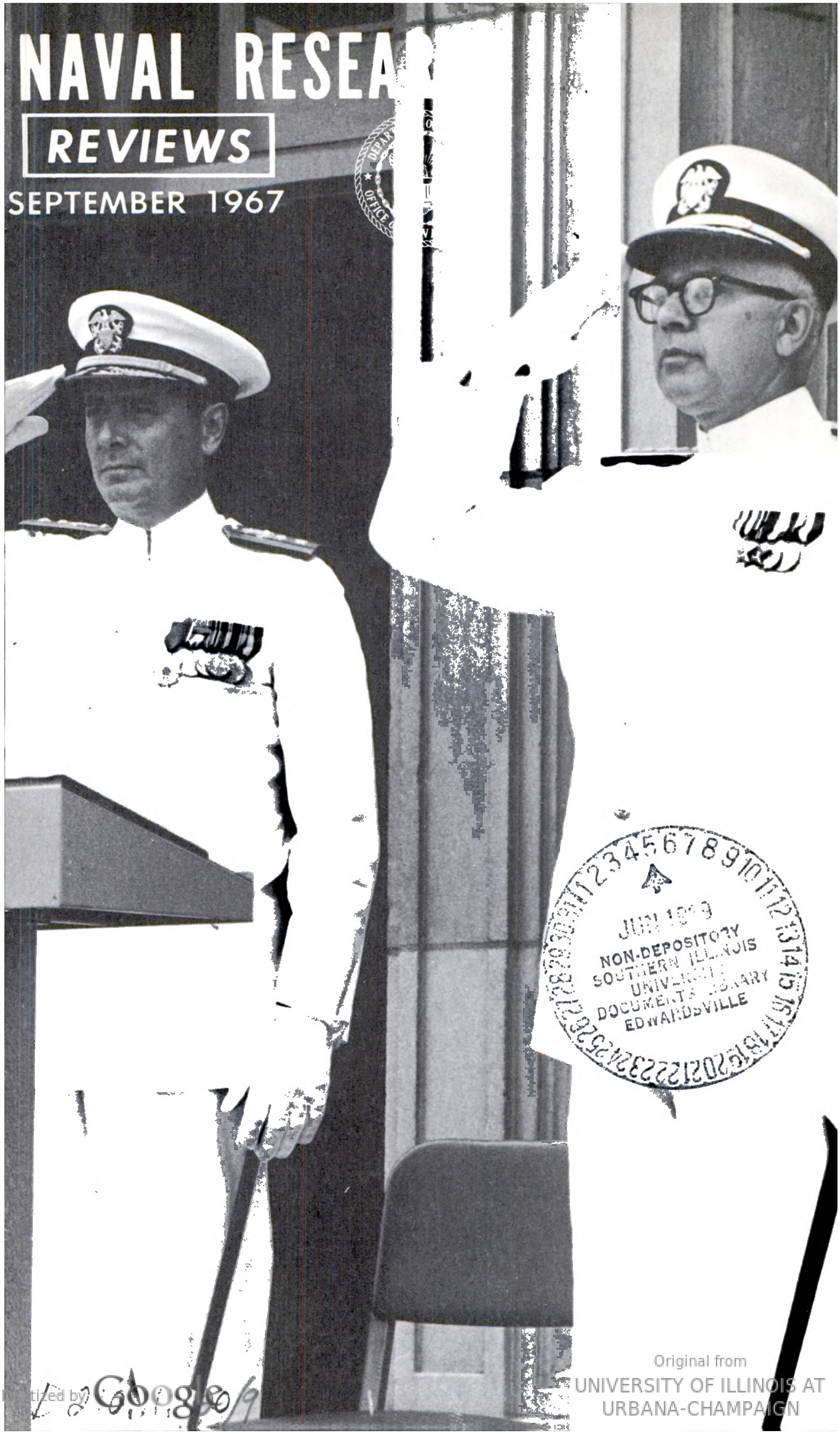
NAVAL RESEA
REVIEWS
SEPTEMBER 1967

Portraits in Science

Dr. Robert M. FANO

Dr. Fano is Ford Professor of Engineering and Professor of Electrical Communications at M.I.T. He organized and directs M.I.T.'s project MAC (Machine-Aided Cognition-Multiple-Access Computer).

During W.W.II, Prof. Fano worked on microwave components and filters at M.I.T.'s Radiation Lab. From 1950 to 1953 he was group leader of the Radar Techniques Group of Lincoln Lab.

Among his publications is the book "Transmission Of Information." Dr. Fano co-authored Vol. 9-Radiation Lab. Series and two textbooks on electromagnetic theory.

A member of the Research Laboratory of Electronics, Dr. Fano is also a Fellow of the American Academy of Arts and Sciences and is a member of the Association for Computing Machinery.

Computer-Aided Ship Design and Construction

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Punched cards are seen everywhere today—in science, industry, and government. These cards—whether paycheck or bill—are an indication of the increasing use of the computer in the United States today. The reason for the overwhelming acceptance of these machines is that they answer the need for processing large masses of data quickly and cheaply.

Unfortunately, the computer has not been fully utilized by one important segment of U.S. industry—shipbuilding. As an indication of how much the shipbuilding industry needs a cheap, easy way to process large amounts of information, consider the number of electrical connections that go into building a ship. Many ships will have as many as 250,000 electrical connections; some, a half million. Although keeping track of that many connections is an enormous job for humans, it is well within the capacity of a computer.

Mechanical aids to computation have been with man for a long time. However, modern work in the field of digital calculators is relatively recent. The first half of the 19th century did see the development of a concept for a general purpose calculating machine which would accept "programs" of specific instructions to do specific jobs, but nothing more was done until almost a century later. In the 1930's, further theoretical studies were made, and calculators using relays were demonstrated by Bell Telephone and Harvard University. During World War II, ENIAC, an electronic computer used to calculate ordnance tables, was developed at the University of Pennsylvania. The British also had a computer working on a war-related task.

Theoretical development continued throughout the late 1940's, and in 1950 UNIVAC, the first commercial computer, was put on the market. Since then, development of the field, both technically and theoretically, has been extremely rapid. It appears that the pace will increase in the future.

Development Within the Navy Department

The Navy Computer-Aided Ship Design and Construction (CASD&C) project dates back to 1948, when the Navy Ship Engineering Center (then part of the old Bureau of Ships) began work on a computer-aided ship design project. This pioneering effort explored the new field and provided the Navy with some of its first computer programs—largely mechanized versions of lengthy, tedious, and repetitive mathematical operations. Such programs were not only relatively easy to write, but also relieved engineers and designers of much "non-creative" labor. The process of calculating the sectional modulus of a structure, for example, is a very repetitive procedure: The cross-sectional area is multiplied by its distance from a reference line, the result added to an accumulating total, and the process repeated as many as 50 or 100 times. A very simple computer program can perform these multiplications and additions, and do it with much more speed, accuracy, and reliability than an engineer.

As programming skills were developed and refined and better equipment became available, the size, complexity, capabilities, and number of programs increased. Many of the current programs are similar to the section modulus program in that they are designed to relieve designers of the necessity of performing simple, but boring and time-consuming operations. Others are quite complex, represent a distinctly higher level of programming skill, require more sophisticated equipment, and offer correspondingly greater returns. For example, in designing a ship, it is necessary to know just how that ship will react when floating on the water's surface. By making a long series of calculations, it is possible for the designer to predict quite accurately the waterline at which a ship will float—if indeed it does float. Such calculations are important because initial designs *have* been made for ships which, if completed, would sink like a rock. The calculations involved are not particularly sophisticated in the mathematical sense, but they are lengthy and complex and handle large amounts of data—a thousand numbers alone are required just for input data to describe the hull form. Also, this program is not just a simple repetitive task. Rather, some 21 groups of calculations are involved, the order of which must be determined as the data is being processed. The computer program for this, now in everyday use, saves a great deal of time and labor in ship design. Also, the computerized system has less human intervention and is therefore less prone to human error.

At the present time, certain modifications and refinements are being made in the program. For example, experience indicated that one of the most frequent sources of error was the human operator who made up the original description of the ship's hull. To check this description, the program now includes a drawing made by a computer-directed plotting machine which indicates visually exactly what the computer thinks the input data looks like. Any errors are easily noticed and can be quickly corrected. A body plan of a ship drawn by a computer-directed plotting machine is illustrated in figure 1.

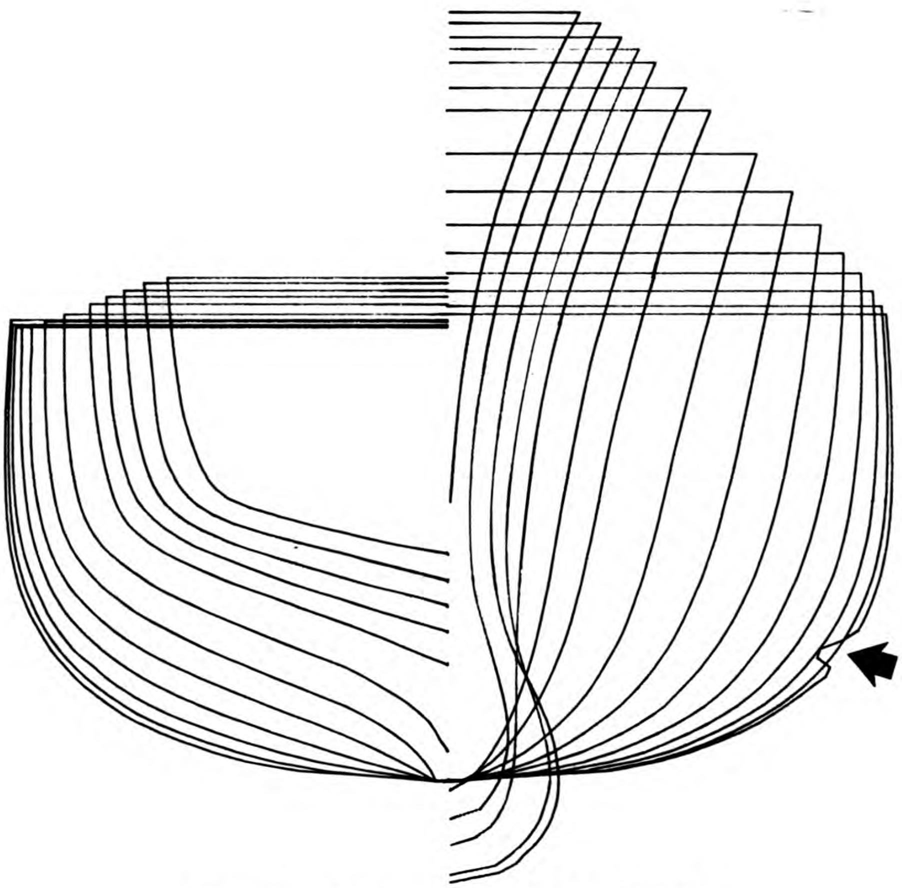


Figure 1 — Computer-drawn plan of a ship's hull.
Note how easy it is to spot a bad data point.

Accomplishments

To get an idea of the scope of the Navy's effort in this field, it is useful to examine the areas where work is being done and the programs which have been written. The existing programs can be divided into four somewhat arbitrary groups: Requirement Definition, Concept Formulation, Contract Design, and Detail Design and Construction.

The first group—Requirement Definition—currently contains very few examples. However, at least 14 programs in this area are under development. As the name implies, such programs attempt to analyze a given military situation and determine what requirements that situation would place upon a weapon system.

Concept Formulation programs consist mainly of programs popularly known as "feasibility" studies. As a typical example, a destroyer feasibility program is given information as to required speed, range, type of propulsion plant, amount and types of electronic gear, and amount and types of weapons. The program then provides a description of a technically feasible ship which can meet the operational requirements stated. Such programs are extremely useful, since it is not at all unusual for the Pentagon to request an analysis of a particular ship type for five different speeds, five different ranges, three different weapons systems, and four different sonar systems. Such a request represents 300 complete ship designs—a prohibitively expensive task if done manually. Existing computer routines can design that many ships in less than two minutes—and run a cost estimate as well. Such programs presently exist for destroyers, nuclear attack submarines, amphibious assault ships, and Fast Deployment Logistic (FDL) ships.

The Contract Design area includes 105 programs which are either complete or under development. Programs in this area generally perform some engineering calculation or design procedure. Examples are a submarine framing and shell plating program, a shaft horsepower program, a propeller design program, and an electrical load analysis program.

Detail Design and Construction programs are written and used primarily by the various Naval Shipyards. Approximately 200 such programs exist. They generally are detailed construction-oriented engineering design programs.

As the various programs have developed, a large mass of data in machine-sensible form has been accumulated. Such background information is an essential input to the design process. Although this backlog of information is currently available and stored at NAVSEC, the Naval Shipyards, and various R&D centers around the country, it is not in a form immediately useable by computers. However, as programs are being developed and used, this backlog information is gradually being converted into useable form. When this task is completed, the resultant data may easily be converted for use by any program. Also, it may be transmitted by wire to the various engineering centers for their use.

New Trends in Technology— Central Computer and Terminal Hardware

The growth in the speed and information-handling capability of computers has been spectacular. Computing power and speed have increased a thousand-fold, while both cost and physical size have been greatly reduced. This additional power and speed at lower cost have enabled the computer to go from the original simple programs to those which are infinitely more complex and which handle a great deal more data. Because of this large capacity, it is possible for a modern computer to overwhelm its output devices with more data than they can possibly handle. Also, program computations are often held up waiting for slow input devices to provide incoming data. Equipment manufacturers have responded to this problem with a system of operation known as time-sharing and with new input-output devices.

Figure 2 — A hypothetical example of a man-machine conversation. Arrows indicate computer responses.

HELLO?
→ USER CODENAME?
GEORGE.
→ NEW OR OLD PROBLEM?
OLD.
→ OLD PROBLEM NAME?
STABILITY.
→ WHICH SHIP?
CVAN 71.
→ READY.
PRESEMT LOCATION OF CENTER OF GRAVITY?
→ EH??
PRESENT LOCATION OF CENTER OF GRAVITY?
→ 30.21 FT ABOVE KEEL.
ADD 27.3 TONS 10.0 FT ABOVE KEEL.
→ OK.
PRESENT LOCATION OF CENTER OF GRAVITY?
→ 30.18 FT ABOVE KEEL
SIGN OFF.
→ TERMINAL TIME 5.03 MIN 05/07/69

When operating as a time-sharing system, a computer may process 20 or more programs concurrently by having many input-output terminals operating effectively simultaneously. This is possible because each terminal operates at a much slower rate than the central computer. To the individual using a terminal, it appears that he has the computer all to himself.

