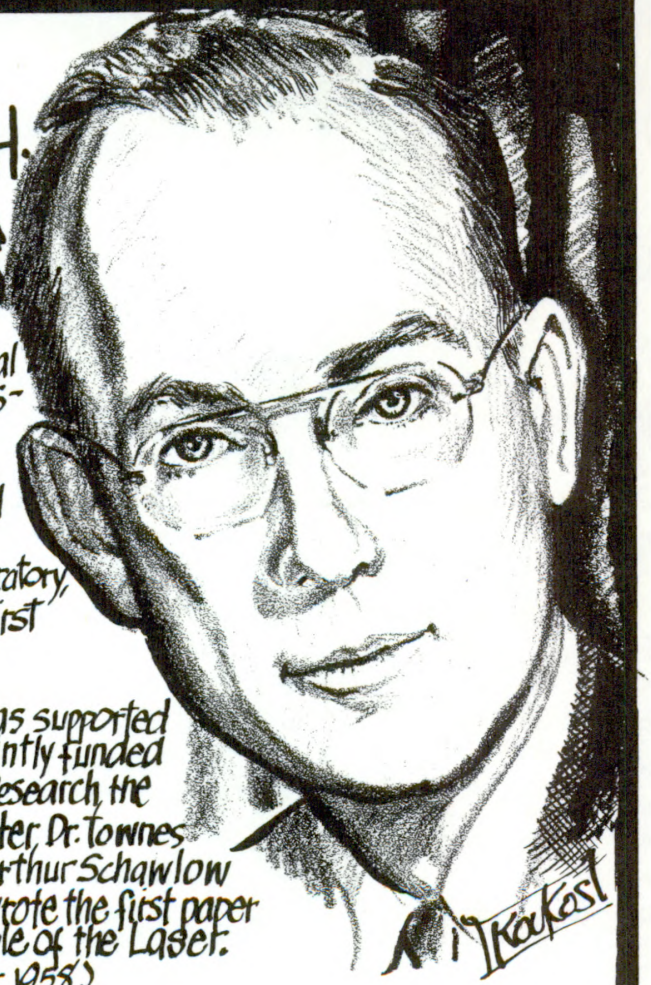
NAVAL RESEARCH

REVIEWS

OCTOBER 1968

Portraits in Science



Dr. Charles H. TOWNES

While working in the general field of microwave spectroscopy in the early 1950's Dr. Townes conceived and together with Gordon and Zeiger at the Columbia University Radiation Laboratory, designed and built the first Maser.

His work at Columbia was supported by a research contract jointly funded by the Office of Naval Research, the Army and the Air Force. Later Dr. Townes together with Dr. Arthur Schawlow at Bell Laboratories wrote the first paper enunciating the principle of the Laser. (Phys. Rev. 15 December 1958)

For his fundamental work in quantum electronics Dr. Townes shared with two soviet scientists, Basov and Prokhorov, the 1964 Nobel prize in Physics. From his post as chairman of the Columbia Physics Department Dr. Townes moved to IDA as the Vice President and Research Director, thence to Provost and Professor at M.I.T. and is currently Professor-at-large at the University of California.

The Broad Application of Naval Research*

RADM Thomas B. Owen
Chief of Naval Research

First, I had better give you some orientation on my function as Chief of Naval Research and explain what naval research is intended to accomplish. Frequently the term "research" is joined with "development," implying that these are two phases of one continuous process. This is not the case. It is true that for administrative purposes the two are joined together at higher levels. The principal administrator for naval research and development activity is the Assistant Secretary of the Navy for Research and Development—presently Dr. Robert Frosch. He establishes policy and exercises management and control over all Navy R&D matters. One of his major responsibilities is the supervision of the Office of Naval Research. As Chief of Naval Research, I report directly to him and serve as his principal advisor on naval research.

Naval research, therefore, is a separate process from development. Our job is to accumulate constantly new knowledge, new ideas, and novel concepts which in our estimation are likely to be needed to solve operational problems that will occur ten to twenty years from now.

To be more specific, naval research can be defined as that effort which is aimed at increasing our general knowledge in areas we believe of potential interest to the Navy. This includes studies in the physical, mathematical, engineering and life sciences. The objectives of these studies is to produce ideas, examine phenomena, and develop theories that may ultimately lead to advanced materials, devices, vehicles, and equipment of use to the Navy. As I indicated, research is not necessarily concerned with problems of immediate military application; it is generally long-range in nature and not time-oriented. The reason for this is that the creative process cannot be controlled or regulated.

It can be expected that it will require a number of years for a scitist even with single-minded dedication to discover a new phonomenon in nature, such as the principle of the laser. After that, it requires a further period of years before the new discovery is sufficiently understood to be translated into practical operational use. Finally, the engineering or development phase may be extended because we usually are dealing with materials, fabrication techniques and structural forms never tried before.

Research therefore is a long-term process, and this is true whether it is basic research, applied research or the type of research we call

*Based on a paper presented by RADM Owen at a Naval Research Reserve Seminar in Nuclear Science, Oak Ridge, Tennessee, October 27, 1967.

exploratory development. We call it basic research when the purpose is to gain broad knowledge of a field, such as solid state physics, with no specific future problem in mind. When we are thinking of a solution to a possible future development problem, such as the need for a radically new type of aircraft, we call it applied research. When we think there is a possible solution to a military problem at hand and want to evaluate its feasibility or practicability, we call it exploratory development. This could be a new vertical lift principle for example. In this case, experimental hardware is fabricated to test or demonstrate the proposed new concept in the laboratory. Our research responsibilities end once we have established a new principle or demonstrated the technical feasibility of a new idea of use to the future fleet.

Most of the research supported by the Office of Naval Research is considered to be basic research. I would like to dwell on that particularly, because we seem to have great difficulty in explaining basic research to the public and in demonstrating the need for a continuing and substantial long-term investment therein in order to insure our future capability at sea. The *New York Times* aptly stated the case for support of basic research in a recent editorial:

> "The fundamental lesson of the history of science is that basic research is the indispensable seed bed for all future technology, the ultimate source of the new wealth and of the improved capacity to save lives that future technology could bring."

The essence of basic research is that the scientist must be free to follow his own creative imagination. ONR at its inception in 1946 based its contract research program procedures on this philosophy, and has continued to follow this policy with a high degree of success ever since. An investigator at a university seeking new truths in his special area has a new idea or new approach he wants to explore. He applies to us and perhaps also to other Federal research agencies for support. If ONR decides to provide the support from our limited budget, it is because we have carefully weighed the following considerations:

First, we are sufficiently familiar with the reputation and background of the particular scientist to be confident that he will come up with an important piece of new knowledge. Second, our understanding of possible future Navy problems leads us to believe that this new knowledge will be a key piece in a puzzle whose solution will greatly benefit the Navy. Finally, we provide the support because this is the only guarantee that this piece of research, which has such potential significance for the Navy, will ever get done. It frequently turns out that no other Federal research agency, military or otherwise, has enough mission-oriented interest in the proposed research to give the scientist necessary assistance. Sometimes ONR shares the cost with another

agency to provide the needed funds. In any case, ONR support is essential. If we did not exist, not only would the Navy suffer but also our national storehouse of scientific knowledge and technology would be that much poorer.

Probably the best example of the long-range nature of basic research and how it eventually results in broad applications, including naval operations, is the story of the laser. ONR has played a key role in supporting basic research in this field, just as it has in solid state physics and other areas of the physical sciences. It happens, though, that its activity with respect to lasers has been unique.

The story starts with Dr. Charles H. Townes of Columbia University. In the early postwar years Dr. Townes worked in the general field of microwave spectroscopy supported by ONR, the Army and the Air Force. As he wrote recently in *Science* magazine, two decades ago few areas of physics seemed as unpromising from a practical viewpoint as the study of the interactions between microwaves and gas molecules. Then in 1951 he made the intriguing discovery of what happens when ammonia gas molecules, excited to higher energy states, enter a resonant microwave cavity. Once in that cavity, the excited gas molecules gave their excess energy in sharply defined microwave radiation. This was the maser, a device that amplifies microwave radiation. The Navy utilized the maser as an ultrasensitive low-noise receiver in its radio telescopes and also to develop an ultraprecise atomic clock, especially needed for navigation. More important, it was the stepping stone to the laser, which operates on the same principle. Dr. Townes made this discovery in 1958 in conjunction with Dr. Arthur Schawlow of Bell Labs. Incidentially, Dr. Townes in 1964 won a share of the Nobel Prize in physics for his work, an honor that has been received by several other ONR-supported scientists.

The substance used for a laser may be crystal, glass, liquid or gas. When the substance is placed in a resonant optical cavity, the molecules are raised or "pumped" to a high energy state and then stimulated so that virtually all the excess energy is released simultaneously. Although the total energy emitted by the laser is not tremendously great, its ability to concentrate that energy into a small area and within a small wavelength interval is so great that its effective temperature is much higher than that of the sun. This is due to the fact that light generated by the laser is so pure in color or monochromatic, and has a high degree of directionality.

When in 1961 the Department of Defense decided to launch a major effort to develop practical laser devices, the program was assigned to ONR. This was in recognition both of our earlier relationship to the development of both the maser and the laser and our excellent record of research management. Since then, the ONR program has made major contributions to the progress of laser research. New

materials and improved pump sources have been studied and developed to achieve maximum brightness and high power. The problem of transmitting a laser beam over long distances through the unstable and unsteady atmosphere is under study. The problem is complicated by the fact the air itself breaks down in the presence of extremely high intensity beams and disrupts the transmission of such beams. Since the answers to many of these problems are beyond the present state of knowledge, ONR is also conducting a basic research program in fundamental optics and physics. At the same time, we are experimenting with the possibility of employing a laser beam in conjunction with conventional radar to obtain substantially sharper resolution. This, by the way, is an example of exploratory development.

As I indicated earlier, ONR does not itself develop practical devices. The information we obtain on new principles or new concepts we have tested is disseminated widely to the scientific and technical community through ONR-sponsored seminars and symposia and the publication of reports. In the case of our laser research program, as in other programs, this information will apply to more than military use. In fact, the applications of the laser will probably be the broadest of any discovery made since the end of World War II. As a measuring device with unmatched accuracy, as a surgical technique with pinpoint focus, as a communication means capable of carrying many more channels than now possible—these applications merely suggest the fantastic future of the laser.

