve Seminar in Applied Research, Albuquerque, New Mexico	August 7, 1967
Research Reserve Electronics Computers Seminar, College Station, Texas	September 4, 1967
Research Reserve Seminar, Naval Research Laboratory, Washington, D.C.	June 3, 1968
Research Reserve Upper Midwest Seminar, Minneapolis, Minnesota	June 10, 1968
Research Reserve Seminar, Man—His Capabilities and Limitations in Systems, Seattle, Washington	June 17, 1968

NRL Fabricates Multiple Contact Microwave Diode

Three NRL scientists have fabricated and tested a multiple contact microwave diode, the first of its kind, which gives promise of resolving at no additional cost the power-frequency dilemma associated with single contact diodes.

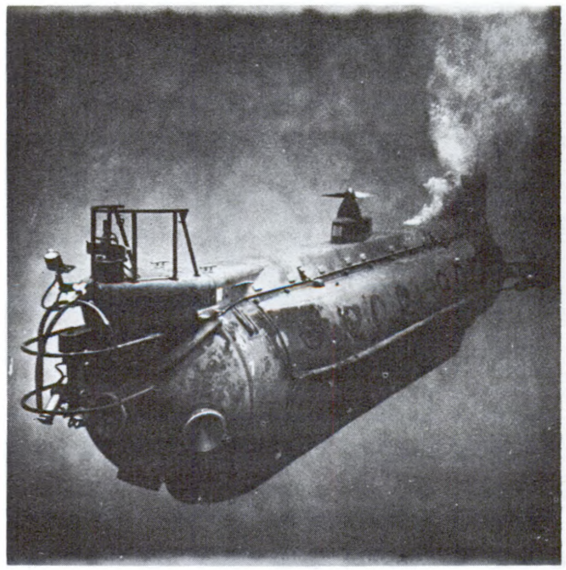
In a report appearing in the December 1966 Proceedings of the IEEE, Howard M. Day, Alan C. MacPherson, and E. F. Bradshaw disclose that tests show the multiple contact Schottky barrier microwave diode which they fabricated makes it possible to increase the dynamic range and the power capability of microwave varistor diodes without compromising the sensitivity.

The authors believe the multi-contact scheme can be extended to other kinds of microwave diodes. They also point out that if the number of contacts in an array diode is treated as a variable, that number can be used to adjust the nominal diode impedance even in situations in which power handling and dynamic range are not an issue.

It is noted in the article that the idea for a multi-contact microwave diode is not new, but that fabrication difficulties had been great enough to make it an impractical idea until recently. With the advent of silicon monolithic technology, which is used as a basis for the parallel interconnections, it becomes practical to create a diode with a number of small area contacts in parallel on the same die. The contacts must be separated enough to be noninteracting electrically and thermally, and the power must be shared equally between the various contacts to solve the power-frequency dilemma.

For purposes of comparison, a conventional single contact diode was made from material within 30 mils of the nine dot array. Along with the expected increase in dynamic range, the arrays exhibited low level properties as good as or better than the single contacts.

Experiments With Aluminaut Completed



A series of experimental dives with the deepsea research submarine, Aluminaut, has proven the capability of such craft to effectively perform undersea oceanographic surveys. The Naval Oceanographic Office conducted the experiments during January 1967. Scientists from the Naval Electronics Laboratory, San Diego and the Lamont Geological Observatory participated in the operations. Five dives were made, each ten hours long, to a depth of 1000 feet.

The purpose of the first dive was to make a reconnaissance of a selected area off the coast of Florida. During dive number two, made to a bottom depth of 1000 feet, a photographic and visual reconnaissance was conducted up slope to 100 feet. The vehicle cruised at ten feet off the bottom for a period of six hours. Visibility in deep water was excellent, limited only by the power of the artificial lights. However, when Aluminaut neared shore, visibility dropped to about 25 feet. Since the vessel has wheels, it actually rode along the bottom during part of this dive.

During the third dive, when Aluminaut was resting on the bottom, a series of steel balls of known weight and diameter were dropped at given distances from the bottom, causing the waters to cloud. Determining the degree that visibility is obstructed by such disturbances is important to the Navy in its planned program of rescuing personnel from sunken submarines with rescue vehicles.

Dive number four investigated the maximum visual and acoustic ranges to a variety of bottom markers. The last dive was conducted to evaluate Aluminaut's characteristics while operating at depth. The vessel's hovering abilities were evaluated, speed runs were made, maneuverability was tested, buoyancy control was appraised, and other characteristics were examined.

