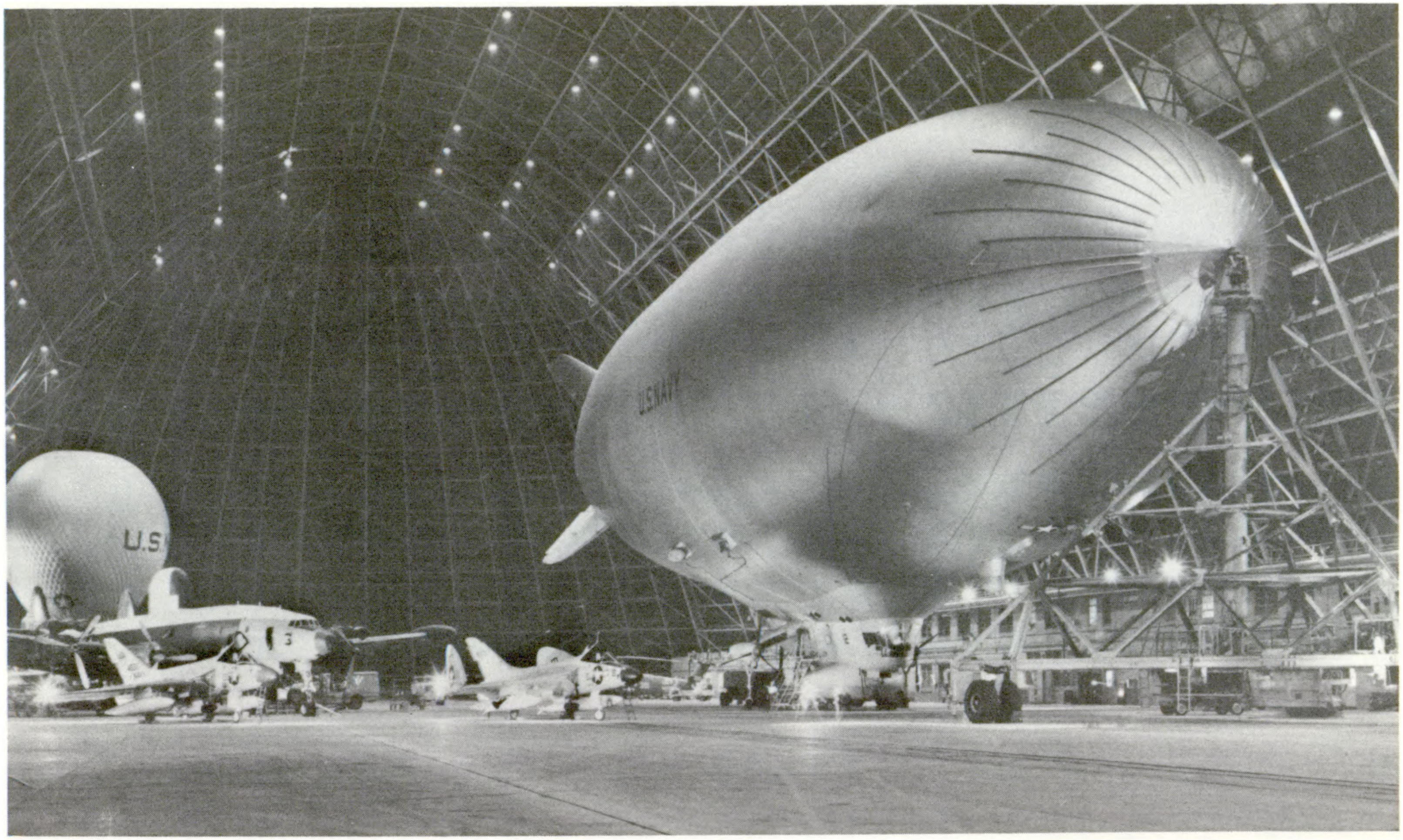
AVAL RESEARCH

REVIEWS

CTOBER 1960

DEPARTMENT OF THE NAVY · OFFICE OF NAVAL RESEARCH

AVEXOS P-510



Aircraft of the Naval Air Development Unit inside the hangar at NAS, South Weymouth, Mass. (See p. 18.)

New Technology and the Shipboard Manning Problem

Captain J. Garrett
Air Warfare Officer
Office of Naval Research

The problem of providing adequate numbers of trained personnel for manning the ships of the Fleet is an ever present one that appears to be accentuated rather than alleviated by the present era of accelerating technology.

Technologies in the fields of aviation, electronics, atomics, missiles, and space are providing us with increased numbers of equipments and weapons that in turn demand additional personnel for their operation and maintenance. These systems and their support personnel are having to be "appended" to the already heavily manned ships of WW II design without commensurate reductions in the systems that they replace. Concurrently, within a level dollar budget, a higher percentage of those dollars are having to be diverted to the research, development, and procurement of the products of our accelerating technology. Fewer dollars are thus available for pay and allowances while there is a need for more and better men to man each ship.

Rising wages and the increasing attractiveness of industrial employment are among a host of other reasons why adequate manning of the Navy's ships is an ascending problem. The only interim solution has been to reduce the number of ships in the active fleet and to operate the remaining at something less than their full design capability.

If, then, technological growth is responsible at least in part for the acuteness of our manning problems, we might ask: Can technology also be used to ease the problem that it is creating? If so, how must we proceed?

During the past several months, considerable attention has been directed to these questions within the Office of Naval Research. The procedure followed, in attempting to generate some ideas on how, and where, technology might be applied to ease shipboard manning problems, has included consideration of the following:

- New technological tools available
  - Mechanization tools
  - Automation tools

- Economic considerations
  - Savings
  - Costs

- Operational considerations

- Areas of application

TECHNOLOGICAL TOOLS AVAILABLE

Admittedly, recent technological growth has been stimulated by the glamors of aviation, electronics, atomic energy, missiles, and space. Within those areas, the constraints on weight, space, and time, as well as the need to minimize personnel hazard, have led us to very sophisticated tools of mechanization and automation—tools that have replaced or reduced the number of personnel required within a system.

Those tools, however, need not be restricted to use in the sophisticated systems and vehicles for which they were specifically developed. If properly adapted, they might have even more rewarding effects—for the Navy—upon the propulsion plants, ship control systems, navigational systems, damage control and repair systems, and, certainly, record-keeping systems of the more prosaic Navy ship.

The tools under consideration are as follows:

Mechanization tools. Equipments and systems involved in the processes of generating, storing, transmitting, converting, or absorbing of energies.

Automation tools. Equipments and systems involved in the processes of collecting, storing, transmitting, displaying, evaluating, and/or responding to information.

By so viewing the tools that have been recently developed or improved upon in other military or commercial applications, we can better determine what economic or operational advantages might result from their application in shipboard systems. As an example, under energy conversion devices, we now have available static d-c to a-c convertors that operate with no moving parts. If our design goal is to remove a maintenance man from the system or to reduce the ship's self-noise such devices might be seriously considered.

SAVINGS

Some of the savings that could be achieved by the reduction of the on-board count of officers and enlisted men by one, for the 20-year life of a ship, are indicated by the table that follows. These estimates are based on 1960 wage and equipment costs and not the escalating costs that might be anticipated.

Shipboard Manning Costs (20-Year Ship Life)

	Per Officer	Per Man
Pay and allowances	$130,000	$90,000
Training and travel amortization	60,000	20,000
Retirement annuity	13,000	9,000
Habitability space	6,750	2,700
Habitability equipment	2,250	800
	$212,000	$122,500

Additional savings resulting from reductions in requirements for house-cleaning, stores handling, personnel administration, personal safety equipment and personnel access provisions have not been included in these estimates. Stations that demand 24 hours manning, and thus the assignment of three officers or enlisted men per station, become the equivalent of appreciable capital investment.

COSTS

We must be alert, of course, to the other economic considerations; namely, the cost of introducing new technological tools into our ships.

Such costs might include:

- Research, development, test, and evaluation
- Amortization of increased initial investment
- Increased maintenance costs resulting from
  - Increased amounts of equipment
  - Increased system complexity
  - Increased amounts of test equipment
  - Increased quality of maintenance personnel
- Additional equipment improvement and retrofit costs

All of these costs may not actually exist in every case. For example, it is understood that in the automation of commercial power plants, maintenance costs were reduced rather than increased. Furthermore, in other commercial applications, it has been found that the initial cost of automatic controls was less than the cost of proper display dials, recorders and manual control mechanisms for the manned system that was replaced.