Another one of our long-range research program provides an excellent example of what results when we nurture basic research at universities over a long period. When ONR was established, it was the only Federal agency in existence geared to support university research. We decided at that time to give nuclear research a boost by sponsoring the construction of nuclear accelerators at several universities to study high energy particles.

Stanford University scientists wanted to take the pioneering approach of developing a linear electron accelerator, and we supported this program. In the process of solving the problem of generating the high power necessary to accelerate the electrons, Stanford developed the klystron tube. That device, in turn, materially aided early high-powered radar development. The success of Stanford's linac, incidentally, made possible the construction of the two-mile linear accelerator recently completed for the Atomic Energy Commission.

The klystron is an example of serendipity, the unexpected bonus from research. Now, the Stanford linear accelerator program is providing what might be called planned serendipity. It has occurred to the scientists there that the efficiency of their machine could be considerably improved by making use of the phenomenon of superconductivity—the fact that the electronic efficiency of certain materials significantly

increases under supercold conditions. We are now supporting the development of a cryogenic linear accelerator at Stanford, not just for interest in nuclear physics, but because we believe this basic research program to be a highly promising means of translating cryogenic technology from the laboratory to practical applications.

ONR can appreciate this possibility because we have a long history of support of research in low-temperature physics. We could foresee eventually such applications as a gyroscope virtually free from error, powerful magnets energized by a few storage batteries, and shipboard electronic equipment much more compact and with much greater reliability than we have at present. It might also make possible a practical and efficient electric drive propulsion system. Through basic research we have gained an understanding of the principles involved. Now basic engineering problems must be solved before cryogenics can become a full-blown technology. Toward this end, for example, the Stanford accelerator will employ the first large-sized refrigeration system ever designed to maintain an operating electronics system at temperatures 450° below zero Fahrenheit.

A point worth mentioning is that the graduate research students who have the opportunity and good fortune to work in the programs I have discussed above are obviously gaining invaluable experience. These are the bright young scientists and engineers of tomorrow upon whom the Navy and the other military services are depending to staff their laboratories and conduct future research. If these students did not have available to them the training gained in pioneering research program stimulated by Navy funding, not only their future would be limited but so would the future of this country.

I think by now I have given you a clear indication how practical results are bound to stem from basic research. Furthermore, it should be evident that funds spent for military research by the Navy, in particular, do double duty. The same new knowledge that will benefit our future Navy will be of equal, if not greater, benefit to our society as a whole. Ten years ago solid state physics was an esoteric area of research. It might have been hard to justify our support in that field if we had been really pressed. Now that this research has revolutionized the electronics industry as well as given us highly advanced weapons system, we can talk about our support with some degree of pride.

The trouble is that recently we have not been given many opportunities to dwell on past accomplishments. Today people are anxious for immediate payoffs. Unfortunately, immediate returns on investment cannot be guaranteed in the field of basic research.

We have much better luck in handling this question in other types or research, where we are moving toward the solution of basic but specific problems. This is especially the case in our biological research. Research aimed at keeping Navy men as fit as possible applies obviously

to all people. The other military services, of course, as well as Federal health agencies are equally concerned with combating disease and sickness. The Navy, however, has special problems which are of less interest to other groups. Whole blood, for example, can only be stored for 21 days after which it is unfit for transfusions. This can be a critical problem aboard ship in the case of long cruises as well as at small field hospitals. This is why the Navy has had a major program for a number of years aimed at developing techniques both for storing whole blood for years through freezing and for thawing it quickly and safely so it can be used immediately for transfusions, including rare blood types, when needed. So far, the experimental use of frozen blood in Vietnam has been highly successful. The same techniques used for blood can also be applied to other human tissues so that some day we may have readily available a stock of human "spare parts" to repair bodies damaged by injury or disease. Before that happens, we must solve the transplantation problem. Toward that goal, ONR biological research is studying the so-called immune response.

A less dramatic problem but one which concerns the Navy is the high incidence of dental caries among Navy recruits. As a result, a great deal of time and effort must be spent by Navy dentists in providing dental care. We would naturally like to eliminate or at least substantially reduce the occurence of cavities. One research project points to some intriguing results. We have discovered that some of our new recruits reporting from certain parts of Ohio, South Carolina and Florida had no cavities whatsoever. Fluoridated water undoubtedly helped, but it had to be more than that. The answer seems to be that these young men were raised on food grown principally in their home areas. Certain chemicals in their native soil apparently have strongly inhibited the growth of cavities. Right now we are trying to find out just which chemicals in the soil are the cause in the hope that this may lead to a major solution to this problem.

In materials research one of our major problems is the ability of metals to withstand the new stresses created by advanced technology. For example, it has become increasingly evident to nuclear physicists and engineers that many structural materials used in nuclear reactors are significantly affected by high-level nuclear radiation. Irradiated pressure vessels, which are the key parts of atomic power plants, may lose some of their ductility and become subject to brittle fracture. We are learning more about such problems at the Naval Research Laboratory, with partial support provided by the AEC. At NRL's High-Level Radiation Laboratory various metals that have been previously exposed to high-energy neutron or other radiation are exhaustively studied. Structural, electrical and magnetic properties are also investigated.

The Navy has long recognized the value of research in the psychological sciences, particularly in drawing man and machine together in

a more effective relationship. For a number of years ONR has been directing a research program focusing on the pilot and crew in an aircraft cockpit. The objective is to simplify both the many displays and the operations he must perform in some cases on an emergency basis.

We see the computer as the key to sharp improvements in human performance. Therefore we are seeking to develop more effective communication between man and computer. This goal has important implications for the training of men. The Navy presently faces the problem of training an enormous number of immature, inexperienced, short-term personnel to operate and maintain fantastically complicated systems. The tireless computer with its ability to store vast amounts of information can take over this teaching job. In this technique the student is connected directly to the computer, with information exchanged back and forth in real time. Not only can the computer teach the student, but also by storing details of the individual student's learning history, the computer can determine how to deal with the student as he is being taught. The Naval Academy in a pilot program has recently installed an educational computer, which will be programmed for a variety of language, social science, engineering and mathematical courses for midshipmen.

The broad application of naval research is perhaps best exemplified by the Navy's man-in-the-sea program. A new project in this area initiated by ONR has attracted the interest and support of the National Aeronautics and Space Administration and several activities within the Department of the Interior. This is TEKTITE I. It involves placing a team of our scientists on the ocean bottom where for 60 straight days they will live and work at a depth of 50 feet. This operation, which will be the longest continuous undersea stay yet attempted, will take place place off the Virgin Islands early next year.

The program combines two objectives. ONR and Interior will gain valuable experience in marine science studies conducted by scientists actually living for long periods on the ocean floor. ONR and NASA will be able to study and observe the behavior of a small group of men living in prolonged relative isolation. This data can be applied to both future undersea missions and to extended manned space missions.

The Navy is steadily making substantial improvements in its operational capabilities. What is going into the fleet today is the result of scientific research performed years ago. This time lag tends to mask the very real and direct benefits the Navy gains from basic research. It also obscures the fact that every new concept and idea created through naval research has a second-order or even third-order effect. In fact, the final impact of naval research can never be measured or identified because it may be decades before the potential of a new principle, such as the laser, is fully exploited.

Naval research therefore plays a key role not just in the future of the Navy but in the future of man.

Comparisons of Managerial Values and Behavior

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The staff of the Management Research Center is in the second year of an extended program supported by the Ford Foundation, Office of Naval Research and The University of Rochester, to study managerial behavior and attitudes in a number of different countries. A standard set of simulations which deal with problems faced by all managers and organizations are used to collect the basic research data. Managers complete the standard simulations in the context of a training program. Presently, over 25,000 of these exercises have been distributed to specially formed research organizations in Europe, Asia, North America, and Latin America. The cooperating research groups consist of social scientists and management trainers from each region of the world. These groups are responsible for organizing the collection of data and submitting it to the central data bank. The data is processed and within three weeks, computer printouts summarizing a batch of data are sent back to the responsible trainer. In this way the individual collecting the data has direct feedback concerning his group so that he can improve his subsequent training sessions. Both short and longer reports on the data comparing several or a large number of countries are also periodically sent out to all members in the organization. This drastically cuts down the usual three-year delay from the time a research project is completed until a report appears in an archival journal. This means that the results of the research project and their implications for management can be included in training programs.

Presently, over 8000 individual protocols from managers have been stored in the central data bank at The University of Rochester. For the benefit of the researchers, an inventory listing the available data by country is periodically sent to all members in the project. This fosters cooperative cross-cultural investigations. Thus for example, a researcher in Greece can compare data he has with information other investigators have collected in Columbia, Spain, and India. Because data will multiply during the next several years, at this stage of the project there are summary results to illustrate the differences and similarities among managers in various countries.

Culture Motivation

One of the intriguing questions which confront all those who think about similarities and differences in cultures is "What motivates individuals in another culture?" To get at this question, one simulation asks the respondents to rank, by the order of importance, 11 life goals. The group also ranks the same goals as they think the others would rate them. In all the cultures investigated, there are consistencies in what managers think are important life goals and what they perceive as totally unimportant life goals. Self-realization has been given high importance by managers in all the cultures which we have studied. Affection has been given fairly high importance, but not as high as self-realization. Managers have uniformly responded that wealth and prestige were low in importance for themselves. There are dramatic differences in certain other life goals as to their importance among cultures. United States' managers attribute much more importance to leadership than managers from other countries. English managers are similar to ones in the United States, but they attach much more importance to the life goal of pleasure. Managers from Spain give service and duty much higher importance than do managers from other countries, and place less importance upon independence and pleasure. Dutch managers place significance upon the importance to themselves of expertise. Also the Dutch perceive duty of more importance than do other national groups. Italians perceive service to be of less importance than do other groups and also rank pleasure lower than any other group tested.

When managers judge the importance of the various life goals to others, they generally perceive others as similar to themselves. However, managers from all countries tend to perceive others as attaching less importance to their own valued life goal and as having more regard for life goals they thought were of lesser importance. For example, affection was given a fairly high rank in all cultures, but it was judged to be of less importance to others. But for each country studied there were differences for certain life goals in the perception of what is important to me and what is important to others.

