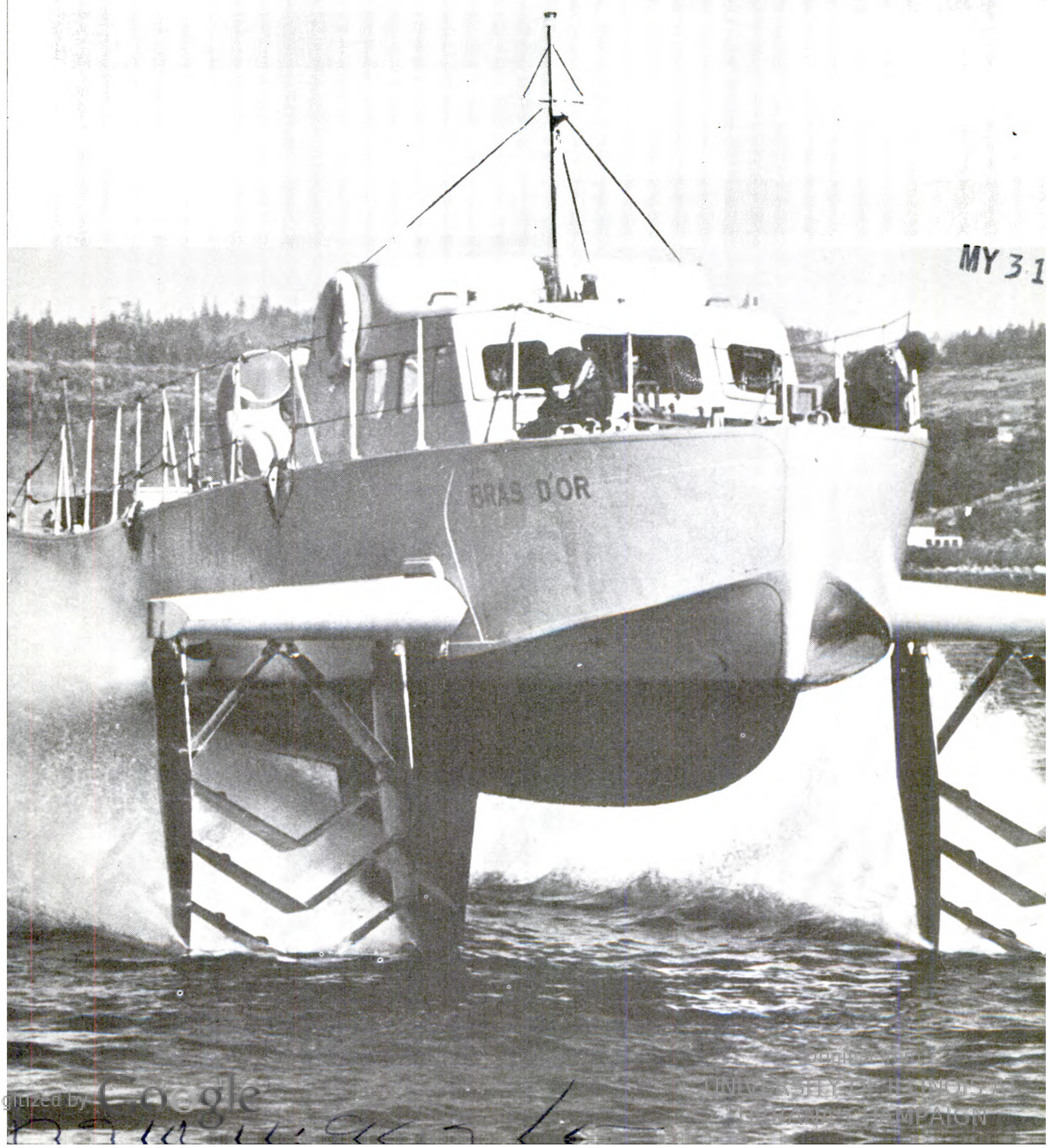
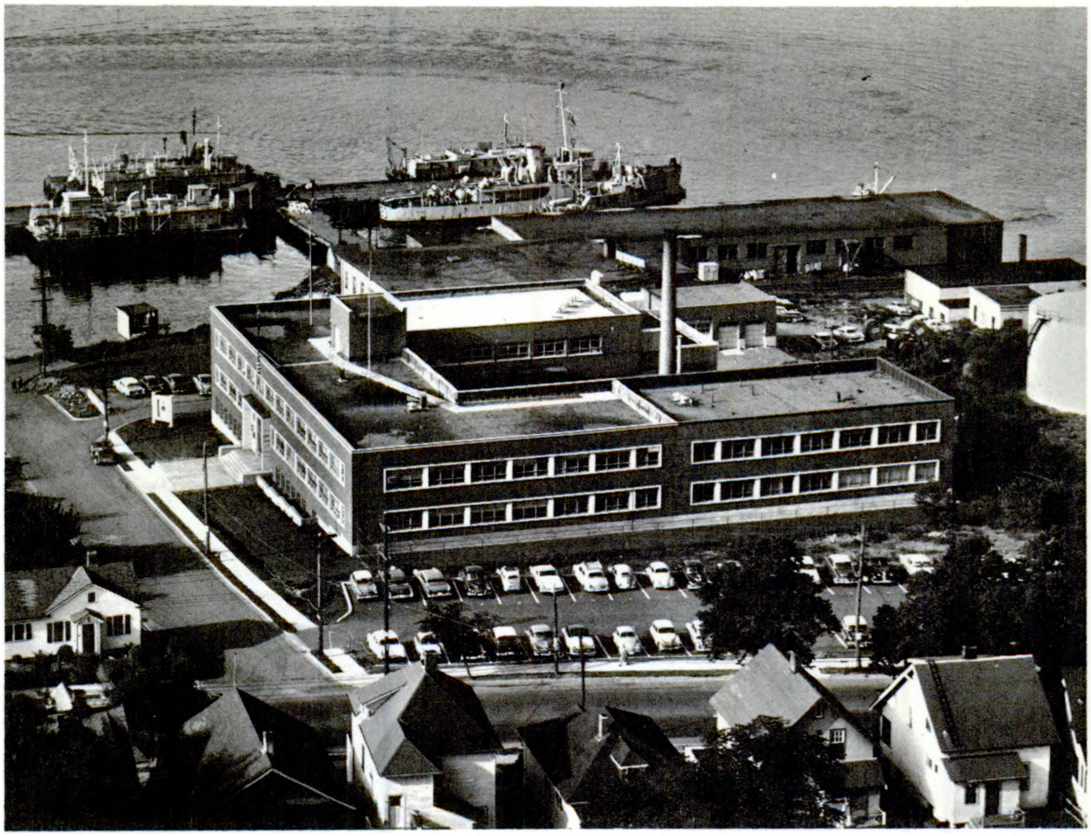
NAVAL RESEARCH REVIEWS