OPERATIONAL CONSIDERATIONS

Technological changes, although directed at reducing manning requirements or operating costs, might provide us with certain additional operational advantages such as:

- Quicker reaction times
- Less equipment committed to training and in-transit
- Less man-inflicted equipment damage
- Fewer lives exposed to hazards (more effective escape and rescue might be possible.)
  - Less vehicle defensive capability required
  - More aggressiveness is possible
- A new foundation for growth in operational capabilities

To illustrate one of these advantages, we are constantly concerned with the protection of personnel. Aviation has a far simpler problem because of the small size of aircraft crews. Thus the great vulnerability of military aircraft has been somewhat offset by the development of effective escape and rescue systems, which are practical because of the few people involved. It is presently argued in some quarters that naval ships have become more vulnerable as a result of modern missilery and the increased capability of submarines. By building less costly ships and making possible more effective means of protecting or rescuing the crew, there is less chance that a ship's vulnerability would become a critical factor in planning our future Navy.

Fewer men on combat ships, for example, might make possible practical and less elaborate—and therefore less expensive—means of protecting them in combat environments that are now characterized by blast, heat and radiation. In addition, there would be obvious benefits in peacetime operations through the reduction or elimination of the need for personnel to work in hazardous areas of the ship. Thus, while the original objective may be to reduce shipboard complements for reasons of cost, such reduction may also assist in the solution of other naval problems.

In our efforts to reduce manning requirements, obviously we must be careful that operational capabilities are not reduced below acceptable limits. Standards of reliability, flexibility, availability, and maintainability must be formalized and carefully followed. Such standards should be established on the basis of current operational requirements, however, and not simply because "that's the way we've always done it."

As an example, it is used to be essential for the naval ship to have an abosolute self-healing capability. It might break down or develop some other emergency hundreds of miles from the nearest facility able to provide assistance and it might even be unable to communicate with a source of possible assistance. However, the advent of world-wide communications and jet air travel means that a modern ship is rarely, if ever, out of communications range or more than a few jet hours from assistance. Therefore, the equipment, materials and personnel needed to enable a ship to repair all possible damage without outside assistance could be substantially reduced.

As the cost of maintaining personnel aboard ship—measured in dollars, effort, space, hazard, and complexity—increases, commensurate reduction in the number of "just-in-case" personnel on board may be the answer to some of our problems.

AREAS OF APPLICATION OF NEW TECHNOLOGIES

Knowing what tools are available and what economic and operational considerations are involved, the final problem is to define the areas of application that might yield the most profitable gains in reducing manning requirements. Some guidelines that have been suggested thus far in the considerations of how and where new technologies might be applied to ease shipboard manning problems are:

● New ship design, rather than modifications of current designs or retrofit of existing ships, will be required if full advantage is to be taken of new technologies in reducing manning requirements and costs.

● Automation must not be limited to operator functions but must be extended to include maintenance functions as well. Where operation and maintenance of one equipment is performed in series, by one man, no reduction in manning is accomplished by automation of the operator function alone.

● Single-purpose ships and ships with deterrent roles, as compared to multipurpose ships, would lend themselves to higher degrees of automation.

● Ships with offensive tasks rather than defensive tasks would lend themselves to higher degrees of automation. This results from the relative ease of programming for the lesser number of targets that are associated with offensive tasks than with defensive tasks.

● Shipboard internal functions for which known technologies can make extensive savings in manning requirements include:

- Propulsion plant control
- Equipment and personnel record keeping
- Ship control and navigation
- Communications
- Damage detection and control

● Appreciable operational gains, as well as significant reductions in the amount of dynamic self-defense capability that must be provided, may be realized where the crew size could be reduced to the extent that practical escape and rescue provisions could be provided.

● Savings to be derived from mechanization and automation exceed the mere savings in wages of the on-board crew. Savings in pipeline personnel, habitability costs, and training costs are also of significant magnitude.

● Higher wage rates expected for the future could offer additional monetary compensation for increased automation and mechanization at this time.

● Research, development, test, and evaluation conducted in connection with such a Navy program would have value as a form of subsidy for the U. S. Merchant Marine, which has an urgent need for reducing crew sizes if it is to survive in international competition.

● The implementation of any program to accelerate the introduction of technology into the ships of the fleet, or even to encourage such a program, will require some reorientation of our doctrines, organization, and practices.

● A not insignificant consequence of accelerated automation afloat may well be the psychological and political impact on the international scene. If, in fact, we are engaged in an international technological race, the ships of our navy and maritime service could well be one of the media through which our technological prowess is most impressed upon others.

In conclusion, sufficient techniques and experience are now in hand from other military and commercial applications to greatly reduce the manning requirements and to enhance the efficiency and effectiveness of performing the more mundane functions on naval ships. Significantly, this potential is available as we face forthcoming problems of mass obsolescence of WW II ships and international trends and defense philosophies that portend requirements. The responsibility for the more vigorous pursuit of such a solution to these problems lies with those among us who see the vital roles that will be demanded of the Navy by the end of the present decade.

Project SURIC

The Navy is conducting a study to reduce crew requirements of surface ships by turning over many control functions to automated machinery. Project SURIC--for Surface Ship Integrated Control--has the goal of having Naval surface ships operate with fewer men, yet outperform current operating ships, by simplifying and centralizing shipboard operations. The study is due to be completed within one year. Results of the study are to be incorporated in a destroyer escort, a ship type which will continue to be a major factor in antisubmarine warfare. The Navy hopes to realize substantial cost and space savings by making use of data processing and automation equipment. Project SURIC is being carried out by the Office of Naval Research; Sperry Rand Corporation; and Gibbs and Cox, Incorporated, Naval architects.

The first Henry Bryant Bigelow Medal for oceanography was awarded August 10 to the man it honors. Dr. Paul M. Fye, Director of Woods Hole Oceanographic Institution, Woods Hole, Mass., presented the award to Dr. Bigelow during the annual meeting of the Corporation and Board of Trustees of the Institution. Dr. Bigelow, one of America's foremost marine scientists, was among the founders of the Institution. He is now Chairman of the Board of Trustees. The Bigelow Medal was established earlier this year by the Woods Hole Trustees without the knowledge of their Chairman. It is designed with a likeness of Dr. Bigelow on the face and the Institution's first and most famous research vessel, ATLANTIS, on the back. With it go a citation and a cash prize of $2500. It is to be awarded from time to time to those "who make significant inquiries into the phenomenon of the sea." The Woods Hole oceanographic program is supported extensively by the Office of Naval Research.

Body Temperature Regulation in Marine Birds

Thomas R. Howell and George A. Bartholomew
University of California, Los Angeles

Midway Island is famous as the landmark of one of the decisive Naval battles of World War II, in which a large Japanese task force suffered a major defeat and was forced to turn back with heavy losses. But Midway has long been famous among ornithologists as a peaceful, predator-free nesting site for sea birds of many different kinds. It is the breeding ground of large numbers of albatrosses (better known as "gooney birds"), shearwaters, petrels, boobies, frigate birds, tropic birds, and terns. Most of these birds, which nest primarily on remote islands where natural enemies are absent, have never evolved the wariness of man and his machines that is so necessary to the survival of animals inhabiting less isolated localities. The lack of "avoidance responses" makes the birds a hazard for aircraft during takeoffs and landings, but it also makes them splendid subjects of study for the biologist.

We have long been interested in the means by which animals survive and flourish in environments that provide serious problems for their vertebrate inhabitants. Many sea birds that breed on small islands nest entirely in the open, exposed during long periods of incubation and brooding to solar heat that may be quite intense. This stress may be

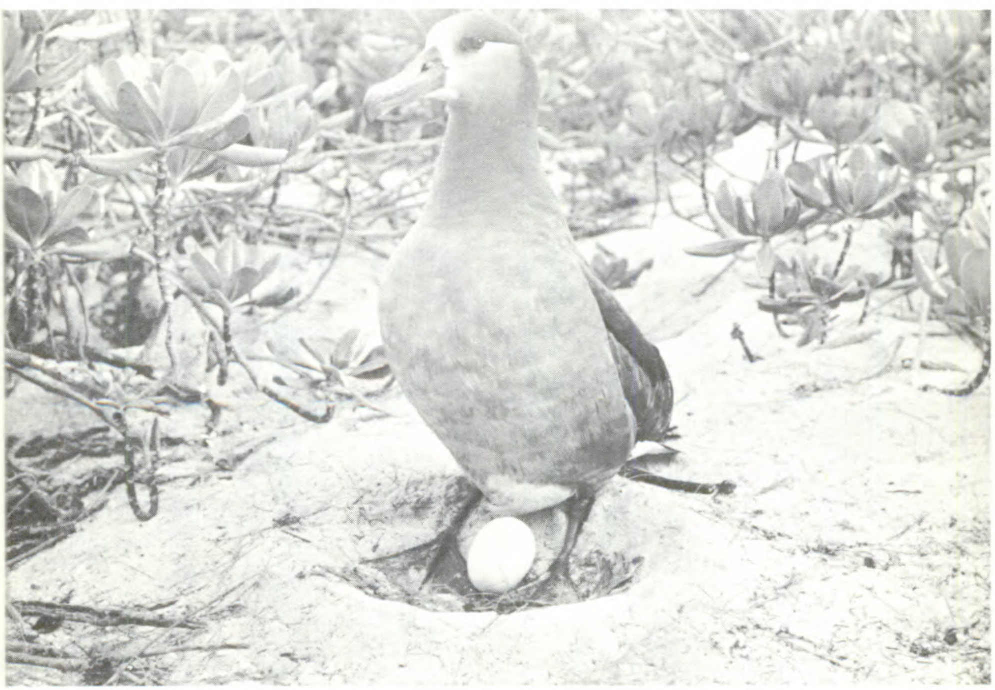


Figure 1--Black-footed Albatross (Diomedea nigripes) with its egg.

especially critical for newly hatched young birds if the parents are absent. We wished to study the physiological and behavioral adaptations that enable the birds to meet successfully the challenge of an environment such as that found on Midway.