In particular, regarding this perceptual shift, the Spanish and Italian managers tend to see more significant differences between their own life goals and those of others when compared with managers from the United States, England, and Holland. For the Spanish and Italian managers prestige was given little importance in self rankings but was ranked as a very important life goal when they estimated its importance to others. The Spanish group said service was an important life goal to self, but it was seen as being of little importance to others. In a similar fashion the Italian managers saw affection as an important life goal for themselves, but unimportant to others. In the United States and England the perceptual shift was in expertise, which was

ranked low in importance to themselves, but was given significantly more importance to others. One might infer that projection of certain life goals on others, while indirect, is a more accurate estimate of own motivation than is the statement of our life goals.

Money Versus Working Conditions

Another indirect way of looking at the values that each manager feels to be important is by determining the amount of money he will pay for the services of individuals with certain selected attributes and job situations. In one of the simulations the managers are asked to make salary recommendations for 10 engineers. Three of the engineers differ in performance going from the 10th to the 90th percentile. The other seven engineers were all at the 50th percentile in performance, but have differing job situations, ranging from a boring job to a job with unfriendly co-workers. The result from this simulation indicates that the United States' managers are much more willing to pay for high performance than are managers from other countries, especially developing countries, such as Colombia and India, where managers are willing to give almost the same salary increase to the man working at the 10th percentile as the one at the 50th percentile in merit. The Americans are much less prone to reward an individual for an unplesant job condition than are the European managers.

In another simulation designed to tap feelings about company objectives, managers are asked to make decisions whether or not to spend money on five company problems. For example, one problem is whether or not to purchase safety equipment for $225,000 based upon the annual report and a brief description of the company. In the research data we have to date, there seems a definite tendency for managers in European countries to make the more humanistic decision with regard to these budgeting decisions. Compared to Americans, European managers are less concerned with keeping costs down and more interested in alleviating undesirable conditions. Also, it is clear that United States' managers are much more concerned with profits and growth as objectives for their companies. European managers are inclined to see satisfactory company operations and good will in the community as more important to them than to the Americans.

The data we have been discussing has required the managers to make decisions about situations. However, the simulations discussed up to this point have not required the respondents to engage in actual overt behavior. The data we will report next actually requires the respondents to participate in various activities or games where their performance can be directly measured by either their own response or by some measure of productivity or effectiveness.

Management Roles

In one of the simulations concerning supervision, managers are asked to take one of six different roles to play. They play the role of the authoritarian supervisor, permissive supervisor, participating supervisor, vitally involved subordinate, moderately involved subordinate, or uninvolved subordinate. While each member of the group knows the role he is to play, he is not aware of the role being played by other members in his group. Some decided differences have been obtained with over 500 managers from 12 countries. As shown in Table 1, over 62 percent of the Dutch-Flemish managers were most satisfied as subordinates when meeting with a participative supervisor. In contrast, only 22 percent of the Greek managers when playing the role of the subordinate were satisfied with the participative supervisor. There was an equally large difference in the satisfaction between cultures with those who played the role of the supervisor. As shown in Table 2, only 14 percent of the Anglo-American supervisors were

TABLE 1
Reported Satisfaction of Subordinates
With Participative Supervision
Following Decision-Making Meeting

Culture of Managers	Percent of Subordinate Most Satisfied
Dutch-Flemish	63
Latins	50
Anglo-Americans	46
Indian	42
Scandinavian	37
Greek	22

TABLE 2
Reported Satisfaction of Supervisors
With Uninvolved Subordinate
Following Decision-Making Meeting

Culture of Managers	Percent of Supervision Most Satisfied
Anglo-Americans	14
Latins	22
Dutch-Flemish	28
Scandinavian	35
Greek	42
Indian	53

satisfied in a decision-making role with an uninvolved subordinate. In contrast, over 50 percent of the Indian managers were most satisfied with the subordinate playing that role. These striking differences should certainly be of concern to anyone who is involved with either subordinates or supervisors from different cultures.

In another simulation involving communication proficiency, Indian managers showed marked differences with American and European managers. The situation had two parts. In the first part, one-way communication, one manager who acted as the sender, verbally communicated instructions to solve a problem to another manager who played the role of the receiver. The receiver was not allowed to ask questions. It was determined that the Indian managers required almost twice as much time to complete the task and were much less accurate than managers from Europe and the United States.

In the second part of the exercise, two-way communication was permitted; now the receiver could ask questions of the sender. In this situation, the Indian managers again required at least twice the time to complete the task, and the quality was half that of either European or American managers.

Two-Way Communication Best Method

In comparing one *versus* two-way communication, we find in general that for all countries two-way communication takes more time, but is more accurate. In most countries, two-way communication was more satisfying, less frustrating, and preferred by both sender and receiver. The one exception was Indian managers who acted as senders. They stated that two-way communication was not preferred. This fits in nicely with the results of the previous discussion on supervision where the Indian manager preferred the uninvolved subordinate. In effect, the Indian manager wants to give direct ordess without receiving any feedback or comments from the subordinate.

In another simulation requiring the active participation of the managers, a negotiations session is conducted where the managers take the role either of union or of management negotiators in order to settle five issues including salary raises and vacation pay. The results of the simulation show that the bargaining and negotiating strategies of managerial groups from India, Spain and the United States were remarkably similar as are outcomes of the negotiations. Nevertheless, there were specific differences between the behavior of Indian and Spanish managers. The Spanish managers were least committed to their pre-bargaining strategies and as a consequence were able to settle the dispute most quickly. They were most concerned with avoiding a strike and gave the highest total gains to workers.

Managers in one simulation are requested to make plans for a mythical country with a choice of either a low risk short term or longer

range high risk program. Indian managers preferred the longer range more idealistic plans of longer range while United States' managers preferred solutions of shorter range immediate payoff and lower risk.

The definite differences between the American managers and managers from the rest of the world in terms of values, attitudes, and behavior have a number of implications. First, it is apparent that the American administrator who either works in a multi-national organization or deals with individuals from another culture should be aware that there are wide variations among countries on many dimensions which influence a manager's effectiveness. For example, the more typical American style of participative management would not be perceived in a favorable light by Greek subordinates.

Second, if we accept as fact that American managerial style has contributed to our country's economic growth, then for developing countries to achieve higher rates of economic growth, they may have to consider rewarding employees more on the basis of ability rather than for environmental circumstances, and placing more value on leadership, competitiveness and profits, as do American managers.

Our continuing investigation of managerial behavior and practice will extend our sample and range of generalization. The information system is set up to feedback results to managers. Therefore, it should have significant effect upon their behavior when faced with transnational managerial problems.

Orchid Island Expedition

Surrounded by a primitive people and their culture, the small, remote Orchid Island has remained in nearly complete isolation for centuries. To this island 45 miles southeast of Taiwan, a team of fifteen from the U.S. Naval Medical Research Unit No. 2 (NAMRU #2) came during April 1968 to collect data on infectious and parasitic diseases. Over 2000 aborigines of the Yami Tribe live in six small villages on the island subsisting on taro, millet, fish, goats, and pigs. Until recently the aborigines have remained relatively isolated; however the occasional tourist and the development of a small aircraft landing strip have brought changes to the primitive culture. A soon-to-be completed deep water anchorage will end Orchid Island's isolation.

Even though the island was surveyed in 1959, this is the first return trip for NAMRU #2's team. All six Yami villages were surveyed. One village was not accessible by road and had to be entered on foot; in this climate, which has an average temperature of 80° and an annual rainfall of more than 100 inches. NAMRU #2 scientists carried supplies and equipment on their backs.

Collections included over 200 human and 200 animal bloods for studies of scrub; typhus, leptospirosis, arboviruses, and respiratory viruses; over 1000 stool specimens for parasite examination; chiggers and mosquitoes, both larvea and adults; and snails and other suspected intermediate hosts of parasitic and bacterial diseases. Over 200 tuberculin tests were done on inhabitants of two representative villages for comparison with the previous studies. The team also carried out extensive public health education demonstrations and assisted in planning for improved sanitation.

Valley Fever

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The southwestern region of the United States has a problem that is occasionally felt throughout the country and, indeed, the world. The problem is caused by a fungus that grows in the soil covering wide areas of California, Arizona, New Mexico and Texas. The fungus is pathogenic, producing serious disease in man. And because it occurs over thousands of square miles of land, it can't be eradicated. Distant regions and countries often first learn about the problem when illness arises in their residents who have visited our endemic zones, or when fungus-contaminated products exported from the Southwest infect distant recipients.

The fungus, called *coccidioides immitis,* does not colonize new territories so its major public health significance is restricted, in the United States, to the Southwest. There are endemic foci, also, in Mexico and Central and South America. The general name for the disease produced by *coccidioides* is coccidioidomycosis or, more popularly, valley fever, because of its frequent occurrence in the San Joaquin Valley of

LOWER SONORAN LIFE ZONE OF THE UNITED STATES (approximate)

1. The known areas of coccidioidal endemicity occur within the boundaries of this zone:

A. Arid to semiarid climate
B. Alkaline soil
C. Relative freedom from severe frosts
D. Prevalence of the creosote bush (Larrea tridentata)

2. Highly endemic coccidioidal areas correlated with locals that are:

A. Hot and dry for several months (120° to 32°F, mean summer temperature)
B. Winter wet season of 12.7 to 31 cm annual mean rainfall.

(Bakersfield, Fresno, Phoenix, El Paso)

California. Despite the name of the illness, its symptoms and consequences may involve much more than fever. The Bureau of Medicine and the Office of Naval Research are sponsoring the research to find a vaccine for valley fever.

Varieties of Valley Fever and Populations at Risk

In its most gentle form, valley fever is symptomless, and at its most savage, it kills and maims. An estimated 85,000 Americans yearly are exposed to the fungus of valley fever; the immediate cause is almost invariably the same, breathing contaminated air. During the warm, dry months of the year, valley fever spores are discharged into the air and reported illnesses mount in May and June and continue through September to November. There are sporadic cases of infection contracted from soil-contaminated wounds and scratches, but the primacy of the respiratory route of infection is clear.