The terminals may be located either at the same site as the central computer or geographically "remote." If they are remote, special hardware and data transmission equipment may be required. Three different types of terminals are planned: conversational, graphic, and batch. Any one type or a combination of these terminals will be installed at NAVSEC, Naval Shipyards, and private contractors' design sections.

The conversational terminal will be similar in appearance to a teletype unit. It is called a conversational terminal because it will "respond" to the user. He will type in his program, note the computer's response, and then make changes if the wrong instruction has been entered. This program-changing capability will make it possible for the engineer to participate in solving his problem to a much greater extent than when he sends his data to a processing center and waits for the results. It will allow him to use his common sense, background information, and intuition—all qualitites that a computer lacks. Conversational terminals can be used for developing or running small programs, updating and manipulating data files, or transmitting messages.

The graphic terminal will be used to communicate by means of a picture of a ship or one of its components. Although these terminals

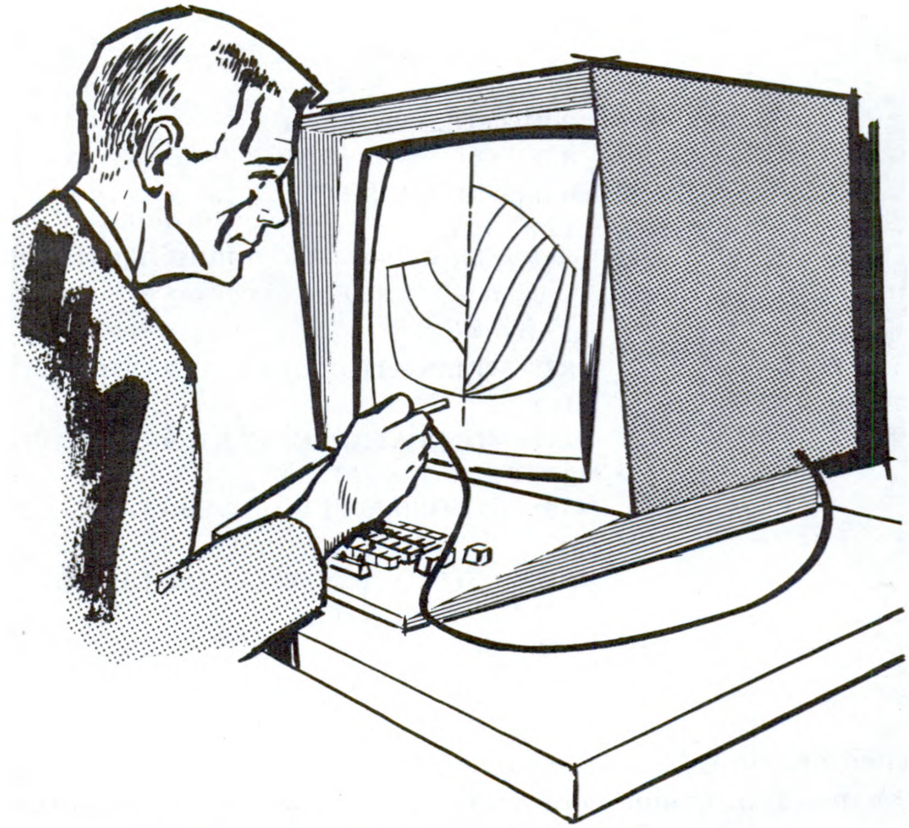


Figure 3 — An engineer using a graphical computer terminal equipped with a "light pen."

cannot be used in all situations, they can often save reams of input-output data and hours of human and machine time. Such terminals would generally use Cathode-Ray Tubes (CRT) to display graphs or drawings of an object and often would be equipped with a "light pen" used to designate items on the CRT screen (see figure 3). By using this light pen, a designer will be able, with the help of the computer, to manipulate the images on the screen. Such a system could be used in designing a hull. After a general hull outline is displayed on the screen, the light pen would be used to indicate desired changes in the hull's form. As the development of the hull form proceeds, the computer will be able to supply the designer with information on hull displacement and stability. At present a hull must be designed manually, a process which takes about two weeks, not counting the time necessary for displacement and stability calculations. Use of a graphic terminal could reduce the time required to one day.

The batch terminals will consist of a high speed card reader, card punch, and a line printer. They will be used for large programs not requiring human intervention—or programs with large amounts of input-output.

The central computer and its ancillary devices will provide the processing services for the terminals. It will provide not only the arithmetic and logical capability of the system, but also the high-speed memory, bulk memory, and the executive or "bookkeeping" routines required to assign and execute problems and store programs, data, and files. The system must be able to support a large number of terminals, it must have provision for large data and design files, and it must have facilities for time-sharing and multi-processing. Based on experience gained with an IBM 7090 and consideration of the expanding workload expected with the new system, it has been determined that the system must be at least six times faster than current large computers such as the 7090. However, since future requirements are not completely predictable, prudence would dictate that the memory, computing power, and terminal-handling capability of the new computer should be expandable up to ten times the original installation size. Also, this expansion must be possible with little or no interruption of work being done.

Future Projects and Goals

The development of larger amounts of data in a form useful to a computer, the increasing complexity of the programs, and the rapidly increasing number of programs all combine to demand some sort of coordinated control over the new field. Unfortunately, there were many instances of duplication of efforts in the early days of computer installations—not necessarily within NAVSEC, but certainly within the maritime industry as a whole. For instance, nearly every shipyard, naval R&D center, and private shipbuilding firm in the country has a program that calculates hull displacement. Such a program costs time and money to develop, and this expense has been borne many times over. What is needed is a system that will allow programs and data to be passed from one design group to another.

To understand the proposed solution to the problem outlined above, it is useful to recall the current design and production system. A ship's design and construction can be conveniently divided into three phases: concept formulation, contract definition, and detail design. During the concept formulation phase, the ship's mission has already been outlined, but the ship system best capable of accomplishing that mission has yet to be defined. A designer, using intuition and technical knowledge, creates a tentative solution and then checks it to determine its adequacy and technical feasibility. If the solution is not acceptable, he changes it and checks it again. When an acceptable solution is found, the process moves on to the contract definition phase. Here a larger number of designers are involved, and the concept is expanded in more detail. Subsystems are more carefully defined, interfaces are highlighted, and some of the engineering details are added. Then the detail design phase

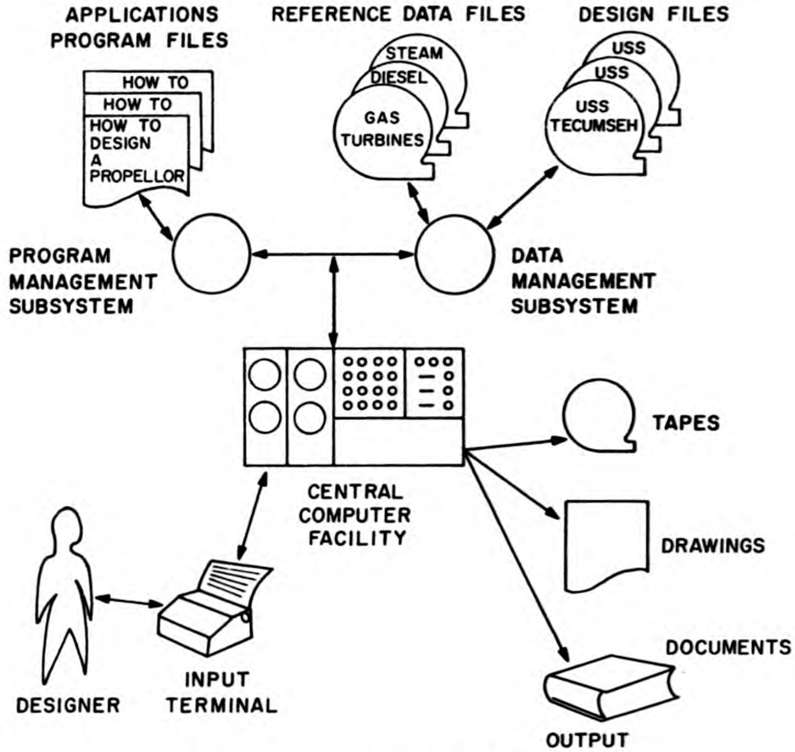
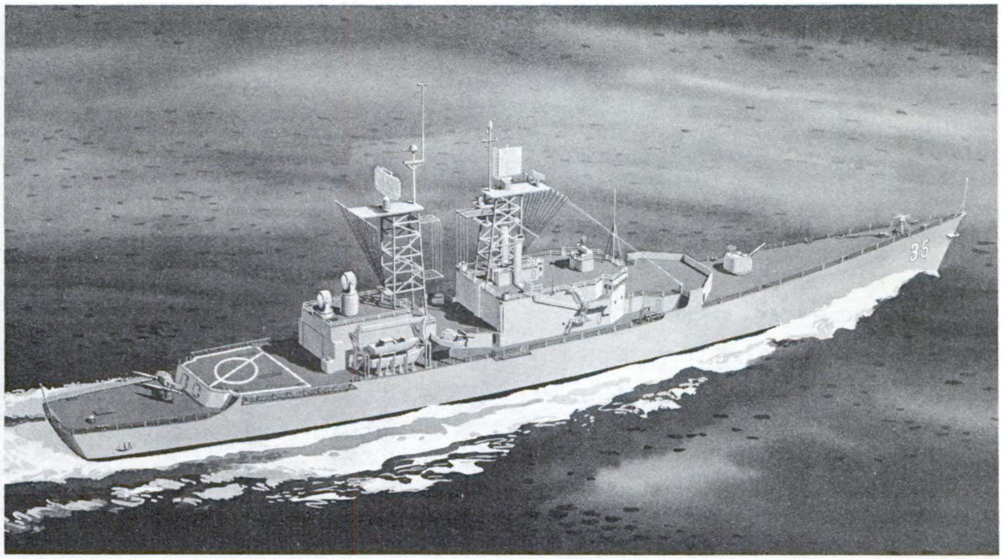


Figure 4 — Proposed CASD&C Subsystem

takes over to develop the final working drawings, parts lists, and procurement plans needed for actual building of the ship.

While the process outlined above may appear straightforward, in actual practice the order of design actions cannot be precisely determined. This is due to new equipment developments, discovery of interferences, or a change in requirements. Thus, it is necessary to provide a design system that will allow the design functions to be assembled and used in a nearly random manner. Also, some efficient arrangement must be made to ease access to the design data files, and to be certain that the data obtained is in useable form. Finally, communications between the various design groups that operate concurrently during the later design stages should be improved.

The system proposed for this job is a combination of central and terminal hardware and programs which provide various services to the designer (see figure 4). This system is versatile enough so that most of the services a designer needs are available in any order he may require. Data banks are included and, within security limitations, are accessible to all users. The central system also holds within its data banks a complete up-to-date description of the ship being designed. Thus, since this description will be available to all designers through the central system, many of the old communications problems can be automatically bypassed.



Naval Ships of the future—such as this nuclear guided missile destroyer leader—are being designed with the help of computers today.

Coordination with Other Agencies

It is expected that, as the CASD&C system is developed, it will prove beneficial to tie it in with other related computer-based systems. Six related systems which represent possible interfaces are: Ship System Formulation (TDP 46-27X), Ship Construction Cost Analysis Study, Navy Maintenance and Material Management (3M) System, Naval Shipyard Management Information System (MIS), Shipyard Modernization Program, and Military Operational Environmental Simulation and Information Collating System. All of these systems are potential sources of data for the CASD&C system. In fact, some data from the 3M system have already been used in concept formulation programs to predict the reliability of a proposed ship.

Since one of the major objectives of the CASD&C project is to help modernize and update the United States maritime industry, it has been proposed that the computer programs developed be provided to all companies involved in the US shipbuilding effort. The results should be a more productive, competitive maritime industry and a much better planned, designed, and built fleet for the United States.

A Conference on the Structure of Density Matrices and their Application to Energy and Order Effects Problems in Matter will be held at Carruther's Hall, Queen's University, Kingston, Ontario, Canada, August 27-31. Additional information on this conference, which is co-sponsored by ONR, may be obtained from Professor A. J. Coleman, Queen's University.

The 1967 International Congress on Magnetism will be held at the Sheraton-Boston Hotel, Boston, September 10-16. Additional information on this congress, which is sponsored by ONR, may be obtained from Dr. H. C. Wolfe, American Institute of Physics, 335 E. 45th St., New York, N. Y.

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Research Contributions to Computer-Aided Instruction

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The population explosion, galloping technology, the rising tide of new information, and vast new educational programs are among the many factors that are placing heavy new demands upon existing educational resources. At the same time, high training costs, teacher shortages, lengthened training time, and a host of other factors serve to reduce these resources. Consequently, the gap between requirements and resources continues to widen. Projections for the future are not optimistic.

Every segment of modern society is faced with this serious situation. Each is trying to find effective and efficient ways to promote learning. Each is seeking to extend the scope of the topics taught and to improve the percentage yield of the "raw material" processed.

The military services, as a large and important segment of our society, share these problems and the concern for their solution. As a matter of fact, few organizations have a greater stake in the successful solution of the educational requirements-resources gap. As a prime beneficiary of the output of the public schools, the military is directly concerned with improvements made at that level. Also, the military must train an enormous number of immature, inexperienced, short-term personnel to operate and maintain fantastically complicated weapons systems in order to enable them to carry out hazardous assignments throughout the world. Although the services are rightfully proud of their current training accomplishments, it is questionable whether existing techniques will be adequate for the future.

For the past several years the Office of Naval Research has focused an aggressive program on this problem. It has joined with other research organizations to identify and attack critical research issues which limit our understanding of the learning processes and how to control them. One promising approach employs the digital computer as a means for administering individualized adaptive training and education. This concept is depcited in figure 1.