Most of the sea birds have precocial young – that is, chicks that are relatively well-developed on hatching. The eggs require a long period of incubation, and the parents must sit for three weeks (terns) to more than two months (albatrosses) before the egg is pipped (Figure 1). The hatchling is covered with down and is able to move in a well coordinated manner shortly after its emergence from the egg (Figure 2). None of this is surprising as the precocial young of the domestic fowl and ducks are familiar to all, but advanced development at hatching is an essential prerequisite for survival of open-nesting specified on a coral atoll.

By taking continuous temperature records inside pipped eggs, we found that the young bird can maintain its body temperature above that of a cooler environment well before hatching. Incubation by the parents is, of course, needed even at this late stage to bring about full development in normal time, but in some cases of exposed nests the heat of the sun is so great that the parent's function is to shield the egg rather than to apply heat to it. Once hatched, the young birds show remarkable ability to avoid overheating even when exposed to considerable heat stress. For example, Sooty Tern chicks – one day old – maintained a safe body temperature (105.8-109.4 degrees Fahrenheit), despite exposure to direct sun for almost an hour during which black-bulb temperatures reached 114.8 degrees Fahrenheit, a lethal body temperature for small birds. The Sooty Tern hatchlings, incidentally, will go directly to even a small spot of shade and crouch there, taking advantage of every available means to avoid extra heat (Figure 3).

The young terns, boobies, tropic birds, and others keep their body temperature down by extremely rapid panting and the resulting evaporative cooling. The boobies are related to the pelicans and also have a gular (throat) pouch, although it does not approach the size and proportion of that of their larger relative. This pouch is useful in temperature regulation, for during heat stress its moist inner surface becomes more vascular, the bill is partly opened, and the entire pouch is fluttered

Figure 2 – Laysan Albatross (Diomedea immutabilis) with recently hatched chick.

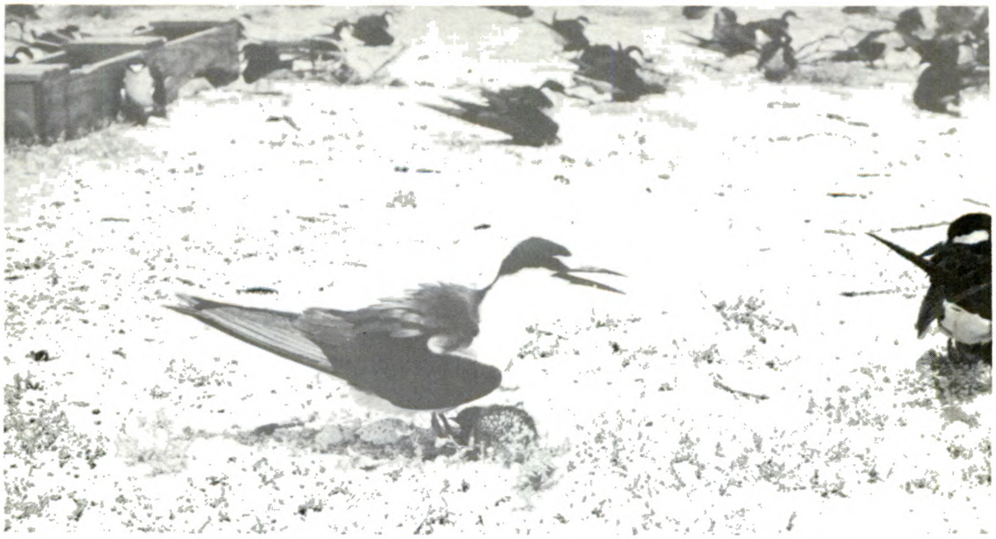


Figure 3--Sooty Tern (Stern fuscata) shading its newly hatched chick.

rapidly. Considerable evaporative cooling is thus accomplished without the necessity of increasing the rate of respiration. We tested the effectiveness of the cooling by sealing shut with masking tape the bills of several nestling boobies and tropic birds that were maintaining normal body temperatures although exposed to severe heat stress (Figure 4). Within a few minutes after panting was prevented, the body temperatures rose rapidly toward the lethal level. The bills were then unfastened, and a few minutes of vigorous gular fluttering brought the body temperatures down into the "safe range" although the environmental heat was as great as before.

The young albatrosses are also precocial, but they hatch in late January or early February on Midway, and are not exposed at an early age to the intense solar heat faced by the summer-nesting terns and boobies. When moved out of their nests, the albatross chicks remain wherever placed; they do not wander in search of shade like the terns, probably because the winter environment is mild enough to permit relatively easy body temperature regulation even in full sun. The young albatrosses, however, are not able to fly and fend for themselves until about six months after hatching, and the "juveniles" are thus exposed to the summer sun later in the year. At this time they may be seen sitting in the open in a peculiar posture, resting on their "heels" with the webbed feet spread and held up in the air (Figure 5). The birds also turn themselves so that the feet are usually in the shade of the their bodies. We found that the foot webbing of the juveniles was well vascularized and that the foot temperature was about 42.8 degrees Fahrenheit higher than that of the surrounding air — and there is

Figure 4--Young Red-Footed Booby (Sula sula) with bill taped shut to prevent evaporative cooling.

almost always a breeze blowing on Midway. Thus, heat is lost from the feet by convection and radiation. The surface of the ground in the sun has a higher temperature than the feet, and if the birds kept their feet on the unshaded ground they would take up heat from the substratum.

Some juveniles crouch on the ground with the feet under them. These seem to be birds that have not moved from the place where they roosted the previous night. The substratum under them, shielded from the sun, is still cool, but the birds' feet have a higher temperature and heat is therefore lost from the feet to the ground.

Figure 5--Juvenile Laysan Albatross resting on its heels with feet raised.

Albatrosses, like boobies, terns, and others, also keep their body temperature down by rapid panting. This long-sustained evaporative cooling involves considerable water loss by the birds, and the manner in which this loss is replaced in regions where there is no available fresh water had puzzled zoologists for many years. The physiologist Knut Schmidt-Nielsen recently discovered that sea birds have a specialized nasal gland capable of excreting concentrated sodium chloride solution. This enables the birds to drink sea water; the excess salt is removed by the nasal gland and drips in solution from the nostrils. Scientists Frings and Frings have recently described the action of this gland in the Laysan and Black-Footed Albatrosses of Midway Island.

Most young birds, however, do not even have access to sea water until they are able to fly. Their diet, as supplied by the parents, includes quantities of marine animals that have a high water content, although the salinity is also high. Apparently the nasal gland functions in young birds also to remove the excess salt and thus keep the tissues hydrated despite the water loss necessitated by evaporative cooling.

In summary, it appears that the nesting sea birds of Midway overcome the stresses of their environment by several means. The attentiveness of the parents protects the eggs and newly hatched chicks under most circumstances. The young birds, however, are capable of avoiding overheating although unattended for unusually long periods. If shade is available, they may move to it. In particular, they utilize rapid panting for evaporative cooling, and juvenile albatrosses also use the large webbed feet as "radiators" for the dissipation of heat. Adults replace the water lost through evaporation by drinking sea water and excreting excess salt from the nasal gland; young birds receive food with a high saline water content and excrete salt in the same way as the adults. Thus, regions that would represent "desert islands" for many animals are populous sanctuaries for those that have evolved the necessary adaptations.

Professor Wilson, Dr. Hoskins, and Dr. Trumbull Receive Navy's Superior Civilian Service Award

The Navy has honored three civilian scientists for outstanding accomplishments in the field of research. In ceremonies on August 16, RADM Rawson Bennett, Chief of Naval Research, presented the Navy Superior Award--the Navy's second highest recognition of civilian achievement--to Professor Edwin B. Wilson, Dr. Roy G. Hoskins, and Dr. Richard Trumbull.