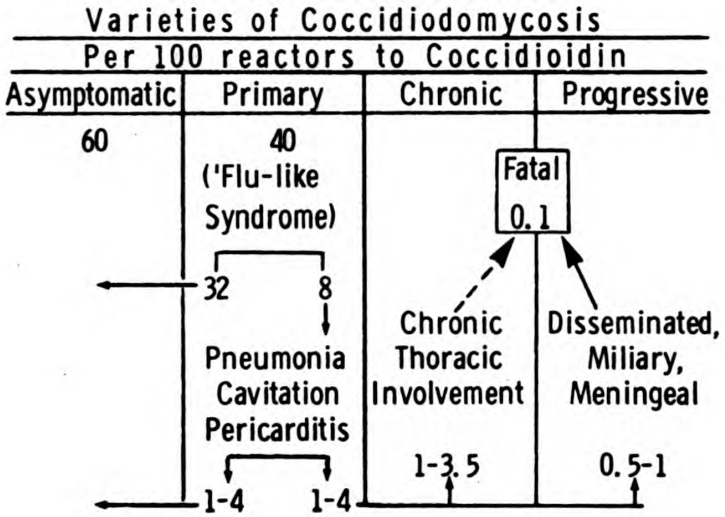
All segments of the population in regions where the fungus is prevalent are at risk, but those in agricultural pursuits, who have close contact with the soil, and people undergoing military field-training, often show a particularly high incidence of disease. Medical officers have reported that at Williams Air Force Base, near Phoenix, the cost of valley fever, in terms of man-days of hospitalization, greatly exceeded the combined corresponding costs of the three most frequent acute illnesses, tonsillitis, upper respiratory infections and gastroenteritis, and all traumatic injuries!

Fortunately, most coccodioidal infections are not severe; approximately 60 percent of infections pass unnoticed or are accompanied by transitory symptoms of malaise. In these cases, the infection is usually diagnosed retrospectively by a coccidioidin skin test. However, approximately 40 percent of valley fever infections produce moderate to severe pulmonary disease, in which one-fourth of the patients require medical attention and, in approximately 3 percent of all coccidioidal experiences, prolonged chronic sequellae, sometimes leading to death, ensue. The striking public health importance of these percentages becomes clear when it is appreciated that vast populations are exposed; between 80 and 90 percent of residents in the areas of Bakersfield, Phoenix and El Paso show skin reactivity to coccidioidin which is indicative of exposure.

It is not the purpose of this description to outline the pathologic manifestations of advancing valley fever. Virtually every tissue of the body, including the nervous system, may become involved and be damaged irreversibly. The only treatment is administration of an antibiotic, Amphotericin-B, which is usually restricted in use to advanced or potentially lethal cases because the antibiotic is itself toxic and may produce very serious, permanent kidney malfunction.

The Rationale for a Vaccine Search

Skin sensitivity to coccidiodin, indicative of contact with *coccidioides,* was studied very extensively by the late Dr. C. E. Smith of the School of Public Health, University of California, Berkeley. After determining the reaction of literally thousands of inhabitants in California's San Joaquin Valley and recording their medical history, a relationship became evident: Once a patient recovered from valley fever, or even if an infection was totally asymptomatic, there was virtually no subsequent history of symptomatic coccidioidomycosis. And this was so, despite the likelihood that exposure occurred time and time again. The importance of the observation lay in the inference, unrecognized before Dr. Smith's study, that man was capable of an effective immunologic response to *coccidioides* and hence successful vaccination was potentially feasible.

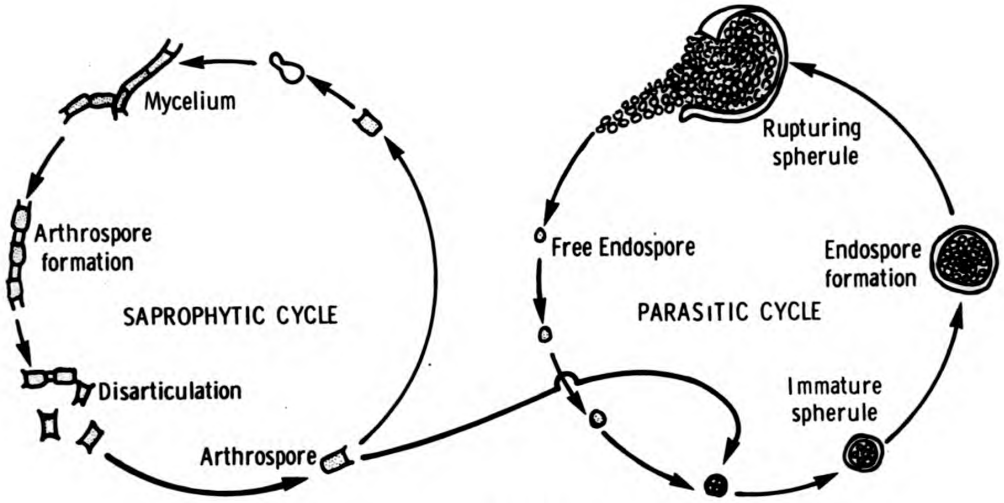


A Word About Mycology

Two characteristics of *coccidioides immitis* should be described to clarify the approach used in a search for a vaccine. The first is that the organism changes its shape and form when it leaves the soil (saprophytic existence) and invades living tissue (parasitic existence). The second is that the different forms have different properties.

In the soil, or in lifeless laboratory nutrients, *coccidioides* grows in a threadlike form called a hypha to form a mat or mycelium. Within the threads, tough structures called arthrospores are formed. When dry, the threadlike structure fractures and the arthrospores are released. They readily become airborne. If they land elsewhere in the soil, they generate new hyphae and the cycle is repeated.

But if the arthrospores are inhaled and lodge in the lung, they become round and enlarge to many times their original volume and are called spherules. Within the body of the spherules, small living structures, endospores, develop. In time the spherules rupture and the endospores are released; they become blood-borne and lymph-borne, and are carried to other loci in the body to generate new spherules. In this manner, *coccidioides* may colonize healthy tissues to produce generalized disease.



DIFFERENT FORMS OF COCCIDIOIDES IMMITIS

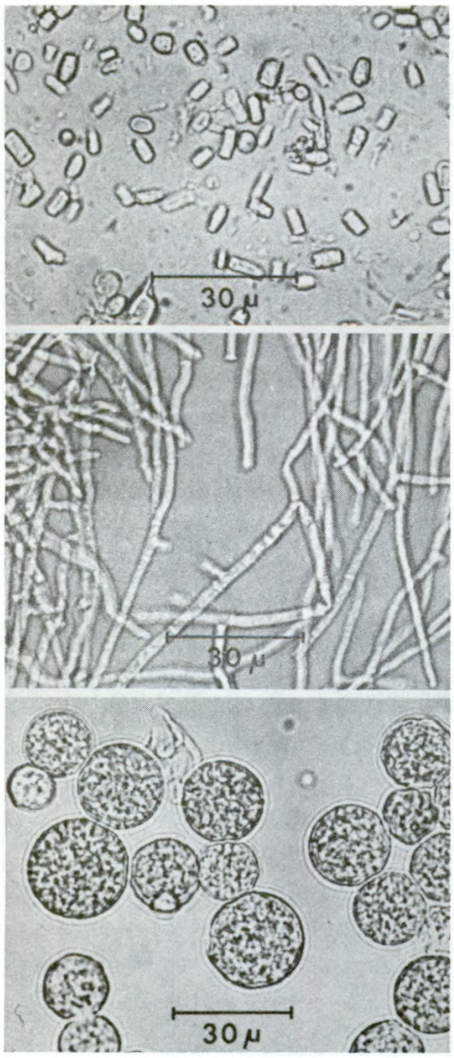
The Spherule Vaccine

A perplexing feature was that early vaccines afforded little protection. Scientists of the U.S. Naval Biological Laboratory found killed mycelial or arthrospore preparations did not protect animals well when they were subsequently infected or challenged with living arthrospores. This was so despite the observations that Dr. Smith made of human beings and despite similar experimental findings that animals surviving infection became strongly immune.

It was only after years of research work that the reason for the inadequacy of the vaccines became apparent: The killed mycelial and arthrospore structures were poorly endowed with protection-inducing antigens or immunogens. Accordingly, the spherule was investigated for its immunologic efficacy. Naval Biological Laboratory scientists modified a spherule growth medium developed by Army scientists and used it with a virulent strain of *coccidioides* designated silveira. Methods and procedures were then devised to free the spherules of mycelial and arthrospore structures so that valid comparisons of the immunizing properties of each could be made.

The initial comparisons were made in three groups of mice vaccinated with killed mycelia, arthrospores or spherules and later challenged with 127 to 185 arthrospores. A fourth group of challenged mice received no vaccine at all. The mortality results after a 3- to 6-month observation period were striking:

Percent death (19-23 mice/group)			
Nonvaccinated	Spherule-vaccinated	Mycelium-vaccinated	Arthrospore vaccinated
83%	11%	50%	57%



Anthrospores (top), mycelia (center) and spherules (bottom) of coccidioides immitis

Over a period of three years, the spherule vaccine was improved such that now virtually all spherule-vaccinated mice survive challenge doses in the magnitude of 800 to 1000 arthrospores, whereas 90 percent of nonvaccinated animals succumb to a challenge dose of 70 to 100 arthrospores.

Recently, in a joint study conducted by the Naval Biological Laboratory and the Veterans Administration Hospital in San Fernando, California, mice vaccinated with killed strain Silveira spherules were challenged with aberrant strains of *coccidioides.* Five such strains, almost unrecognizable as *coccidioides,* as well as two typical strains, were used in the study. The mice were well protected in all cases, suggesting that strain differences are not likely to be too important a feature in a mass vaccination trial.