The block at the top of the figure represents that portion of a computer system devoted to the single student. The solid lines in the diagram indicate how the student is connected to the computer. Information passes along the loop back and forth between the learner and the computer. This information exchange occurs in real time. While this is going on, the computer is processing the information that is

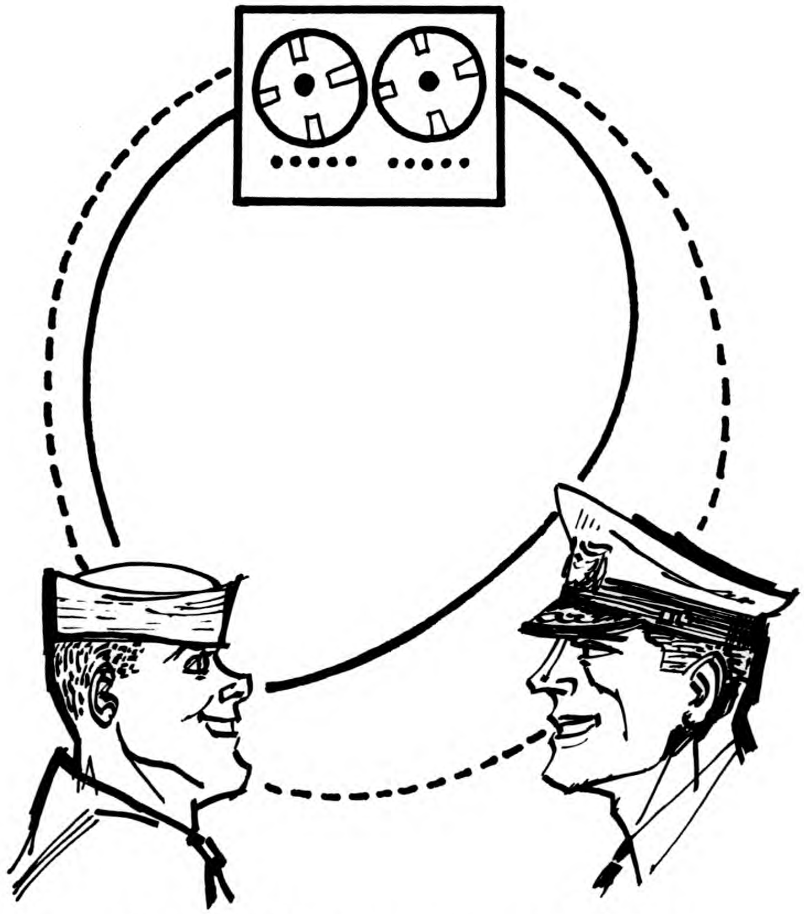

Figure 1 — Schematic representation of individualized adaptive teaching system

available to it in accordance with its internally stored program. It is especially important to note that information is not only taken from the store for the student's use, but also added to the store during the course of the dialogue. In this manner, details of the individual student's learning history can be used to determine how to deal with him even as he is being taught. This powerful feature allows the system to "change teachers" or teaching techniques during the course of instruction to accommodate differences among students, topics, and learning styles. Furthermore, because computers are, first and foremost, vast data processors, they permit extensive computations, detailed analyses, and highly sophisticated techniques for making on-line decisions. This includes the ability to assess the student's current state of knowledge. This assessment can then be compared with earlier states of that student's knowledge, the performance of other students, or the individual instructional goals. At the same time, the student is digesting the information available to him.

The dotted loop shown in the diagram includes an instructor who plans, designs and supervises the instruction. He is included to correct any false impressions that an instructor is not required in this type of instruction. However, the instructor does not have to be physically present and does not have to be involved with the details of the on-going instruction of a particular student each and every minute.

It is important to emphasize that the type of computer-assisted instruction (CAI) depicted here is quite general. Information of any kind can flow in either direction. This exchange, which is usually in short bursts, may be used for drill, practice, tutoring, testing, information retrieval, gaming, simulation, supervision, guidance, *etc.* Only the creativity and imagination of the program designer limits the nature of the interaction. The key point is that whatever is going on is for the sole purpose of upgrading the student's competence.

The ONR Program in Computer-Aided Instruction

The ONR program in computer-based individualized adaptive instruction began in the fall of 1961. At that time, a national conference sponsored by the ONR Information Systems Branch, the ONR Personnel and Training Branch, and the System Development Corporation was convened. This conference, which brought together leading researchers in education, psychology, and computer applications, marked the beginning of a closely coordinated and cooperative research program which draws upon the resources of both ONR branches. Over the years that program has grown and has served as a national focal point which has played a leading role during a period of very rapid expansion in CAI research.

Until recently, most of the effort in this area has been limited to basic research. With few exceptions, these research efforts have been carried out by civilian researchers and sponsored by the military services. Often, a given research center has received support from several sources. As progress has been made, the military services have begun to introduce programs to investigate the potential of CAI in military training and education settings.

During the mid-fifties several ONR-sponsored researchers began to explore independently several new ways to develop understanding in a student. Generally speaking, these explorations stemmed from an interest in human problem solving and other cognitive processes. Typically, the prospective learner was directed toward some goal or end state. He was then permitted to seek information about significant portions of his environment under conditions which provided him with the information that he sought. This type of information was mechanically augmented to allow him to draw conclusions about the relationships between his own actions and the changes which they produced.

The early work of O. K. Moore at Yale University was of this character. It emphasized the learning dividends that can be derived from placing a youngster in an environment in which he is free to explore under conditions which encourage him to do so. At the same time, he is provided "feedback" information which relates his actions to changes in the environment created by these actions. Extensions of this general notion have led to the development of the much publicized "talking typewriter" which has proved to be a successful adjunct to instruction in the areas of reading, spelling, and other language arts.

Following the 1961 conference on computer-based instruction, ONR decided to pursue research in the area of adaptive individualized instruction as vigorously as funds would permit. Earlier work* clearly indicated that many serious problems would have to be solved before the promise of adaptive computer-mediated instruction catering to the needs of the individual student would become a reality. Consequently, ONR's Personnel and Training Branch planned a concerted research program which would seek to contribute to further understanding and effective development of this difficult area. Current and recent computer-aided instruction research efforts monitored by the Branch are described below.

The study being conducted by Bolt, Beranek and Newman concentrates on the development of software and strategies for teaching highly trained men to seek out, organize, and interpret information in order to solve complex problems. Demonstration programs have been written for teaching such topics as electronic trouble shooting, medical diagnosis, and criminal investigation. These topics are not only directly relevant to Navy interests, but also serve as vehicles for developing effective new flexible programming techniques which can be widely employed.

The University of Illinois' Project PLATO grew out of the Tri-Service-Supported Coordinated Systems Laboratory. For the past several years, it has been funded by the Advanced Research Projects Agency (ARPA) through an ONR-monitored contract. Now in the PLATO III configuration, the system consists of 20 specially designed student terminals which can be operated independently or interconnected under program control. It provides a powerful research tool for attacking challenging problems on a multi-disciplinary basis.

Many topics have been programmed experimentally for the various versions of PLATO. PLATO IV, to be introduced in late 1969, will be

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*Coulson, J. E., and Silberman, H. F., *Results of Initial Experiment in Automated Teaching,* System Development Corporation, Santa Monica, California, July 1959.

Licklider, J. C. R., "Preliminary Experiments in Computer-aided Teaching," *Programmed Learning and Computer-based Instruction* (Edited by John E. Coulson), New York:John Wiley & Sons, 1962, p. 217-239.

Rath, G. J., Anderson, N. S., and Brainerd, R. C., "The IBM Research Center Teaching Machine Project," *Automatic Teaching: The State of the Art* (Edited by E. H. Galanter), New York:John Wiley & Sons, 1959. Chapter 11, p. 117-30.

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designed around a revolutionary plasma gas discharge tube developed in conjunction with PLATO by CSL personnel. It is anticipated that this tube will provide a high-quality, relatively inexpensive replacement for one of the most costly components in the current student terminals. It will also significantly reduce the demands which the visual display places upon the central processor.

For several years, SOCRATES, another CAI project, was carried on at the University of Illinois. One of the earlier CAI systems, it was employed to test the effectiveness of various teaching strategies. One particularly interesting study examined the desirability of tailoring the type of motivating remarks directed at the student by the computer in accordance with measured aspects of the student's own personality. Current CAI efforts at Illinois have been consolidated in Project PLATO. The former director of SOCRATES has undertaken a new ONR contract at Harvard University. This study will examine various computer-based instructional strategies *in vivo* in connection with the university's medical, paramedical, and health sciences education and training.

The Training Research and Development Laboratory at the University of Pittsburgh conducts a broad, integrated research program. ONR, with ARPA assistance, contributes to the CAI phase of their program. Their principal CAI concern is with the design and evaluation of procedures and devices for bringing the learner into effective contact with the subject matter he is trying to learn with minimum emphasis on his reading and typing skills. Experimental input-output equipments are being developed and tested along with new computer languages in order to improve communication between the computer and the authors of new instructional material. Touch-sensitive displays for inputing information and random-access audio output devices are among the new equipment that is being used. The use of pre-recorded audio outputs permits the presentation of voice messages or other sounds and allows one to talk to the non-reader. It is expected that such equipment and techniques for its use will prove valuable in teaching radio code, sonar target classification, and foreign languages. Special emphasis is placed upon those aspects of computer language which make it easy to deal with the human learning processes in the terms of the psychologist concerned about the learning.

Stanford University is another principal R&D center in the CAI area. In this connection, it is best known for its work in teaching reading and mathematics to elementary school children. Although ONR does not provide support for that research, it does provide support for some of the general theoretical investigations of individual staff members. The findings of these investigations apply to CAI; however, they also have broader implications. Of more direct relevance is a contract which has just been concluded within the Stanford School of Engineering. This work, funded by ONR's Information Systems Branch, sought to develop and apply sophisticated operations research models to the problem of optimizing the sequence of instructional topics on an individual basis.

The University of Southern California has been exploring ways to use computer-based instruction to familiarize Navy technicians with a specific new (to them) item of electronic equipment, and to teach them how to tune it up and diagnose certain malfunctions if they are present. Their efforts have been sufficiently successful to encourage their expansion and extension.

Limitations to CAI Development

A great deal more has to be learned about the learning processes and how to control them before CAI can realize its promise fully. Even when this new information is available, there are three major problems that can be expected to limit the rate at which effective CAI can develop. The first limitation is the dearth of technical communication. By its very nature, CAI is multidisciplinary. It can only grow effectively through the joint enterprise of educators, learning theorists, computer experts, and a variety of other specialists. To open up the necessary channels of communication, Entelek, Inc., in conjunction with ONR, has arranged a series of meetings and working groups. It also collects and disseminates research abstracts, descriptions of computer programs, and similar material intended to promote CAI research and development by means of the timely exchange of technical information.

A second potential handicap to the expeditious development of CAI is the difficulty of preparing adequate instructional material for presentation to the student. Information International is currently completing a contract aimed at determining how to explain things clearly and how to enlist the digital computer to assist in producing good explanations. To some extent, every teacher and writer is concerned with some aspect of this problem.

Third, in order for CAI to be successful, a broad base of technological support is required. The General Learning Corporation is currently completing a study aimed at stipulating the kinds of support necessary to integrate research, development, and employment of CAI in the Navy. It seems quite clear that independent, uncoordinated, unsupported, competitive efforts cannot realize long-range Navy goals. The GLC study seeks to spell out just what has to be done in order to develop new and superior ways to interconnect computers, translate programs, assist authors, develop trained supporting personnel, and provide information services to those wishing to exploit the potential of CAI in the Navy.

At the present time, there are numerous CAI-related activities taking place within the Navy. Such activities may be identified at the Naval Training Center at San Diego, the Naval Schools Command at Mare Island, the Naval Ordnance Test Station at China Lake, the Naval Weapons Laboratory at Dahlgren, the Training Device Center at Orlando, the Naval Air Training Technical Command at Memphis, the War College at Newport, the Postgraduate School at Monterey, the Naval Academy at Annapolis, *etc.* In addition, the Bureau of Medicine and Surgery is in the process of developing CAI programs in malariology and ward management under contract with Penn State and HRB-Singer respectively.

With one exception, all of these efforts are outgrowths of the ONR research program in computer-aided instruction. That program is being carried forward to provide needed leadership and guidance in the pursuit of new knowledge and new ways for controlling the learning processes of students through CAI techniques. It continues to serve as the keystone in a Navywide adventure aimed at harnessing modern technology in the service of education and training, and thus reduce the gap between personnel requirements and resources.

CDR Maragos Appointed NRL's Director of Support Services

CAPT James C. Matheson, Director of the Naval Research Laboratory, has announced the appointment of CDR George Maragos as Director of Support Services at the Laboratory.

In his new position, CDR Maragos will administer seven divisions which provide support for scientists, engineers and technicians engaged in research. They include security and administrative services, personnel, supply, technical information, engineering services, public works, and the facilities at Chesapeake Bay.

CDR Maragos, 43, has been Engineering Services Officer at the Naval Research Laboratory since July 1966. He is a 1946 graduate of the United States Naval Academy where he later served as an instructor of Electronics and Electricity and Military Chairman of the Science Department's Electronics Committee.

A native of St. Louis, Mo., the new Director of Support Services has had sea duty aboard the cruisers PORTSMOUTH and HOUSTON and the aircraft carrier SAIPAN. Prior to reporting to NRL, he had been liaison officer at the Surface Missile Systems Project Office at the Ship Systems Command Headquarters. He had also been assigned to the Portsmouth, N.H. Naval Shipyard, the Florida Group of the Atlantic Reserve Fleet, and the then Bureau of Ships.

A System for Management/ Logistic Control

Fred J. Bellar, Jr.
Marvin Denicoff
Robert Lundegard
Logistics and Mathematical Statistics Branch
Office of Naval Research

One of the primary responsibilities of the Office of Naval Research is to be aware of current and emerging technology and to stimulate and expedite the infusion of this technology within the Naval Establishment. This article discusses one possibility of utilizing recent advances in data processing technology to develop an improved system for management control. The primary focus of this discussion will be in the area of logistics. However, it should be understood that the ultimate system could encompass other areas of command responsibility, logistics being only one such area.

Present Deficiencies

Recent years have witnessed much improvement in logistic control procedures. Certain deficiencies continue, however, to plague the military planner. The lack of an integrated logistics data base has resulted in fractionation of files. This, in turn, has inhibited standardization of data elements and measurement units and has prevented the achievement of the logical interfaces within and across the major logistic function areas. Logistic data file management is generally far removed both geographically and organizationally from the sources of the data being managed. Thus, the data are often contaminated due to excessive human processing and filtering. An additional deficiency is related to the lack of a method for rapidly retrieving data. This has prevented logistic managers from assessing the current state of logistic readiness. Finally, since there is no flexibility in directing and modifying the form or content of responses, minimal interaction has occurred between the logistic manager and the data base.

Provisional Description

In this section a general provisional description is presented of the kind of control system which now appears within the state of the art or very close by on the horizon.

