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RESEARCH REVIEWS

HANDLING "HOT" MATERIALS

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DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

COVER PHOTO: Research on nuclear physics has made the handling of irradiated or "hot" materials a painstaking necessity at places where work is going forward on radiation and allied subjects. It is customary to build a "Hot Lab" with elaborate special equipment. Such a facility now in operation at NRL is described beginning with p. 17.

Research Reviews endeavors to report briefly highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. Articles which meet these broad criteria and possess a good degree of readability are welcomed. Manuscripts and changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C.

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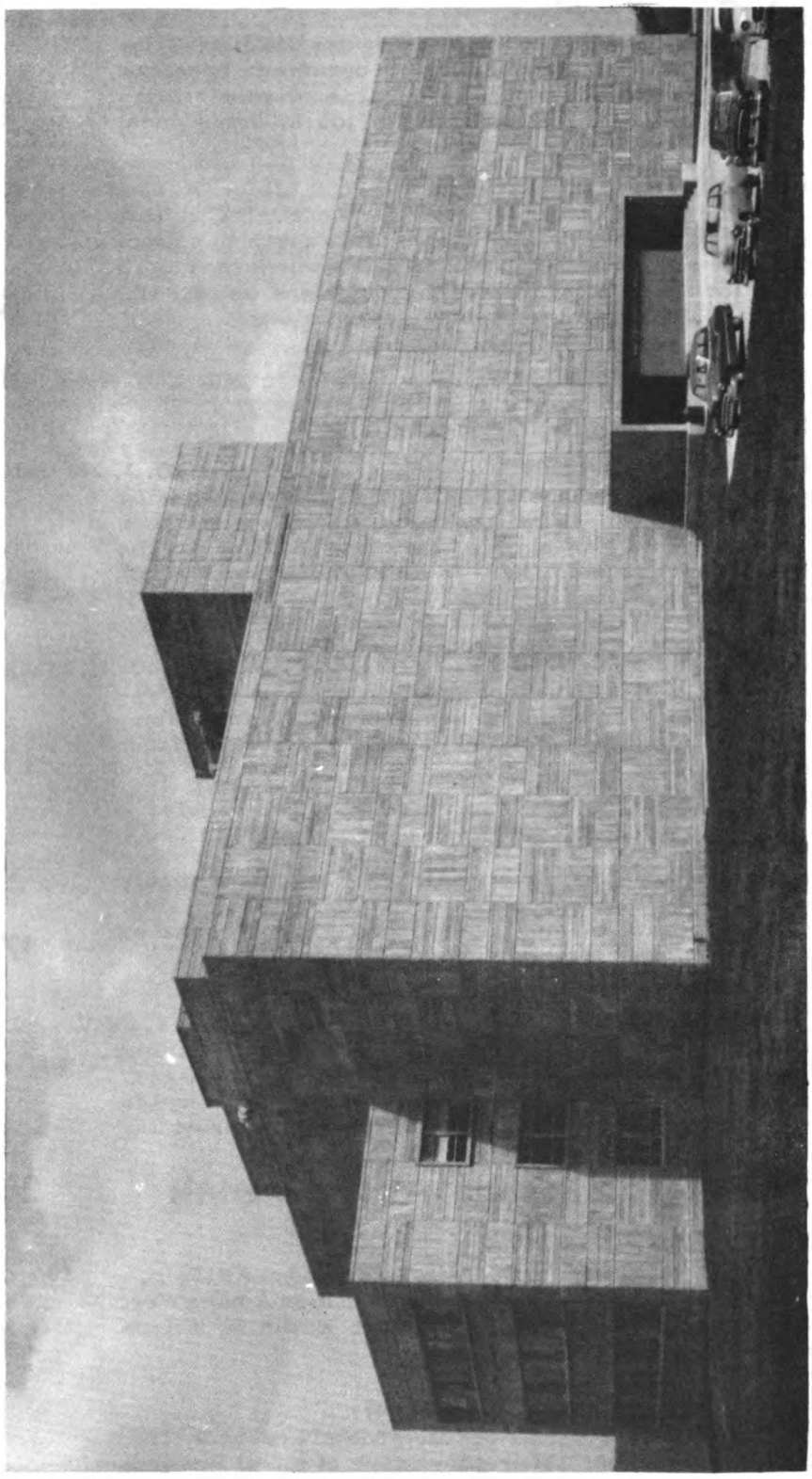

New building of the Armed Forces Institute of Pathology (See p. 29)

Research Coordination

I. Estermann
Deputy Science Director for Coordination
Office of Naval Research

When, in 1946, Public Law 588 created the Office of Naval Research, coordination of research within the Department of the Navy was stated as one of its major responsibilities; and from these early days on, certain steps to carry out the mandate of the law were part of ONR's regular activities. More recently, in 1954, the Report on Reorganization of the Department of the Navy (the Gates report) re-emphasized the importance of coordination of research and development, and the Secretary of the Navy issued an Instruction which brought on new plans and a special organization for the implementation of this responsibility.

The word "coordination" has many connotations. Many of ONR's regular activities have always contributed to coordination of research, but they did not represent an identifiable program. Now that coordination is in a more active phase, this concept requires a re-examination from a more philosophical point of view. If coordination of research is meant to be synonymous with control, coordination of basic research would probably do more harm than good, since the coordinator would be duty-bound to tell a large group of competent people what type of research should be carried out, and how they should do it. Such a person would have to be omniscient, or at least much smarter than everybody else.

The job of the Coordinator of Research, in our opinion, is quite different—his function is more like that of a catalyst. That is, he has to make it possible for the research in the Navy Department to be coordinated, but the coordination of research must definitely be a joint enterprise in which all the people involved play an equal role, and there is no distinction between the coordinator and the coordinated. Therefore, the philosophy of coordination of research can be described as a joint undertaking with other Navy bureaus and laboratories for the purpose of developing a better sceintific program.

As a first step in this phase of coordination, the Assistant Chief for Research has been assigned responsibility for the implementation of the instruction of the Secretary of the Navy with respect to research coordination. The position of Deputy Science Director for Coordination, held by the author, has been created to serve as focal point for the coordination of research; and a separate group of ONR key employees has been set up to coordinate development.

The techniques for research coordination are now being developed, and there have been a large number of meetings which brought together persons interested in this activity for the purpose of constructing a set of tools for doing the work. It should not be forgotten, however, that a tool is just a tool, and that the objective is not identical with the tool. The objective is to bring about an interaction of scientific minds for the improvement of the Navy's research program. The tools are somewhat more pedestrian and down to earth.

The tools consist of somewhat tedious operations, like collecting information, classifying information, sorting information, condensing information, and doing a great many things which I would call spade work, but which have to be done before the ultimate objective of bringing about the interchange of scientific ideas can be accomplished.

The sequence of operations, which we are now pursuing, is as follows:

Looking at the total research program of the Navy, a number of scientific fields have been identified and selected for the first attempt at systematic coordination. We are not trying to do the whole job at one time. The choice of fields is a pragmatic one, not governed by general philosophical areas, or by best subdivisions of science, but by the Navy's interest in fields which can be identified as suitable units within the framework of the research program of the Navy, and not necessarily within the framework of general science. It means we will not use the same breakdown that the Library of Congress, for instance, is using, or the "Science Abstracts" are using.

The second principle is that the designation of the scientific fields is to be independent of the hardware end-items which are expected to result from the research, or of the operational requirements which have been assigned by the Chief of Naval Operations. For instance, semi-conductor research as a scientific field has contributed to all kinds of hardware developments, and may be identified in at least a dozen operational requirements, because semi-conductors are very useful for gadgets that can find a place in a great variety of the Navy applications.

The present way of cataloging research in the Navy and in the Department of Defense goes by operational requirements, and consequently, there is no way of identifying the individual items of semi-conductor research at the present time without examining a vast number of existing project cards. For coordination of a research program we would need a catalog of research which will bring together the items according to their scientific and technical relationship, and not according to operational requirement under which they are authorized.

The second step, after identifying these fields, is the collection of a minimum amount of information about each research task or sub-task. We define as the sub-task the smallest unit of research from which technical reports result. This is again quite different from our normal way of listing projects as line items for budget purposes. Very often we have one project which has only one such task, but more often we find projects listed in the budget and in the summary reports, which have possibly a dozen or more research units. This applies also to our ONR breakdown by projects and tasks, where a "task" is not always the research unit that we need for scientific coordination. We have single tasks, like Project SQUID, which are composed of more than twenty research units which ought to be treated as individual units, but do not appear as such on our project cards. A similar task at the U. S. Navy Post Graduate School combines about twenty different pieces of research.

One of our present efforts is to collect a Navy research summary similar to the ONR research task summary, which will not only include

the programs of ONR, but also the research programs of all the Navy laboratories as well as the research phases of the contract programs of the Navy bureaus. The summary will essentially serve two purposes. One purpose is to supply to the coordinating committees and the advisory panels of the Secretary of Defense, who are charged with the study and evaluation of the Defense research programs, enough information to examine and evaluate the Navy program in various fields. The second and perhaps even more useful purpose is to provide the individual research worker with a handbook of research in the Navy. By consulting this handbook he will be able to find out who else in the Navy works in the technical area with which he is concerned. The information that he needs must be detailed enough to make it possible for him to decide whether the work is likely to be of interest to him, but should not be much more detailed than that, because if it becomes too detailed, the search procedure requires more time and the utility of the handbook goes down. The best compromise between "title only" and "long description" is a task description which conveys just as much information as is needed to accomplish its purpose. Excess information is just as undesirable as too little information, and in general, the optimum amount of information for each research unit will probably vary between half a page and two pages, double-spaced; but that is a rule which may have exceptions.