Scope of the Monkey Trial

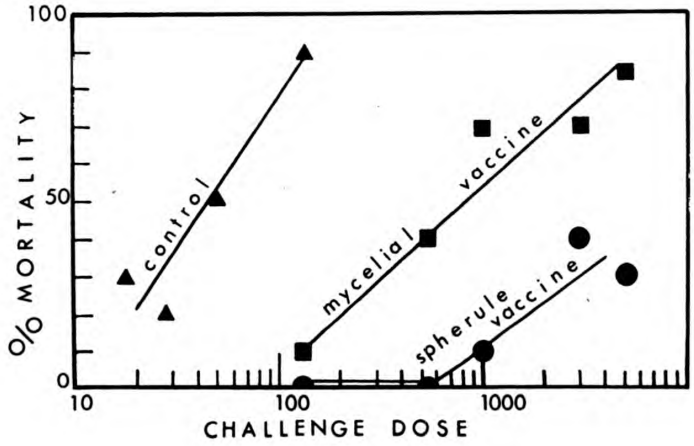
After the vaccine had been tested in many hundreds of mice, a trial was conducted with *macaca irus* (cynomolgous) monkeys to determine if vaccination also protected primates from

death after challenge. Ten nonvaccinated and nine spherule-vaccinated animals were exposed to aerosolized *coccidioides immitis* arthrospores under conditions which were calculated to permit each to inhale approximately 200 arthrospores. Within nine months, seven of the nonvaccinated were dead or moribund. Only one of the vaccinated animals died; a second was inadvertently killed during removal of blood by cardiac puncture. X-ray analysis as shown on page 20 suggested the mechanism of protection. Disease, evidenced by widespread shadows on the lungs, was prevalent in the nonvaccinated groups (C series). In contrast, few such detectable lesions were seen in the chests of the vaccinated monkeys (V series). Apparently, immunization enabled the animals to contain the infecting organisms in small lesions and somehow prevented the disease from spreading.

Containment of Infection

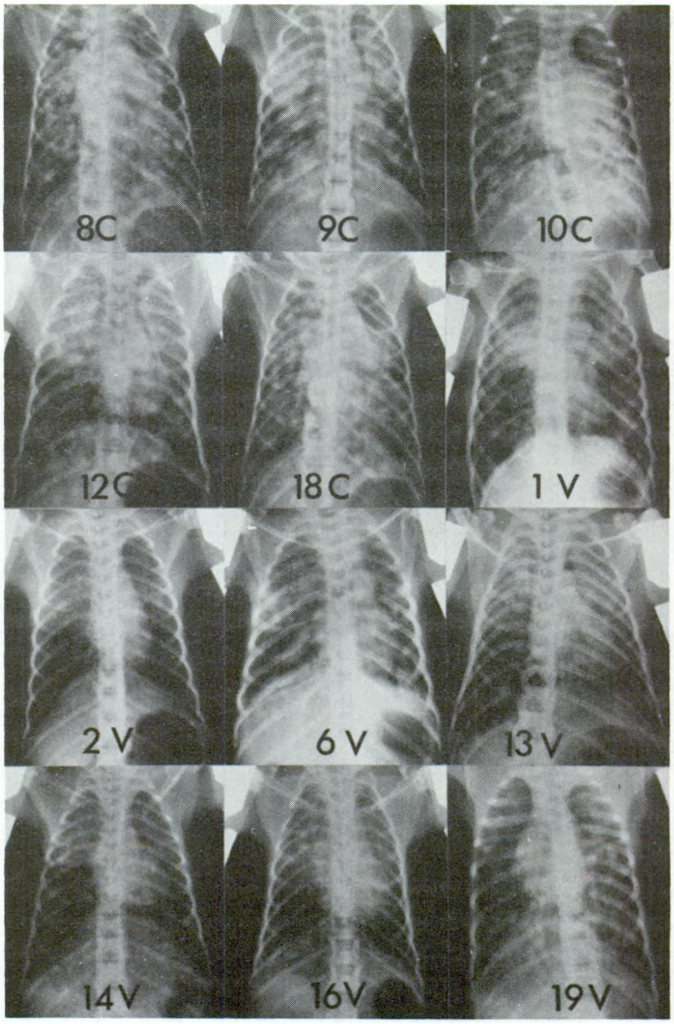
In both mice and monkeys, vaccination prior to challenge produced three profound effects:

- Life was preserved;
- Disseminated infections (involvement of tissues or organs other than the lung) were either prevented (mice) or minimized (monkeys), and
- The extent of fungal growth was limited.



Mortality in vaccinated and nonvaccinated mice challenged with coccidioides immitis

Microscopic studies also showed that vaccination predisposed the animals better to contain *coccidioides* in well-organized lesions. Typically, the lesions of vaccinated mice and monkeys were fewer and smaller than in the nonvaccinated and fewer of these lesions were disintegrating, or undergoing necrosis. Additionally, the lesions of the vaccinated animals contained fewer organisms and had superior architectural organization (round cell infiltrate and fibrosis) than those of nonvaccinated



X-ray plates of vaccinated (V) and nonvaccinated (C) monkeys made at 207 days after infection

animals. And, finally, the process by which the lesion became architecturally organized to contain *coccidioides* occurred more rapidly in the vaccinated than in nonvaccinated animals.

Vaccination did not prevent infection; it minimized the consequences of infection. The animals were then able, over a period of many months, to eliminate or markedly reduce the number of *coccidioides* cells in their tissues.

Where are the Immunogens?

The spherule structure is large (up to 80 microns in diameter) and organizationally complex. It contains many hundreds of endospores within a doubly refractile, thick-walled housing.

A project was undertaken at the Naval Biological Laboratory to determine the location and chemical nature of the immunity-inducing

substances, or immunogens. An answer was obtained to the first part of the question, but not to the second part.

It was found that when the spherules were ruptured, three cell fractions could be separated for study. These were the soluble components, the endospores, and a particulate fraction, presumed to be fragments of the wall. The soluble fraction and the endospore fraction were totally inactive as vaccines. However, the particulate fraction induced strong immunity.

Procedures were then devised to remove the wall of the spherules in such a manner that the walls were essentially intact and identifiable as walls when viewed through the microscope. The walls were washed and freed rather completely of other cellular structures. Used as a vaccine, these induced strong immunity. Moreover, when the walls were mixed with the rest of the spherule components, the immunity induced by the mixture was no stronger than that induced by the isolated walls themselves. For this reason we concluded that the wall of the spherule was the major residence of the immunogens.

As yet we've failed to characterize the immunogens chemically. To accomplish this it is necessary to isolate them, in soluble form, from the wall. All procedures thus far employed, chemical, physical and enzymological, have not yielded a satisfactory soluble preparation. Several properties of the immunogens were determined during these studies. There is a heat labile immunogen and one that is very stable to heat. Chemical and immunological analyses suggest that the former is a protein and the latter a complex sugar; optimal results occur only when both are represented in the vaccine.

First Human Studies

Unfortunately, there is no assurance that a biological product that is efficacious in animals will also be efficacious in man. A necessary step that must precede any trial of a vaccine in man is that of determining if the vaccine is safe and the dosage that may be injected safely.

In November, 1961, scientists of the U.S. Naval Biological Laboratory volunteered as "guinea pigs" for testing the vaccine and eight were selected. At first very small doses of the spherule vaccine, 0.2 mg, were injected into the volunteers who were then observed for a month. There was no ill effect. Gradually the dosage was increased, by very small increments, to 2.7 mg. Still there was no ill effect although one volunteer developed transient hives which lasted for two days. It was later learned that this individual was hyper-allergic also to other stimuli: grasses, strawberries, beer, changes in temperature and that he had a flu-like response on receiving another vaccine several years earlier. He reported further, that his one brother has similar allergic responses.

Observing that the vaccine was safe in dosages up to 2.7 mg, 59 paid volunteers were obtained to extend the study. Proceeding very cautiously, over a four-year period, an answer was found to the question of safe dosage. At doses up to 5 mg the vaccine was well tolerated although there was occasional mild tenderness and slight swelling at the inoculation site. At doses in excess of 5 mg there was local discomfort and swelling which lasted for 7 to 10 days. Some who were sensitive to the fungus because of a prior infection (*i.e.*, coccidioidin-positive skin test) developed a transitory mild fever. This indicated that dermal reaction should be ascertained prior to vaccination.

The study thus provided an estimate of the dosage that could be tolerated comfortably by man and it also showed that the vaccine was safe. However, no data on the vaccine's possible efficacy in man was obtained; the study was not designed for that purpose. And, indeed, information on the usefulness of the vaccine for man can only be gleaned from a very long-term study because of two intrinsic problems pertaining to human valley fever.

For the Future

Ideally, in a human trial to determine the utility of a vaccine, two large groups of volunteers would be required. Cooperating physicians would treat the volunteers either with the vaccine or an innocuous preparation termed "placebo." The containers for both would be coded such that neither the physician nor the volunteer would be aware of the contents. At a later date all volunteers would be infected deliberately and the course of the disease would be followed.

This ideal procedure cannot be considered in the case of valley fever nor is the above idealization intended to recommend it, because there is no safe and sure therapy to terminate the illness.

An alternative approach would be to treat, as above, groups of people who reside in endemic regions and to follow their subsequent clinical history. It would be important to select only those who have had no prior contact with *coccidioides*. Inevitably, some would become infected by virtue of their residence in the endemic zones. The extent and ratios of clinically manifest illness in both groups would then provide an index of the vaccine's usefulness for man. Conceivably, personnel from outside the areas of endemicity arriving for military training at bases in the region could be utilized for such a trial.

Still, two intrinsic problems, alluded to earlier, remain. The first is that only 40 percent of the nonvaccinated volunteers can be expected to contract illness and in approximately 25 percent of these cases will the illness be sufficiently severe to require medical attention. Thus, for the findings to have statistical meaning, the initial numbers of volunteers would have to be very large. The second problem is that the time of

exposure can't be predicted; it may occur shortly after arrival of the volunteer in an endemic region or only after many years. Hence the clinical followup would have to be long-term. Since both military and civilian populations in this country are mobile, difficulties in followup can be anticipated. Nevertheless, despite these problems, the study is feasible and, in the judgment of Naval Biological Laboratory scientists, worthwhile. It is to be considered for the future.

A by-product of this study on a vaccine for valley fever has been the development of a model experimental system to study antifungal immunology. Currently, there are no other fungal diseases for which an effective experimental vaccine has been developed. It is hoped that the information and techniques learned through this research will help to open other doors in fungal prophylaxis. An immediate tangible result of the work is that a tool is provided by which the immune mechanisms that operate in experimental coccidioidomycosis of animals can be investigated.