MAY 1962

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH





Naval Research Establishment, Dartmouth,
Nova Scotia

The first organized naval research in Canada—

like its United States counterpart 25 years earlier—was born of wartime necessity to bolster a mushrooming navy caught up in World War II. Faced, early in 1940, with a new and deadly application of science—the German magnetic mine—naval officers and civilian scientists gathered in a garret over a paint shop in the Naval Dockyard at Halifax, Nova Scotia, to tackle the problem of fitting degaussing coils to ships—to any and all comers—of a growing stream heading east across the Atlantic.

Probes used by the Pacific Naval Laboratory for measurement of underwater turbulence. From top to bottom: thermister, temperature microstructure probe, hot-film probe (turbulence), and current meter.

Naval Research in Canada

J. R. Longard
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Scarcely had this small group, working as a detachment of the National Research Council of Canada, set up magnetic ranging facilities when acoustic mines and the acoustic torpedoes were discovered to be in use. Noisemakers were developed for minesweeping, and the ideas they embodied were later employed in the development of the first anti-acoustics torpedo device, an original Canadian design, and sound ranging of ships was commenced. This early interest in underwater acoustics has been continued through success and failure of this day, growing and outlasting the founding nucleus of dedicated workers. In 1943 the group became His Majesty's Canadian Naval Research Establishment, with all scientists in uniform as commissioned officers for easier access to the ships of the large convoys assembled at Halifax.