After these more clerical steps are completed we will attempt to break up each of the major scientific fields into a suitable number of smaller sub-fields and will examine the programs in these sub-fields for technical adequacy and consistency. This step will not only involve ONR people, but will require the assistance of scientists in other parts of the Navy and even from outside of the Navy who will be set up as working groups to make suggestions and recommendations leading to improvement of the program. It is hoped that these groups will have sufficient scientific prestige to give the necessary weight to their recommendations.

Another anticipated useful activity is the preparation of summary reports about the state of certain fields of research of interest to the Navy, which can be made available to a larger number of people, and from which they can extract information that is of use for their own work. These reports should be particularly valuable for the people at the applied end of the research scale, and for some of the development engineers, because the development engineer is usually not able to wade through the big stacks of technical reports on certain subjects and to extract from them the information he needs.

Another coordination activity which is not new at all, but has been going on since ONR started, is the arrangement for seminars and symposia in certain fields. They go on practically every day in some branch of ONR, and they are very useful in bringing people together who work in the same field, and in helping them to learn from each other's mistakes, and to benefit from each other's accomplishments.

Plans on organization are still in the development stage. So far we have set up only a very small group of people specifically charged with coordination and are drawing on the time and talents of all the

members of the Research Group. We hope to be able to continue this way with the possible exception of a few additional full-time employees who may take over some of the more specific aspects of the work, which demand too much time for assignment to the scientific personnel of the Research Group as additional duty.

One job just being completed is in response to a request from the Coordinating Committee on General Sciences of the Assistant Secretary of Defense for Research and Development. This committee has requested the three services, Army, Navy, and Air Force, to provide a complete research program summary, pretty much patterned after the ONR task summary, of the programs of these three services within certain scientific areas. The committee has listed thirteen scientific fields, which are grouped into four major ones, namely, geophysical sciences and equipment, physical sciences, engineering sciences, and biological sciences.

In addition to that, and in preparation for the other activities, work is going forward on a catalog of scientific activities in the Navy. The object is to identify the different groups, laboratories, sections, organization or bureau desks, who are concerned with certain areas of science, so that we will know where to seek or obtain answers to questions that may arise in any of these fields of research. Such catalogs have already been completed for four different fields: infrared, chemistry, structural mechanics, and hydrodynamics. They list the names of the individuals responsible for certain problem areas, the special areas of interest in the field, where they can be found, and how one can write to them. This catalog will probably also become a useful tool for all Navy scientists as a complement to the task summary.

In conclusion, we want to quote from the most recent report of the Commission on Organization of the Executive Branch of the Government (Hoover Commission), which deals with the research and development activities of the Federal Government. It states in its Recommendation No. 11:

"That the Secretary of the Navy and responsible senior Navy officers give strong administrative support to the new functions of the Office of Naval Research in coordinating and integrating the development program of the Navy. A staff adequate in size and of the highest research and development competence be provided, and the programmatic recommendations of the Office of Naval Research be implemented."

ONR Contractor Receives Award

Dr. Ralph Wichterman, Professor of Biology at Temple University, has received a Darbaker Award for his ONR-sponsored research. This award, for senior members of the Pennsylvania Academy of Science, was presented at the 31st Annual Meeting in Philadelphia.

His paper, "The Usefulness of the One-Celled Animal, Paramecium, in Studying the Biological Effects of High-Dosage X-Radiation" (subject discussed in Research Reviews, Oct. 1954), was selected for the award. This paper was presented at the General Session of the Academy and will appear in the Proceedings of the Pennsylvania Academy of Science.

Salt Dust from the Sea

A. H. Woodcock, Meterologist
Woods Hole Oceanographic Institution

On a clear night the visible "beam" from a flashlight reveals the presence of minute dust-like particles suspended in the air. At sea and in marine air over land, many of these particles are the sea-salt residue from very small droplets which are ejected into the air by bursting bubbles at the sea surface. Knowledge of these particles is important because it aids us in our search for understanding of the formation of fog, cloud and rain drops, and of the corrosion of metals exposed to winds of marine origin.

The breaking waves caused by winds on the open sea force much air beneath the sea surface in the form of small bubbles. These bubbles range in size from less than one-thousandth of an inch up to about one-tenth of an inch in diameter. Figure 1 shows what happens when bubbles of this size burst at the surface of the sea. The sequence as pictured is based on comparisons with high-speed motion pictures taken at 0.00003 seconds exposure time. Many of the small droplets which are so produced (several per bubble) remain air-borne, the water evaporating and leaving a minute crystalline residue. Thus winds passing over the sea often acquire a burden of salt dust simultaneously with the addition of water vapor. Well-mixed marine air, which has passed over hundreds of miles of sea surface will commonly contain from 10 to 100 of these salt particles per cubic inch from the surface up to the bases of the local cumulus clouds.

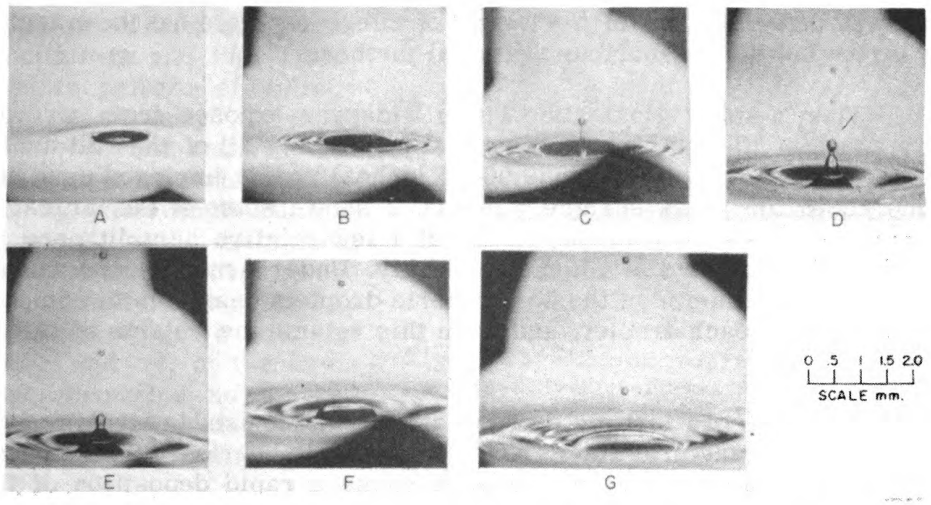

Figure 1 - Bubbles bursting at a water surface and producing droplets. a - Bubble approaching surface; b - Bubble just after rupture; c - Initial rise of jet; d, e, f, and g - Projection of droplets and decay of jet.

Other natural phenomena which produce great numbers of small bubbles in sea water, and hence add to the salt-nuclei population of the air, are melting snow, sleet and hail, and impinging raindrops. For instance, individual snowflake clusters release as many as 500 bubbles as they melt in the surface waters of the sea. Most of the bubbles produced in the sea by these precipitation elements are of microscopic size.

When droplets are ejected into the air from the bursting bubbles, they commonly carry with them a strong positive charge. This charge on the droplets has been measured by D. C. Blanchard, utilizing a modified form of Millikan's classical oil-drop experiment. Blanchard's preliminary results indicate that electrical current flow due to the transfer of charged droplets from the sea surface to the atmosphere may contribute largely to the well-known electrical interchange between the earth and the atmosphere. Investigation of the electrification of these droplets from the sea is continuing.

At the Woods Hole Oceanographic Institution we have also developed techniques for sampling and weighing air-borne sea-salt particles. Samples taken from aircraft have shown that the particles are carried by the winds to great heights in the atmosphere, and observational evidence is accumulating of a physical connection between the sea salt in these particles and the salt in rain waters.

As everyone knows, table salt (NaCl) crystals tend to become wet when the weather is humid. In fact, at a relative humidity of 80 percent, a single small crystal will, if left exposed for a sufficient time, collect enough water from the air to dissolve completely and to form a droplet. At a given humidity and temperature the amount of water collected in this way by a mass of NaCl is directly related to its weight, and this is also true for a particle of sea salt. This fact was utilized in weighing indirectly the minute sea-salt crystals sampled in the free air. Such an indirect determination of the weight of micro-crystals has been tested by direct but more laborious chemical methods.

When a small glass slide 1 mm wide was exposed from aircraft at a speed of 70 mph, it was found that practically all of the salt nuclei larger than about one micron (0.00025 inches) radius impinged upon and adhered to the glass surface. Figure 2 shows some of the largest of these particles as crystalline nuclei at a low relative humidity and as hemispheric droplets at a higher humidity. Under a microscope, measurements of diameter of the hemispheric droplets enable us to compute the volume of each droplet, and from this volume the weights of salt in solution.

Exposure of a test plate, of the standard size used in studies of the corrosion of structural steel, revealed that salt-bearing winds blowing over and around such steel surfaces cause a rapid deposition of the highly corrosive sea salts. This role of winds in increasing salt deposition had not been previously explored, and its revelation made it possible to explain some anomalous corrosion results, such as edge corrosion and the effects of the size, shape, and position of the metal surfaces upon corrosion rate. Air in motion through ducts of various kinds will tend, also, to deposit the suspended salt particles in a similar manner.