Ocean Scientists To Evaluate Charting System Aboard Speedboats

Scientists of the U.S. Naval Oceanographic Office plan to evaluate the suitability of operating a new automated survey system aboard small speedboats in the coastal and riverine areas of Duck Roads and Clinton Harbor on the coast of Connecticut.

The scientfic team composed of members of the Charting Techniques Branch of the Research and Development Department will install the HYDRA Survey System, a compact, electronic instrument package constructed to record depths in relation to position and time at high speeds, aboard two experimental small survey launches (XSSLs) in an effort to expand the HYDRA-small craft approach to riverine and coastal surveying. As in two previous experiments on the HYDRA Survey System, the scientists chose the test site along the northern shore of Long Island Sound because a navigational positioning chain necessary to the operation of HYDRA is located in the area.

The scientists hope to make the HYDRA Survey System fully operational aboard two experimental small survey launches, the XSSL-2 and the XSSL-3, which are modified speedboats similar in size and weight but different in hull design and material. The scientists plan to evaluate the performance of the two hulls in relation to wind and wave conditions and to speed. Both boats are propelled by 120-horsepower inboard-outboard motors; the XSSL-2 has a fiberglass, deep V-shaped hull, and the XSSL-3 has a cathedral-like hull made of aluminum.

The XSSL-3 is different from the standard speedboat in that it is equipped with a small watertight enclosure to protect the men and the delicate HYDRA survey instrument from salt-water spray and inclement weather. Although not equipped with a cabin, the XSSL-2 has a canvas, convertible top, which hopefully will function as a protective covering.

The HYDRA Survey System, consisting of three electronic units each weighing 50 pounds, records depth information needed in charting topographic features of the ocean floor; also the system picks up data on the navigational positions and the times at which the depth readings were taken. The compact instrument package translates the depth readings, along with positions and times, into computer language and stores the data on magnetic tape aboard the survey craft.

Research Notes

Aluminum Cores for Lead Castings

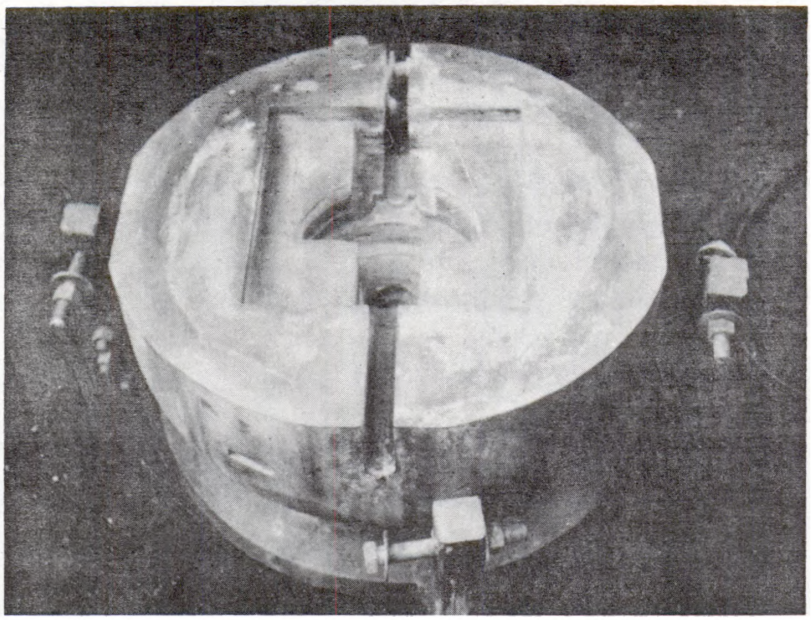


Figure 1 — Completed lead casting after removal of aluminum core

The Naval Research Laboratory Foundry produced a large lead casting having an external hemispherical shape and containing an intricate, deep cavity. The casting was designed to contain radioactive materials. A photograph of the completed casting is shown in Figure 1.

To produce the casting, the external shape was formed using conventional sand molding techniques; however, the cavity was formed with an aluminum core. After pouring the lead casting, the core was removed by dissolving it with a caustic solution. The primary advantages gained in producing a lead casting with this type of core are:

- The strength of the aluminum made it possible to produce thinner core sections than are possible with sand cores.
- Lead penetration into sand cores seems to be a common problem which makes core removal difficult without damaging the casting. The use of the aluminum core eliminated this problem.

The aluminum core was cast using Alloy 356 (7.0% silicon-0.3% magnesium-balance aluminum). However, any of the available casting alloys would have been acceptable. No attempt was made to degas the melt used to produce this aluminum casting, since gas porosity generally resulting from an untreated melt would tend to increase the caustic reaction rate assisting in faster removal of the core.

The removal of the aluminum core could have been performed by immersion of the entire lead casting in a tank of hot caustic solution. However, it was elected to perform the entire operation on the foundry floor using the simple and inexpensive arrangement shown in Figure 2. A ten percent caustic (sodium hydroxide) solution contained in a steel drum was heated by an electric immersion heater. A siphon flow, regulated by a hose clamp, delivered solution to the casting. A dam made of putty held the caustic solution over the entire aluminum core. The solution was delivered to the casting top at one end

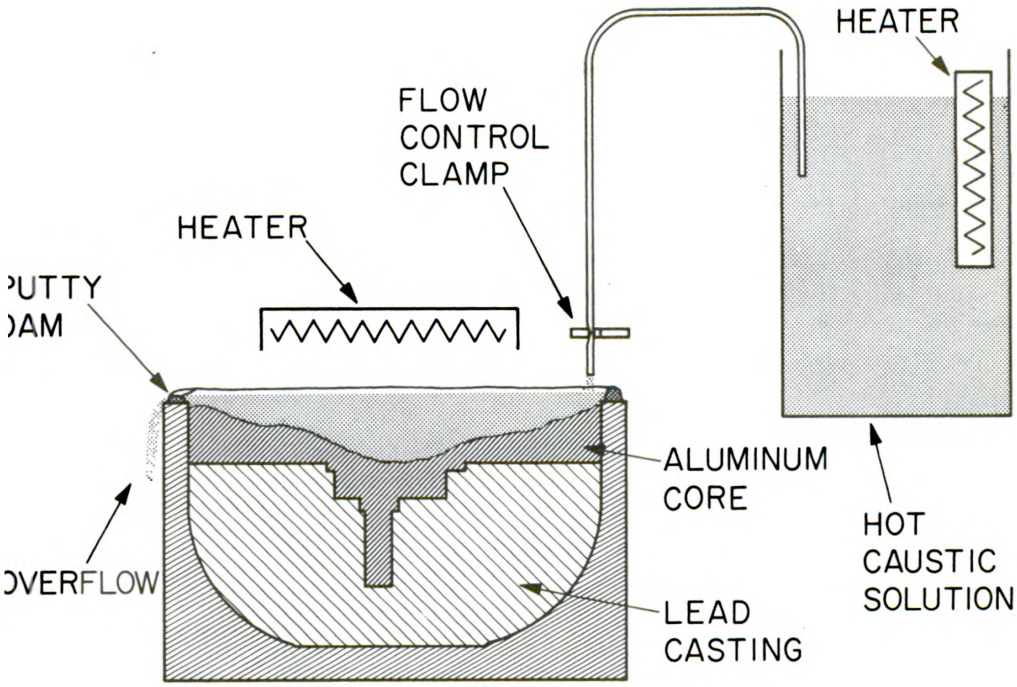


Figure 2 — Core removal operation

and permitted to overflow at the opposite end of the casting. Electric heating lamps located above the casting were used to keep the solution hot. Since this operation was performed in a well-ventilated room, no special ventilators were used.

About 30 hours were required to remove this aluminum core. No operator attention was required other than keeping the tank filled with the solution. It was not necessary to dissolve all of the aluminum because the caustic solution undercut the core in several instances making it possible to remove large sections of metal.

The production of this casting was the first attempt by the Naval Research Laboratory Foundry to produce a cavity in a lead casting using an aluminum core. The success of this trial will undoubtedly encourage the production of more intricately cored lead castings in the future.

British Trans-Arctic Expedition

The Office of Naval Research's Arctic Research Laboratory (NARL) at Barrow, Alaska, has extensively supported the British Trans-Arctic Expedition, which is attempting to make the first successful Arctic crossing on top of the ice, by men and dog teams. The expedition started from Barrow in February. ONR's drifting research ice station T-3, operated by NARL, provides a key communications link between the expedition and the outside world. NARL air dropped supplies to the men during the early weeks of the expedition.

Led by Mr. Walley Herbert, the four-man British Expedition departed Barrow to cross the North Pole for Spitzbergen, a total distance of 2800 miles, in 16 months. The Arctic has been successfully traversed most recently by Navy nuclear submarines traveling under the ice and by the Navy's drifting research ice station ARLIS-II. The information gathered in the past several years by these means together with experience in resupplying drifting ice stations is credited by the British in making an Arctic crossing a practical goal.

A vital radio relay station will be operated on T-3 during the middle part of the crossing. Reliable radio communications with the Herbert party requires that it always be within

500 miles of a radio station. Present radio communications are established at NARL, Barrow, operated by a Royal Air Force Communications specialist, who will later transfer his operations to T-3. The operator maintains daily radio contact with the field party and relays weather data, position, and general traffic directly to England. He will also conduct experimental studies on Very Low Frequency (VLF) radio propagation. The expedition itself will carry out a series of scientific studies on pack ice environment.

The route of the Trans-Arctic Expedition will be from Barrow, Alaska, north-northwesterly across the geographic North Pole to Spitzbergen. After leaving Barrow the expedition traveled over ice arriving in the vicinity 84° N 172° W about mid-June. From mid-June to mid August, the party will drift on the ice pack until the ice begins to reform, Then the party will push on to 83° N and 168° E, arriving about 1 October, at which time the party will winter over until the first light in the spring of 1969. During this period the party expects to drift toward Spitzbergen. The party will break camp about 1 March 1969 and push on to Spitzbergen expecting to arrive June 1969.