Professor Wilson, a General Sciences Consultant to ONR's Branch Office in Boston, was chosen for his part in the successful planning and organization of research programs in behalf of ONR and the Navy. He was also cited for his "immeasurable contribution to the welfare of the Navy and the Nation." He has been a Professor of Mathematics at Yale University and Professor and Head of the Physics Department at M.I.T., and is now Professor of Vital Statistics, Emeritus, at Harvard University. Professor Wilson has been continuously serving ONR in his present capacity since 1948.

Dr. Hoskins, a Biological Sciences Consultant, ONR, Boston, received the Award for his outstanding contributions to the establishment and continuation of a significant research program in the biological sciences under Navy sponsorship. He has held positions at Starling-Ohio Medical School, Northwestern University Medical School, Ohio State University, Harvard Medical School, Memorial Foundation for Neuro-Endocrine Research in Boston, Worcester State Hospital, Tufts University Medical School, and Boston State Hospital. Dr. Hoskins has also been serving ONR continuously in his present capacity since 1948.

Dr. Trumbull, Head of ONR's Physiological Psychology Branch, received the Award for his part in the direction and development of an outstanding and dynamic research program in physiological psychology that is well recognized throughout the United States, Canada, and Europe. He has been an instructor at Green Mountain Junior College, Pultney, Vermont, and Syracuse University, and served on active duty with the U. S. Navy from 1943 to 1946 and from 1951 to 1953. Dr. Trumbull has been serving continuously with ONR since November 1953.

ONR's Shark Research Program

S. R. Galler
Head, Biology Branch
Office of Naval Research

The Navy's interest in the problem of developing improved protective measures against shark attack is a broad one. This problem includes not only the measures necessary to protect survivors at sea, but also the protection of underwater swimmers on training or operational missions. In addition, the Navy is concerned with the protection of certain types of experimental and operational equipment against shark attack—for example, the buoyancy equipment used to float recoverable missile nose cones. Of course, the Navy is also interested in protecting beaches at naval facilities set aside for training and recreational use by naval personnel. Closely associated is the Navy's concern with the protection of the civilian populations located in areas which may be under the Navy's administrative control.

During the early stages of World War II, as the need for an antishark agent became apparent, the Navy undertook to plan and sponsor a cooperative research and development shark-repellent program. This effort included scientists from the Naval Research Laboratory, the Fish and Wildlife Service, and the Woods Hole Oceanographic Institution. As a result of this program, a shark repellent was developed and packaged, and field trials were carried out off the southeastern coast of the United States and in other areas. The field observations indicated that the shark repellent, which, incidentally, consists of copper acetate nigrosin dye, was often quite effective in deterring sharks from attacking bait known to be attractive to these animals. The repellent was later incorporated into survivor kits and has been used by naval personnel up through the present. So much for the historical background.

The Navy's World War II shark repellent is also manufactured commercially. However, it would appear that in spite of its general effectiveness, sharks sometimes attack persons using it. Unfortunately, reliable data is not currently available to determine the conditions of the shark attack, or whether the victim was using the repellent in the correct manner. This fact, plus the continued evolution of an increasing variety of equipment and underwater operations of various kinds susceptible to shark attack, led to the decision of the Office of Naval Research to activate a shark research program aimed at the development of new or improved antishark materials, equipment, and techniques. This program, initiated with a symposium held at Tulane University in April 1958, is conducted through the ONR Biology Branch. The symposium evaluated the state of knowledge concerning the biology, geographic distribution, and behavior of sharks as well as the "state of the art" of antishark techniques and agents. Since that time, the Office of Naval Research, in cooperation with the American Institute of Biological Sciences and a number of this country's leading scientists, has initiated a number of research investigations aimed at closing the gaps in our knowledge of sharks, their behavior and habits. This knowledge, in turn, will provide us with a basis for the development of more effective means for controlling their activities.

Shark investigations are currently being sponsored by ONR at the University of Hawaii, the U. S. National Museum of the Smithsonian Institution, Cornell University, the Lerner Marine Laboratory of the American Museum of Natural History in Bimini, Bahamas, and the Fishery Technological Laboratory (U. S. Fish and Wildlife Service) at Boston, Massachusetts. At the coordination level, ONR supports the Shark Research Panel—which was established by the American Institute of Biological Sciences at the request of ONR. The Panel consists of leading American scientists familiar with the shark problem; it is headed by Dr. Perry W. Gilbert of Cornell University. Although the Panel does not include official representation from any Government agency or bureau, it does cooperate fully with any public or private organization desiring its advice or assistance. The primary responsibilities of the Shark Research Panel are to maintain a continuing review of all research activities conducted throughout the world which are pertinent to the shark control problem. The Panel has established communication with competent scientists throughout the United States and abroad and has been helpful in encouraging the development of cooperative shark research projects.

Also, the Panel has undertaken to compile a comprehensive list of all known cases of shark attack and authenticate these cases whenever possible. This has been an undertaking of considerable magnitude. Whenever news of a shark attack case reaches the Panel, a questionnaire is sent to everyone connected with the case who can help authenticate it. As a result of the splendid cooperation from numerous public and private agencies, including the Smithsonian Institution, the Fish and Wildlife Service, state and local police agencies, state and local medical examiners, private physicians, reporters, and, of course, scientists throughout the world, the Panel has succeeded in obtaining useful data about several hundred instances of shark attack. This information is being summarized in a forthcoming book to be published by the Shark Research Panel.

The various ONR shark-research projects follow, with a brief descriptiom of each:

- At the University of Hawaii a project is seeking to determine the behavior and sensory responses of Pacific Oceanic species of sharks to various chemical and physiological agents. In addition to research being conducted at the principal laboratory on Oahu, experimental shark pens have been constructed on Eniwetok in order to permit field experimentation and observations on Pacific species of sharks. The principal investigator is Dr. Albert L. Tester.

- Dr. L. P. Schultz, Curator, Division of Fishes, the U.S. National Museum of the Smithsonian Institution, is conducting an ONR research project on the geographical and environmental distribution of sharks. A repository for specimens of sharks has been established in connection with the project. And Dr. Schultz, in his capacity as Secretary of the Shark Research Panel, has established a file at the Smithsonian Institution where all shark attack records of the Shark Research Panel are maintained.

567419 O - 60 - 2

● Dr. Perry Gilbert of Cornell, in addition to serving as Chairman of the Shark Research Panel, is the principal investigator of ONR's project, "Research on the Structural and Functional Biology of Sharks." The project attempts to determine the sensory mechanisms utilized by sharks to detect and "home in" on its prey.

● Dr. Henry Kritzler is the principal investigator of ONR's project, "Studies of Shark Behavior Under Field Conditions," at the Lerner Marine Laboratory of The American Museum of Natural History, Bimini, Bahamas. The project is designed to maintain a field research facility for use by scientists engaged in investigations of Atlantic species of sharks. The facility consists of a unique system of shark pens designed to permit field trials of shark repellents. In addition, there is an operating pen where scientists can anesthetize very large sharks and perform necessary surgical procedures upon them. Afterwards, sharks are returned to an observation pen where post operative reactions and behavior are noted.

● At the Fish and Wildlife Service's Fishery Technological Laboratory, in Boston, Dr. M. A. Steinberg is the principal investigator for an ONR project that undertakes to discover and isolate substances from decaying shark meat as well as from other sources which appear to show promise as repellents. These substances are then made available to other scientists for laboratory and field tests against sharks.

Two of the nation's leading scientists, Dr. W. H. Brattain and Dr. Harvey Brooks, have been appointed to vacancies on the Naval Research Advisory Committee (NRAC) by the Secretary of the Navy. Dr. Brattain is a member of the technical staff of Bell Laboratories and was a co-winner of the Nobel Prize in 1956 for his work leading to the development of the transistor. Dr. Brooks holds a position at Harvard University in the Division of Engineering and Applied Physics.

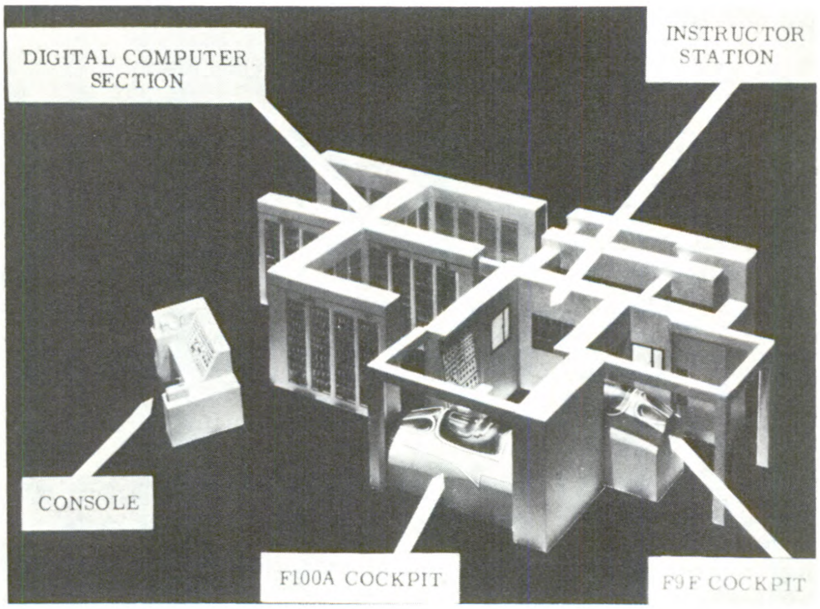
Present membership of the Committee includes such internationally-known scientists, engineers and administrators as Dr. C.G. Suits, Vice President and Director of Research, General Electric Company, who is Chairman of NRAC; Dr. C. C. Furnas, Chancellor, University of Buffalo; Dr. T. Keith Glennan, Director, National Aeronautics and Space Administration; Dr. A. B. Kinzel, Vice President - Research, Union Carbide Corporation; and Dr. I. I. Rabi, Department of Physics, Columbia University, also a holder of the Nobel Prize.