Hardware Complex. In gross hardware terms, the system might take its form from the now emerging multi-access, time-shared, on-line computer concept. "Multi-access" means a system which contains more than a single input/output console; "time-shared" means the sharing of central processors so that at one instant of time a particular console has control; and, finally, "on-line" means the ability of each console (user) to have almost instantaneous access to a central processor. Thus the system might be structured as illustrated in figure 1. The system would be supported by a battery of central processors connected to memory cells by means of a memory controller, and to a collection of individual consoles, data storage units, automatic input/output devices, and remote processing units by a monitor controller. The total system would encompass the entire naval command structure. Each decision maker would have his own access console which would be connected by communication links to the central system. Each decision maker would have complete authority for the structure, integrity and maintenance of his own particular working data file. In this way, he might think of the system as his own exclusive property.

In existing systems of this general type, each remote access user communicates with "his" computer by means of service routines provided by the central system or alters these programs to suit his own purposes. Each user of the naval system under discussion would have a similar ability; but, in addition, certain of these raw data files would be integrated to form a comprehensive naval data file. Thus, the remote user would have the ability not only to process his own locally generated data, but also to use an integrated data file to improve his decision-making processes.

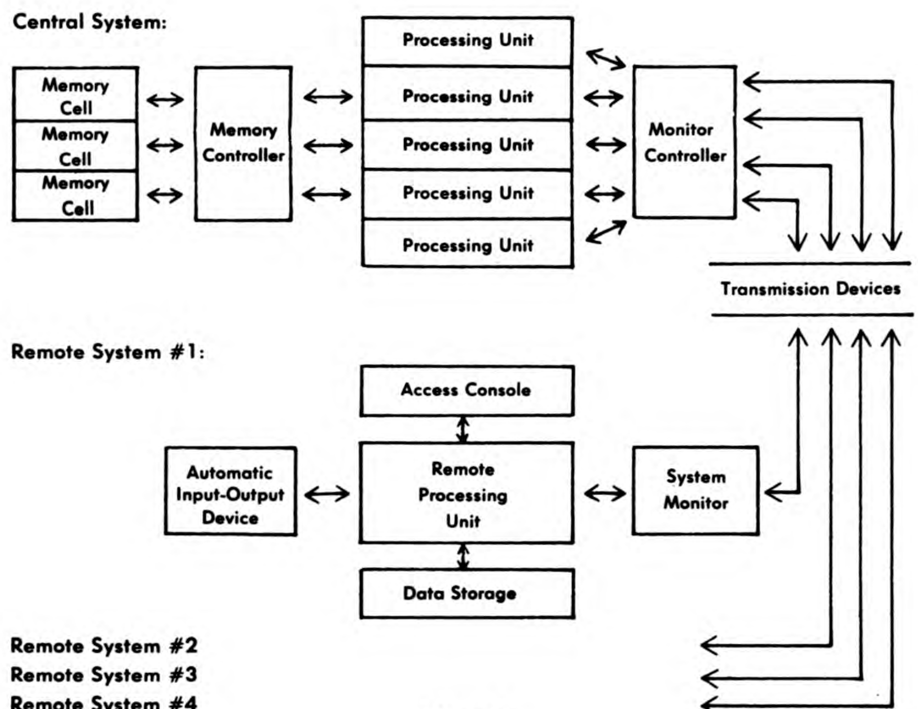

Figure 1

Even now, the literature is abundant with information and descriptions of existing systems of this type. However, these systems are significantly smaller than that which would be required for logistic applications. Systems now exist with more than 50 consoles tied to a central computer. In these systems, when access is obtained, a computer with a memory of approximately 50K words of 50 bit length is available. During each access period, individual programs of about 250K steps may be executed and, if additional steps are involved, additional computer cycles may be employed to complete the program. Communications between the computer and each of its multi-consoles may be made by five or eight-level teletype, TWX or data phone circuits.

Software Complex. It is envisioned that the hardware would be supported by a software package designed to overcome the deficiencies described above. In particular, the software package would provide an ability to retrieve large quantities of stored data. The basic requirement should be flexible and rapid interaction with the data base. Thus, the software package would provide service routines enabling each manager to communicate with his data file. These service routines would be sufficiently flexible so that alterations could be made to suit individual purposes.

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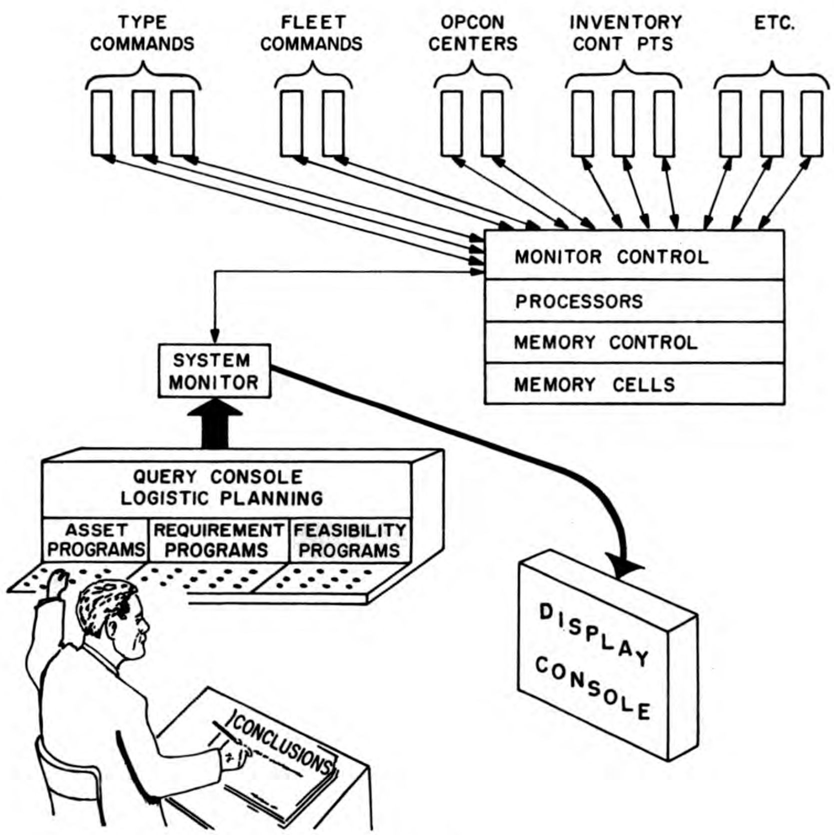


Figure 2

RADM Thomas B. Owen, Chief of Naval Research

CHANGE

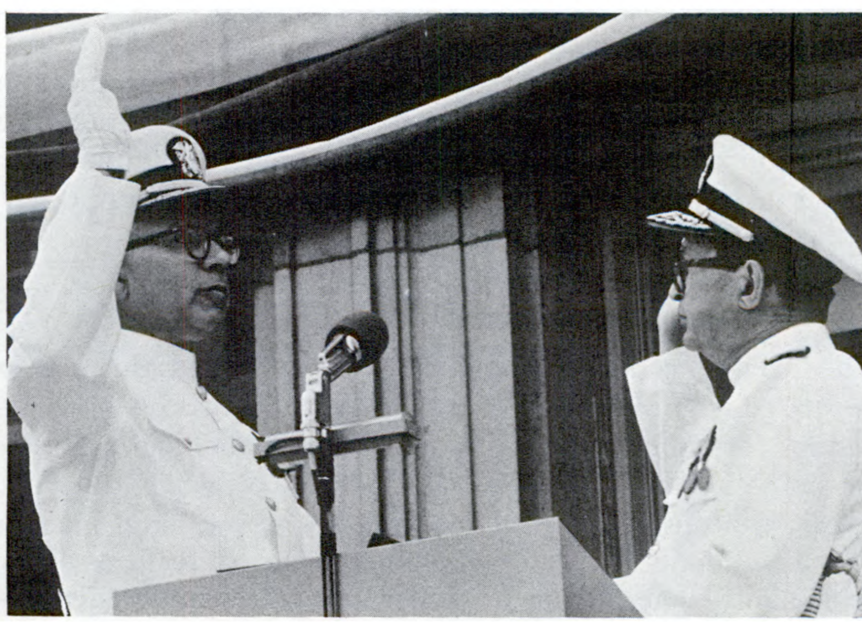
Mr. and Mrs. W. W. Owe

The families of RADM Leydon and RADM Owen at the ceremony

OF COMMAND

n, relatives of RADM Owen, during benediction

Outgoing Chief, RADM John K. Leydon, and Asst. SecNav Robert A. Frosch, Jr.



RADM Owen being sworn in by RADM W. A. Hearn, JAG

With respect to functional programs, routines would be available for many diverse purposes. The general responsibilities of a logistics staff consist of planning, monitoring, responding to problems, and recommending policy changes. To support these four categories of effort, functional programs of three general kinds are desirable (see figure 2). First, "asset" programs are required so that general subsets of input asset or configuration data can be retrieved in a wide variety of forms, *e.g.,* by commodity area (ammunition, POL, facilities), function (air search, propulsion), *etc.* Next, "requirement" programs are required to develop the logistic capabilities needed to support given operational capabilities along these same functional or commodity lines. Finally, "feasibility" programs are necessary so that the full effect of various logistic policies can be ascertained with respect to single or multiple functional or commodity areas.

The greatest impetus to the development of useful functional programs will be observed when the initial system is actually in being. These developments will occur as the result of the users' abilities to extend the system's capability through their own personal creativity. The initial software should provide a flexibility which allows, or even encourages, significant evolution in functional programs.

Data Content. At the present time, the data content of the system can be described only in generic terms. It is obvious that this content will establish constraints on system use. However, the data content of an initial or prototype system for logistic control need not be as extensive as that which will be required when the scope of the system is broadened to include other areas of command responsibility. Also, since each command user would determine his own data file content, it is only the integrated central file which is described here. It is assumed that the integrated file would include a codified material and military configuration of every ship and aircraft, historical ship and aircraft utilization and performance/readiness data, selected equipment performance data, information related to maintenance and material support, technical data on material and personnel, and information on projected forces and their planned utilization.

System Potential

The data processing capabilities provided by multi-access, on-line, time-shared computation systems appear to furnish a tremendous potential for improved decision-making methodologies and logistics operations economies. The unique potential which this emerging scientific concept seems to make available to the naval management/logistic community is composed of four principal features and various combinations thereof. In the following paragraphs, each of these features is discussed in some detail and various naval applications are suggested. In considering these applications, one should observe that no application is absolutely pure. Thus, what is listed under integration may also require a rapid retrieval capability to be useful.

Integration Potential. A standardized quality assured integrated file structure which embraces all Navy logistic functional interests offers the possibility of achieving a timely integration and compatibility over the many dependent decision processes within each of the major logistic areas. Of perhaps even more significance, it may be possible to facilitate both the understanding and accomplishment of the logical interfaces across major logistic areas. For example, methodologies for contingency planning would be greatly enhanced. The multi-access concept would enable direct interrogation of a comprehensive, standardized information file to determine total or specialized logistic requirements in support of specified operational capabilities. The operational capabilities in question might be considered singly, or a number of such capabilities might be aggregated in order to determine the logistic consequences of the overall plan. With respect to a particular contingency plan, such planning might include determining support ships by type, or determining the transportation needs for initial and continuing support relative to air *versus* sea-lift requirements, as well as the optimal routing and scheduling of such shipments.

Data Management Potential. Integral to the multi-access concept is the assignment of responsibility for the integrity and maintenance of files or subparts of files to a single organization most concerned with the ultimate utility of the data being generated. That organization would be directly linked to the central computer through its console and selected because of its close administrative proximity to the data's basic source. Thus, it would be ideally suited for: (a) effecting the first level control and audit over the data base, (b) minimizing human contamination of first level audited information by using its console to implant data directly into its file and the central files, (c) avoiding contamination of its file through automated techniques which prevent other activities from erasing or changing the file information. Also, the central monitor would be available to assist with these auditing responsibilities. The assistance provided by the central processor is tied to the availability of a comprehensive data base, and to the high speed capability for utilizing one file to check on the validity of another and for employing a battery of automated data processing and statistical techniques to screen and correct errors ranging from single field transposition errors to gross cases of under or over-reporting.

Retrieval Potential. Stored data has no intrinsic value; its worth arises from its ultimate use in some decision-making process. The on-line feature of the emerging hardware concept thus becomes particularly exciting.

The ability to retrieve large quantities of stored data offers almost unlimited possibilities to the logistics manager. One such possibility is the routine screening of configuration files to determine population trends with respect to end items either aggregated in total or with respect to particular commands or geographical areas. These findings, when published routinely or in direct response to interrogation, would be essential to decisions on material retention, disposal, and distribution.

The ability to retrieve information rapidly would allow the manager to direct and achieve both the timing and form of his responses. Not only would he have the option of prescribing routine reports forwarded on some time-oriented schedule, but he also would have the ability to utilize his console to achieve exception-type response reporting through selective interrogation of his file and the central processor integrated file. As for time-oriented reporting, the concept of the central processor as an accessible and obedient tool of management would provide a flexibility that does not presently exist. The on-line capability of a multi-access system would give the manager the capability of effecting dynamic changes in the form and timing of the feedback. Event-oriented responses could be increased or decreased through changes in control limits; calendar responses could be speeded up, slowed down, or stopped altogether by similar changes in control.

Interaction Potential. The potential for interaction is closely related to each of the topics discussed above. It is obvious that only limited interaction is possible without a rapid retrieval capability. Also, the benefits of any interaction would be severely restricted without an integrated file of valid data. Thus, it is the combination of a centrally available, readily accessible, comprehensive data base coupled with the multi-access capacity for high-speed data processing and rapid interrogation that provides a never before achievable capability for managerial interaction and experimentation. This interaction and experimentation is possible in many diverse areas. As an example, managers could work over functional requirement areas, *e.g.,* POL or ammunition, and determine through simulation techniques the consequences of various logistic decisions. These analyses could be performed over single functional areas or aggregated over appropriate related areas. Such analysis would be particularly advantageous to the logistic planner and would be very beneficial in determining feasible responses to current problems.

Thus far only those types of interaction that suggest themselves independent of the data itself have been considered. It is obvious that certain types of analysis or forms of query will only make themselves known to an analyst who has been able to interact intimately with the file. For insights of this type, the manager and his computer can truly be characterized as a team working together toward a common goal. It seems conceivable that the most important and significant advances will be produced by this type of relationship.