One of the most exciting aspects of the study of atmospheric salt particles concerns the role of these particles in raindrop formation. Over a period of about five years, evidence has been slowly accumulating that each large salt particle becomes the nucleus upon which raindrops form in marine air. The evidence supporting this idea is in the form of comparisons of the number and weight of the salt nuclei per unit volume of relatively clear air with the number of raindrops and the weight of salt dissovled in them in an equal volume of rainy air. These comparisons are too complex to detail here, but may perhaps be basically understood from the following remarks.

When rainwaters are sampled at cloud base in a manner which separates the drops into several size-range categories, it is found that the salinity of the water from each of these categories is different and that a very similar pattern of salinity can be directly computed from observed raindrop and salt-nuclei size-distribution curves. The implication of this result is that the natural rain-forming process is one which simply adds relatively salt-free water to the salt nuclei and yet, at the same time, produces no marked alteration in the distribution of salt per unit volume of air.

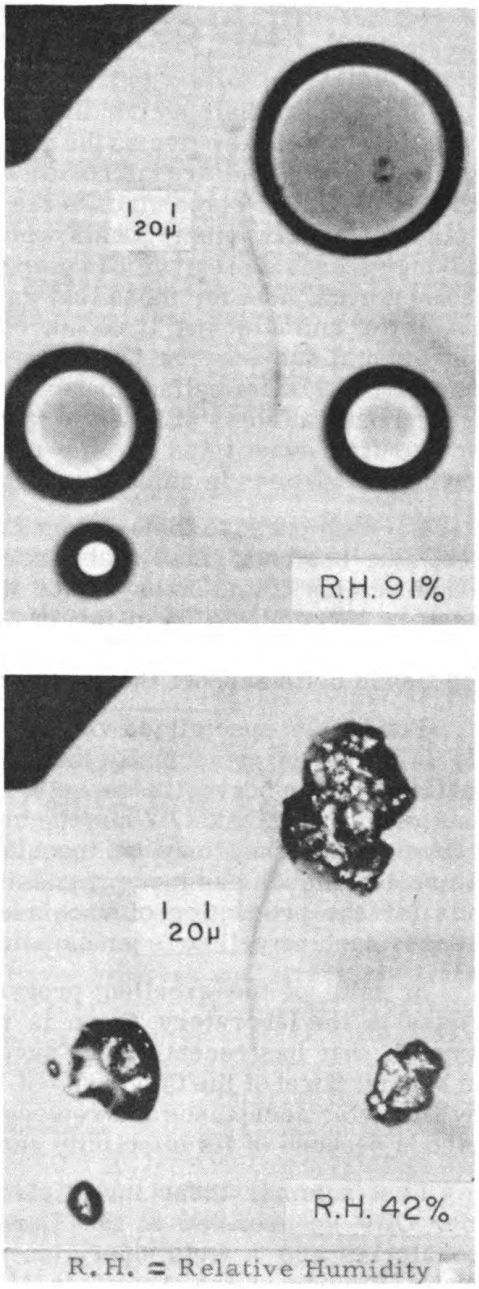

Figure 2 - Photomicrographs of a few of the sea-salt nuclei deposited by winds on a 4 x 6 inch test plate. Upper picture--Nuclei in crystalline masses. Lower picture--Nuclei dissolved in water

We are continuing our study of the interrelationships of sea surface conditions, air-borne salt and rain formation, for it may provide powerful evidence indicating the detailed mechanics of rain formation in marine air masses. Such evidence is, of course, of vital concern, for understanding of the details of the natural rain-forming process may lead to new methods for artificially altering this process.

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Fish as Food for Viruses

Throughout their entire lives, viruses are as dependent upon the host cell in which they live as the mammalian embryo is upon its mother. By definition viruses are micro-organisms that can grow only in a suitable host cell. For some viruses the "suitable host" may be a bacterium or other microorganism, plants, animals and man. When it comes to studying viruses so that we can use them or control them, we can easily use the normal host for those that cause disease in bacteria, plants, and most lower animals; but it is not convenient to use human beings as experimental subjects for those viruses that normally infect only man. Even for other mammalian viruses it is often inconvenient and costly to keep the natural hosts around the laboratory. Many attempts have been made to find substitutes for the natural hosts or to find methods for growing the viruses in an artificial host.

For this purpose the avian embryo in which the eggshell becomes a test tube has been most widely used and has given excellent results. A modification of the embryonated egg technique has been to take tiny pieces of the embryo from the egg and allow the tissue to grow in a solution of salts (like those found in animal tissue fluids) in a test tube. Such tissue cells support the growth of viruses very well too.

For highly specialized viruses such as those that grow naturally only in the liver or normally infect only nerve cells, pure cultures of hepatic cells or nerve tissue cells respectively may be grown in test tubes or culture flasks. When the cells have reached the proper stage of development they may be inoculated with the virus. Use of tissue culture techniques has made it possible to grow viruses in large quantities for the production of vaccines used for the prevention of virus diseases such as yellow fever or poliomyelitis.

In spite of the excellent progress that has been made in growing viruses in the laboratory, there is room for better methods. A new approach that has recently been suggested by Doctors Murray Sanders and Manuel Soret of the University of Miami, Deparment of Microbiology, may find wide acceptance and replace or at least supplement some older methods because of its simplicity and great economy.

Last summer these investigators were conducting some studies under ONR sponsorship at the Lerner Marine Laboratories. These laboratories are a field operation of the Department of Fishes and Aquatic Biology of the American Museum of Natural History and are located at Bimini, BWI on the edge of the Great Bahama Bank about sixty miles east of Miami, Florida. While there they learned about the Gambusia, a tiny fish that gives birth to living young with a yolk sac attached. A single female Gambusia (commonly called the mosquito fish because of their enormous appetite for mosquito larvae which they destroy in large numbers) may produce hundreds of microscopic embryos. Sanders and Soret found that by removing the young from the mother by Caesarian operation many of them could be obtained and grown in test tubes and cultures flasks containing ordinary tissue culture fluids. Tubes containing these embryos have been inoculated with the virus of Eastern Equine Encephalomyelitis (EEE) virus.

Several hundred cultures were studied with regard to the development of the embryo and the propagation of the virus. A final stage of the investigation involved the injection of fish tissue into mice, and the inoculation of mice with EEE virus.

After a year of intensive effort, the investigators have enough positive findings to support additional work with Gambusia embryos as a host. It is expected that other viruses than EEE will grow in this media or similar embryos as the history of virus propagation bears out this expansion of usefulness. Furthermore the number of viruses multiplying in vitro, as well as their titers, increase as investigators become more proficient in their techniques. The history of rabies and poliomyelitis are good examples of the last statement. On the other hand, a note of caution is necessary in prophesying results from a new agent on untested cells.

The Gambusia is not the only viviparous fish that can be used in this way. Other varieties may prove to be even more satisfactory, but many experiments will have to be made before the best one is found. It is still too early to know if this new approach to the growing of viruses is really superior to these now in use; but this we can say—the fish themselves are the bait in these virologists tackle box.

—Roger D. Reid

Graduate Program in Naval Architecture at the University of California, Berkeley

A doctorate program in Naval Architecture has been established in the Department of Engineering, University of California, Berkeley. This program will emphasize hydrodynamic aspects of the field and is intended to provide the advanced training required for modern research on Naval problems and design of Naval vehicles and structures (ships, submarines, underwater missiles, breakwaters, etc.). This program is to be closely coordinated with research sponsored by the Office of Naval Research and will help complete a training sequence now provided through the Master's Degree level at other universities. Material to be emphasized in course work includes: advanced mathematics and statistics, wave propagation and the hydrodynamics of free surface effects (ship motions, maneuverability, slamming, etc.), hydrofoil theory, ship vibrations, dynamic stability of underwater bodies, modelling theory, propeller theory, ship and missile noise problems.

The graduate program was developed with the advice of Prof. G.P. Weinblum, Director, Institüt für Schiffbau, Hamburg University, and is under the immediate direction of Prof. H.A. Schade, Director of Engineering Research, University of California. Candidates will have an opportunity to participate during thesis work in Navy sponsored research on Hydrodynamics of Naval Architecture, Ship Motions, and Maritime Cargo Transportation.

Naval activities are being encouraged to take advantage of this opportunity for development of their staffs by supporting the participation of outstanding technical Naval Officers and civilian engineers and scientists.

Resistance to Insecticides and the Study of Evolution

David J. Merrell
Department of Zoology
University of Minnesota

INTRODUCTION

The problem of development of resistance to chemical substances on the part of insects, bacteria, and higher organisms is of great importance, both practically and theoretically, in biology. Two principal hypotheses have been advanced to explain the phenomenon. One, the adaptation of individuals to the presence of a toxic substance by alterations in their metabolic processes, perhaps accomplished by special "adaptive enzymes," is especially attractive to those who postulate a common mechanism between the above phenomena and the type of adaptation seen in human development of tolerance for alcohol and narcotics.

The other hypothesis, which offers explanation on the basis of heredity and depends upon the presence of a certain number of genetically resistant "organisms" in the normal population, which increase greatly in number when the predominant strain in the population is killed off, is the hypothesis for which evidence is offered in this paper.
—Editorial Board

The thought of evolution usually conjures up images of dinosaurs and mastodons, of events that have occurred in the distant past. Darwin spoke of evolution as descent with modification. The significance of this definition lies in the fact that the evolving unit must be a breeding population, the most inclusive breeding population being the species. The descendants differ from their ancestors because they have different hereditary characteristics. Since these hereditary traits are governed by the genes, the descendants must differ from their ancestors in the kinds or in the frequencies of their genes. Thus, evolution is nothing more than a series of changes in the gene content of a population. With this as a definition of evolution, it is obvious that many evolutionary changes are now occurring.