The expedition consists of four men and 40 dogs; the men are a glaciologist, a geophysicist, a medical doctor, and a radio-operator. Although the trans-Arctic traverse is an adventure, the previous experience, planning preparation, and training for the expedition by its members is outstanding. The members of the party will no doubt contribute to the knowledge of the Arctic:

- *Synoptic weather observations.* Throughout the 16 month crossing, weather observations will be made four times daily and transmitted once a day to a member of the B.T.A.E. stationed on the drifting ice island (T-3); who in turn will relay the data through normal channels to all meteorological services in the Northern Hemisphere.

- *Glaciological program.* Ice thickness and snow density profiles will be measured throughout the crossing and, during the mid-summer and winter drifting periods, a heat balance study will be made which will include measurements of the ablation and disintegration of the sea ice, sea temperatures, ice drift, and incoming and reflected solar radiation, together with a micrometeorological program.

- *Geophysical program.* A geophysical traverse will be made during the winter period as the expedition drifts across the submarine Lomonosov Ridge. This program will include ocean depth soundings, magnetometer, and gravity measurements.

- *Wild life study.* Information will be gathered on the wanderings of polar bears and a log will be kept of all bears, seals, and birds shot, dissected and eaten.

- *A study of survival techniques.* The expedition is fitted out as a hunting party with sledges which can be converted into boats. Experiments will be made with lined igloos and survival shelters; in addition, a program of physiological and psychological research is being conducted throughout the journey on members of the expedition.

Below is a sample report sent by the expedition to NARL:

> "British Trans-Arctic Expedition Progress Report 10 to 16 August 68
> As of 10 August 68 Party's position was 82 degrees 56 minutes North 162 degrees 30 minutes West. Polar bear got among dogs during the evening radio schedule. Managed to chase him off. Got about 200 yards off for half an hour watching party. 11 through 14 August party drifting slightly North and West. As of 15 August party position 83 degrees 05 minutes north 162 degrees 38 minutes West. Ice floe soaking wet after several days of rain. We have no intention of leaving floe at moment as crystal ice needles everywhere and very sharp. Virtually impassable for dogs. Party position at end of week 83 degrees 15 minutes north 162 degrees West."

Underwater Skills Research

A research program to investigate the sensory behavior and speech performance of underwater sailors has been announced by the Naval Submarine Medical Center, New London, Conn.

To promote optimal use of man's special senses in submarine operations, specific research has been designed to improve methods of using sensory skills not now used, and to select individuals for submarine duty who have specific sensory skills. Included in the research are plans to devise techniques of optimizing performance and sensory surveillance, as well as determining abilities in monitoring visual, auditory, and tactual displays.

The study of man's ability to speak efficiently in underwater environments forms the second major area of research. Specific experiments are planned in speech production and reception in closed environments and undersea habitats, verbal communications among divers and swimmers, and the effects of water immersion of verbal behavior.

The research project is part of the continuing program of studies conducted by the Behavioral Sciences Division of the Submarine Medical Center.

Scientific Expedition Drills to 2500 Feet in Deep Sea Floor

U.S. scientists and engineers, in the most ambitious deep ocean drilling expedition ever attempted have drilled 2500 feet and recovered selected core samples at ocean depths around 10,000 feet. Operations have now been completed at two sites and drilling has started at a third location.

At the first drilling site, the scientists and engineers, drilling from a ship over a water depth of 9259 feet, successfully recovered selected core material from 2500 feet beneath the floor of the Gulf of Mexico. The previous record for core recovery at deep ocean depths was 601 feet into the floor of the Pacific Ocean off Guadalupe, Mexico, in 1961.

At a second site, called the Sigsbee Knolls, located about halfway between Louisiana and the Yucatan Peninsula, the drill hole was in 11,753 feet of water. At this site the drill penetrated 480 feet of sediments. The 12,233 feet of drill string at this site is the longest known for deep ocean drilling from a floating platform. Gas and oil was noted in the core material recovered from the Sigsbee Knolls site, and the hole was plugged with cement to prevent seepage and contamination of the sea water.

The operations were part of the Deep Sea Drilling Project (DSDP) of the Scripps Institution and the National Science Foundation. The basic goals of deep sediment drilling are to gain new insights into the history and origin of the oceanic basins and of the continents and to learn more about the processes that have led to their formation and modification. While the objective of the program is to add to the store of basic knowledge, it has been recognized that exploration of the crust of the earth could result in information that has more immediate practical value.

During the 18-month sea-going phase of the Deep Sea Drilling Project, the Challenger, the self-propelled drill ship, will travel approximately 40,000 miles and drill a number of holes in the floors of the Atlantic and Pacific Oceans. Water depth at the drilling sites will vary from 5000 to 20,000 feet. Coring will be conducted up to 2500 feet into the sea bottom. Analysis of sediments are to be undertaken by scientists at Universities and Government agencies throughout the nation.

The record depth core recovery marked the beginning of the deep sediment drilling scientific program and realization of a ten-year scientific dream to recover sedimentary material from great depth in the oceans of the world.

ONR's Exhibits

To tell the story of research projects sponsored by the Office of Naval Research, its Public Affairs Office each year prepares exhibits to be displayed at universities, naval installations, professional and scientific meetings and other special events.

Last year 30 exhibits traveled the length and width of the United States to show the role of ONR in scientific research. More than 90,000 people, including thousands of professionals and scientists viewed these exhibits which cover many fields such as oceanography, hydrobiology, microbiology, and human engineering man-in-the-sea program. Over three million people see each year a permanent ONR exhibit in the Chicago Museum of Science. The museum exhibit is part of the Navy's seapower display and covers a variety of scientific fields including oceanography, weather and cloud meteorology, underwater acoustics, ship recognition, human engineering and deep sea research.

Exhibits displayed at universities help the recruiting program for the Naval Reserve Officers Training Corps. Other exhibits at naval installations inform naval operating units of the part played by the Office of Naval Research and its Laboratories in increasing the effectiveness of the Navy through applied research.

Most of the exhibits are manned by personnel from the Public Affairs Office, who explain the exhibit and the missions of ONR and its Laboratories. Handouts and late news items of Navy research are available at the exhibits to up-date new and old research progress.

Navy Symposium Calendar

National Conference on Environmental Effects on Aircraft and Propulsion Systems to be held at the Holiday Inn, Bordentown, New Jersey, October 8-10, 1968. Additional information may be obtained from Mr. J. Lawrence Palcza, Program Vice-Chairman, Naval Air Propulsion Test Center, P. O. Box 176, 1440 Parkway Avenue, Trenton, New Jersey 08628. Phone: Area Code 609-882-1414, Extension 317. Sponsored by the Naval Air Propulsion Test Center.

Navy Symposium on Underwater Acoustics to be held at the U.S. Navy Underwater Sound Laboratory, New London, Connecticut, November 12-14, 1968. Additional information may be obtained from Mr. John B. Hough, Office of Naval Research, (Code 466), Washington, D.C. 20360. Phone: Area Code 202-696-2693. Sponsored by the Office of Naval Research.

Symposium on Unconventional Inertial Sensors to be held at the Naval Applied Sciences Laboratory, Brooklyn, New York, January 29-30, 1969. Additional information may be obtained from Mr. A. S. Oravetz, Naval Applied Science Laboratory (Code 954), Washington & Flushing Avenues, Brooklyn, New York 11251. Phone: Area Code 212-725-4500, Extension 279. Co-sponsored by the Naval Applied Science Laboratory, Naval Air Systems/Ship Systems Commands, Director of Laboratories of the Air Force Systems Command and the Institute of Navigation.

Dr. Raymond C. Elton has been appointed head of the Naval Research Laboratory's High Temperature Physics Branch in the Plasma Physics Division. In his new position, Dr. Elton administers a research program in physics and utilization of ultra-high temperature plasmas as well as plasma spectroscopy. Dr. Elton received a B.S. degree in physics from Virginia Polytechnic Institute and both his M.S. and Ph.D. degrees from the University of Maryland. He joined the Naval Research Laboratory staff in 1958.

On the Naval Research Reserve

NRRC 13-1 Hosts Seminar on Man in Systems

"Man, His Capabilities and Limitations in Systems" was the theme of the 15th Annual West Coast Research Reserve Seminar hosted by NRRC 13-1 in Seattle, Washington. The seminar started with a welcoming address by RADM H. J. Trum, Commandant, Thirteenth Naval District. RADM Thomas Owen, Chief of Naval Research discussed research in areas affecting the Navy man.

The objective of the seminar was to better utilize and understand man as he performs in a particular set of circumstances and environments. The seminar presentations were oriented primarily toward naval weapon systems.

Technical sessions during the two-week period included "Man's Sensory Mechanisms," "Environmental Effects on Man," "Man in Aircraft Systems," "Display Devices—Aids to the Operator," "Simulation and Evaluation," "Man in Other Operating Environments," "Personnel and Training," and "Human Factors in the Navy."

The seminar banquet was highlighted with a presentation by Dr. Richard Trumbull, Research Director, Office of Naval Research. Dr.

At the seminar banquet Dr. Richard Trumbull, Research Director, Office of Naval Research, discussed the psychological factors associated with the human in systems.

Trumbull discussed the psychological factors associated with the human in systems.

The seminar heard from representatives of the Naval Air Station on Whidbey Island, Personnel Research Activity at San Diego, and the Deep Submergence Project Office at San Diego. Navy human factor specialists from the Office of the Chief of Naval Operations and the Naval Air Development Center also addressed the group. CAPT Miller, an attendee from NRRC 9-16, East Lansing, Michigan talked on "Crisis Conditioning—The Human Element in Hazardous Environment Systems." CDR Stern of NRRC 13-1 was chairman of this seminar which was attended by 115 Research Reservists from the 8th, 9th, 11th, 12th, and 13th Naval Districts.