Program Management

Even though the intuitive advantages of the emerging technology are quite evident, they must be rigorously established and formalized before final approval is given for system development or implementation. Even if the advantages are accepted, difficult questions still remain relating to how the concept is to be implemented or if it is even feasible to implement such a broad concept in a single increment. Most data processing systems have experienced evolutionary growth, but this need not always be the case. Based on past ADP experiences and the new technology, perhaps now is the time to take a large step forward. However, the following questions arise: What specifications should be related to this step forward? What are the user operational requirements and how should these be associated with system design goals and conceptual characteristics? From a cost-effectiveness point of view, is the system really worth the effort? Are there serious interface problems or management organizational problems that need to be resolved? While in-depth answers to these difficult questions cannot be provided in this article, it is hoped that some insight into certain management problems has been provided.

The three principle component features in the basic structure of the overall system are: (a) a hardware component consisting of computers and transmission devices, (b) a system software component which can be thought of as executive routines or controls that tie the various pieces together and allow them to operate for some useful purpose, and (c) a functional software component that allows the system to provide for the operational requirements of its potential users. Because of the interrelationship between these components, it is difficult to conceive of hardware developments separate from the associated software programs. To a large extent, the hardware program will determine the type of software produced. At the same time, the widely diversified software requirements of the users will specify the type of hardware and systems software to be employed. Hence, while it may be possible for the hardware and software phases of development to proceed independently, it would appear much more appropriate for these phases to occur in conjunction with each other. This is only possible, however, if one organization is given responsibility for an entire program.

Although choosing a single group would have many advantages with regard to properly coordinating the development of all three component features, certain problems would immediately arise if such a course of action were pursued. These problems primarily have to do with the visibility required of the group. Not only must it have the technical proficiency of data processing scientists and engineers, but it must also possess a clear and continuing understanding of the functional requirements of all levels of naval management and command. Also, throughout the entire development, there must be a continuing interactive dialogue between the developmental group and selected areas of the technical research and military user environment. To plan and organize such an effort will obviously be a monumental task in itself. This degree of visibility must, however, be established and maintained if the system is to meet its full potential in military relevancy and utility.

Dr. Robert Hein Receives Hulburt Award

Dr. Robert A. Hein, a Naval Research Laboratory physicist whose contributions in the field of superconductivity and investigations in the temperature range within 0.1° of absolute zero (−273.15°C or −459.67°F) have earned him international recognition, received the 12th annual E. O. Hulburt Science Award on July 6. The award, named for NRL's first Director of Research, was presented to Dr. Hein by CAPT James C. Matheson, Director of the Laboratory.

Dr. Hein's contributions include discovery of superconductivity in tungsten and iridium as well as measurement of the critical magnetic field in the latter down to 0.04° Kelvin. He was also the first to discover superconductivity in a semiconductor.

Dr. Hein has been a member of the NRL Staff since 1950.

Lloyd Berkner, Leader in Science, Dies

Lloyd V. Berkner, 62, a leader in shaping U.S. science policy over the past two decades, died on June 4, in Washington, D.C. He was stricken with a heart attack while attending a meeting of the Council of the National Academy of Sciences.

Mr. Berkner served as adviser or organizer for a number of U.S. scientific programs, and was active in promoting U.S. participation in international endeavors. In 1950 he suggested the International Geophysical Year and became the principal administrator of the U.S. part of the program during its operation in 1957 and 1958. He was asked by Secretary of State Dean Acheson to set up the first military assistance program under NATO in 1949, and was largely responsible in 1950 for the assignment of scientific attachés to American embassies abroad.

Berkner's chief fields of scientific work were radio wave propagation, the structure of the upper atmosphere, and solar disturbances.

The Navy's Remote Computing Program

Robert F. Graham
Chairman, Remote Computing Study Group
Naval Material Command

Remote computing in the Navy is closing the gap that exists between the slide rule and the extremely complex task of preparing and programming a computer run, delivering it to the computer room, and then waiting from hours to days for the solution. The remote computing concept is almost like having a computer of your own—as far away as your finger tips and continuously "at your service." Yet that computer can be only a few feet away or at a distance of hundreds of miles.

In 1964, the Chief of Naval Material, in an attempt to set up a rapid-reply system that would solve the Navy's day-to-day developmental and logistical problems, established a study group to consider connecting remote conversational and batch-type terminals to computers. In this manner, the computers would become available simultaneously to many users to solve many different problems. Further, it was envisioned that the remote-computing/time-sharing methodology would be the accepted way of processing on the forthcoming larger third-generation computer systems.

A few examples of the Navy's current advancement and use of the remote computing ADP technique are described below.

Naval Weapons Laboratory, Dahlgren

Since the Naval Weapons Laboratory has the mission task and Navy responsibility to "conduct theoretical and experimental studies of computing machines and machine components, ... as well as .... evaluations and design of data processing systems," it is vitally concerned in this area. Consequently, NWL initiated a research approach in remote computing which has enabled it to evaluate direct-access computing concepts experimentally by utilizing both existing systems and a NWL pilot system. Although preliminary work with existing systems has proved useful, most of NWL's efforts are being concentrated on its pilot system. This system utilizes one of the newly advanced, medium scale modular "third-generation" computers. This computer, installed in 1965, has user terminals that include cathode ray tube (CRT) displays, "light" pens, alphanumeric keyboards, and function keyboards.

This facility uses general purpose languages such as FORTRAN, console communication languages, display-oriented languages such as those for analog simulation, and symbol manipulation. The system is run by an elementary monitor and time-shares the terminals with a background program. There are two principal user languages. The first, called Analyst Assistance Program (AAP), a partial subset of FORTRAN, is intended mainly as a computational aid for exploratory analysis. The other is an analog simulation language. AAP permits the user to compose, modify or use parts of a program via the light pen. The values of the variables and the available function and codes are visually presented on the CRT display.

Also, NWL is currently developing a collection of graphic programs to be used either separately in or incorporated into a display-oriented conversational FORTRAN system. Work on symbol manipulation (a procedure for using formal mathematics in solving differential equations or the algebra of series) is being continued as a separate phase. The specifications for its implementation have not yet been fully determined.

The overall project objective is to improve the computer's usefulness as a tool for mathematicians, scientists, and engineers by providing them with direct access to a medium size, time-shared computer system. In this manner, the response time is greatly improved and the users make on-line decisions that otherwise would have to be pre-programmed. The results of NWL's pilot study of terminals, languages, graphic displays, *etc.,* are expected to be an invaluable aid in the development of very large time-sharing systems to be installed at other Navy activities during 1968.

U.S. Naval Academy, Annapolis

From a modest beginning where midshipmen used remote terminal equipment tied into a computer center to solve engineering calculations, the U.S. Naval Academy has embarked on an extensive computer-aided educational program. An educational computer has been installed which will be programmed for a variety of language, social science, engineering, and mathematical courses for midshipmen. Augmenting the central computer will be remote terminals, CRT's, television, films, slides and recordings needed to present courses of current and particular interest to the academy.

Office of Naval Research

The Navy Automated Research and Development Information System (NARDIS) is under the direction of the Office of Naval Research. Its basic objective is to establish and maintain a common data bank of scientific, technical, and administrative information on all Navy-sponsored research and development. This data bank is used as a major source of RDT&E information by the higher military, management, scientific and technical echelons of the Navy.

Future developments for NARDIS will be oriented toward a real-time system with remote control features. It is anticipated that plans for these developments will not only incorporate and emphasize direct access devices such as disc files, drums, *etc.*, but will also include remote control features to permit some users to communicate with and query the NARDIS data bank from their locations.

NOTS China Lake and NRDL San Francisco

The Navy's first in-house large remote-computing, time-sharing effort began in March 1967 using the UNIVAC 1108-II system at the Naval Ordnance Test Station, China Lake, California. The implementation plan is based on the following four-phased effort:

- Remote time-sharing and batch processing,
- Conversational, on-line programming,
- Upgrading of communication circuit to broadband capability, and
- Installing cryptographic devices and a communication processor at the Naval Radiological Defense Laboratory to service all peripheral devices and CRT remotes at that activity.

This large-scale data processing system, which was installed to support the varied and complex research and development work at NOTS, will also be used on an experimental basis to provide primary computational support to NRDL. Data will be transmitted over communications circuits between the two laboratories—some 425 miles apart—thus providing quick response from the computer at China Lake to the scientist in San Francisco.

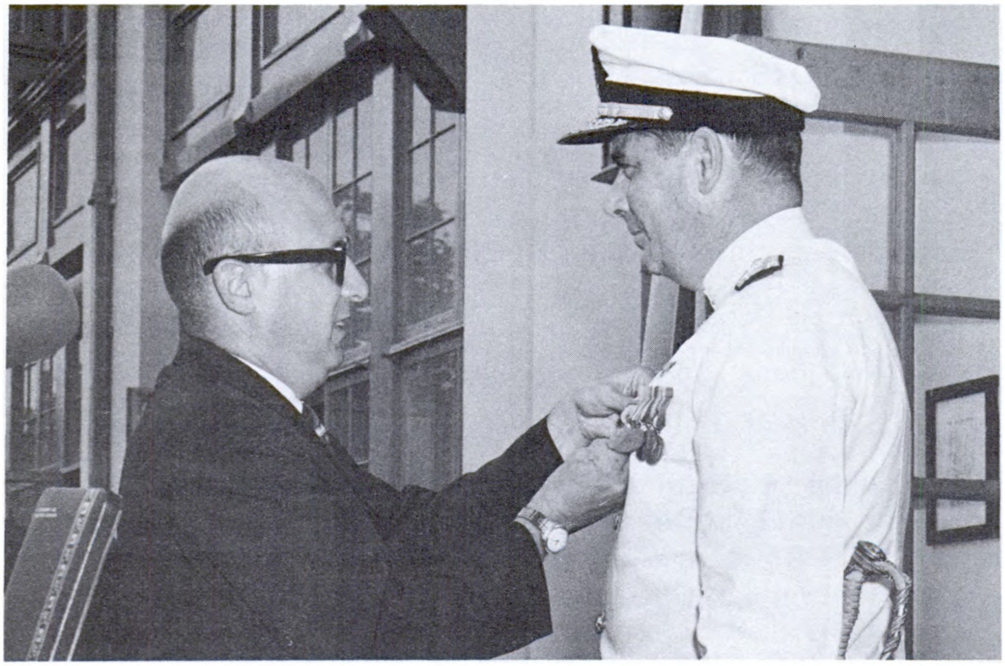
By mid-October 1967, both the batch processing and the simultaneous conversational type capability are expected to be fully operational. At that time the basic UNIVAC 1108-II will be servicing four high-speed batch terminals, about 25 conversational typewriter terminals distributed throughout both laboratories, and several other remote devices which provide CRT hard-copy capability.

By 1970-1971 additional remote-computing/time-sharing centers supporting the research, development, test and evaluation, business, and logistics requirements of the Naval Material Command will be operational throughout the United States.

Remote computing, when combined with communications advancements such as broad-band line facilities, high transmission speeds, and satellite relays, will further provide greater sophisticated data processing capability to a multiplicity of users.

It is the Navy's intent that every technological development in the computer/communications environment will be employed to the fullest potential in support of global naval operations.

RADM J. K. Leydon Receives Legion of Merit



RADM John K. Leydon, who completed a three-year tour of duty as Chief of Naval Research and retired from active service on June 30, was presented with the Legion of Merit for "exceptionally meritorious conduct" while serving as Chief of Naval Research. The award was presented by Dr. Robert A. Frosch, Assistant Secretary of the Navy for Research and Development, during a change of command ceremony held at the Naval Research Laboratory.

The citation, which was signed by the Secretary of the Navy for the President, reads as follows:

> "For exceptionally meritorious conduct in the performance of outstanding services during the period June 1964 to June 1967 as Chief of Naval Research. During this period of intensive naval research and dynamic evolution of coordinated Navy effort in oceanography, Rear Admiral Leydon has made major contributions to the scientific and engineering achievements of the Office of Naval Research. Exercising outstanding skill and resourcefulness, he has enhanced the scientific posture of the Navy, insured the maximum technological advancement, and has been responsible for unprecedented enthusiasm and morale among personnel in the offices and laboratories under his cognizance. In addition, he has insured the most effective utilization of limited resources of men and money. By his effective leadership and personal professional achievements, Rear Admiral Leydon has reflected great credit upon himself, the Office of Naval Research, and the Naval Service."

RADM Leydon has accepted a position with the investment firm of Paine, Weber, Jackson, and Curtis in New York City, New York.

Research Notes

World's Lowest Recorded Temperature Obtained by NRL

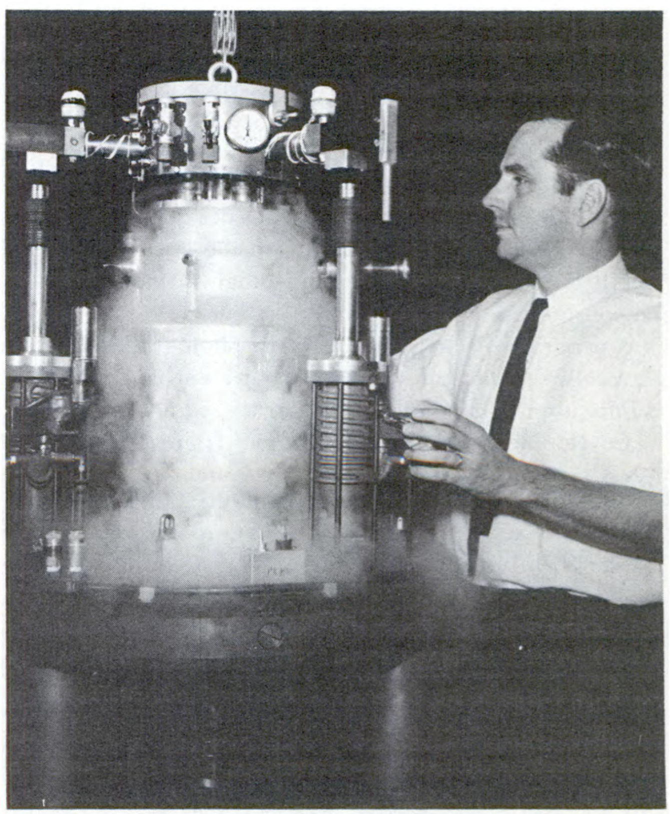
Naval Research Laboratory scientists recently achieved the world's lowest recorded temperature. Dr. Arthur Spohr, with the assistance of Mr. Edwin Althouse, cooled a bundle of five copper wires to a temperature of less than one-millionth of a degree Kelvin above the absolute zero. The previous low had been about 1.3 millionths of a degree. Dr. Spohr and Mr. Althouse are in the Cryogenics Branch, Solid State Division.