For example, the work of the animal and plant breeders in developing new breeds or varieties is essentially a manipulation of a breeding population. The development of the Santa Gertrudis cattle, beef animals able to thrive on grass feeding in the heat of Texas summers, is evolution on a small and somewhat distorted scale. The labors of the wheat breeders to develop new varieties resistant to the new strains of wheat rust which are constantly coming to the fore are evidence of the capacity of the wheat rust as well as the wheat to evolve. In the field of medicine the so-called wonder drugs and antibiotics became less wonderful as the processes of mutation and natural selection in populations of susceptible micro-organisms gave rise to resistant populations.

With this background of information, it should not be surprising to learn that the experience with insecticides has been rather similar. The introduction of new insecticides such as DDT has been followed by reports from all parts of the world that different species of insects, which at first were easily controlled by the insecticides, no longer were being killed (see Research Reviews, December 1952). Reports of resistant mosquitoes, house-flies, lice, and other species began to accumulate.

The change from susceptibility to resistance usually occurred within the space of a few years from the time the agent was first used in an area. Such a rapid change does not fit in with the usual concept of evolution as a ponderous, slow-moving process, and hence other explanations were offered. Among them were the ideas that the resistance was due to the ability of the insect to modify its physiology so that it could tolerate the insecticide, or its behavior so that it no longer came in contact with it. An alternative to these concepts of individual adaptation was the possibility that the resistance was due to the action of natural selection (or somewhat unnatural selection, perhaps, since DDT was added to the other selective forces) acting on the hereditary variability in the insect populations. Under this theory, the genes, of whatever kind, which permitted the organism to survive and reproduce, would increase in frequency in the population, the genetic composition of the population would thereby change, and hence evolution, on a small scale, would occur.

At the outset, therefore, it seemed necessary to try to discover which theory of the origin of resistance was correct. In view of the experiences cited above with antibiotics and plant diseases, the more reasonable assumption seemed to be that resistance was the result of natural selection acting on the genetic variability. One way to test this assumption was to find out whether populations with different amounts of genetic variability developed the same amount of resistance.

The species chosen for study was the fruit fly, Drosophila melanogaster, the best known species of all genetically. For the test, two inbred lines which had each been brother-sister mated for more than 20 generations, and hence had little variability left, were exposed to DDT in population bottles, which permit the continuous maintenance of a population of flies for an indefinite period. These two populations, though exposed to DDT for 30 months, with a large percentage of flies being killed each generation, failed to become more resistant. On the other hand, six different populations, descended from wild populations with a large store of variability, developed resistance to DDT when compared with their controls.

These results lend support to the hypothesis of natural selection since, if individual adaptations were responsible, the amount of genetic variability in the population should not matter. Further evidence in this respect is the fact that the tests of resistance, comparing exposed and control populations, were conducted with progeny of exposed flies, which had never been in contact with DDT, and hence had never had a chance to make any individual adaptation to the insecticide. Nevertheless, the tests showed them to be more resistant.

Of seven laboratory stocks tested, only one became more resistant than its control. Interestingly enough, this stock was descended from the same parental stock as one of the inbreds in which no resistance developed. These results would appear to indicate that the usual methods of maintaining stocks of flies in the laboratory must lead to considerable inbreeding.

Hybrid populations from crosses of the two inbreds, from five of the exposed but non-resistant laboratory stocks, and from five stocks which increased in resistance, were also tested. Only the latter became more resistant than its control. Since the variability was increased by the crosses, it is clear that not genetic variability per se, but the proper kinds of genes must be present in the population for resistance to develop.

In three of the populations in which resistance appeared, a rather unusual event occurred, for, despite continued exposure to DDT, the ability of these populations to tolerate the insecticide declined. The most reasonable explanation appears to be that selection was so rigorous that a relative handful of flies survived each generation to become the parents of the next. The resultant inbreeding would either bring to expression harmful genes usually concealed in the heterozygous recessive condition, or by chance, in the process of gamete formation and fertilization, some of the genes favorable to resistance would be lost. In either event, a decline in resistance would result.

A rather paradoxical finding was that higher concentrations were more effective in producing resistance in populations than low. Hence, the more effectively one controls the insect population, the sooner one may expect the method no longer to be effective. Paradoxical too, perhaps, is the fact that inbreeding seldom occurs in wild populations, and if it does, its effects are apt to be soon over-ridden by the migration of individuals from adjacent populations. Therefore, practically all natural populations can be expected to become more resistant if exposed to insecticides.

Though not completed, tests indicate that the increased resistance is due to the combined action of many different genes or multiple factors. Other workers have also found multiple factors to be responsible for resistance, but some have reported that a single dominant gene is responsible. Still others have postulated some sort of cytoplasmic inheritance, but the evidence in these cases is not clear-cut. Since it has already been suggested that resistance develops because of the action of natural selection on the available genetic variability, differences such as these are to be expected. In different populations, the kinds of genes conferring greater resistance will often differ, and hence the genetic mechanisms resulting from natural selection will also be different. It is this versatility of the species in their ability to adapt to new selection pressures which makes the problem of control by insecticides so difficult. It also makes the hope for a perfect insecticide, to which no species will become tolerant, rather remote at the present time.

Physiological Psychology Symposium

Clinton H. Maag
Physiological Psychology Branch
Office of Naval Research

A symposium representing the research program of the Physiological Psychology Branch of the Office of Naval Research was held 10-11 March 1955 at the U. S. Naval School of Aviation Medicine, Pensacola, Florida. This setting provided an opportunity for ONR contractors to get a first-hand view of Navy problems and "in service" research operations.

The many outstanding scientists attending represented such diverse fields as Physiology, Psychology, Neuro-Anatomy, Psycho-Physics, Psycho-Acoustics, and Bio-Chemistry. This multiplicity of disciplines provided a rich source of stimulation as each scientist became better aware of the techniques, contributions, and problems of others. In addition, this meeting allowed the participants an opportunity to obtain a picture of the integration of their own work with that of other scientists in the Navy research program.

This symposium was unique in several aspects. The participants were all recognized as leaders in their respective fields. These men were requested to hypothesize beyond their present research data. The participants were encouraged to indulge in "educated guessing" relative to the status of current research and to suggest areas of inquiry and procedures which would maximize research reward. It should be recognized that this type of presentation differs in content and intent from the factually buttressed reports characteristic of most symposia.

With the type of orientation indicated, it is rather difficult to summarize the concrete results of these meetings. The ultimate value will be determined by future modifications in the thinking and research of the participants. The following are some of the more tangible research results reported at this symposium.

Dr. Beidler of Florida State University and Dr. Pfaffmann of Brown University investigating the sense of taste, have measured the response of the chordal nerve to the stimulation of various chemical solutions placed on the tongue. This quantitative approach is a relatively novel technique in the study of taste sensitivity. Most previous studies in this area have been dependent upon either a conditioned response of an animal or subjective verbal reports of human subjects as to whether or not the substance tastes sweet, sour, bitter, etc.

Dr. Kenshalo and Dr. Nafe of the Florida State University have obtained data that lead them to question some of the established theories concerning the psychophysiology of the sense of touch. It has been maintained in many quarters that the human body possesses specific sense receptors for pain, cold, warmth, and pressure. These investigators have postulated, on the basis of their work to date, that a single type of sense organ can adequately receive and initiate neural impulses related

to these different sense impressions. This sense organ is innervated by tissue movement and ceases to respond in the absence of tissue movement. Such a concept has interesting implications for theories of adaptation based upon fatigue or recuperation of the sense organ. To account for the perception of thermal stimuli it is hypothesized that constriction and dilation of the vascular system is sufficient to produce the tissue movement required to initiate the neural impulse.

As a consequence of this research, it appears that the quality or differentiating characteristics of the various skin senses must depend upon other principles than differences in the receiving mechanism. Perhaps the sensations of warmth, cold, pressure, and pain are distinguished by specific patterns of neural discharge or perhaps by channeling within the central nervous system. Research is in progress to provide information concerning this problem.

Dr. Geldard of the University of Virginia discussed the possibility of using the sense of touch as a communication channel. (Research Reviews, Oct. 1954). In many military tasks an individual's eyes and ears are utilized to their maximum for sensory input; and consequently we must turn to other sense modalities as possible signal receivers. On the basis of preliminary research, Dr. Geldard has found that it is possible to utilize patterns of tactual stimuli as a means of communication. Such a process, if proven feasible, would have important applications, not only in those tasks in which the individual's eyes and ears are already in use, but also in those situations which require communication in the absence of light and sound.

The subject matter on the topic of vision ranged from the nature of the visual stimulus to the biochemical changes that take place in the retina and the resulting integration of neural impulses. Numerous applications of current research to naval operations were generated from these discussions. Of particular significance to naval aviation was the material presented by Dr. Ludvigh of the Kresge Eye Institute. His research group has demonstrated that normal 20/20 vision for a stationary target does not guarantee comparable acuity for a rapidly moving target. There are considerable individual differences in the extent to which visual acuity deteriorates as the target increases in velocity. Dr. Ludvigh has "screened out" what he terms "velocity susceptible" and "velocity resistive" individuals. Obviously, this research has considerable significance to all Navy tasks which require tracking of a rapidly moving target.