THE ORGANIZATION

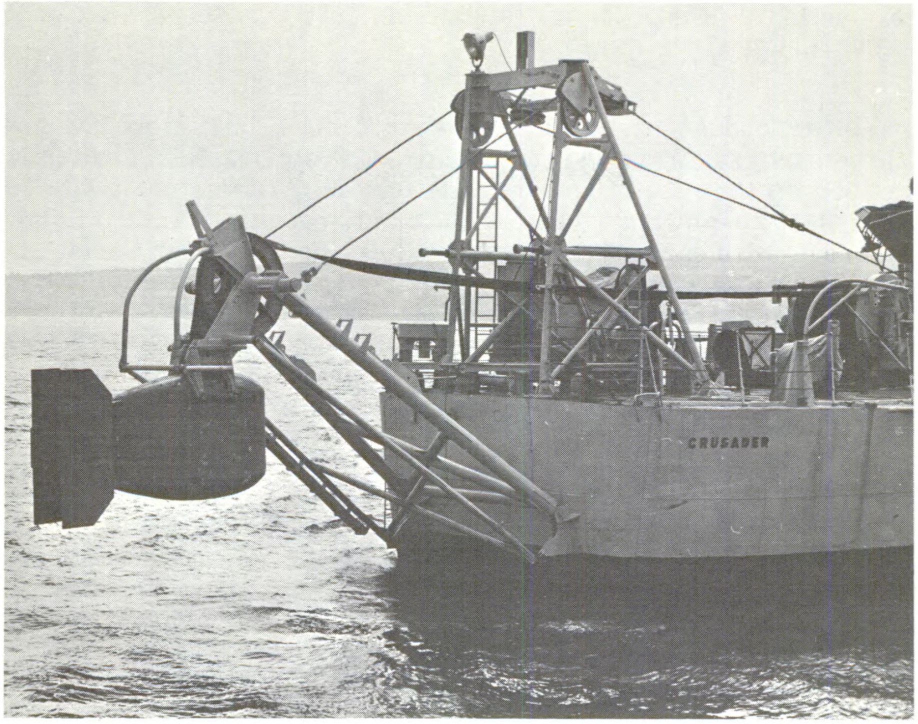
At the end of World War II, it was realized that this and similar laboratories that had proven so valuable to all three Services during war should not be allowed to perish in the violent postwar swing away from war and uniforms, but should be maintained to build up a scientific reservoir of military science should war again threaten. This principle was applied by the formation, in April 1947, of the Defence Research Board (DRB) as a civilian scientific organization within the Department of National Defence to aid all three fighting services.

Progressive consolidation of the wartime laboratories into this new body brought the Naval Research Establishment (NRE) into DRB in October 1947 and the creation of a west coast counterpart, the Pacific Naval Laboratory (PNL), a year later.

DRB is now a scientific complex of eight major specializing laboratories across Canada, and a coordinating headquarters in Ottawa with tentacles reaching into most phases of Canadian scientific life and effort; into major universities in the form of sponsored chairs or research grants; and into other governmental and industrial laboratories with research and development contracts. The research program is carried out in its own laboratories through a separate DRB budget, by agreements with other government agencies, and with industry, sometimes on a cost-sharing basis. Thus naval research, for example, is not the sole preserve of NRE and PNL but is supported in the Canadian Armament Research and Development Establishment, the Defence Research Telecommunications Establishment, the Defence Research Medical Laboratories, the Department of Mines and Technical Services, the Fisheries Research Board, the National Research Council, Canadian universities, and elsewhere.

This coordinated effort, coupled with the Canadian policy of concentration on a relatively few carefully selected research projects rather than dissipating her limited scientific manpower and funds on "across the board" coverage of military science, has proven very effective. The very considerable United States and British scientific help in achieving overall balance is freely and gratefully acknowledged. By drawing on this far larger pool of scientific and technical advice, Canada is able to field fully modern and efficient fighting services.

Front of Pacific Naval Laboratory, Esquimalt, British Columbia



Experimental model of Canadian variable depth sonar on stern of HMCS CRUSADER.

THE PROGRAM

Canada has, up to the present, concentrated almost solely upon the undersea warfare aspects of naval science. RCN, RCAF Maritime Air Command, and DRB as partners in this task, have programs and facilities which reflect this specialization.

THE NAVAL RESEARCH ESTABLISHMENT

NRE, the larger of the two DRB laboratories devoted to the research aspects of undersea warfare, is located on Canada's east coast in Dartmouth, Nova Scotia, just across the harbour from the Royal Canadian Navy base in Halifax.