Since its establishment in 1946 when the Office of Naval Research was created, the Committee's objective has been to translate the requirements of naval science into a broad research and development policy. The technical knowledge and management experience of its members are utilized in three ways: in realizing the most from research funds, in deployment of research personnel, and in optimum utilization of the nation's research facilities.

The Committee recently issued the first research study ever made on basic research in the Navy. Prepared under contract with the Arthur D. Little Company of Cambridge, Massachusetts, the report emphasized the continuing importance of basic research to the Navy in insuring a constant flow of new scientific product from the laboratory into operational use.

TDC's New Computer-Type Flight Trainer

A highly sophisticated adaption of the computer technique to flight training was demonstrated by ONR's Training Devices Center on September 13. The device is called UDOFTT, for Universal Digital Operational Flight Trainer, Tool. After seeing what the trainer can do, RADM Rawson Bennett, II, Chief of Naval Research, said "[It] is the most versatile device in existence today and one that is expected to be the forerunner of an entirely new family of training devices."



Mockup of UDOFTT

In the demonstration, a "flame out" emergency was introduced into a simulated Air Force F-100A Super Sabre jet flight by an instructor outside the cockpit. When this engine failure was introduced into UDOFTT, the pilot of the simulated flight, CDR John H. Bahlman, cut off all electrical circuits while the supersonic jet descended from 15,000 to 7000 feet, restarted his engine in midair, and brought the plane in for a safe landing. Each operation was performed under realistic conditions within UDOFTT's sealed F-100A cockpit. (See inside back cover.)

With the UDOFTT digital system, complete mathematical representations of the characteristics of the aircraft to be simulated are transferred through punched cards into the computer's magnetic core memories. Thereafter, manipulation of the plane's controls provides new information to the computer, which then computes the equations of motion and activates the instruments in the cockpit to correspond to the plane's "actions." UDOFTT may be changed to simulation of another vehicle type by simply processing punched cards on that vehicle into the computer. This represents a distinct advance in the art; although individual special-purpose analog computers have been used for flight simulation in recent years, they are restricted—without substantial modification—to simulation of a single aircraft. The new computer operates at a rate of more than 200,000 operations per second. It thus provides a flexible system with "real-time" capability—the ability to respond instantaneously to the commands of a student pilot within the cockpit or an instructor at an external control panel.

The importance of the new device, and the story of its development, are brought out in the following statement by the Chief of Naval Research.

"With the advent of jet aircraft at the end of World War II, we entered a new era of aviation. Although the impact was not felt immediately, the hot pilot who could fly by the seat of his pants began to become obsolete. As we crashed through the sonic barrier and headed for higher Mach numbers, military aircraft became more complicated to fly and more expensive to build. In direct proportion to this increase, the training program for a jet pilot also became more expensive and especially more time-consuming.

"It soon became obvious that the safety of the pilot as well as the protection of his costly aircraft meant that we must train the pilot as thoroughly and as realistically as possible to fly his airplane before he ever left the ground. We had to rely more heavily on synthetic flight trainers and simulators.

"Both the Navy and the Air Force turned to the Naval Training Device Center, which since 1946 has developed thousands of different types of training equipment at its Long Island site for all three services. NTDC produced a whole series of operational flight trainers which trained pilots more quickly and thoroughly on the ground at a fraction of the cost of using aircraft as trainers.

RADM Bennett

"Another problem arose, however. Building a flight trainer for each individual type of aircraft takes time and is expensive. Although the initial cost is amortized by the savings in the training program, the amazing progress in our technology in the postwar years has increased the rate of obsolescence of modern military aircraft. Therefore, the flight trainer for the individual aircraft was also subject to rapid obsolescence.

"The logical answer was to build a universal flight trainer which could be readily adapted to train a pilot to fly any type of aircraft either currently operational or which might be designed in the future. There was no way of adapting current equipment since what was needed was a new large-scale digital computer capable of great flexibility, speed and accuracy.

"This universal trainer has now been achieved in the way that most major advances have been accomplished in the postwar era. First of all, any new breakthrough must be preceded by a long period of basic research usually at a university. In this case, the Universal Digital Operational Flight Trainer, Tool (UDOFTT), was evolved after 6 years of basic research at the University of Pennsylvania under an NTDC contract.

"Then an industrial organization must be found willing to tackle the unprecedented problems involved in a major new development. We were fortunate in finding an aggressive company such as the Sylvania Electric Products, Waltham, Mass., a subsidiary of General Telephone and Electronics Corporation. Finally, the program was assured of success through interservice cooperation. The $2 million program for the final development of UDOFTT was supported jointly by the Navy and the Air Force. It is certain that this joining of forces by the two services speeded up this day that has now arrived.

"In UDOFTT we have today the first jet trainer simulator to use a high-speed digital computer system. More than that, its unmatched versatility marks it as the forerunner of an entirely new family of training devices. This development comes none too soon as man prepares to pilot himself through the unknown vastness of space."

FIRST OF A NEW CLASS OF FLEET BALLISTIC MISSILE SUBMARINES

The first of a new class of nuclear-powered ballistic missile submarines will be named USS LAYFAYETTE in honor of the French marquis who joined the Continental Army during the American Revolution. The LAFAYETTE will be built at Groton, Conn., and will be the lead ship in the third class of fleet ballistic missile submarines. It will be designated SSB(N) 616.

There are now two POLARIS submarines in commission. They are the USS GEORGE WASHINGTON and USS PATRICK HENRY. Both will be ready for operation this year, each carrying 16 solid-fuel, 1200-mile nuclear missiles. The GEORGE WASHINGTON has successfully fired four POLARIS test vehicles. Three travelled more than 1100 miles down the Atlantic Missile Range. The fourth was launched successfully on August 1, but was destroyed by the Range Safety Officer after it developed a malfunction during the first stage of powered flight.

Ryan Electronics, San Diego, Calif., has been awarded a BuWeps contract to incorporate recent advancements into earlier models of the Doppler aviation equipment. The equipment being modified is a helicopter hovering and ground velocity indicator that automatically and continuously measures and displays drift, heading, ground, and vertical speeds without the aid of ground stations, wind estimates, or true air-speed data.

SKYHOOK-Aerotriever System Operations Conducted by NADU

The present SKYHOOK technique here described was developed by Mr. Robert Fulton, Jr., under contract to the Air Programs Division of the Office of Naval Research. The program was undertaken because it was realized that modern long-range aircraft have created their own air-sea rescue requirements; that is, pilots might be downed in distant and inaccessible places that can be reached quickly only by long-range, fixed-wing aircraft. On August 12, 1958, Staff Sergeant Levi W. Woods, USMC, was the first volunteer to be picked up from the ground and winched aboard a marine P2V aircraft using this system.

HOW SKYHOOK WORKS

A buoyant drop-container, rescue packet is parachuted from the aircraft to the person on the surface, who then readies it for the pickup operation. The rescue packet has been made very simple in design so that even injured personnel can manage it by following the easy to read instructions. The packet contains a harness which first comes out of the packet and is put on like a pair of overalls. The harness is attached to a 500-foot, high-strength, nylon lift line which is attached to a balloon. The balloon is already plugged into a helium bottle, so that the person to be rescued has only to open a valve until the balloon is inflated. When the balloon rises to the limit of its tether, the passenger is ready for pickup. The aerodynamic shape of the balloon operates to erect the lift line vertically in wind conditions up to 40 knots.