Dr. Gibson of Cornell University outlined a research program concerned with the stimulus cues for perception of motion. One of these cues, which has not had the benefit of systematic research, is the change in perceived surface texture as the velocity of the target or observer is increased. Such a phenomenon is quite apparent in landing an aircraft as the texture of the earth and runway appears to change as a function of altitude and speed. Dr. Gibson indicated the importance of such sensory impressions to the pilot in the efficient operation of an aircraft.

Dr. Fitts of Ohio State University discussed accurate specification of stimulus characteristics. He pointed out that quite frequently individuals are required to make refined responses to very complex stimuli.

The stimulus pattern of a PPI scope is an example of such a situation in which we do not know whether the subject is responding to the brightness, velocity, pattern, shape, or any number of other stimulus variables. Dr. Fitts and his co-workers have made considerable progress in the isolation and quantification of such complex stimuli.

A major portion of the symposium was devoted to the latest research and development in the field of hearing. Various aspects of this subject were discussed by Drs. v. Bekesy and Zwislocki of the Harvard Psycho-Acoustic Laboratory, Wever of Princeton, Gross of Lehigh, Neff of the University of Chicago, Ades from the University of Texas, and Tolhurst of the School of Aviation Medicine, Pensacola, Florida. Dr. H. Davis of the Central Institute for the Deaf served as Chairman of this session on various aspects of audition and communication.

The range of discussion precludes any adequate summary here; a full report on the symposium will be distributed soon. As in the case of vision, this portion of the symposium was organized so that the papers were presented in the same functional order as the physical and neurological events leading to perception. First, speakers talked about the nature of the sound stimulus followed by a discussion of the action of the cochlea, the nerve impulse and finally the neural activity at the cortical level. Dr. v. Bekesy presented a model of the cochlea with an explanation of how, under certain circumstances, a sound wave might move along the cochlear membrane toward rather than away from the source. This concept may be of major significance in the explanation of several paradoxical auditory phenomena.

From the more applied standpoint, Dr. Zwislocki's comments and discussion concerning the noise attenuation characteristics of various type ear plugs and helmets were of considerable interest, as were his theories upon the future developments in attenuation. His observations have a direct bearing on research being conducted on the problem of high-level jet noise and its effect upon certain flight-deck personnel aboard aircraft carriers.

Dr. Bishop of Washington University Medical School presented a stimulating paper on the subject of neural transmission. Congruent with the orientation of this symposium Dr. Bishop "went out on a limb" to question the commonly accepted principles of "all or nothing" and "one way" transmission in certain segments of the nervous system. Results from his highly competent work indicate the need for revision of many presently accepted basic principles of neural transmission.

Dr. R. C. Davis of the University of Indiana concentrated his attention on the autonomic nervous system. He discussed the measurement of various physiological responses following visual stimuli. Since it is the autonomic system that is primarily active in the reaction to stress, the findings of Dr. Davis are of major significance to military operations in which stress of many sorts is quite common and the consequent breakdown and loss of manpower a major problem. The techniques of measurement and correlation of the various physiological responses developed by Dr. Davis promise to be of considerable aid in the investigation of human response to stress situations.

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Figure 4 - The General Mills Mechanical Arm
is a heavy duty manipulator

The Hot Lab is equipped with a periscope for use when a closer view of objects inside the hot cell is needed or when photographs of "hot" objects are required. A microscope can be used in connection with the periscope for the making of microscopic examinations. When the periscope is not needed, the vertical legs on the hot and cold sides are removed and kept in racks on the wall.

As a rule specimens are prepared in advance at NRL—recently a group of three completed the cycle of preparation at the Laboratory, irradiation at the Nuclear Reactor Test Station in Idaho, and return to NRL. The material to be irradiated happened to be a liquid; 40 cc of each sample was made up, and sealed respectively in 50 cc quartz ampules. The three ampules were in turn placed in stainless steel tubes which also were sealed. Shipment to Idaho Falls from NRL was no problem as the three tubes made only a small package. But as soon as the three specimens including ampules and tubes had been irradiated in the Test Station reactor, then came the elaborate precautions. The specimens were placed in a bulky lead container, sealed, and shipped by truck. A vehicle of the Atomic Energy Commission on a routine run carried the NRL shipment most of the distance—as far as Schenectady, N. Y. Then a commercial trucking service brought the lead container and its well-shielded specimens to NRL. Deliveries such as this one are made directly to the Hot Lab, and it becomes the job of personnel attached to the Lab to "take over."

Usually the specimens are transferred from the lead container to the heavy cask in a preliminary operation which serves to put the hot

material in a shielded place of high security (Figure 5). Later at the convenience of scientists interested in the specimens, a more elaborate operation unfolds. This involves the use of a milling machine, which is operated by remote control (Figure 6), and cuts off one end of the stainless steel tubes. As the end of each tube comes off, an operation follows which requires the utmost skill and delicacy. The quartz ampule must be carefully removed from the tube with manipulators, and placed in a small metal bucket with a long hoop handle. Then as quickly as possible, the bucket and its ampule are taken out of the hot cell with a long pair of tongs. In a flash the ampule is transferred to a lead container, and the interested scientists who will work with the specimen--who have been standing by--take the container and its specimen to their own shop.

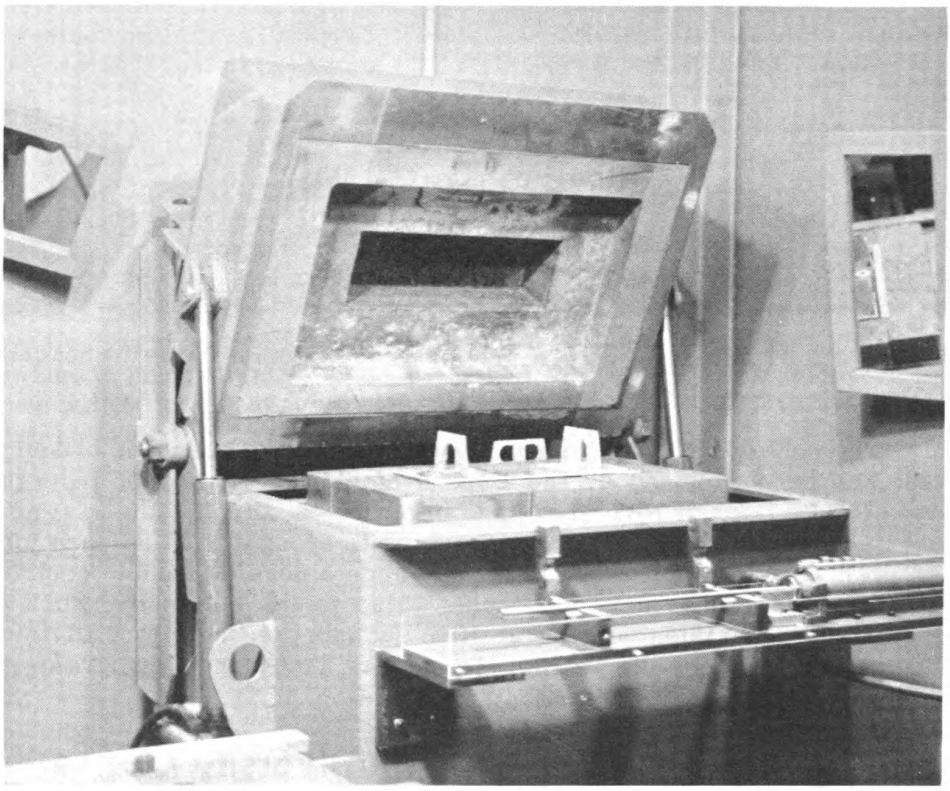


Figure 5 - Heavy lead cask for maximum security of "hot" materials

When personnel at the Hot Lab undertake to handle specimens, there is always a man from the Health Physics Unit at NRL on hand. He takes readings for radiation with his own portable monitor. Later when the operation is completed, he participates in "cleaning up" the Lab, and takes charge of unwanted material that is "hot." This is usually the stainless steel tube, and the small grains of metal that resulted from milling off one end. Hot waste is stored in a lead-lined vault outside the Hot Lab. Ultimate disposal of these wastes is made by casting them in concrete blocks which are dropped into the ocean well out from land.