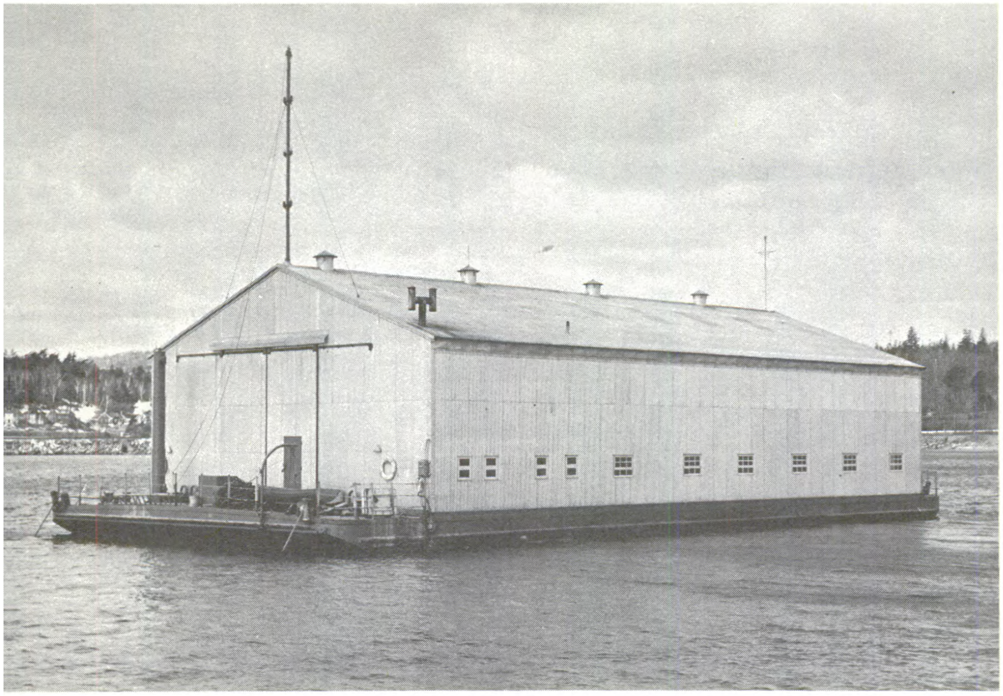
This laboratory, with 150 scientists and technicians plus a supporting staff, specializes primarily in underwater acoustics. To carry on advanced studies in this field, to which it devotes 50 percent of its staff, it maintains excellent calibration and measurement facilities, backed up by electroacoustic transducer research and development, a sophisticated instrumentation pool, and good mechanical design and construction capabilities. Far from being a desk-herding organization, NRE has the full-time use of two sea-going ships and the North Atlantic Ocean on its doorstep. Sea trials for measurement and test are a major activity and Sea State 6 a common working experience that quickly teaches a healthy respect for a difficult and dangerous environment. NRE has completed its development of variable depth sonar, now under evaluation by the RCN, and is going on to other deep-ocean acoustics problems.

NRE had an early start in the hydrofoil craft field and now has three such craft as research vehicles. The original NRE studies started in 1950 with the acquisition from the RCN of a 7.5-ton craft with ladder-type surface-piercing foils. This craft, resulting from official RCN interest commencing in 1947, was named the KCB after Casey Baldwin, a collaborator with Alexander Graham Bell in the hydrofoil pioneering days of World War I. This work has led to the building of the 20-ton Bras d'Or and the extremely useful 3-ton RX craft, with everything adjustable. In 1960 NRE produced a report entitled "All Weather 200 Ton Hydrofoil Craft and their Application in Anti-Submarine Warfare." An engineering feasibility and preliminary design study, based on this report has been conducted by the deHavilland Aircraft Co. of Canada, Ltd., and is now essentially complete—with very encouraging results. The United States is constructing test vehicles both larger and smaller than the one considered by Canada, but by agreement the configurations are radically different. Hydrofoil craft may easily develop a major capability as anti-submarine search and attack vehicles in the near future.

NRE has for years been a leader in the field of cathodic protection of ships' hulls and in anti-fouling paint systems compatible with such protection. Improved methods of electroplating nickel, copper and zirconium to an aluminum base have also been developed. Recently, attention has turned to the possibility of producing low-weight high-strength multi-laminate materials by the use of super-strength metallic films on plastics or sintered metals. Such materials, if successfully produced, would have many important defence applications.