Experiments which produced the low temperature record were preliminary steps in development of an apparatus to study interaction forces between nuclei, the most delicate known forces, to examine the effects of oriented nuclei, and to extend other measurements into a new and unexplored temperature range. Over 50 years ago, a similar exploration into the range of temperatures near 10°K (Kelvin) led to the discovery of a totally unexpected phenomena called superconductivity.

The Kelvin scale used by researchers in the low temperature science known as cryogenics has degrees of the same size as the centigrade scale, but the number of degrees Kelvin is measured upward from the absolute zero rather than from the freezing point of water. Absolute zero on the Kelvin scale is equivalent to −273.15°C or −459.67°F, appreciably below the lowest recorded outdoor temperature of −126.9°F and even below the temperature of about −454°F usually associated with outer space.

Although the difference between the temperature obtained at NRL and the previous known low is comparatively small, it has great significance since in this range most physical

Dr. Arthur Spohr adjusts the apparatus in which he achieved the world's lowest recorded temperature. The NRL scientist cooled a bundle of fine copper wires to less than one-millionth of a degree above absolute zero.



properties of a material, including the degree of orientation of its atomic nuclei, vary markedly with even a slight change of temperature.

At room temperature, nuclei of most materials behave like tiny magnetic needles in constant motion, pointing first in one direction, then in another. As the temperature is lowered, the nuclear magnets become more oriented in relation to each other and at absolute zero the nuclei would have the highest state of order possible for the material.

For their experiments, Dr. Spohr and Mr. Althouse employed a magnetic cooling technique called nuclear cooling which was first demonstrated in 1956 at Oxford University by Dr. N. Kurti and Dr. Spohr. The apparatus consists essentially of two parts or stages—electronic and nuclear. The electronic stage consists of a paramagnetic salt cooled from 1°K, the temperature of the surrounding liquid helium bath, to about .002°K by a separate magnetic cooling process. The nuclear stage or specimen in which the final low temperature will be obtained is connected to the electronic stage by heat-conducting copper wires.

A huge magnetic field applied to the nuclear stage generates heat which flows up the copper wires to the electronic stage which, at this step in the procedure, is cooler. The link between stages is then broken, and the magnetic field at the specimen reduced to zero. Cooling which takes place in the last step results from a phenomenon called the magnetocaloric effect. Final temperature depends upon the initial starting temperature, intensity of the initial magnetic field, and strength of the internuclear forces.

Dr. Spohr credits the low temperature record established at NRL to two factors. First, the salt used in the electronic stage created a lower initial temperature than had been obtained elsewhere using other materials. Second, the specially designed electromagnet used in NRL experiments was able to produce a field at least three times more intense than had been obtained with other two-stage magnets. The Laboratory is one of the few research facilities capable of producing the power needed to run magnets of this strength.

NEL Deep Sea Oceanographic System

Advancement of sea floor exploration has been furthered by a technique devised and developed at U.S. Navy Electronics Laboratory, San Diego. The technique is titled NEL Deep Sea Oceanographic System.

Basically, the system is a grouping of instruments, including a pair of cameras, two small corers, and a sediment sampler within a hoop frame which is used for stereo-photographic study of the sea floor. The system was designed by NEL's Carl Shipek to examine the small microrelief topographic features on the sea floor normally too small to be detected by depth fathometers and scanning sonar. Scientific data is collected and observed simultaneously from the wire-lowered system.

A program of analyzing deep sea photographs has been in effect at NEL since 1947. Carefully selected camera stations have enabled a number of photographs to be taken of different environments in widely scattered areas.

Development work on the system's frame and sonar control system began at NEL in 1959. In December of that year, this frame was put to its first test on "Monsoon," a Scripps Institution of Oceanography cruise to the Indian Ocean. A total of 34 lowerings from the research vessel ARGO proved the operational value of the hoop frame.

The NEL Deep Sea Oceanographic System has the following capabilities:

- All components have been pressure tested to 20,000 psi—the system can be lowered to maximum ocean depth.

- Stereo photography is possible with semiwide-angle lenses to give normal view in water with 50 percent to 80 percent overlap depending upon target height. Target illumination is provided by electronic flash capable of producing 100-watt seconds of input power to a xenon-filled type flash tube pulsing every 15 seconds.

- Electronic programming turns the flash and camera circuits on and off as desired.

- The sonar control of the system is normally a repackaged Edgerton pinger.
- Sediment and water sampling is possible when the system first touches the sea floor. Water currents also are measured at this time.
- Recording of tilt, direction and target centers is routine.

The total system weighs less than 600 pounds in water; is constructed of polished stainless steel; is easily handled on deck; and the durable packaging assures dependable extended use at sea.

Satellite Radar Antenna

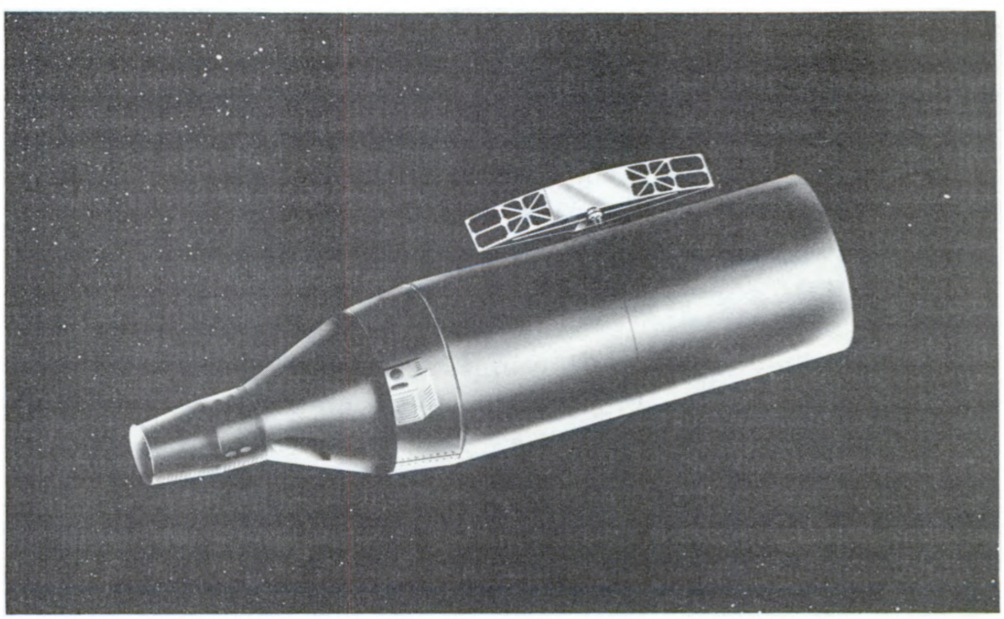
Naval Research Laboratory engineers have built a lightweight radar antenna designed for stowage aboard satellites and deployment at the required time during orbit. It demonstrates the feasibility of using relatively large radar antennas for mechanical pointing and scanning in satellite applications.

The antenna is a parabolic cylinder with an aperture 24 ft wide by 40 in high which is fed by a slot array. The reflector, consisting of seven rigid sandwich panels hinged together, stows in a space three ft by four ft by nine ft and can be deployed through a hatch 32 in by 42 in. Total weight of the new antenna, pedestal and associated components is 64.6 pounds. Laboratory engineers believe this weight can be reduced through refinement in the basic design.

With its relatively large aperture, the NRL designed antenna provides better resolution of targets than can be obtained with smaller aperture antennas.

The mechanical azimuth scan cycle is sinusoidal with a period of four seconds. Scan amplitude is adjustable up to a maximum of 45 degrees. The pedestal employs a torque isolation system to prevent reactions from disturbing the orientation of the vehicle. The center of the scan pattern can be pointed to any azimuth. Elevation angle is fixed. Electrical power consumption is kept small by using a resonant mechanical spring-inertia system tuned to scan frequency. Measured peak power is 26 watts at an amplitude of 27 degrees at sea-level environment.

Reflector accuracy is adequate for L-band operation. It is believed that the same techniques could be used to construct a successful S-band antenna of the same aperture.



On the Naval Research Reserve

New Special Assistant for Research Reserve

On July 1, 1967, CDR Robert W. Keniston, USNR, reported as Special Assistant to the Chief of Naval Research (Research Reserve) as relief for CAPT D. J. Marker, USNR, who retired on May 31, 1967.

CDR Keniston, a TAR officer since 1959, has most recently been Head of the Reserve and Foreign Training Branch in the Bureau of Naval Personnel. Prior to that he served as Executive Officer of the USS WACCAMAW (AO-109) for three years. Other duty assignments include duty in the office of the Inspector of Naval Material; as Operations, Communications and Personnel Officer aboard the USS YOSEMITE (AD-19); and as Security Officer in the ONR Boston Branch Office.

CDR Keniston entered the Navy in 1943 and was commissioned in February 1945 after attending the Naval Reserve Midshipman School, University of Notre Dame. During 1945 and 1946 he served as Officer-in-Charge of LCT 325 and as Communications and Cargo Officer aboard various patrol craft in the Asiatic-Pacific area and participated in the initial occupation of the Japanese Islands.

Upon release from active duty, CDR Keniston, a native of Portland, Maine, returned to the University of Maine where he received a Bachelors Degree in Zoology in 1948. Prior to his recall to active duty during the Korean Crises he was employed as a chemist by the Commonwealth of Massachusetts at the Institute of Laboratories where he participated in research on blood and blood fractionation. Also during this period he was a member of Naval Reserve Research Company 1-1.

NRRCs 8-7 and 8-3 Prepare for Seminars

Two Naval Reserve Research Companies in the Eighth Naval District are busily preparing for seminars later this summer.

NRRC 8-7 of Albuquerque, New Mexico, will sponsor the Fourth Research Reserve Seminar in Applied Research at the Sandia Base, August 7-18, 1967. The subject of the seminar will be fundamental applied research with special emphasis on civilian and military nuclear weapons development, peaceful applications of nuclear research and medical academic research programs. LCDR Robert P. Baker, USNR, commands the host company and LCDR James H. Seaton, USNR, will serve as Seminar Chairman.

NRRC 8-3 of College Station, Texas, will sponsor a seminar on Electronic Computers at the Texas A&M University, September 4-15, 1967. The presentations will be in the fields of game theory, simulation, linear programming, PERT, and their military applications. The host company is commanded by LT Robert N. Olson, USNR, and CAPT Walter H. Thammes, Jr., USNR, will act as Seminar Chairman.

CAPT Richard H. Ballinger, USNR, a member of NRRC 8-3, will be the Eighth Naval District representative for administrative matters.

Argonne National Laboratory Seminar

The first Naval Reserve Research Seminar on "Nuclear Research in Life and Physical Sciences" was held at the Argonne National Laboratory, Argonne, Illinois, during the period April 24 to May 5, 1967. The seminar was hosted by NRRC 9-25 of Forest Park, Illinois, and the Argonne National Laboratory. LCDR Henry C. Krass commands the host company.

Under the chairmanship of CDR Remo Puricelli, a member of NRRC 9-25 and the Argonne National Laboratory management staff, the seminar got underway with an orientation talk and welcome by Dr. A. V. Crewe, Director of the Laboratory. His remarks were followed by those of Mr. K. E. Dunbar, manager of the Chicago Office of the Atomic Energy Commission, who gave a brief description of the organization and functions of the Atomic Energy Commission.

CAPT L. B. Melson, USN, Assistant Chief for Research, Office of Naval Research, Washington, D.C., discussed the highlights of some of the research programs sponsored by ONR.

The seminar staff and attendees were honored and privileged to have RADM D. C. Lyndon, USN, Commander, Naval Reserve Training Command, Omaha, Nebraska, participate in the opening session of the seminar. (Naval Reservists throughout the nation were saddened to learn that RADM Lyndon died less than three weeks after this presentation.)

The purpose of the seminar was to provide an insight into and acquaint the attendees with the research and development activities carried out at Argonne, especially the research on the effects of nuclear energy on man's health and environment. The presentations were given by noted scientists, representing the major scientific divisions at the Laboratory. Tours of the onsight facilities and field trips to the research centers of Abbott Laboratories and the Naval Ordnance Plant were included in the program.

A typical daily program of the seminar included convening in the conference room of a scientific division's building; opening of the session with a short description of the division's activities by the division director; a schedule of speakers who talked on the highlights of the research work engaged in by the division; and finally, a tour of the building's laboratories that would be of special interest to the seminar participants.

On the social side, Happy Hours were held on Monday, April 24 and Wednesday, May 3. The Happy Hour on May 3 was followed by a banquet with Dr. A. E. Crewe making the featured address. On this occasion, Dr. Crewe spoke on "Science and Crime."

The seminar was attended by sixty-six reserve officers of the Navy, Army and Air Force.

RADM John K. Leydon presents the annual Award for General Excellence to the FY 1966 recipients, Naval Reserve Research Company 3-14, Poughkeepsie, N.Y. Shown receiving the Award on behalf of 3-14 are CDR William Lang, Commanding Officer (left), and CDR Richard Messina, Executive Officer. The winning research reserve company is selected by a panel of judges basing their decision on general unit performance as reflected by the annual unit inspection, annual unit report, training schedules, and visit reports by the cognizant research reserve coordinator.

An International Conference on Stress Corrosion Cracking will be held at the Corrosion Center, Department of Metallurgical Engineering, Ohio State University, Columbus, September 11-15. Additional information on this conference, which is co-sponsored by ONR, may be obtained from Mr. R. W. Staehle, Ohio State or Dr. R. C. Carlston, ONR Metallurgy Branch.

Selected Contract Research Reports

The contract research reports listed below have been extracted from Technical Abstract Bulletins 67-11 and 67-12 of June 1 and 15, 1967. Government agencies and their contractors who are registered with the Defense Documentation Center of the Defense Supply Agency may obtain *free* copies from the Center at Cameron Station, Alexandria, Virginia 22314. Abstracts of the reports are found in TABs 67-11 and 67-12.