The aircraft is equipped with a horizontal "yoke" or wide fork extending forward from its nose (Figure 1). In operation, the pilot simply flies a level path upwind, into the lift line, engaging it below the balloon at an altitude of approximately 500 feet (Cover). On contact, the

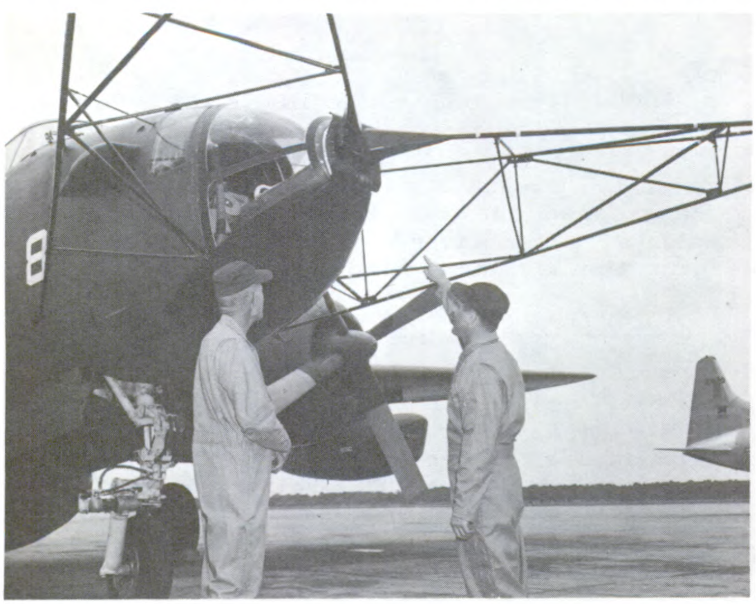


Figure 1--Aircraft equipped with a horizontal "yoke" or wide fork.

balloon tears loose, and the line is locked to the plane by a mechanism in the crotch of the yoke.

Once engaged, the line trails back along the underside of the fuselage. When the person or load picked up has stabilized in flight, a crewman at a rear deck hatch snares the line with a J-hook; then by means of a snatch block and clamps, a loop of the line is brought aboard and secured to a powered winch. The line is then reeled in, and the person or other load is brought into the aircraft through the hatch.

Figure 2–Aerodynamic-shaped ballon.

Because of the geometry involved, initial shock forces are light—much less than those experienced in a parachute jump—and have caused no discomfort in personnel pickups. While easily understood, this is sometimes not readily apparent and is illustrated in Figure 3. In the illustration, AB represents distance of aircraft travel following line engagement, BC represents equivalent load travel. Thus the transition from zero to aircraft speed is gradual, minimizing acceleration forces.

ARCTIC OPERATIONS

In June 1960, the Naval Air Development Unit (NADU) was assigned the mission of conducting SKYHOOK test operations in the Arctic. Following installation at the Overhaul and Repair Department, NAS, Quonset Point, the aircraft was delivered for testing on August 2. Then, after only three days of crew familiarization, the P2V departed for Point Barrow, Alaska, on August 6. There the project test schedule was arranged by Mr. Max Brewer, Director of the Navy's Arctic Research Laboratory. Tests consisted of six pickups designed to evaluate the equipment under a variety of conditions. Pickups were made of inert loads only; no lifts of personnel were attempted.

The first pickup was a demonstration for the scientific community at Point Barrow, and was completed successfully despite rapid weather deterioration immediately after takeoff. On this occasion line engagement was completed even though the ground was hidden by a fog bank which had rolled in, obscuring to the pilot all but the balloon floating above.

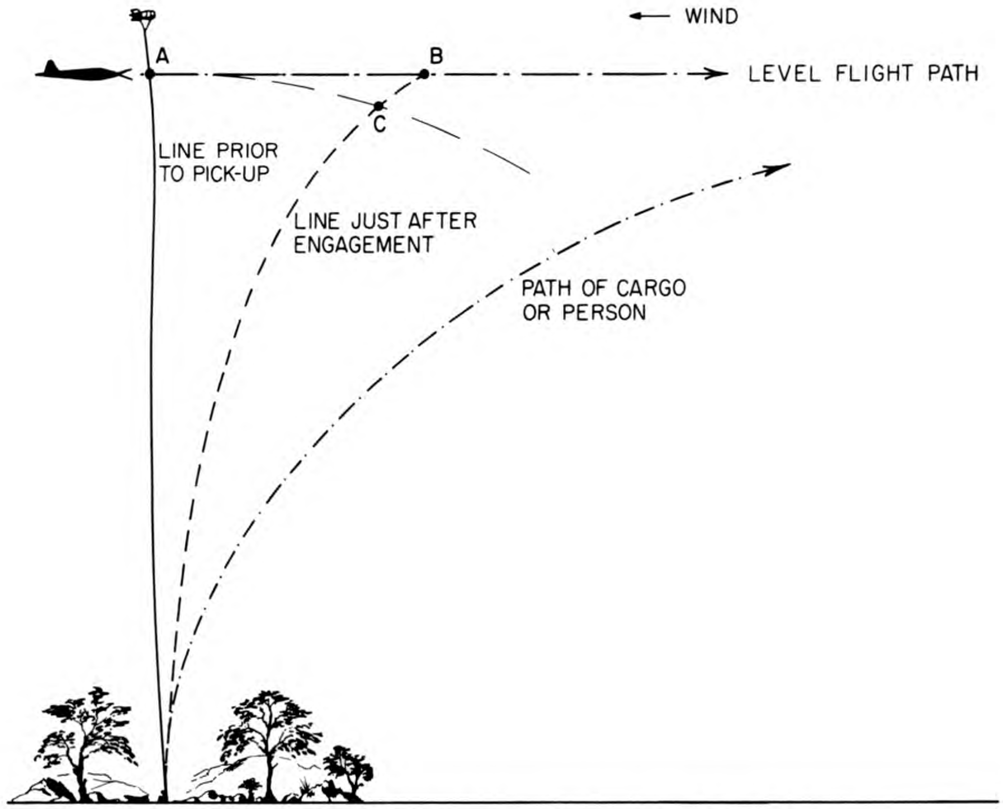


Figure 3--Geometry of air retrieval by SKYHOOK.

Subsequent pickups were all successfully accomplished as follows:

- Two pickups of mail from Floating Ice Island T-3.

- Pickup of such artifacts as mastadon tusks from an archaeological party on the tundra.

- Geological samples were picked up from Peters Lane Camp.

- A pickup was made from the deck of the icebreaker USS BURTON ISLAND. In this instance, a buoyant pickup package was dropped into the sea where it was recovered by ship's boat. After delivery to the ship, the balloon system was activated from the deck.

IN CONCLUSION

The demonstrated success of Project SKYHOOK additionally provides a capability for logistic aerial pickup to speed delivery of equipment and materiel from ship-to-shore or from ship-to-ship over great distances. Inert loads up to 400 pounds have been successfully picked up in earlier tests. It appears quite feasible for future development to consider 1000-pound-load pickups.

In addition to the NADU installation described, the Bureau of Naval Weapons has supported a now completed SKYHOOK installation in a P2V of Naval Air Development Squadron Six. This will facilitate a mission capability of VX-6, which includes the conduct of search and rescue in forthcoming operations on the Antarctic continent. These developments are being followed with much interest by the U.S. Coast Guard.

CAPT Rodgers

In this article, it is appropriate to commend Mr. Robert Fulton, Jr., of Newtown, Connecticut, who has perfected this system over a period of years. In many cases he has conducted tests with his own plane. In the course of his development work he has supervised hundreds of pickups by military aircraft of instrumented dummies and animal subjects. Through his ingenuity and courage many technical and operational obstacles were overcome to make the present SKYHOOK system development safe, practical, and operationally acceptable.

CAPT Edward A. Rodgers, USN, commanding the Naval Air Development Unit and senior pilot of the P2V, is credited with the expeditious and successful completion of the Arctic tests of the SKYHOOK system. On his invitation, Mr. Fulton accompanied the flight as passenger-observer.

A 60-inch reflector telescope, able to determine the distances and motions of stars as faint as the 18th magnitude up to 100 light years or 600 trillion miles from the solar system, will be installed at the Naval Observatory five miles west of Flagstaff, Ariz., the Navy has announced. The "seeing" capacity of the proposed telescope will increase a hundredfold the ability of man to measure the motion and determine the position of celestial bodies, both natural and artificial. This is the first large reflector telescope designed expressly for astrometric work. It can be used for visual and photographic observations of binary and multiple star systems, and photoelectric and spectographic studies of very faint objects in addition to the determinations of stellar distances. The Navy's new telescope will be housed near the Observatory's 40-inch telescope that is now being used for work in astrophysics and for study of comets.

Research Notes

Signals from Saturn

Two outstanding successes in radio astronomy were reported early in September by the University of Michigan: detection of the first conclusive signals from Saturn, and from a planetary nebula of our own galaxy. The identifications were made by the University's 85-foot radio telescope, which was built with Navy assistance and is being operated under an ONR contract. The findings were reported by Professor Fred T. Haddock, Director of Michigan's radio astronomy program, at the 13th General Assembly of the International Scientific Radio Union in London.