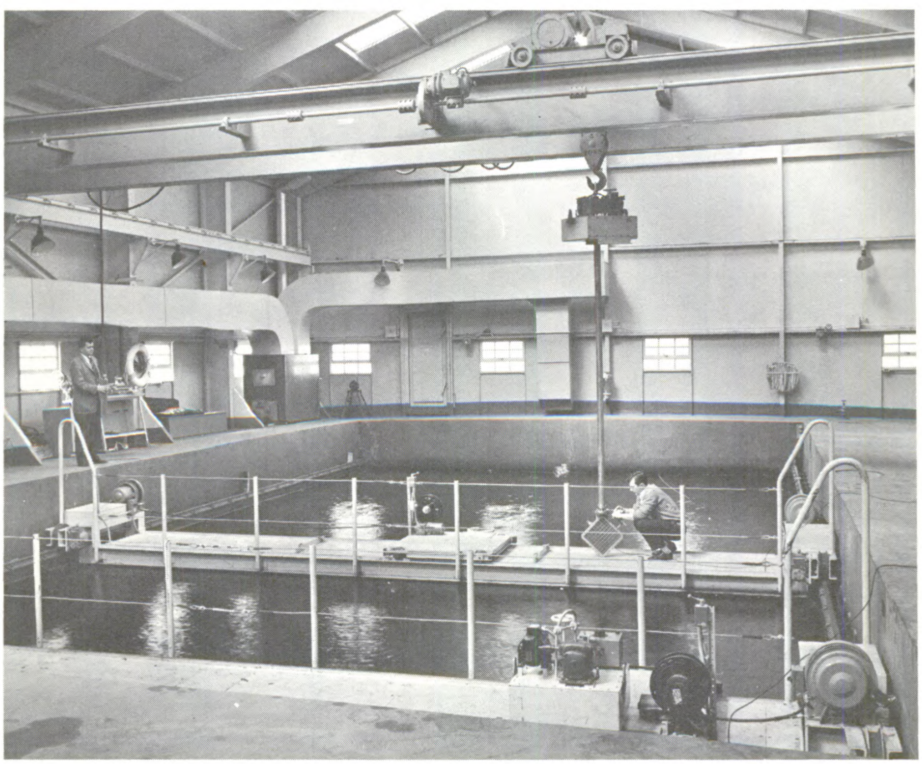
NRE provides the Services in the Halifax area with an increasingly active consultative and measurement service to deal with scientific and technical problems on a day-to-day basis.

Bottom hydrophone and winch used by the Pacific Naval Laboratory for underwater acoustic measurements in the Arctic, set up off Isachsen.



Naval Research Establishment barge used for calibration of underwater transducers.

Interior of Naval Research Establishment transducer calibration barge showing open well and handling gear.



THE PACIFIC NAVAL LABORATORY

PNL, the second of the DRB laboratories oriented toward undersea warfare, is located in the naval dockyard at Esquimalt, B. C., on the southern tip of Vancouver Island. Somewhat smaller than NRE, PNL nevertheless devotes itself to research in several fields of potential application to antisubmarine warfare.

Since its inception, PNL has been actively engaged in underwater acoustics problems of propagation, reverberation and ambient noise, in deep and in shallow waters, at medium and low frequencies. In the field of Arctic acoustics, PNL has now completed three under-ice operations, each relating to a different type of ice cover. Operation PACLABAR, in 1959, dealt with new, relatively uniform shore-fast ice in the Barrow Strait; Operation ICE PACK, in 1961, was carried out under rough polar pack ice in the Prince Gustav Adolph Sea; and a September 1961 operation in M'Clure Strait took place under mixed conditions. These operations, undertaken in cooperation with the Royal Canadian Air Force, the Department of Mines & Technical Surveys and the Department of Transport, were highly successful in measuring propagation and ambient noise. It is very clear from these experiments that the acoustic environment in the Arctic is highly variable and that much more extensive studies are needed.

The PNL program of electromagnetics research is aimed primarily at the detection of and communication with submerged submarines. Recently completed electromagnetic background experiments in the 0.003 cps to 15 kc spectrum in cooperation with Stanford University have shown remarkable correlation between geomagnetic micropulsations measured simultaneously at two high-latitude, magnetically conjugate points—Great Whale River, Quebec (on Hudson Bay), and Byrd Station, Antarctica. These studies promise to throw a good deal of light on the origin and behaviour of extremely low frequency electromagnetic distrubances.