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

AERONAUTICS

Carrier Landing Analyses; Systems Technology Inc., Hawthorne, Calif.; Durand; AD-650 232

Dynamic Analysis of the Tethering Cable Portion of a High Altitude Tethered Balloon System Under Fully Deployed Conditions; National Engineering Science Co., Pasadena; Soldate; AD-651 024

Survey on Seaplane Hydro-ski Design Technology. Qualitative Study; Edo Corp., College Point, N.Y.; Pepper and Kaplan; AD-650 769

ASTRONOMY AND ASTROPHYSICS

Cosmic Ray Exposure Ages of Iron Meteorites by the Ne21/Al26 Method; Chicago U.; Lipschutz *et al;* AD-650 655

Further Observations of Planetary Nebulae at 10 cm Wave-Length, Including the Peculiar Nebula NGC 6302; CalTech.; Thompson and Colvin; AD-651 014

A Distance Limit for the Quasi-Stellar Object 3C 147; CalTech.; Shuter *et al;* AD-651 029

Infrared Photometry of Beta Persei; Flower and Cook Observatory, Philadelphia; Chen and Reuning; AD-649 656

A Liquid Nitrogen Cooled, Rocket Borne, Infrared Telescope; Cornell U., Ithaca, N.Y.; Harwit *et al;* AD-649 657

Observatory Reports: Warner and Swasey Observatory, Case Institute of Technology, Cleveland, Ohio; Warner and Swasey Observatory; McCuskey; AD-649 658

Observations of Galactic and Extragalactic Emission at 408 Mc/s. The Determination of the Accurate Positions of Radio Sources by the Lunar Occulation Technique. Observations of Emission From Flare Stars; Nufield Radio Astronomy Labs, Jodrell Bank (England); Haslam *et al;* AD-649 720

On the Possibility of Selecting Quasi-Stellar Galaxies From Blue Stars by Observations in the Near Infrared; CalTech.; Braccesi; AD-649 853

2800 Radio Emission From Eleven Quasi-Stellar Galaxies; CalTech.; Braccesi; AD-649 893

ATMOSPHERIC SCIENCES

Coordinated Experiments on Auroras; Lockheed Missiles and Space Co., Palo Alto, Calif.; Evans; AD-649 796

Analysis of Low Latitude D and E Region Data; IIT Research Inst., Chicago; Sears; AD-649 821

Comparison of Jimsphere and Rawinsonde Wind Shears; Control Data Corp., Minneapolis; Belmont and Shen; AD-650 836

BEHAVIORAL AND SOCIAL SCIENCES

A Real-Time Study of Information Requirements for Project Selection in Research and Development; Northwestern U., Evanston, Ill.; Rubenstein; AD-650 231

Mathematical Structure and Analysis of the Nonsymmetric Game; Yale U., New Haven, Conn.; Levitan and Shubik; AD-649 849

The Role of the Newman-Pearson Lemma in the Theory of Discrete Search; Yale U.; Kadane; AD-649 850

The Determinants and Effects of Industrial Research and Development; Princeton; Grabowski; AD-650 137

Oceanographic and Hydrographic Systems for Training; Lockheed Aircraft Service Co., Ontario, Calif.; Padgett and Dolph; AD-649 815

Rational and Interactional Decision-Making Roles in Task-Oriented Groups; Akron U., Ohio; Washburne and Darmofall; AD-649 824

Emotional Symptomatology and Subjective Stress in Isolated Pairs of Men; Naval Medical Research Inst., Bethesda, Md.; Haythorn *et al;* AD-649 888

The Interface Between Personnel and Organizational Psychology; Pittsburgh U.; Bass; AD-649 918

A Cost-Reward Analysis of Reactions to Extreme Stress; Texas U., Austin; Radloff and Helmreich; AD-650 153

Some Cultural Differences in the Perception of Social Behavior; Ill. U., Urbana; Triandis *et al;* AD-650 229

The Effects of Fear of Failure on Risk-Taking and Performance; Bucknell U., Lewisburg, Pa.; Rolf and Birney; AD-650 302

Translation and Application of Psychological Research; Human Factors Research Inc., Goleta, Calif.; Mackie and Christensen; AD-650 309

Attitudinal Effects of Stress and Justification, a Replication and Extension; Texas U., Austin; Helmreich; AD-650 310

Three-Mode Factor Analysis of the Behavioral Component of Interpersonal Attitudes; Ill. U., Urbana; Triandis *et al;* AD-650 365

Some Network Characterizations for Mathematical Programming and Accounting Approaches to Planning and Control; Carnegie Inst. of Tech., Pittsburgh; Charnes and Cooper; AD-650 613

Optimal Continuous Review Policies for Two Product Inventory Systems With Joint Setup Costs; Columbia U., N.Y.; Ignall; AD-650 793

A Further Study of the Use of Human Factors Information by Designers; Bunker-Ramo Corp., Canoga Park, Calif.; Meister and Sullivan; AD-651 076

Contextual Predictability and Frequency Factors; Ill. U., Urbana; Parisi *et al;* AD-651 095

Studies of Binaural Interaction; Tracor Inc., Austin, Texas; Bourbon and Evans; AD-651 145

BIOLOGICAL AND MEDICAL SCIENCES

Pattern Recognition by Using an Associative Memory; Northwestern U., Evanston, Ill.; Yau and Yang; AD-650 967

Dental Materials; Michigan U., Ann Arbor; Peyton; AD-650 583

Large Bodies of Mycoplasma and L-Form Organisms; Pa. State U., University Park; Kang and Casida, Jr.; AD-650 714

Effects of Nitrogen Supplements on Nitrogen Fixation by Aerobacter Aerogenes; S. Dakota St. U., Brookings; Patil *et al;* AD-650 721

Release of Chemical Factors From the Diencephalic Region of the Unanaesthetized Monkey During Changes in Body Temperature; Purdue U., Lafayette, Ind.; Myers; AD-650 733

Feasibility of Using Linear Pattern Classifiers for Probabilistic Pattern Classes; Northwestern U.; Yau and Chuang; AD-649 928

Homograft Rejection by Neonatally Thymectomized Germ-Free Mice; Notre Dame U., Ind.; Bealmear and Wilson; AD-650 528

An Oligomeric Structure of Aspartate Transcarbamylase From Escherichia Coli; Calif. U., Berkeley; Changeux *et al;* AD-650 523

Drug Effects Upon Performance as a Function of Data Input Rate; Institute for Research, State College, Pa.; Hurst *et al;* AD-649 822

CHEMISTRY

Molecular Structure of a Carborane (1,2-Dicarbaclovo-dodecaborane) Derivative, B10Cl8H2C2H2; Harvard U., Cambridge, Mass.; Potenza and Lipscomb; AD-649 751

Molecular Structure of Carboranes A 1,2-Dicarbaclovo-dodecaborane Derivative, B10Cl8H2C2H2; Harvard; Potenza and Lipscomb; AD-649 752

Preparation and Structure of a New Boron Hydride, B20H16; Harvard; Friedman *et al;* AD-649 799

Octaborane (12); Harvard; Enrione *et al;* AD-649 915

Preparation, Isolation, and Structure of B8H12; Harvard; Enrione *et al;* AD-649 924

Ultrasonic Vibration Potentials in Tetraakylammonium Halide Solutions; Western Reserve U., Cleveland; Zana and Yeager; AD-650 413

Nuclear Magnetic Resonance Spectroscopy. The Configurational Stability of Primary Gringnard Reagents: Structure and Medium Effects; CalTech.; Whitesides and Roberts; AD-649 639

Molecular Structure of B4H6C2 (CH3)2; Harvard; Streib *et al;* AD-649 797

Acetylene-Oxygen Reaction in Shock Waves, Origin of CO2; Harvard; Homer and Kistiakowsky; AD-649 632

Boron Hydrides: LCAO-MO and Resonance Studies; Harvard; Hoffmann and Lipscomb; AD-649 748

Calculation of the Barrier to Internal Rotation in Ethane; Harvard; Pitzer and Lipscomb; AD-649 750

An LCAO-MO Study of Static Distortions of Transition Metal Complexes; Harvard U.; Lohr, Jr., and Lipscomb; AD-649 801

Perturbed Hartree-Fock Calculations. Magnetic Susceptibility and Shielding in the LIH Molecule; Harvard; Stevens *et al;* AD-649 920

Perturbed Hartree-Fock Calculations. Further Results for Diatomic Lithium Hydride; Harvard; Stevens and Lipscomb; AD-649 921

Polarization of the Lowest-Energy Allowed Transition of Beta-Ionylidene Crotonic Acid and the Electronic Structure of the Polyenes; Yale U.; Parkhurst and Anex; AD-649 661

Perturbed Hartree-Fock Calculations. Polarizability and Magnetic Properties of the HF Molecule; Harvard; Stevens and Lipscomb; AD-649 922

Perturbed Hartree-Fock Calculations. Second-Order Properties of the Fluorine Molecule; Harvard; Stevens and Lipscomb; AD-649 923

A Survey of ESR in Heat Treated Carbon Blacks; State U. of N.Y., Buffalo; Arnold; AD-649 994

Proton Adsorption at the Ferric Oxide/Aqueous Solution Interface. Analysis of Kinetic Data; M.I.T.; Berube *et al;* AD-650 035

On the Formation and Decomposition of Graphite-Bisulfate; State U. of N.Y., Buffalo; Inagaki; AD-650 126

Silver Oxide Electrode Processes; Calvin Coll., Grand Rapids, Michigan; Dirkse; AD-650 152

Preparative Electrophoresis in Liquid Columns Stabilized by Electromagnetic Rotation. The Apparatus; Calif. U., Los Angeles; Kolin; AD-650 191

Preparative Electrophoresis in Liquid Columns Stabilized by Electromagnetic Rotation. Artifacts, Stability and Resolution; Calif. U., L.A.; Kolin; AD-650 192

Quantitative Studies of Ultrasonic Vibration Potentials in Polyelectrolyte Solutions; Western Reserve U.; Zana and Yeager; AD-650 412

High-Temperature Spectral Emissivities and Total Intensities of the 15 Micron Band System of CO2; General Dynamics/Convair, San Diego, Calif.; Ludwig *et al;* AD-650 527

Muonium Chemistry; Yale U.; Mobley *et al;* AD-650 451

Stereochemical Aspects of the Diels-Alder Reaction; CalTech; Lambert and Roberts; AD-650 825

Absolute Infrared Intensity Measurements on the Fundamental of NO; Calif. U., San Diego; Varanasi and Penner; AD-650 659

Momentum Transfer and Inelastic Collision Cross Sections for Electrons in O2, CO and CO2; Westinghouse Research Labs., Pittsburgh, Pa.; Hake, Jr. and Phelps; AD-650 751

A Study of Random Network Models. Characterization of a 300-Unit Tetrahedral Network and Comparison With Vitreous Silica and Liquid Water; Melpar, Inc.; Falls Church, Va.; Ordway; AD-650 754

Atomic Absorption Analysis for Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Ni, K, Rb, Na, and Sr in the Hudson River; Columbia U., Dobbs Ferry, N.Y.; Fabricand *et al;* AD-650 853

Experimental Investigation of the Absorption of Infrared Radiation; Philco-Ford Corp., Newport Beach, Calif.; Butch and Bryvnak; AD-651 043

EARTH SCIENCES AND OCEANOGRAPHY

A Strong Seasonal Bio-Acoustic Source of the Eastern Caribbean; Columbia U., Dobbs Ferry, N.Y.; Hole; AD-650 852

Net Zooplankton Data From the Northeast Pacific Ocean: Columbia River Effluent Area, 1961, 1962; Wash. U., Seattle; Peterson and Anderson; AD-651 075

The Influence of Variable Depth on Steady Zonal Barotropic Flow; Wash. U., Seattle; Porter and Rattray, Jr.; AD-650 646

Deuterium and Oxygen 18 Variations in the Ocean and the Marine Atmosphere; Scripps; Craig and Gordon; AD-650 965

A Compilation of Moored Current Meter Observations; Woods Hole; Webster and Fofonoff; AD-651 112

The Origin of Manganese Nodules on the Ocean Floor; Wash. U., Seattle; Bonatti and Nayudu; AD-650 647

The Spectrophotometric Determination of Ammonia and Labile Amino Compounds in Fresh and Seawater by Oxidation to Nitrite; Wash. U.; Richards and Kletsch; AD-650 650

Lower Cretaceous Rocks (Neocomian-Albian) Dredged From Blake Escarpment; Lamont Geological Observatory, Palisades, N.Y.; Heezen and Sheridan; AD-650 677

Sediments of the Caicos Outer Ridge, The Bahamas; Lamont; Schneider and Heezen; AD-650 679

An Eocene Dredge Haul From the Tuamontu Ridge; Lamont; Burckle and Saito; AD-650 680

Deep-Sea Iron Deposit From the South Pacific; Miami U., Fla.; Bonatti and Joensuu; AD-650 695

Deep-Sea Authigenic Calcite and Dolomite; Miami U.; Bonatti; AD-650 696

A Tubular Spring Valve Used as a Tight and Thin-Walled Core-Retainer; Scripps; Rosfelder; AD-650 723

On the Change in Electrical Conductance of Seawater With Temperature; Oregon St. U.; Weyl; AD-650 589

Palagonite Tuffs (Hyaloclastites) and the Products of Post-Eruptive Processes; Wash. U.; Nayudu; AD-650 648

Nutrient Regeneration From Phytoplankton Decomposing in Sea Water; Wash. U.; Grill and Richards; AD-650 649

Dissolved Gases Other Than Carbon Dioxide; Wash. U.; Richards; AD-650 653

Anoxic Basins and Fjords; Wash. U.; Richards; AD-650 654

Extension of Northeastern-Pacific Fracture Zones; Scripps; Menard; AD-650 660

Columbia River Plume Identification by Specific Alkalinity; Oregon St. U.; Park; AD-650 661

Carbonate Cycle and the Buffer Mechanism of Recent Oceans; Oregon St. U.; Pytkowicz; AD-650 662

Concentration Profiles of Barium and Lead in Atlantic Waters off Bermuda; Scripps; Chow and Patterson; AD-650 663

Instruments and Methods: A Large Water Sampler, Rupture-Disc Triggered, for Studies of Dissolved Organic Compounds; Woods Hole; Clark, Jr. *et al;* AD-650 713

Calcite: Rates of Dissolution in a Vertical Profile in the Central Pacific; Scripps; Peterson; AD-650 964

Quasigeostrophic Free Oscillations in Enclosed Basins; Wash. U., Seattle; Rattray, Jr. and Charnell; AD-649 719

The K2 Tide in Oceans Bounded by Meridians and Parallels; Weizmann Inst. of Science, Rehovoth (Israel); Accad and Pekeris; AD-650 111

Oceanography Using Remote Sensors; Texas A and M U.; College Station; Capurro and Leipper; AD-650 288

Airborne Measurements of Infrared Sea Temperature in the Northern Gulf of Mexico; Gulf Coast Research Lab, Ocean Springs, Miss.; Drennan; AD-650 314