Aluminaut, which is owned by Reynolds Submarine Services, took part in the salvage of the H-bomb lost off the coast of Palomares, Spain in January 1966.

Selected Contract Research Reports

The contract research reports listed below have been extracted from the Technical Abstract Bulletin 67-2 of January 15, 1967. Government agencies and their contractors who are registered with the Defense Documentation Center of the Defense Supply Agency may obtain *free* copies from the Center at Cameron Station, Alexandria, Virginia 22314. Abstracts of the reports are found in TAB 67-2.

For non-DDC users, most reports may be purchased from the Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, Springfield, Virginia 22151.

AERONAUTICS

Research on VTOL Water Hover Effects; LTV Aerospace Corp., Dallas, Tex.; Marsh; AD-642 938

Airplane-Albatross Collisions on Midway Atoll; S. Ill. Univ., Carbondale; Fisher; AD-643 423

Visual Requirements for a Wheels-Up Warning Signal Device on Aircraft; Dunlap and Assoc., Inc., Stamford, Conn.; Bailey *et al.;* AD-642 865

Model Tests with a Catamaran Seaplane in Waves; Netherlands Ship Model Basin, Wageningen; Wahab and Swaan; AD-643 011

Human Factors in the Design of Airships; Dunlap and Assoc.; Channell; AD-643 118

ASTROPHYSICS

Free-Free Transitions of Electrons in Gases; Queen's Univ., Belfast, N. Ireland; Dalgarno and Lane; AD-643 222

Origin of the Microwave Radio Background; Princeton Univ., N.J.; Peebles and Dicke; AD-643 395

ATMOSPHERIC SCIENCES

Ion Temperature in the Ionosphere Obtained from Cyclotron Damping of Proton Whistlers; Iowa Univ., Iowa City; Gurnett and Brice; AD-643 399

Continuous Particle Sampler Study Program; Meteorology Research, Inc., Altadena, Calif.; AD-643 000

BEHAVIORIAL AND SOCIAL SCIENCES

Applied Mechanics Surveys; SW Research Inst., San Antonio, Tex.; Abramson *et al.;* AD-642 860

Is Information Retrieval Approaching a Crisis; Hebrew U., Jerusalem; Bar-Hillel; AD-643 226

Human Factors in the Design of the Submarine Control Room; Dunlap and Assoc.; Channell; AD-642 799

Shimoku Posed as an Assignment Task; System Devel. Corp., Santa Monica, Calif.; Hormann; AD-643 264

Tests for the Extent of Generalization of Classical Conditioning Under Identical Training Schedules; Indiana U., Bloomington; Furedy; AD-642 781

Behavior in Groups; Pittsburgh U., Pa.; Bass; AD-642 863

Effects of the Mass Media of Communication; Hunter Coll. of City U. of N. Y.; Weiss; AD-643 167

Modes of Resolution, Concept Formation, and Research Strategy; Hunter Coll.; Weiss; AD-643 168

A Methodological Study of Behavioral and Semantic Differential Scales Relevant to Intercultural Negotiations; Ill. U., Urbana; Davis; AD-643 274

Social Status as a Determinant of Respect and Friendship Acceptance; Ill. U.; Triandis *et al.;* AD-643 275

Speculation on the Structure of Interpersonal Intentions; Ill. U.; Osgood; AD-643 277

Effect of Stimulus Range, Duration, and Contrast on Absolute Judgments of Visual Size; Johns Hopkins U., Baltimore; Garner *et al.;* AD-643 349

Effects of Dimensional Redundancy on Visual Discrimination; Johns Hopkins; Lockhead; AD-643 350

Interpersonal Attitudes Among American, Indian, and Japanese Students; Ill. U.; Triandia *et al.;* AD-643 397

On the Statistical Analysis of Mobility Tables; Chicago U., Ill.; Goodman; AD-643 385

BIOLOGICAL AND MEDICAL SCIENCES

Effects of Magnesium Pemoline on Shock Avoidance Conditioning and on Molecular Neurochemistry; York U., Toronto, Ont.; Gaito *et al.;* AD-643 271

Tolerance to the Induction of Interferon by Vaccinia Virus in Germfree Mice; Notre Dame U., Ind.; Considine and Starr; AD-643 348

On the Diversity of -SH Groups in DPNH Dehydrogenase and their Tentative Localization; Calif. U., San Francisco; Mersmann *et al.;* AD-643 362