In addition to these and other projects such as the measurement of underwater turbulence, PNL provides an active consulting and technical service for the RCN and RCAF on the Canadian west coast.

OTHER DRB LABORATORIES

The Defence Research Telecommunications Establishment, the Canadian Armament Research & Development Establishment, the Defence Research Chemical Laboratories, and the Defence Research Medical Laboratories have and are making contributions in the areas of their specialities to the field of anti-submarine warfare or to naval science in general. Radar, missile studies, directional explosives, and ship's "citadel" protection against fall-out and biological and chemical warfare are just a few examples of many projects undertaken in these laboratories.

THE ARMED FORCES

The Royal Canadian Navy and the Royal Canadian Air Force Maritime Command both have anti-submarine warfare as a primary responsibility and have appropriate research and development programs. In cooperation with DRB, these services provide and operate research ships and aircraft; help fund some of DRB's research projects; and place numerous research and development projects with industry or other governmental agencies outside the Department of National Defence by contracts or various types.

The RCN is currently operating five research vessels (four 1300-ton and one 800-ton ships) for DRB and other agencies interested in various aspects of naval research. A new 1500-ton ship designed specifically for research will soon be under construction to meet the expanding PNL ocean-going needs.

Projects placed with industry by the RCN and RCAF are generally but not exclusively in the development category and cover numerous fields in the defence equipment spectrum.

Perhaps one half of the projects, however, have strong research aspects and many are undertaken by the National Research Council of Canada (NRC), the Department of Mines and Technical Surveys (DM&TS) or other government agencies. Both NRC and DM&TS have large scientific laboratories covering many fields and have very extensive technical facilities for applied research across the country. Projects range from navigational devices, through electronics to metallurgy and model studies of ship hulls.

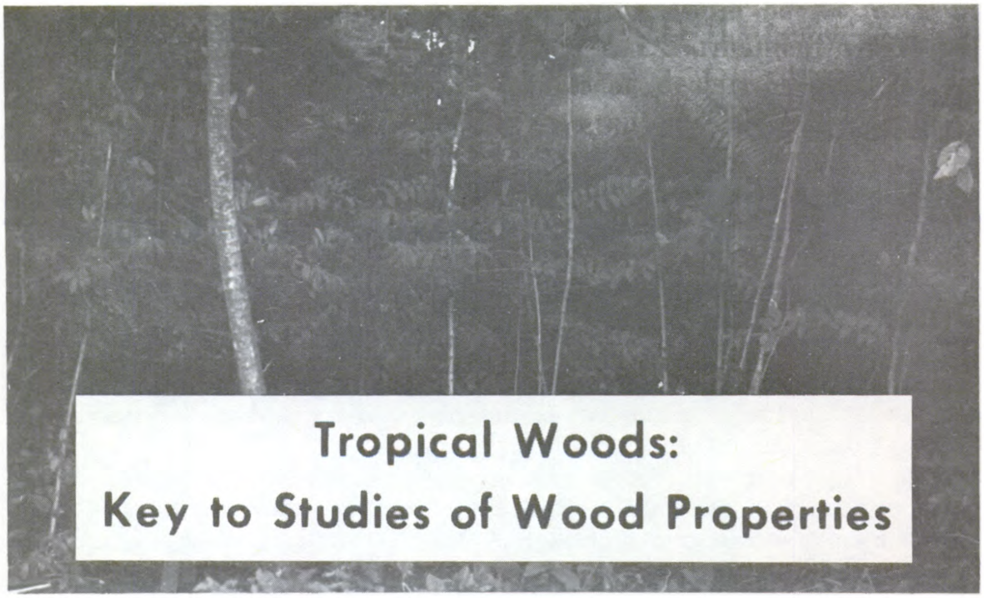
DM&TS expect to open their new Bedford Institute of Oceanography in the summer of 1962. This institution is to employ 300 scientists and to operate several ships in both the military and non-military aspects of oceanographic research, including hydrographic survey and submarine geology.

RCN, RCAF and DRB operational research teams operating within the Service structure have made significant contributions to both Canadian and United States Navy ASW techniques and equipment design.