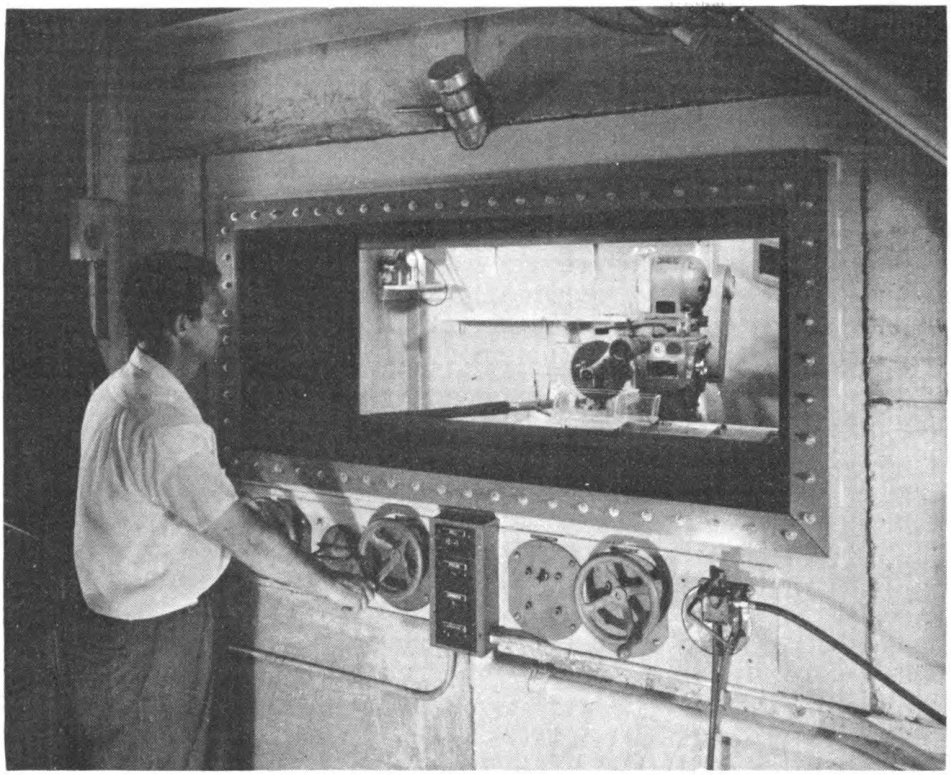


Figure 6 - By remote control a machining job is done inside the hot cell

The cost of building the new laboratory, and the purchase of equipment has been financed by the Bureau of Ships. Personnel from the Radiation Division at NRL serve as operators, and from time to time a qualified man from Engineering Services is brought in to do such jobs as cutting off the end of stainless steel containers by remote control. While the new facility is of particular value to the continuing work of the Radiation Division, others at NRL such as the Chemistry Division plan to make use of the "handling" service in expanded programs on radiation problems.

ONR Research Becomes a University Course

Another university course is being offered based on the theoretical and experimental material developed by scientists working on a contract with the Office of Naval Research. The latest is a course being offered at California Institute of Technology under Dr. M. S. Plesset and with Drs. Wu and Parkin taking charge as instructors. "Hydrodynamics Applied to Naval Architecture" is on the graduate level and will deal with such topics as: Theory of tidal waves and surface waves. Wave resistance of a body moving through water of infinite and finite depth. Wave profile due to ship motion. Resistance of ships. Lifting surfaces in free surface flows (hydrofoils, planing surfaces). Free boundary theory and theory of cavity flows. Dynamics and stability of vapor bubbles in a liquid. Propellor theory. Experimental apparatus and techniques for the study of hydrodynamic problems (water tunnels, towing tanks).

On the basis of the notes prepared on this course, Drs. Plesset and Wu plan to write a book on the subject.

Linear Programming

Dr. Alan J. Hoffman and CDR George L. Voegeli, SC, USN
Logistics Branch, Office of Naval Research

Linear programming has emerged as a new branch of applied mathematics that has already shown tangible results in meeting troublesome problems of management planning. As a contrast to most branches of applied mathematics in which the usefulness depends on aspects of science and engineering at least as esoteric as the mathematics itself, linear programming provides an essentially scientific treatment to certain operational problems faced by the executive, the planner, the business man, or the manager. Neither the statement of these problems nor the solution are customarily cloaked with imponderable and abstruse terminology—they are set forth in clear, concise language that can be readily understood by the rank and file of people on the operating staff.

On the other hand, to formulate the practical management problem (if, indeed, the problem lends itself to linear programming) and perform the computing which is necessary to solve it does require a skill and experience with the technique. For these skills, the government can turn to an agency such as the Deputy Chief of Staff/Comptroller within the U. S. Air Force, to the National Bureau of Standards, or to the Office of Naval Research and its contractors. And there are others. When a civilian organization is confronted with a problem susceptible to solution by linear programming techniques, it is likely that management consultants will be called in, or that qualified people will be employed to establish an operations research staff.

The subject of linear programming has come rapidly into prominence with much of recent progress traceable to the initial effort of government-supported research. It is proper now to expect that any knowledgeable group, in and out of government, will have a working concept of the benefits to be gained from linear programming, and at the same time possess the initiative to recommend to executives the merits of these mathematical aids to management.

Several specific examples are presented to show how operational problems can be met. The Air Force problem and the Navy problem are hypothetical, but both serve well to bring out the methods employed by linear programming. For more detailed information in the field of linear programming, the reader may wish to refer to such periodicals as the Naval Research Logistics Quarterly, Management Science, and the Journal of the Operations Research Society of America. A book which is basic on the subject is An Introduction to Linear Programming by A. Charnes, W. W. Cooper, and A. Henderson published by John Wiley & Sons, New York, 1952.

THE AIR FORCE PROBLEM

A problem on the changing of aircraft engines, time factors involved, and the related procurement of new aircraft engines, well illustrates how linear programming actually served an Air Force command.

The problem is taken from a brochure dated 17 December 1954, prepared by the Computation Division, Directorate of Management Analysis, DCS/ Comptroller, Headquarters, U. S. Air Force. The situation and requirements are formally stated:

> In order to accomplish its mission, a base requires monthly inputs of spare engines to meet specified engine change requirements. Engines removed for overhaul are transported from the base to an assigned repair depot. After they are overhauled, the engines are transported back to the base for possible reinstallment. If a monthly requirement for replacement engines is greater than the number of overhauled engines available at the base, new engines must be procured for that month.
>
> The base can utilize air or surface transport in moving engines to and from the depot. After they are overhauled, the engines are transported back to the base. Similarly for an engine transported by surface lift. The total time an airlifted engine is in transit and in repair is, of course, less than the time for a surface-lifted engine. However, since airlift is an expensive means of movement, it must be used judiciously.
>
> The problem is to determine a schedule of monthly air and surface shipments of used engines that requires the minimum number of new engines to be procured and uses the maximum amount of surface lift. A shipping schedule that takes full advantage of the fast transport--the one that uses airlift exclusively--will also require the minimum number of new engines to be procured. In general, there are other schedules that call for the same number of new engines, but use less airlift. Out of these schedules, the one that uses the least airlift is the ultimate solution of the problem.

A Numerical Example. A base flying hour program requires a certain number of monthly engine changes, as listed in line 1 of Table I. It takes three months for an engine to be airlifted, repaired, and airlifted back to the base; and five months for a surface-lifted engine. By assuming all the engines are airlifted, the schedule given in Table I results:

TABLE I
AIRCRAFT ENGINE CHANGE PROBLEM

Months - Numerical Designators	1	2	3	4	5	6	7	8	9	10	11	12	Totals
	Number per Month												
1. Engine Change Requirements	2	3	4	5	1	5	7	8	10	5	2	1	53
2. Engines Airlifted from Base to Depot	2	3	4	5	1	5	7	8	10	5	2	1	53
3. Engines Airlifted from Depot to Base	0	0	0	2	3	4	5	1	5	7	8	10	45
4. Engines Procured to Meet Requirements	2	3	4	3	0	0	1	7	5	0	0	0	25

The total number of engines procured—the footing total on line 4—is 25. This figure represents the minimum procurement for any schedules of air and surface shipments.

A computational procedure is applied to the schedule in Table I in accordance with methods described in "On the Solution of the Caterer Problem" by J. W. Gaddum, A. J. Hoffman, and D. Sokolowsky, and also in "The Caterer Problem" by W. Jacobs. These two articles were published in Volume 1 (1954) of the Naval Research Logistics Quarterly. In the aircraft problem at hand, the number of engines airlifted is reduced to the minimum by utilizing surface-lift whenever possible. The total number of engines procured remains at 25. The resulting shipping schedules and procurement schedule are given in Table II. There can be no other schedule devised that would require less airlift.

TABLE II
SHIPPING AND PROCUREMENT SCHEDULES

Months - Numerical Designators	1	2	3	4	5	6	7	8	9	10	11	12	Totals
	Number per Month												
1. Engine Change Requirements	2	3	4	5	1	5	7	8	10	5	2	1	53
2. Engines Airlifted from Base to Depot	0	0	0	0	1	5	5	2	0	0	0	0	13
3. Engines Surface-Lifted from Base to Depot	2	3	4	5	0	0	2	6	10	5	2	1	40
4. Engines Airlifted from Depot to Base	0	0	0	0	0	0	0	1	5	5	2	0	13
5. Engines Surface-Lifted from Depot to Base	0	0	0	0	0	2	3	4	5	0	0	2	16
6. Engines Procured to Meet Requirements	2	3	4	5	1	3	4	3	0	0	0	0	25

THE NAVY PROBLEM

The Navy example is concerned with a discrete idealization of a scheduling problem in the routing of fuel oil tankers. In the hypothetical problem, the tankers are to be routed for pick-up and delivery in such a way as to minimize the number of tankers required. The data given are:

1. The time when loading is to begin,
2. The length of time for loading-traveling and unloading-traveling between any pick-up point and any delivery point.

The problem is discussed in detail by G. B. Dantzig and D. R. Fulkerson in "Minimizing the Number of Tankers to Meet a Fixed Schedule," published in Volume 1 (1954) of Naval Research Logistics Quarterly. For the purpose of the problem, 20 trips are taken into consideration, and the trips are designated in numerical sequence for convenience.