Comparison of Two Hapten-Specific Rabbit Antibodies; Indiana U., Bloomington; Knoght *et al.;* AD-643 383

Survey of the Population of Species of Sharks in Puerto Rico Suitable for Behavior Studies; Puerto Rico U., Piedras; AD-643 061

Foot Autotomy in the Gastropod Gena Varia (Prosobranchia: Trochidae); Tel-Aviv U., Israel; Fishelson and Qidron-Lazar; AD-643 224

The Day-Night (Circadian) Physiological Rhythms of Large Arctic Carnivors in Natural Continuous Light (Summer) and Continuous Darkness (Winter); Arctic Inst. of N.A., Wash., D.C.; Folk *et al.;* AD-643 263

On Selecting Variables in Succession for Best Discrimination; Information Research Assoc., Inc., Lexington, Mass.; Rao; AD-643 404

Immunologic Studies in Ataxia-Telangiectasia. Delayed Hypersensitivity and Serum Immune Globulin Levels in Probands and First-Degree Relatives; Calif. U., San Francisco; Epstein *et al.;* AD-643 418

Pantothenate and Coenzyme A in Bacterial Growth; Temple U., Philadelphia; Toennies *et al.;* AD-643 353

Effect of Amino Acids on the Nitrogenase System of Klebsiella Pneumoniae; S. Dak. St. U., Brookings; Yoch and Pengra; AD-643 380

Drug Effects Upon Cognitive Performance Under Stress; Inst. for Research, St. Coll., Pa.; Hurst and Weidner; AD-643 022

Physical Factors which Influence Vascular Caliber and Blood Flow; Pa. U., Philadelphia; Peterson; AD-642 826

Responses of the Lateral Geniculate Nucleus to Light Increment and Decrement and the Encoding of Brightness; Texas U., Austin; Jacobs; AD-643 371

Effects of Adaptation on the Lateral Geniculate Response to Light Increment and Decrement; Texas U., Austin; Jacobs; AD-643 421

CHEMISTRY

Magnetic Susceptibility of AgO; Calvin Coll., Grand Rapids, Mich.; Dirkse; AD-642 850

The Dipole Moments of Boron and Carbon Brominated Carboranes; Olin Mathieson Chem. Corp., New Haven, Conn.; Maruca *et al.;* AD-643 010

Vapor Phase Isomerization of O-Carborane; Olin Mathieson; Papetti *et al.;* AD-643 009

Nucleation Processes in Deposition Onto Substrates; Ohio St. U.; Hirth and Moazed; AD-643 206

Nuclear Magnetic Relaxation Studies of (CD30)2 11BH; Ill. U., Urbana; Boden *et al.;* AD-643 333

Ionic Forces in Polymers. Some Properties of the Polyphosphates in the Glass Transition Region; Calif. U., Los Angeles; Eisenberg; AD-643 403

Chemiluminescent Systems; Monsanto Research Corp., Everett, Mass.; Driscoll *et al.;* AD-643 132

EARTH SCIENCES AND OCEANOGRAPHY

Further Measurements and Observations on the Cromwell Current; Rhode I. U., Kingston; Knauss; AD-643 057

Internal Waves in the Arctic Ocean; Lamont Geological Observ.; Yearsley; AD-643 233

On the Water Exchange Through Bering Strait; Arctic Inst. of N.A.; Coachman and Aagaard; AD-643 261

Field Work Carried out in Tanganyika; Ill. U.; Alexander; AD-642 940

Rare Earths in Hawaiian Basalts; M.I.T., Cambridge; Schilling and Winchester; AD-643 359

Continuous Seismic Profiles of the Outer Ridge and Nares Basin North of Puerto Rico; Woods Hole Ocean. Inst., Mass.; Bunce and Hersey; AD-643 166

An Arctic Equivalent of the Grumusol; Arctic Inst. of N. A.; Tedrow and MacNamara; AD-643 278

Magnetic Survey Over the Mid-Atlantic Ridge Between 42°N and 46°N; Wisc. U., Madison; Vogt and Ostenso; AD-643 382

ELECTRONICS AND ELECTRICAL ENGINEERING

Solid State Image Intensifiers; Westinghouse Elec. Corp., Elmira, N.Y.; Fowlis *et al.;* AD-642 848, AD-642 849 and AD-642 933

Multi-Layer Adaptive Networks; Philco-Ford Corp., Newport Beach, Calif.; Stafford; AD-643 173

A Remark on Discovery Algorithms for Grammars; Hebrew U., Jerusalem; Shamir; AD-643 225