Canada, by the combined efforts of many organizations, and with the technical aid of her allies, now operates some of the most modern ASW ships and aircraft in the world. Thus the seed which was germinated in a garret two decades ago is bearing fruit and is doing so in the cause of the Free World.

Keel to be Laid

The keel of the ATLANTIS II, the Woods Hole Oceanographic Institution's newest research ship, will probably be laid sometime in June. The 210-foot, $3,876,000 ship will be the first privately constructed ship designed from the keel up for research since the original ATLANTIS was built in 1931. WHOI expects that the vessel will be put into service in the spring of next year. For an artist's conception of the new vessel, see <u>Naval Research Reviews</u>, October 1961.



Tropical Woods: Key to Studies of Wood Properties

Frederick F. Wangaard
Professor of Forest Products
Yale University

Since the dawn of human history, wood has been a basic natural resource. Man has used it in a multitude of ways, and he continues to broaden its applications and to increase the quantities he requires. Surprisingly, however, he has done little to increase his understanding of it. He has subjected metals and plastics and other substances to extensive experiments, but he has all too often tended to take wood for granted, assuming that he knows just about all he needs to know about it.

This attitude is unreasonable because wood is a substance of great variety—the product of a myriad of species growing in forests which cover about one-third of the world's land area—and thus is not easily understood. In some respects all wood is similar, sharing a common skeletal substance called lignocellulose. But in other respects—more important to the people using the wood, and thus to the researcher, too—all wood is different, each species being endowed with a unique combination of characteristics. For example, there are important differences between species in the amounts and types of extractive materials present, such as tannins and gums, and these have a strong influence on some wood properties. Differences in specific gravity affect other properties, this measure of the volume concentration of wood substance ranging from less than 0.10 in light-weight balsa to more than 1.25 in dense lignum vitae. Although the range of most of our better known domestic woods is relatively narrow, lying midway between the extremes given, even slight differences can be significant, resulting in considerable variation in these woods.

Many such factors help to determine the characteristics of wood, and the need for a unified concept of them and of the behavior of wood under various conditions is evident. This is the challenge to research offered by the study of wood properties.

At the Yale School of Forestry, research along this line has been underway for nearly 50 years. During this period, the School has accumulated a wood collection that now numbers more than 53,000 specimens, most of them tropical in origin. This large "library" of woods has served as the basic reference for many investigations. Much of the early work on tropical woods done here involved extensive descriptions of anatomical structure and the classification of thousands of species. A later program, conducted over an 8-year period, concerned the physical and mechanical testing of woods of Tropical America; this study yielded more basic information on the diversified properties of tropical woods than had ever before been available.

Yale's current research on the properties of tropical woods is based on the concept that these woods represent the broadest possible spectrum of characteristics in structure, composition, and density, and that they can therefore serve as a valuable supplement to temperate North American woods in research aimed at achieving a better understanding of the fundamental behavior of wood. This article deals with some of the problems that have been studied since 1955 with support from the Office of Naval Research.

WOOD-MOISTURE RELATIONS

Wood is hygroscopic, picking up or losing moisture with changes in atmospheric humidity. The resulting swelling or shrinking and other responses to changes in moisture content influence most properties of woods. Thus a basic knowledge of wood-moisture relations is essential to an understanding of wood behavior. Until a few years ago, however, most of the fundamental work in this area had been done on only a few species and much of it on the wood of spruce alone. Because of this limited area of investigation, the literature of wood technology commonly gives a percentage figure for the fiber saturation point of wood which is about the same as that of cotton cellulose. This figure, which is expressed as a percentage of the oven-dry weight of wood, is given as 30 percent. Actually, it varies from wood to wood by as much as 15 percent, and perhaps more. This fact was revealed through our studies of highly diverse species, one of which had a fiber saturation point as low as 19 percent, and another as high as 34 percent.

Considering that the fiber saturation point is essentially the upper limit of a continuous relationship between a wood's moisture content and the relative humidity of the surrounding atmosphere when the two are at equilibrium, it is not surprising that our investigations revealed that each kind of wood attains a distinctive moisture content when at equilibrium with a given relative humidity. Below 50 percent relative humidity this relationship was found to be about the same for all woods, but at successively higher levels of humidity, increasing differences among species occurred, culminating at 100 percent relative humidity in the 15 percent difference mentioned previously. The degree to which tannins and other extraneous materials have "bulked" the submicroscopic capillaries in the cell wall is largely responsible for variation in the hygroscopicity of wood.