The scheduling officer is bound to meet specified times when loading starts—15 different times in the problem at hand—and at designated pick-up points—two points arbitrarily called "A" and "B" in the problem at hand. He seeks to meet the requirements and at the same time make use of as few tankers as possible. The tankers are all the same, and each will be fully loaded. Because this officer has the option of routing the tankers to best advantage between the pick-up points and the discharge points, he calls upon his best ingenuity and skill in working up the schedule. Also he must keep in mind that efficiency is lost if a tanker is kept at sea—the schedule should minimize running time as much as possible.

First the scheduling officer is concerned with a total of 20 trips to be made, but which must need a series of only 15 specified times to start loading at designated pick-up points for delivery to designated discharge points. A list of his required trips is shown with related data:

Trip	Pick-up Point	Discharge Point	Time Tanker Starts to Load
1	A	X	0100
2	A	X	0400
3	A	X	0700
4	A	X	1000
5	A	X	1300
6	A	Y	0900
7	A	Y	1500
8	A	Z	0600
9	A	Z	1200
10	B	X	0300
11	B	X	0600
12	B	X	0900
13	B	X	1200
14	B	Y	0700
15	B	Y	1000
16	B	Y	1300
17	B	Y	1500
18	B	Z	0500
19	B	Z	1000
20	B	Z	1500

For purposes of illustration, the required time for a tanker to start to load is shown above as 0100 and so on through 1500. This does not correspond to a real case should the symbol 0100 be regarded literally as 0100 o'clock. The numbers refer to any time scale (for example, half-days) not necessarily hours.

In order for a tanker which has traveled from a pick-up point to a delivery point to be used for transporting another load, it must return to the designated pick-up point for the second load. The times for loading-traveling from the first pick-up point to the designated discharge point, and for unloading-traveling from that discharge point to the second pick-up point may or may not be sufficient. In any case, the scheduler must know these times for each combination of pick-up and delivery.

For simplicity, we assume in this problem that loading-traveling and unloading-traveling, for each combination of pick-up or delivery take the same time. Let these times be given by:

TIME REQUIRED FOR A TANKER RUN

	Discharge Point X	Discharge Point Y	Discharge Point Z
Pick-up Point A	2	3	2
Pick-up Point B	1	2	1

A schedule which employs seven tankers is:

Tanker 1 - Trips 1, 18, 14, 5
Tanker 2 - Trips 10, 11, 12, 13, 7
Tanker 3 - Trips 2, 6, 17
Tanker 4 - Trips 8, 15, 20
Tanker 5 - Trips 3, 19, 16
Tanker 6 - Trip 9
Tanker 7 - Trip 4

Using linear programming, however, one can find an optimal six-tanker schedule:

Tanker 1 - Trips 1, 18, 14, 5
Tanker 2 - Trips 10, 11, 12, 9
Tanker 3 - Trips 2, 6, 17
Tanker 4 - Trips 8, 15, 20
Tanker 5 - Trips 3, 19, 13, 7
Tanker 6 - Trips 4, 16

It can further be shown that the schedule of loaded trips cannot be accomplished with fewer than six tankers. Also one can easily find, for any number of tankers, the schedule with the least total sailing time.

The benefits of linear programming which have been demonstrated in these two examples are not to be considered proof positive that the technique can be applied with comparable advantage to all problems, no matter how difficult or complex, in the field of scheduling and allocation. But any useful application of a pure yet sophisticated science such as mathematics to our modern work-a-day world can well be regarded as an achievement which borders on a minor miracle. A pattern of worth has been established for linear programming—it promises to serve well in many pressing and even more complex problems in the future.

Nuclear Energy Makes Dielectric Materials

New and better electrical insulating materials have been made experimentally by the use of nuclear energy. Gamma rays from radioactive cobalt have been used at the Naval Research Laboratory to produce the "tailor - made" dielectrics. The materials needed are readily available and may be used in either gaseous or liquid form, depending on the substance involved.

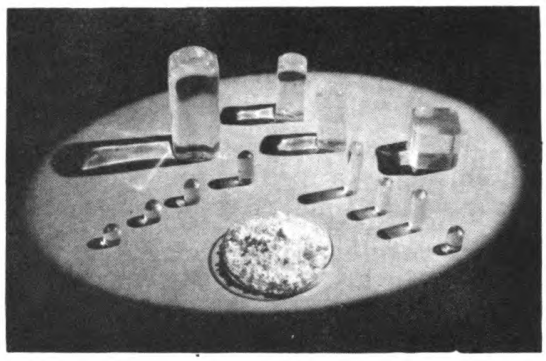


Figure 1 - Dielectric materials produced with nuclear energy

The new and improved insulating materials are produced at room temperatures, without the use of additives normally required in the manufacture of conventional dielectrics. Consequently, they are chemically purer and have greater uniformity. When wires and cables use the new dielectrics, they will be able to withstand higher operating temperatures before the insulation breaks down, and they will also have lower electrical losses.

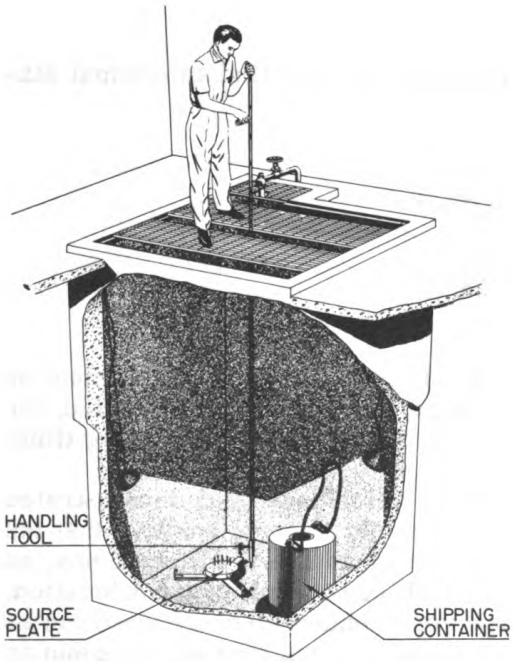
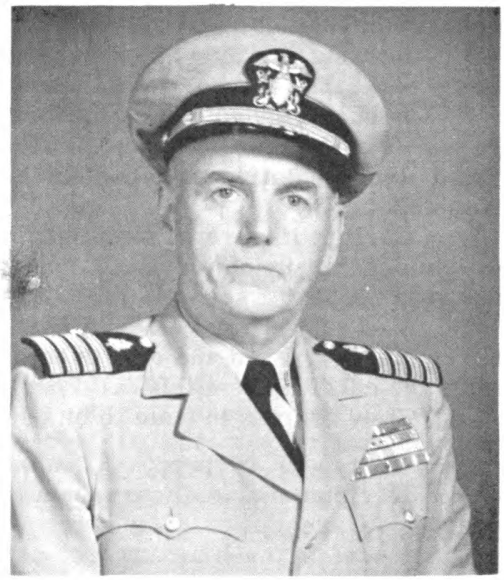


Figure 2 - Cobalt-60 Source

The process by which the new dielectrics are made is chemically known as polymerization—the combination of molecules of a substance to form larger ones. The material is produced through the action of a radioactive cobalt "source," as it is called. The one at the Naval Research Laboratory is contained in a series of stainless steel cans, each one-half of an inch in diameter and seven and a half inches long, which are submerged in a 12-foot deep tank of water. The water provides the shielding necessary for the source; measurements indicate that the radiation background at the floor level is less than that which would be given off by the luminous dial of a wrist watch. A 15-foot long manipulator is used to handle the cans.

Research Notes

CAPT W.M. Silliphant Takes Over Command at AFIP



In a recent change of command at the Armed Forces Institute of Pathology, CAPT William M. Silliphant, US Navy Medical Corps, relieved Brig. Gen. Elbert DeCoursey of the Army Medical Corps as director. From February 1952, CAPT Silliphant has served as Deputy Director of the AFIP, and as a consequence is well acquainted with the duties he now assumes. Nominated by the Board of Governors which is composed of Surgeons General of the Army, Navy, and Air Force, the new Director has the Navy's tour of command in the rotation that takes place normally every four years.

The institute, now in its new, A-bomb-resistant building (see frontispiece) on the grounds of the Army's Walter Reed Medical Center in Washington, D. C., serves as the central laboratory of pathology for all the Armed Services, Veterans Administration, and on a voluntary basis, for the U. S. Public Health Service, the Atomic Energy Commission, and other Federal agencies which might have a need for the services of the Laboratory.

The move of Armed Forces Institute of Pathology to its new building, opens new opportunities to formulate and carry through a comprehensive program on pathology. The new equipment and facilities make it possible to engage in research and also to develop a program of education and teaching. As medical practice is incomplete without pathology, so is pathology incomplete without research and teaching. It is the aim of the Institute to follow these principles in its continuing program.

The change in physical environment from the old museum building comes at a time when environment has assumed a significant role in the diagnosis and treatment of disease. Studies on environment are tending to develop special pathological fields—geographic pathology is already established. Barometric pathology promises to become increasingly important. The Institute has a dedicated program on "Pathology in Relation to Environmental Disease" which reflects this emphasis in the direction of future thought. Facilities now made available encourage the development of laboratory procedures which will greatly contribute to the imaginative and expanded program of the Armed Forces Institute of Pathology.

Bouquet from the Air Force

The following is cited verbatum from a recent press release from the Headquarters, Air Research and Development Command in Baltimore:

"A flight of B-47 jet-bombers was preparing for an overseas mission. Enroute, it would run into unusual radio conditions calling for a special antenna insulator. The item was missing.

"Missing because the hand-sized, plastic insulator needed was newly developed and not yet in quantity production.