Determination of the Hydrodynamic Shape for a Free-Fall Ocean Current Probe; M.I.T.; Kuperstein; AD-650 326

Radiation and Scattering of Transient Gravity Waves by Vertical Plates; CalTech.; Mei; AD-650 387

Isoprenoid Hydrocarbons in Recent Sediments: Presence of Pristane and Probable Absence of Phytane; Woods Hole Oceanographic Institution, Mass.; Blumer and Snyder; AD-649 718

Rare Gases in the Sun, in the Atmosphere, and in Meteorites; Minn. U., Minneapolis; Signer and Suess; AD-650 360

Lake Superior Seismic Experiment: Shots and Travel Times; Carnegie Inst. of Wash., D.C.; Steinhart; AD-649 652

Pleistocene Drainage Patterns on the Floor of the Chukchi; Wash. U., Seattle; Creager and McManus; AD-649 722

Geophysical Investigations in the Area of the Perth Basin, Western Australia; Lamont Geological Observatory, Palisades, N.Y.; Hawkins *et al;* AD-649 723

Isotopic Paleotemperatures; Miami U., Fla.; Emiliani; AD-650 465

Development of an In-Situ Sediment Velocimeter; Columbia U., Dobbs Ferry, N.Y.; Bennin and Clay; AD-649 696

Space Oceanography Project; Texas A and M U., College Station; Walsh; AD-649 697

Chemical Observations in Some Anoxic, Sulfide-Bearing Basins and Fjords; Wash. U., Seattle; Richards; AD-649 717

Track Charts, Bathymetry, and Location of Observations, Chain Cruise No. 1—Nov. 18-24, 1958, Chain Cruise No. 2—Dec. 8-20, 1958, Chain Cruise No. 4—Jan. 12-Feb. 15, 1959, Chain Cruise No. 5—March 9-25, 1959; Woods Hole; Dunkle; AD-650 007

High Pressure Solubility of Calcium Carbonate in Seawater; Oregon State U., Corvallis; Pytkowicz and Conners; AD-650 118

Meridional Distribution of Temperature-Salinity Characteristics of Pacific Ocean Surface Water; Johns Hopkins U., Baltimore, Md.; Lynn; AD-650 119

Tropical Waters in the Western Pacific Ocean, Aug-Sept 1957; Johns Hopkins U.; Cannon; AD-650 123

Variation of Cesium in the Ocean; Scripps; Folsom *et al;* AD-650 444

Cruise Report on 1966: Seismic Refraction Expedition to the Solomon Sea; Hawaii Inst. of Geophysics, Honolulu; Woollard *et al;* AD-650 148

Studies in Marine Geophysics and Underwater Sound From Drifting Ice Stations; Columbia U.; Hunkins; AD-650 409

ELECTRONICS AND ELECTRICAL ENGINEERING

Floating-Point Number Representations: Base Choice Versus Exponent Range; Stanford U.; Richman; AD-651 201

Modulo-m Linear Sequential Circuits, Partial Response Signaling Formats, and Signal Flow Graphs; Harvard U., Cambridge, Mass.; Tufts and Ramamoorthy; AD-650 958

Self- and Mutual-Admittances of Two Identical Circular Loop Antennas in a Conducting Medium and in Air; Harvard U.; Iizuka *et al;* AD-650 640

Experimental Band-Pass Limiter Envelope Distributions and Statistics; Harvard U.; Tufts and Trafton; AD-650 946

Computer Design for Asynchronously Reproducible Multiprocessing; M.I.T.; Van Horn, Jr.; AD-650 407

On the Applicability of Wiener's Canonical Expansions; Information Research Associates, Inc., Lexington, Mass.; Brick; AD-650 193

Development of a Periodically Focused Low-Noise Traveling-Wave Tube Limiter; Microwave Electronics, Palo Alto, Calif.; AD-649 883

ENERGY CONVERSION (NON-PROPULSIVE)

Departure From LTe in the Thermionic Converter; Sperry Rand Research Center, Sudbury, Mass.; Norcross; AD-650 507

MATERIALS

The Mechanical Properties of Ceramic Alloys; Carnegie; Groves; AD-649 823

Thermodynamic Properties of hcp Iron and Iron Ruthenium Alloys; Manlabs Inc., Cambridge, Mass.; Stepakoff and Kaufman; AD-650 151

Network Relaxation Properties of Crosslinked Poly (Ethyl Acrylate) and Poly (Dimethyl Siloxane) in the Rubbery Plateau Region; Princeton; Sperling and Tobolsky; AD-649 896

Impact Shock on Piezoelectric Ceramics; Edo Western Corp., West Salt Lake City, Utah; Skinner *et al;* AD-651 100

On the Dilute Solutions of Silver, Gold and Platinum in Liquid Lead; M.I.T.; Jena and Bever; AD-650 961

Effects of Viscoelastic Lubricant on Squeeze Film Lubrication Between Impinging Spheres; Mechanical Technology, Inc., Latham, N.Y.; Mow; AD-651 155

Plastic Flow Rates in Nylon Interpreted in Terms of Dislocation Motion; Ill. U., Urbana; Dey; AD-650 578

MATHEMATICAL SCIENCES

On the Asymptotic Directions of the s-Dimensional Optimum Gradient Method; Stanford U.; Forsythe; AD-650 619

Varying Length Floating Point Arithmetic: A Necessary Tool for the Numerical Analyst; Stanford U.; Tienari; AD-650 620

Graeffe's Method for Eigenvalues; Stanford U.; Polya; AD-650 627

On a Class of Convex and Non-Archimedean Solution Concepts for n-Person Games; Northwestern U., Evanston, Ill.; Charnes and Kortanek; AD-651 037

Maintenance Policies and Disciplines in Multi-Channel Systems and Markovian Multi-Service Type Systems; Columbia U., N.Y.; Brosh; AD-650 792

Research on Spectral Analysis; Rocketdyne, Canoga Park, Calif.; Goodman and Dubman; AD-649 631

Improved Estimation of Regression Parameters; Stanford U.; Sclove; AD-649 679

Some Integral Equations With "Nonrational" Kernels; Stanford; Kailath; AD-649 740

Almost Diagonal Matrices With Multiple or Close Eigenvalues; Stanford; Wilkinson; AD-650 116

Two Algorithms Based on Successive Linear Interpolation; Stanford; Wilkinson; AD-650 117

"Simple" Stability of General n-Person Games; Princeton; Marchi; AD-650 138

On Iterative Computation of Generalized Inverses and Associated Projections; Northwestern U.; Ben-Israel and Cohen; AD-650 170

Algebraic Spectral Problems; Kansas U., Lawrence; Aronszajn and Fixman; AD-650 226

Bayesian Analysis of Linear Models With Two Random Components (With Special Reference to the Balanced Incomplete Block Design); Wisconsin U., Madison; Tiao and Draper; AD-650 278

Centralized Games; Hebrew U., Jerusalem (Israel); Peleg; AD-650 280

Second Order Sufficient Conditions for Weak and Strict Constrained Minima; Northwestern U.; Fiacco; AD-650 285

The Efficiency of a Nonparametric Selection Procedure: Largest Location Parameter Case; Cornell U.; Dudewicz; AD-650 425

Mean Square Invariant Forecasters for Some Weibull Distributions; Columbia U.; Oliveira and Littauer; AD-650 511

The Physical Interpretation of Weston's Toroidal Wave Functions; Parke Mathematical Labs., Inc., Carlisle, Mass.; Williams and Sherman; AD-649 916

Search-Reduction Tests for a Combinatorial Production Sequencing Algorithm; Carnegie; Glover; AD-649 937

Decision and Horizon Rules for Stochastic Planning Problems: A Linear Example; Northwestern U.; Charnes *et al;* AD-650 173

Convex Approximants and Decentralization: a Sumt Approach; Northwestern U.; Charnes *et al;* AD-650 241

Chance-Constrained Games With Partially Controllable Strategies; Northwestern U.; Charnes *et al;* AD-650 242

Sequential Designs for Spherical Weight Functions; Wisconsin U.; Draper and Lawrence; AD-650 275

Solution Theorems in Probabilistic Programming: a Linear Programming Approach; Northwestern; Charnes *et al;* AD-650 284

MECHANICAL, INDUSTRIAL, CIVIL, AND MARINE ENGINEERING

Evaluation of Response Characteristics of Chain Sampling Inspection Plans; Rutgers—The State Univ., New Brunswick, N.J.; Stephens and Dodge; AD-649 857

Unsteady Propeller Lifting-Surface Theory With Finite Number of Chordwise Modes; Stevens Inst. of Tech., Hoboken, N.J.; Tsakonas *et al;* AD-649 616

Cambered Bodies in Cavitating Flow—a Nonlinear Analysis and Design Procedure; Stanford; Street and Larock; AD-649 734

An Experimental Investigation of the Role of Air in Ship Slamming; Calif. U., Berkeley; Lewison; AD-650 197

Synthesis and Analysis of Some Transport Price Policies With a Chance-Constrained Demand Capture Model; Northwestern; Charnes *et al;* AD-650 283

Measurements of the Turning Performance of the LVT-P5; Walker (Norman K.) Associates, Inc., Rockville, Md.; DeMaio *et al;* AD-650 497

Minimum-Weight Design of Beams for Multiple Loading; Calif. U., San Diego; Mayeda and Prager; AD-650 194

Evaluating the Seakeeping Performance of Destroyer-Type Ships; Webb Inst. of Naval Architecture; Glen Cove, N.Y.; Hamlin and Compton; AD-650 750

Shipboard Systems Costs: A Functional Analysis of Work Aboard Ship. SS Cities Service Baltimore: A Tanker in the Atlantic Coastal Service; National Academy of Sciences-National Research Council, Washington, D.C.; AD-650 843

METHODS AND EQUIPMENT

Remote Sensing by Infrared and Microwave Radiometry. Basic Principles. A Technique for the Correction of Airborne Measurements of Apparent Surface Temperature of Natural Water Bodies. Potential Applications of Infrared and Microwave Radiometry; Wisconsin U., Madison; Menon and Ragotzkie; AD-651 188

MILITARY SCIENCES

Logistics Information Systems; George Washington U., Wash., D.C.; AD-650 748

NAVIGATION, COMMUNICATIONS, DETECTION, AND COUNTERMEASURES

Underwater Hearing Thresholds in Man; Fla. U., Gainesville; Brandt and Hollien; AD-649 669

NUCLEAR SCIENCE AND TECHNOLOGY

Uranium Micromaps: Technique for in Situ Mapping of Distributions of Fissionable Impurities; CalTech.; Fleischer; AD-650 678

PHYSICS

Single-Crystal X-Ray Diffraction Study of Beta-Diborane; Harvard; Smith and Lipscomb; AD-649 753

Single-Crystal X-Ray Diffraction Study of Beta-Fluorine; Harvard; Jordan *et al;* AD-649 755

The Symmetry Minimum Function: High Order Image Seeking Functions in X-Ray Crystallography; Harvard; Simpson *et al;* AD-649 759

Molecular and Crystal Structure of B2OH16; Harvard; Dobrott *et al;* AD-649 798

Single-Crystal X-Ray Diffraction Study of Beta Nitrogen; Harvard; Streib *et al;* AD-649 800

Single-Crystal X-Ray Diffraction Studies of Alpha-N2 and Beta-N2; Harvard; Jordan *et al;* AD-649 911

Single-Crystal Studies of Beta-F2 and of Gamma-O2; Harvard; Jordan *et al;* AD-649 913

Absence of Long-Range Overhauser Spin-Density Waves in one or two Dimensions; Calif. U., San Diego; Hamilton; AD-649 963

Supplementary Dielectric-Constant and Loss Measurements on High-Temperature Materials; M.I.T.; Iglesias and Westphal; AD-650 230

On Determination of the Characteristic Equations for the Stability of Parallel Flows; Michigan U., Ann Arbor; Graebel; AD-649 713

Knudsen Flows Through Long Capillaries; Brown U., Providence, R.I.; Pao and Tchao; AD-649 837

Measurements in a Turbulent Boundary Layer Maintained in a Nearly Separating Condition; National Bureau of Standards, Wash., D.C.; Spangenberg *et al;* AD-650 081

Structure of a Strong Shock Wave as Approximated by a Collisionless Shock With Polynomial Corrections; Northwestern U.; Kovitz and Mintzer; AD-650 442

Jet Diffusion in the Region of Flow Establishment; Iowa U., Iowa City; Sami *et al;* AD-650 555

Measurement of Turbulence by Pressure Probes; Iowa U., Jezdinsky; AD-650 556

Study of Various Aspects of Raman Scattering Using Continuous Wave Optical Masers; M.I.T.; Javan *et al;* AD-650 044

Polarized Proton Scattering From Oxygen at 40.0, 37.1, 34.2, 30.4, 27.6 and 24.2 MeV; Calif. U., Los Angeles; Eldridge; AD-649 942

Polarization Parameter in Elastic Proton-Proton Scattering From 0.75 to 2.84 GeV; Michigan U., Ann Arbor; Neal and Longo; AD-650 156

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Random Noise

CDR Mark M. Macomber, USN has been named Deputy Commander for Hydrography at the Naval Oceanographic Office. He replaces CAPT Victor A. Moitoret who, after retiring from the Navy, will leave for his new assignment as Director of the International Hydrographic Bureau, Principality of Monoco.

Dr. Donald Ross has recently been appointed Associate Technical Director and Head of the Acoustics and Vibration Laboratory, Naval Ship Research and Development Center. Dr. Ross is a specialist in all aspects of acoustics, especially noise control, cavitation, and underwater sound.

Dr. John Huth, Chief Scientist for Research and Development in NAVSHIPS, has been assigned additional duties as Special Assistant for Independent Research and Independent Exploratory Development (IR/IED) within the Offices of Director of Navy Laboratories and Director of Laboratory Programs.

CDR W. B. Walker has been designated Director, ONR Undersea Programs. He relieves CDR J. B. Davidson, who is retiring from the Navy.

RADM Bernard H. Bieri, Jr. has been assigned as Commander of the Naval Supply Systems Command and Chief of Supply Corps. He relieves RADM Herschel J. Goldberg, effective August 1.

Dr. Richard Trumbull has been designated ONR's Assistant Chief for Research (Acting), effective June 21. He will also continue his duties as Research Director.

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RADM John K. Leydon (left) and RADM Thomas B. Owen stand at attention during a Change of Command and Retirement Ceremony held June 30, 1967 at the Naval Research Laboratory. RADM Owen, former Director of NRL, relieved RADM Leydon as Chief of Naval Research. See pages 20-21.