On the Electrically Thick Cylindrical Antenna; Harvard U., Cambridge; Chang; AD-643 227

ENERGY CONVERSION (NON-PROPULSIVE)

Power Generating Characteristics of Savonius Rotors; Stevens Inst. of Tech., Hoboken, N. J.; Mercier; AD-643 160

MATERIALS

Third-Order Elastic Constants of Ge, MgO, and Fused Silica. Temperature Dependence of the Pressure Coefficients of Elastic Constants for NaCl; Pa. St. U., University Park; Bogardus; AD-643 207

Transmission Electron Microscopy of Thin Glass Samples; Harvard U.; Seward *et al.;* AD-643 229

Reduction of Cavitation Damage by Surface Treatment; Minn. U., Minneapolis; Ripken; AD-642 842

The Magnetic Susceptibility of the Mercury-Indium Liquid Alloy System; Franklin Inst., Phila.; Collings; AD-643 147

Design Considerations for Laminated Wood Beams Composed of Two Species; Yale U., New Haven; Biblis; AD-642 783

MATHEMATICAL SCIENCES

Spectral Factorization by Algebra; Stanford U., Calif.; Anderson; AD-643 119

On a Fixed-Width Confidence Interval for the Common Mean of Two Distributions Having Unequal Variances: The Case of One Variance Known; Johns Hopkins; Gleser and Zacks; AD-643 182

Dynamic Programming; Stanford U., Calif.; Howard; AD-643 211

The Saddle Point Method of Approximating Extreme Value Probabilities; Harvard U.; Trafton; AD-643 228

Markov Processes; Cornell U., Ithaca, N. Y.; Shih; AD-643 347

Estimation by Ranking Parameters; Princeton U., N.J.; Hartigan; AD-643 384

On Simultaneous Confidence Intervals for Multinomial Proportions; Chicago U.; Goodman; AD-643 387

On the Multivariate Analysis of Three Dichotomous Variables; Chicago U.; Goodman; AD-643 391

The Asymptotically Unbiased Prior Distribution; Princeton U.; Hartigan; AD-643 393

Multi-Objective Linear Programming; Calif. U., Berkeley; Savir; AD-642 822

The Kappa Shortest Routes and the Kappa Shortest Chains in a Graph; Calif. U., Berkeley; Sakarovitch; AD-642 823

Some Generalizations of the Discrete Optimal Control Problem; NW U., Evanston, Ill.; Bankoff; AD-643 280

MECHANICAL, INDUSTRIAL AND MARINE ENGINEERING

Comparison of Chain Sampling Plans With Single and Double Sampling Plans; Rutgers, New Brunswick, N.J.; Stephens and Dodge; AD-642 935

Measurements of the Leading-Edge Separation Bubble for Sharp-Edged Hydrofoil Profiles; Minn. U., Minneapolis; Wetzel and Foerster; AD-642 827

Investigation of Oscillatory Lift and Drag Forces on a Ventilated Hydrofoil of Finite Span in Regular Waves; Minn. U.; AD-642 828

On the Energy Concepts in the Theory of Elastic Stability; Cal. U., San Diego; Nemat-Nasser and Roorda; AD-643 087

METHODS AND EQUIPMENT

Intrinsic Brittle Strength of Magnesia Bicrystals; Pa. St. U., U. Park; Lange; AD-643 078

A Capacitance Bridge Assembly for Dielectric Measurements from 1 Hz to 40 MHz; M.I.T., Cambridge; Charles *et al.;* AD-643 169

NAVIGATION AND DETECTION

The Meaning of Error in a Short Base Underwater Navigation System; Cath. U. of Amer., Wash., D.C.; Andrews; AD-642 791

Radar Benign/Non-Benign Environmental Analysis; Stanford Research Inst., Menlo Park, Calif.; MacKinnon; AD-643 217

PHYSICS

Pulses in Linear Acoustics; Nortronics, Newbury Park, Calif.; Soulea and Mitzner; AD-643 330

Experimental Investigation of Taylor Instability Using Non-Newtonian Fluids; Minn. U., Minneapolis; Song and Tsai; AD-642 847

Wakes of Lifting Propellers (Rotors) in Ground Effect; Cornell Aeronautical Lab., Buffalo, N.Y.; DuWaldt; AD-643 159

Noise Properties of Microwave Maser Oscillators; Harvard U.; Dmitrevsky; AD-643 230

Preparation of Platinum-Free Laser Glass; American Optical Co., Southbridge, Mass.; Woodcock *et al.;* AD-643 259