"A rush request from the bomber command was flashed to Air Force Headquarters. It was forwarded to the Air Force Development Field Representative attached to the Navy's Naval Research Lab in Washington, D. C.

"Earlier this representative had reported on the Navy's work in developing the insulator and constructing test models. Now he was asked to request a special order of them.

"Men of the Navy Lab pitched in. The insulators were molded, assembled, packaged and delivered to a waiting plane twenty-four hours after the call for them left Air Force Headquarters.

"They arrived in time to be used on the bomber mission."

This type of cooperation is a commonplace nowadays, and the role of the development field representative is taking on new importance. He carries out his duties on a highly personal basis as friendships at his station count as much as any technical knowledge he may possess. The end result of his work is reduced development costs, fewer overlapping projects, and a gain in the over-all effort to improve technology in national defense.

Coordination Among West Coast Navy Librarians

The Council of Librarians of the West Coast Naval Laboratories held its first meeting in San Diego recently. A working charter was agreed upon, and officers were elected. William Jorgensen, Naval Electronics Laboratory, is Chairman and Miss Madeline Canova, U. S. Naval Ordnance Test Station, is Secretary. The purpose of the Council is to promote the interchange of technical information, to cooperate on general library problems and projects, and to make recommendations on library matters to Senior Scientists.

Members are from eight laboratories of the Navy on the West Coast as far north as the Navy Radiological Defense Laboratory at Oakland, Calif. Associate members include the head librarians from the Eleventh and Twelfth Naval Districts. Meetings will be held quarterly with the place of meeting rotated among the several laboratories.

Prof. Edwin B. Wilson Receives Honorary Degree

Wesleyan University at Middletown, Conn. has recently conferred an honorary degree of Doctor of Laws on Dr. Edwin B. Wilson who is currently General Scientific Advisor to the Office of Naval Research. Dr. Wilson is attached to the Boston branch office of ONR, and formerly was Professor of Vital Statistics at the Harvard School of Public Health.

On the Naval Research Reserve

Research Reserve Seminar on "Methods of Research"

During the period 12 June to 25 June 1955, Naval Reserve Research Company 4-7 of Columbus, Ohio, conducted a seminar on research methodology. Sixty-three officers were in attendance. The purpose of the seminar was to give members of the Naval Reserve, particularly members of the Research Reserve, a broad picture of the methods of research used in various fields, and to point out similarities and differences of approach.

Reserve Officers at the research methodology seminar hear Dr. Clyde Williams, President of Battelle Memorial Institute

The speakers who were selected to cover the various aspects of the subject were drawn mostly from the staff of the Battelle Memorial Institute and from the faculty of Ohio State University. In addition, outstanding civilian scientists from Navy, Army, and Air Force installations presented the essentially military methodology which has no counterpart in non-military laboratories.

The presentations were in line with the training objectives of the Research Reserve which are to increase the readiness of the members for assignment to scientific and technical billets in the Naval

Establishment. A wide range of research procedures were discussed and attention was given to a variety of problems in the physical, biological, and social fields. Both basic concepts and applications, especially to naval problems, were discussed.

The first sessions were devoted to a discussion of research in the physical sciences, particularly chemistry, physics, and metallurgy. It was brought out that studies in these fields usually involve only a few variables, and that these are readily controlled. This is in contrast to conditions prevailing in the biological and social sciences investigations. Types of data collected, measuring scales, and methods of data analysis were considered.

The medical and biological fields were taken up next. Many more variables and less precision of the control and measurement were noted with the introduction of animate matter and the human element.

The last category considered was the social sciences, involving even greater complexities, as the interrelations of individuals and groups of individuals were scrutinized. Human factors research was considered both from the standpoint of fitting man to the machine (psychological testing and selection) and designing the machine in accordance with the capabilities and limitations of man (human engineering).

Operations research methods were discussed in relation to the philosophy of science, data collection, and the fitting of models to complex situations. A field trip to North American Aviation, Inc. was made where the application of research findings in naval aircraft was emphasized. Field trips were also made to the Aviation Psychology Laboratory, Ohio State University and to Battelle Memorial Institute where many examples of applied research were observed.

LCDR R. H. Blackmore, Commanding Officer of Naval Reserve Research Company 4-7 was Seminar Chairman. CAPT Theodore Blanchard, Special Assistant to the Chief of Naval Research (Research Reserve), represented the Office of Naval Research in the opening session. CDR J. M. Harrison, Commanding Officer, Naval Training Center, Columbus, Ohio, represented the Commandant, Fourth Naval District.

Research Reserve Seminars

The following seminars are established for the Research Reserve:

Seminar	Convening Date
Naval Research Laboratory Seminar	15 August 1955
ONR West Coast Seminar	29 August 1955
Nuclear Sciences Seminar, Oak Ridge, Tenn.	28 November 1955
Special Devices Center Seminar, Port Washington, N. Y.	9 April 1956
Nuclear Sciences Seminar, Brookhaven National Laboratory, Upton, L. I., New York	4 June 1956
Seminar on Research Methods, Columbus, Ohio	18 June 1956

Brookhaven National Laboratory Scene of Naval Reserve Seminar

Naval Reserve Officers had an unusual opportunity for training duty recently when the Naval Research Reserve, in cooperation with the Atomic Anergy Commission and the Brookhaven National Laboratory, presented the Third Annual seminar at the Brookhaven National Laboratory. The Seminar was conducted by the Naval Reserve Research Company 3-9. CDR John S. Medd, USNR, is the Commanding Officer. Each officer in attendance had completed the Navy correspondence course, "Nucleonics for the Navy," and the seminar afforded additional opportunity to extend knowledge on a subject of vital military concern.

During the introductory ceremonies, RADM F. R. Furth, Chief of Naval Research, gave a talk on "The Mission of the Office of Naval Research." He was followed on the program by RADM R. H. Hillenkoetter who extended greetings from the Third Naval District of which he is Commandant. An interesting presentation on "The Mission of the Atomic Energy Commission" was given by E. L. Van Horn, Manager of the Brookhaven Area, Atomic Energy Commission, and Dr. Leland J. Haworth, Director of the Brookhaven National Laboratory, carried the subject farther by his discussion of "The Mission of Brookhaven National Laboratory."

CAPT Theodore Blanchard, Special Assistant to the Chief of Naval Research (Research Reserve) attended the seminar along with others of the Headquarters Staff in Washington, D. C. The program was organized to include not only instructive talks by scientists at the Laboratory, but also to visit specialized facilities and a nearby manufacturing plant.

The specialized facilities at Brookhaven which were visited included the Reactor Laboratory, the Hot Lab, and the Cosmotron. The group also went to the Biology Department and to the Cobalt Irradiation Field. An entire afternoon was given over to the trip and inspection of the Grumman Aircraft Plant at Calverton, N. Y.

Because some of the most eminent scientists in their field are on the staff at Brookhaven National Laboratory, the lecture periods were most rewarding to the Research Reserve Officers. The program was carefully organized to move along in the field of atomic energy and related subject in a consecutive way. Talks were grouped in morning and afternoon schedules—a few of the topics listed here illustrate the scope of the training:

- Radiation Effects on Materials
- Radiation Chemistry
- Instrumentation and Health Physics
- Tracer Methodology
- Reactors
  - Concepts of Pile Theory
  - Reactor Materials
  - Liquid Metal Fuel Reactor
  - Heat Transfer
- Medical Aspects of the Fall-Out Hazard

On the afternoon of the last day there was an administrative period in which aspects of the Research Reserve program and a selected group of administrative problems were discussed. The seminar at Brookhaven was but one of a series that seeks to extend the capabilities of Research Reservists in nuclear sciences.

Reserve Officers at the Third Annual Seminar of the Brookhaven National Laboratory

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Nuclear Sciences Seminar at Idaho Falls, Idaho

The Second Annual Nuclear Sciences Seminar at Idaho Falls, Idaho, convened on 25 July 1955. This seminar was conducted by Naval Reserve Research Company 13-6 under the sponsorship of the Office of Naval Research, Atomic Energy Commission, and the Operating Contractors at the Naval Reactor Testing Station. LT G. V. Wheeler, Commanding Officer of Naval Reserve Research Company 13-6, was Seminar Chairman.

Among those addressing the seminar at the opening session were Admiral A. N. Bledsoe, USN, Commandant, Thirteenth Naval District; Mr. A. C. Johnson, Manager, Idaho Operations Office, Atomic Energy Commission; CAPT R. R. Sampson, Commanding Officer, Naval Ordnance Plant at Pocatello, Idaho; Hon. E. W. Fanning, Mayor, Idaho Falls, Idaho; and Mr. R. L. Doan, Manager, Atomic Energy Division, Phillips Petroleum Company. Later in the seminar the group heard addresses from RADM F. R. Furth, USN, Chief of Naval Research; and CAPT Theodore Blanchard, USNR, Special Assistant for Research Reserve. An outstanding array of speakers addressed the group during the two-week period. CAPT Blanchard combined his visit to this seminar with an extensive tour of the West Coast area during which he visited all naval reserve research companies in the 11th, 12th and 13th Naval Districts.

Further information concerning the Idaho Falls seminar, as well as reports on the Naval Research Laboratory Seminar convening 15 August 1955 and the West Coast Seminar convening 29 August 1955, will be included in subsequent issues of Research Reviews.

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Navy Reserve Officers attend seminar at Ohio State University, Columbus, Ohio