NRRC 3-14 Hosts Seminar on Military Applications of Data Processing

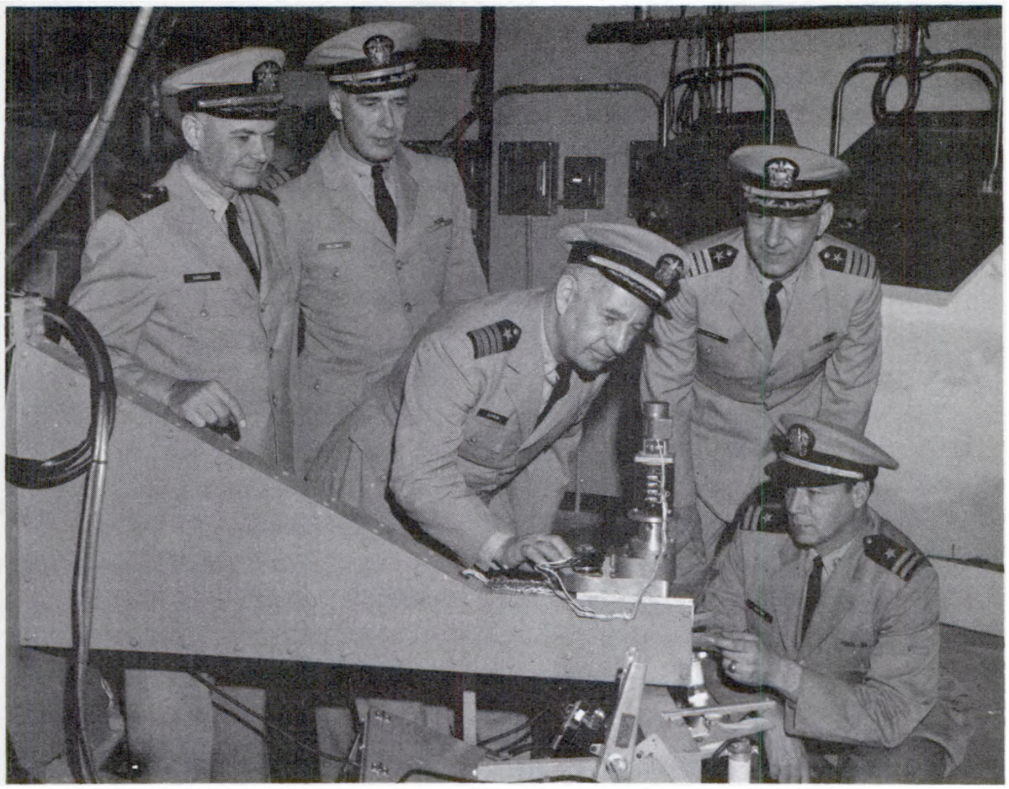
Naval Research Reserve Company 3-14, Poughkeepsie, New York, had the unique experience of hosting a Research Reserve Seminar on the Military Applications of Data Processing. The Seminar was held at the U.S. Naval Academy. CAPT H. E. Van Ness, the Assistant Chief of Naval Research, delivered the keynote address. He described the accomplishments achieved by the military services in the field of data processing and their future plans. The many areas of military application were described by representatives from various commands and systems. Tours were also conducted at the Goddard Space Flight Center, Army Map Service, Andrews Air Force Base Computer Facility, and the U.S. Air Force Command and Control System in the Pentagon.

CDR Norman J. Smith, USNR, was chairman of the seminar, which was attended by 79 Naval Reserve Officers from the First, Third, Fourth, Fifth, Sixth, Eight, and Ninth Naval Districts.

NRRC 5-10 Goes to Florida

The Naval Reserve Research Company 5-10 flew from their home base at the Naval Medical Research Institute in Bethesda, Maryland, to Florida for a four-day tour. The Naval Training Device Center, the Martin-Marietta Corporation, and NASA's Cape Kennedy Space Flight Center were their hosts.

The climax of the training duty was a tour of the Vertical Assembly Building at the Cape, in cubical content the world's largest building, where a Saturn IV was nearing completion. High-speed elevators provided access to observation catwalks around the rocket. The top of the first stage rocket motors is at a 4th floor building level while the top of the rockets 3rd stage is at a 34th floor level.



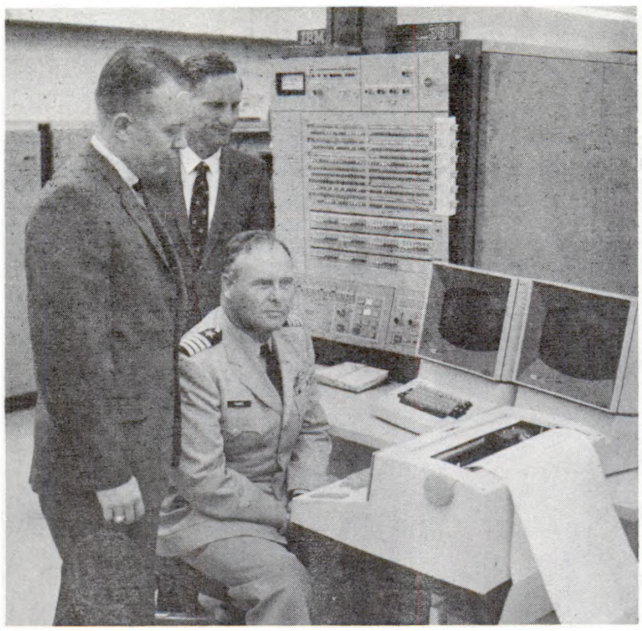
(l to r) CDR Joseph Harrison and CAPTs John T. Holloway, Robert J. Gutheim and Eugene G. Kovach look on as LT Alexander J. Barton, Commanding Officer of NAVRESRSCHCO 5-10, points to an interesting feature on the wide-angle television component of the Shiphandling Visual Display Device at NTDC.

NRRC 5-10 is composed of 70 Naval Reserve Officers whose civilian employment involves scientific or engineering duties in the Washington area. The unit's training program during the past year featured briefings by RADM T. B. Owen, Chief of Naval Research; RADM S. R. Brown, Jr., Assistant Deputy Chief of Naval Operations for Fleet Operations and Readiness; and 21 other military and civilian science experts.

Texas A and M University and NRRC 8-3 Host Sixth Annual Computer-Seminar

The sixth annual Naval Research Reserve Seminar on Electronic Computers was held from 26 August through 6 September 1968. RADM Thomas B. Owen, USN, Chief of Naval Research, stated the following in his message to the seminar:

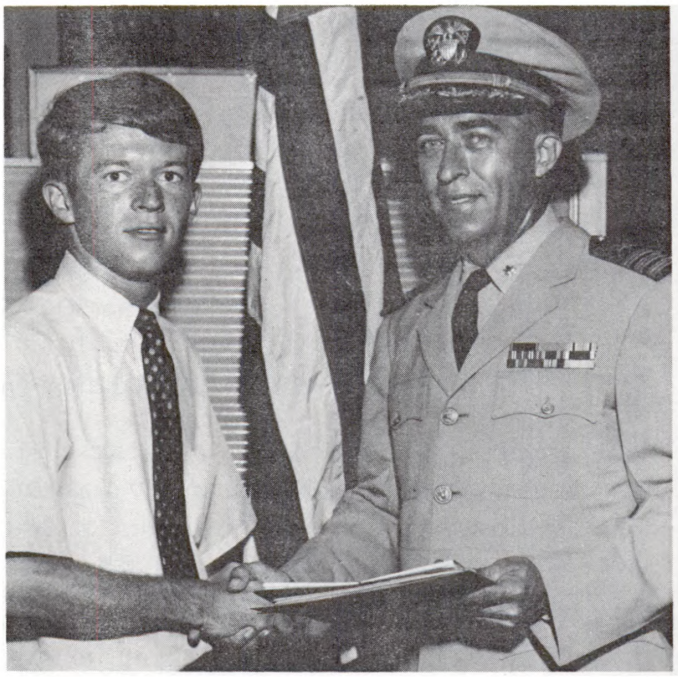
> "In order to comprehend the advances taking place almost daily in the information processing field, it is essential that we be informed of them in coherent fashion. This is the purpose of this specialized seminar."



CAPT Robert Bower, USAR, LT Robert M. Olson, USNR (standing) and CAPT Walter H. Thames, USNR (seated at console) observe operation of IBM 360/65 during Planning session.

The seminar provided basic information for newcomers on computer programming and speakers on advanced topics of interest. Texas A&M University contributed lecture rooms and the use of the IBM 360/65 computer. CAPT Walter H. Thames, USNR, was chairman of the seminar which was attended by 56 Research Reservists from all sectors of the United States.

The Special Assistant for Research Reserve, CDR R. W. Keniston had the pleasure of administering the oath of enlistment into the Naval Reserve to his son, Robert W. Keniston, Jr., who is a student at Strayer Junior College where he is majoring in Data Processing Systems. He hopes to provide the Navy with the benefit of his training when he begins his active duty with the Navy in 1969.



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Holographic Interferometry

The cover picture is an example of holographic interferometry, a new and extremely useful optical technique for vibration measurements. The fringes result from optical interference of the coherent laser illumination used in the holographic process, and are read as contours of equal vibration displacement. Stationary or nodal regions are readily recognized because of their high relative brightness.

The specimen pictured is a clamped edge thin plate driven at one of its higher order modes of vibration. The mode is easily recognized as, but obviously differs from, the classical mode having two vertical and three horizontal nodes. The hologram has provided an accurate and highly detailed description of the modal structure.

The power of holographic interferometry lies in its simplicity. While conventional interferometry requires optically perfect surfaces and meticulous care in execution, holographic interferometry works equally well with any diffusely reflecting specimen and requires no surface preparation of any kind.

Inexperienced personnel may be readily trained in this measurement technique. The availability of moderately priced high quality lasers places a holography facility within the means of most research laboratories.

Super Magnet

Another step in space technology has been taken by scientists at the Naval Aerospace Medical Institute in Pensacola, Florida with the acquisition of a super-conductive magnet.

The new magnet, operating at a temperature of 452 degrees below zero Fahrenheit, will permit investigation of the biological effects of extremely high magnetic fields, such as those encountered in space. Low magnetic fields have been previously studied at the Institute inside a huge geodesic dome, simulating conditions on the moon.

The niobium-tin wire magnet generates a magnetic field of 110,000 gauss. (A gauss is a unit of measurement of magnetic intensity.) With this new capability, organisms as large as mice can be studied to determine effects of magnetism on the heart, the nervous system, and genetics.

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: $1.75 per year in the U.S. and Canada; $2.25 per year, foreign; $0.20 per individual copy. The issuance of this periodical approved in accordance with Dept. of the Navy publications and printing regulations.

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IN THIS ISSUE

VOL. XXI, NO. 10

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