The Quark Decomposition of Hadron Scattering Amplitudes; Ill. U., Urbana; James and Watson; AD-643 088

ETA Photoproduction in the Region from Threshold to 940 MeV; Stanford U., Calif.; Prepost *et al.;* AD-643 164

The Excitation of Atomic Hydrogen by Electron Impact; Queen's U., Belfast; Morrison and Rudge; AD-643 221

Free-Molecule Langmuir Probe and its use in Flowfield Studies; Toronto Univ., Ont.; Sonin; AD-643 284

An Application of a Variational Principle to the Calculation of Free-Free Matrix Elements for H(−); Queen's U., Belfast; Khare and Rudge; AD-643 218

Applications of Time-Dependent Perturbation Theory; Queen's Univ., Belfast; Dalgarno; AD-643 219

Some Calculations on Creep in a Pressurized Thin Spherical Shell with an Opening; Brown U., Providence; Calladine; AD-643 181

Generation and Detection of Coherent Elastic Waves in Quartz at 114,000 Mc/Sec; Rochester U., New York; Jacobsen and Ilukor; AD-642 807

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Random Noise

Mr. Leonard J. Cole, Head of the Experimental Pathology Branch at the Naval Radiological Defense Laboratory, San Francisco, has recently received a Superior Civilian Service Award. A pioneer in the field of radioprotection, Mr. Cole was cited for his world-recognized studies in several subdivisions of biological research which comprise the broad scope of radiobiology. The award was presented by RADM H. J. Cokely, MC, USN, 12ND Medical Officer.

The Oceanographer of the Navy, Rear Admiral Odale D. Waters, Jr., recently moved with his staff into a new headquarters building and is now located at 732 North Washington Street, Alexandria, Va. The Oceanographer was previously co-located with the U.S. Naval Oceanographic Office at Suitland, Md. The Oceanographic Office will remain in Suitland.

The Honorable Robert A. Frosch, Assistant Secretary of the Navy for R&D, recently visited the Naval Radiological Defense Laboratory, San Francisco. Since this was his first visit to NRDL, he was thoroughly briefed on the Laboratory's history and plans by CAPT D. C. Campbell, Commanding Officer and Director and Dr. E. P. Cooper, Technical Director. He also inspected the laboratory's facilities, including the latest under construction, a 70″ AVF Cyclotron which is scheduled to be in operation in late 1967.

Captain Paul Bauer, USN (Ret), advisor to the Oceanic Biology Program, received the Order of the Falcon from the Icelandic Ambassador on January 30 for his contributions to the research effort on the newly formed volcanic island of Surtsey off the coast of Iceland. During the presentation, ONR was cited for its invaluable support of the research program being carried out on this unique island by the Surtsey Research Society.

Postscript to ONR Laser Story

"The ONR Laser Program," published in the December 1966 issue of *Naval Research Reviews,* told of a unique research management effort involving a number of people throughout the ONR organization.

The article omitted the mention of the major contribution being made to the program by ONR's Procurement Services Group. The magnitude and complexity of the program, plus its unusual nature, required an extraordinary effort in conducting contract negotiations expeditiously. In particular, Thomas J. Schilder, senior contract negotiator, who has chief responsibility for laser contracts, has devoted long hours to gaining expertise and learning the new laser jargon so that he can handle the contracts smoothly and effectively.

The Patents Division also plays an important role since all laser contracts have to be carefully scrutinized upon completion to protect the government's interest in this new and rapidly growing technological area. In particular, Richard Miller, Patent Counsel at ONR Chicago, reviews all patent applications on file from the viewpoint of security.

The services of both Mr. Schilder and Mr. Miller are gratefully acknowledged.

—Dr. Irving Rowe

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NAVAL RESEARCH REVIEWS publishes highlights of research conducted by Navy laboratories and contractors and describes important Naval experimental facilities. Manuscripts submitted for publication, correspondence concerning prospective articles, and changes of address, should be directed to Code 109, Office of Naval Research, Washington, D.C., 20360. The magazine is listed for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Subscription price: $1.50 per year in the U.S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. The issuance of this periodical approved in accordance with Dept. of the Navy publications and printing regulations.

Editor: BEATRICE M. EIESLAND

NAVSO P-510

A view of Parliament Square, London, looking towards Big Ben. During World War II, the U.S. Office of Scientific Research and Development established a London Mission for the exchange of war research information. That office became the Office of Naval Research, London, a unique facility which maintains liaison with European scientific research agencies.