Saturn's atmospheric temperature, minus approximately 280° F, was about that expected on the basis of optical studies. The radio waves were emitted from various depths in the planet's atmosphere. This measurement, at a frequency of three centimeters, may make possible a study of the temperature and density of the rings of Saturn and of the distribution of the gases in its atmosphere. This will require precise measurements at a number of frequencies.

The planetary nebula which was detected is a remote, gas-surrounded dying star. This observation is significant because the source is small and distant--3000 light years away—and radio emission from a planetary nebula had not been definitely detected before. Optical and radio observations of nebulae of this type can help astronomers to determine how stars age and die and possibly how planetary systems are formed. Radio astronomical observations of the planets will provide basic information to be used later by space-probe instrumentation and by manned vehicles.

RV ARGO's Itinerary

The Research Vessel ARGO, of The University of California's Scripps Institution of Oceanography, as of August 23, is on the first leg of its Monsoon Expedition that will last until early March 1961 and take the ship across the Pacific and Indian Oceans almost to the coasts of Africa. This Expedition is the longest yet undertaken by the Scripps Institution ARGO, the largest ship she has operated. (See NavResRev, Sep/60, pp. 18–20.)

Chief Scientist aboard ARGO for the initial phase of the expedition will be Dr. George G. Shor, Jr., Associate Research Geophysicist. Dr. Shor will lead the scientific party until it arrives in Darwin, Australia on September 29. His place will then be taken by Dr. Tjeerd H. Van Andel, Associate Research Geologist, who will direct studies in the waters near Darwin. On October 19, Dr. Robert L. Fisher, Assistant Research Geologist, will become Chief Scientist, directing the investigations in the Indian Ocean. When the ship reaches Wellington, New Zealand, in January on the way home, Dr. Henry W. Menard, Jr., Associate Professor of Geology, will replace Dr. Fisher as Chief

Scientist. There will be other changes in the scientific party at various ports. The Monsoon Expedition will end with the return of ARGO to San Diego in March of next year.

The work being conducted on the converted oceanographic research vessel, a former Navy rescue and salvage ship, is receiving substantial support from the Office of Naval Research.

Flight Capsule for Subsonic and Supersonic Aircraft

The navy has accepted and approved the design of a mockup of an integrated flight capsule, a detachable aircraft cockpit section which would provide improved environmental and increased escape and survival capabilities at both subsonic and supersonic speeds for pilots of the future. Constructed around the actual cockpit section of an F8U-1 CRUSADER, the capsule mockup illustrates the equipment to be perfected in the four-phase program the Navy has contracted with Chance Vought Aeronautics on Project OSCAR (Optimum Survival Containment and Recovery).

A number of advanced features to improve the pilot's efficiency have been designed into the capsule. It provides a "shirt sleeve" environment which permits the pilot to ride unencumbered by protective equipment such as pressure suit, oxygen mask, life jacket and survival gear. A life support system, envisioned for the capsule, will be manufactured to provide the oxygen concentration and cockpit pressurization necessary for the pilot at all altitudes without pressure suits or oxygen masks. It would provide him a safe means of emergency escape from his aircraft at supersonic speeds where an ejection seat is not adequate protection. Advanced systems of cockpit displays and pilot controls have been incorporated to simplify his tasks. The pilot will ride in a nearly horizontal position, which increases his resistance to gravitational forces without the use of conventional "G-suits".

While the capsule was under construction, the Navy tested the system of severing the cockpit section from the rest of the plane fuselage by a "belt" of shaped charges. The Naval Weapons Laboratory at Dahlgren, Virginia, made repeated tests of separating aircraft fuselages on land with such charges. It also successfully cut the capsule section from an F8U CRUSADER while the airplane was submerged in 10 feet of water.

In the event of an emergency during flight, the pilot will separate the cockpit section from the rest of the aircraft and descend to earth by parachutes attached to the capsule. Compartments in the cockpit will contain survival rations, tools, medical supplies and clothing appropriate for the hot or cold areas where he is flying. He will remain in the capsule on land or sea, sending out rescue messages.

Project OZARC

The Navy will launch small high-altitude rockets to measure ozone 45 miles above the earth in a study of upper atmosphere air circulation during a test to be conducted at the Pacific Missile Range this fall. The project will be called OZARC, the name derived from ozone and ARCAS, the name of the rocket being used. Ozone is a form of oxygen found mainly between the heights of about 6 to 30 miles. The rockets will be launched from Eniwetok Atoll and the island of Kauai, Hawaii.

The ozone-detecting instruments will be located in the rocket's nose cone. The presence of ozone in the atmosphere and the ease with which it can be detected make it an ideal "tracer" for the study of large-scale circulation patterns which may extend over half the earth's surface. The placing of launch sites on widely spaced islands will enable scientists to determine something of the nature of these circulations. In addition, the ozone concentration data is expected to provide some information concerning the composition of the atmosphere.

The nose cones will be carried to an altitude of about 45 miles by a small single-stage solid propellant rocket motor called ARCAS. At trajectory peak, the rocket motor and nose shell will be discarded and the instruments lowered through the atmosphere by a 15-foot parachute. During descent, the measurements will be made and the data radioed to ground receiving and recording stations. The parachutes will be made of silk, coated with a thin layer of silver so they can be tracked by radar. The radar tracks will yield information and some additional information concerning winds. The project is sponsored by the Office of Naval Research and is being supported by the Pacific Missile Range.

NESEP: The Navy Enlisted Scientific Education Program

Despite the wisdom of the adage, "Don't hide your light under a bushel," the light is not always apparent to those who possess it. Be the reason humility, unawareness, laziness, or lack of inspiration and confidence, the fact remains that many talents lie dormant unless kindled by a productive idea. Ideas are often sparked by crises. So it was in 1957 when the Navy, confronted with a compelling need for a greater number of scientists and engineers, established the Navy Enlisted Scientific Education Program (NESEP).

Foresighted leaders were convinced that among the enlisted personnel of the Navy and the Marine Corps, there were men and women who possessed the intelligence and ability to earn a college degree in science or engineering and a commission in the U. S. Navy and U. S. Marine Corps. The conviction proved to be a true one: the academic achievement of the 143 Navy and Marine Corps students during their freshman year in college was so outstanding that in 1959, the college program for enlisted petty officers, established in 1956, was incorporated within the NESEP. The combined program is now a significant source of officer career potential. The enrollment in NESEP is approximately 200 men annually in 23 universities. It is noteworthy that the success of the program to date is attributable in large part to the maturity which these enlistees developed while on duty with the Navy, a fact to which both students and faculty members have attested.

To qualify for college enrollment, the applicant must attain a high score on the special entrance examination, must be selected by a screening board of 12 officers, and must successfully complete a prescribed 9-week's course at one of the Navy's two summer preparatory schools. NESEP students attend full summer sessions at the universities. This enables them to enrich the scope of their education through elective courses. Choice of a foreign language is not uncommon and contributes to the development of the whole man concept of education.

The question is often asked, "Why didn't these bright young men enter college after high school?" Not a few of these enlisted men were little impressed with the importance of studies during their high school years, despite the fact that they were endowed with superior intelligence. Others could not afford a college education. Some were not guided toward the subjects which would qualify them for admission to college. It is to the everlasting credit of the Navy, through its faith and vision, that the decision was made to salvage these brains for a purposeful objective. It was believed that Naval service had matured many of these young men and that their enrollment in service schools had filled gaps in their knowledge. The next step was to sell the idea to the colleges and universities. Without the successful college placement efforts of the Navy, NESEP could not have been implemented. University officials were initially skeptical; today they are unequivocally enthusiastic, as evidenced by their letters to the Secretary of the Navy.

While it is too early to cite the specific contributions which these young scientists and engineers are making to the Navy and to the country, it is not too soon to state that among the number of graduates to date over 50 percent have been assigned to newly commissioned guided missile frigates and missile testing ships. It is heartening to witness the careful selectivity in the assignment of these officers to billets which utilize their proven capabilities.

NESEP offers to each Commanding Officer in the Navy an extraordinary opportunity for personal leadership: his encouragement of eligible men of outstanding ability to compete for a college education and a commission may not unearth an Einstein - immediately, but no successful applicant will be inclined to forget such recognition of his talents.—CDR Rita Lenihan, USN, NESEP.

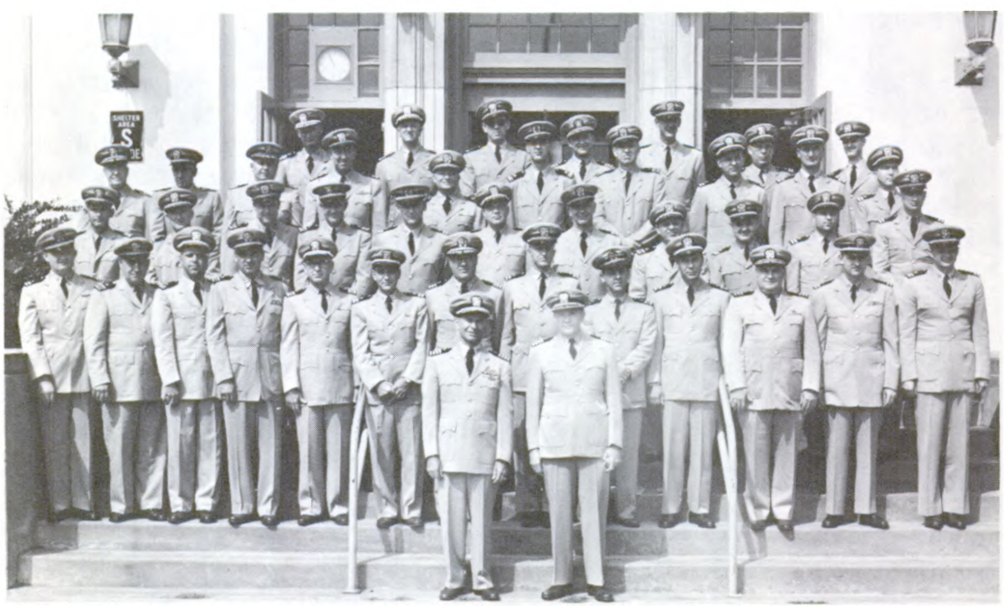
On the Naval Research Reserve

Seminar Held at NRL

The Eighth Annual Naval Reserve Research Seminar was held at the U. S. Naval Research Laboratory, Washington, D. C. from August 14 to 28, 1960. The 42 officers who atended were welcomed to NRL by the Laboratory's Director, CAPT A.E. Krapf, USN, who introduced the Chief of Naval Research, RADM Rawson Bennett, USN. RADM Bennett reviewed the latest naval research projects and their applications.

Naval Reserve Research Company 5-9, headquartered at NRL, arranged a luncheon for the opening day. LCDR C. F. White, USNR, Commanding Officer of NRRC 5-9, introduced the guest speaker, CAPT J. W. Jockusch, Special Assistant of the Chief of Naval Research (Research Reserve), who discussed current legislation affecting the Naval Reserve.

Talks and demonstrations were arranged by each scientific division of the Laboratory—Applications Research, Atmosphere and Astrophysics, Chemistry, Electronics, Mechanics, Metallurgy, Optics, Radiation, Radio, Solid State, and Sound. Included were tours of the 5-Mev Van de Graaff Generator and the NRL Reactor Facility. In addition, the Engineering Services Division presented a review of the services they render. One day was spent at NRL's field station, 40 miles below Washington on the Chesapeake Bay, where the reservists saw some of the practical applications of NRL research.



Officers attending the 8th Annual Naval Reserve Research Seminar at the Naval Research Laboratory

Retirement Points for Speeches at Other Reserve Company Meetings

A recent change in instructions from the Bureau of Naval Personnel authorizes Commandants to issue appropriate duty credits (one retirement point per meeting) to "individual reservists for the conduct of training periods for a company which is other than the member's own unit." For further details, see BuPers Instruction 5400.1I.

NOTICE

There is a change in the title and date of the Aviation Medicine Seminar scheduled to convene at Pensacola, Florida. The title is now "The Research Reserve Seminar in AEROSPACE Medicine," and the date has been advanced to 12 March 1961. This seminar was listed in the March 1960 issue of Naval Research Reviews and scheduled originally for 19 March 1961.

Naval Reserve Research Company 12-2 Presents Nuclear Seminar

Over sixty reserve officers attended the Nuclear Weapon-Nuclear Explosive Seminar at the Naval Base on Treasure Island, San Francisco, California, on 20-21 August 1960. Reserve officers under training duty orders from the Navy, Army, and Air Force came from as far as Utah, and many from Research Reserve Companies in the San Francisco Bay area were in attendance. Among the civilian professions represented were physicists, engineers, university and high school teachers—all of whom provided a stimulating cross section of ideas during the Saturday and Sunday sessions.

The seminar was originated and programmed by Naval Reserve Research Company 12-2 (Livermore, Calif.) under the direction of the Commanding Officer, CDR Carl E. Schweickert, USNR. LCDR H. A. Wellemeyer, USN, Reserve Assistant at ONR's San Francisco Branch

Participants in the Nuclear Weapon-Nuclear Explosive Seminar

Office, helped in coordinating the seminar with supporting officers of Headquarters, Twelfth Naval District.

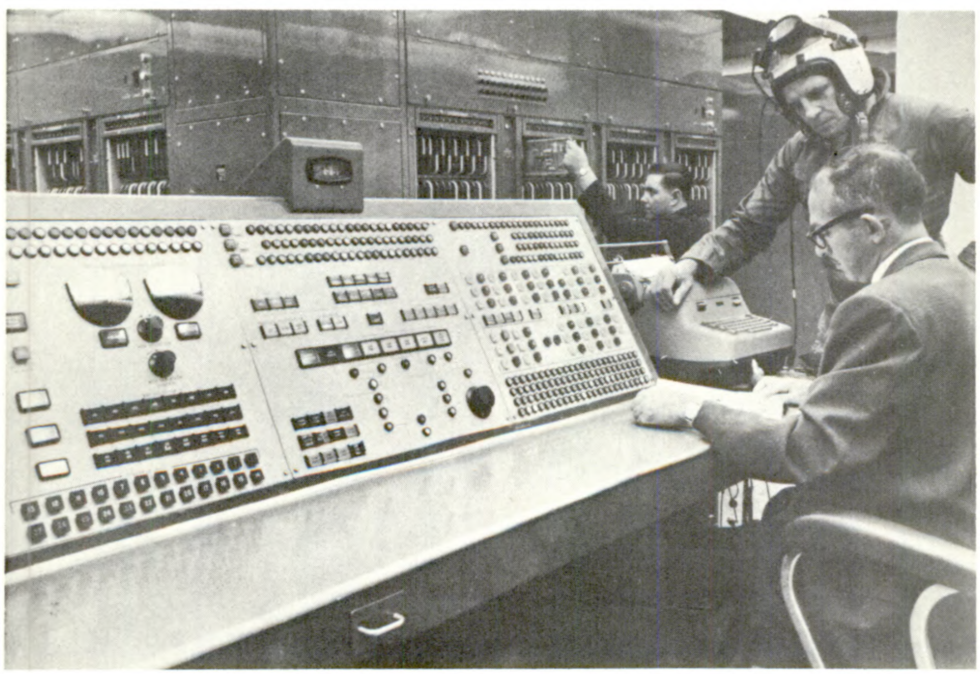
Saturday's session was on the "Detection and Identification of Clandestine Underground Nuclear Tests." It was chaired and opened by CDR Roger C. Preston, USNR, who gave a historical outline which included the conception of a ban on nuclear tests and negotiations at Geneva. Presentations on seismic detection and muffling or disguising underground nuclear explosions were followed by concluding topics covering techniques for determining the exact locations of underground nuclear tests at suspected sites.

Sunday's session, chaired by Lt Col David D. Rabb, was devoted to the "Plowshare Program"—The application of nuclear explosives for industrial and scientific purposes. Speakers presented discussions on the harnessing of nuclear explosives to industrial jobs such as excavation, mining and recovery of natural resources, production of power and isotopes, and ground water control. As pointed out by the chairman, nuclear explosives is a new form of packaged energy, provided in tremendous yields, which exceeds the scope and magnitude of conventional high explosives.

The question periods following the technical presentations permitted attending reservists to take part in the discussions and also served to bring out additional information during both sessions.

Speakers at the New Planning and Management Seminar conducted recently at Princeton University and sponsored by ONR and NRRC 4-1. Left to right: RADM Charles H. Lyman, Jr., USN, Commandant, Fourth Naval District; Assistant Secretary of the Navy for Research and Development, the Honorable James H. Wakelin; and RADM Rawson Bennett, USN, Chief of Naval Research.

U. S. GOVERNMENT PRINTING OFFICE : 1960 O - 567419



Top: Navy Pilot, CDR John H. Bahlman of NAVTRADEVCEN, receives final briefing from Instructor, Erwin Day, Sylvania engineer, prior to taking a simulated supersonic flight in a UDOFTT F-100A Sabre jet. Bottom: The pilot and Milton J. Fisher, Head of the Computer Development Branch, NAVTRADEVCEN, review problems encountered during the simulated flight. Paul Sternberger, Sylvania engineer, inserts a logic card, one of the 2200 that control the arithmetic and logical functions of the computer. (See p. 15.)

IN THIS ISSUE

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. Use of funds for printing this publication was approved by the Director of the Bureau of the Budget, February 12, 1958.

While flying at an altitude of 500 feet, NADU aircraft retrieves the nylon lift line of an aerodynamic-shaped balloon—by means of the horizontal "yoke" or wide fork extending from its nose. See p. 18.