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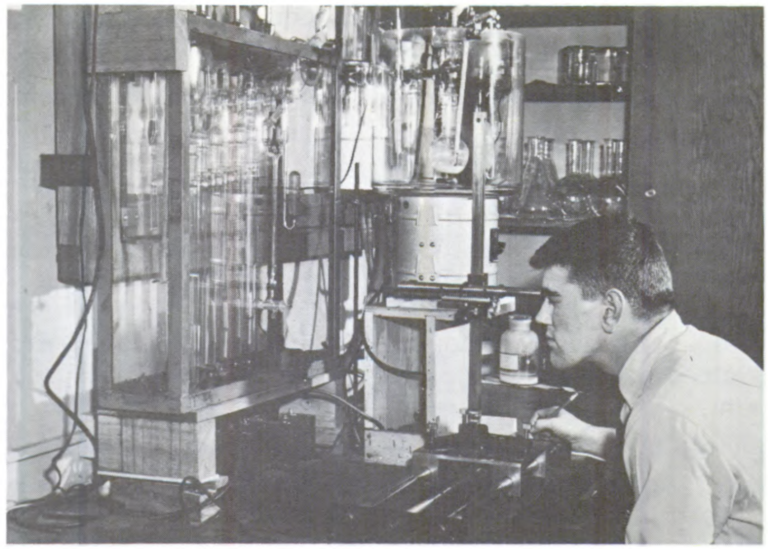
Precise weighing of wood specimens with the temperature and water-vapor pressure controlled.

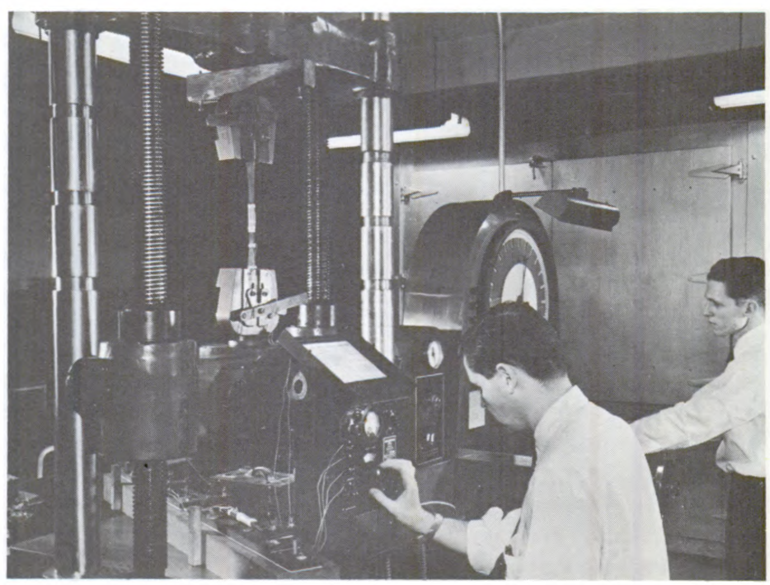


The realization that there is a rather wide variation in the hygroscopicity of different woods has helped greatly in improving our understanding of many aspects of wood behavior with respect to moisture. The unusual behavior of certain individual species—redwood, for example, which loses very little strength on wetting—is now not merely recognized, but also understood. Similar studies of acetylated spruce wood—wood which has been treated chemically to repel moisture—have shown the degree to which hygroscopicity can be reduced by chemical modification of wood, and they also have revealed the nature of the "bulking" mechanism by which dimensional stabilization is attained through such treatment.

TIME-DEPENDENT STRAIN BEHAVIOR OF WOOD

Conventional stress-strain diagrams for wood, based on laboratory tests of a few minutes duration, show a linear, or elastic, range up to

Measurement of tensile creep in wood under sustained load by means of electric strain gages.



about 60 to 70 percent of ultimate stress. Beyond this proportional limit, strain increases more than proportionately with stress until failure occurs. Wood structures are designed to carry stresses well within the so-called "elastic" range. Yet, with time, beams increase in deflection and other stressed members take on "set" as evidence that their behavior is not perfectly elastic.

Studies of "creep" in wood in the form of sustained loading and repetitive loading tests have helped to clarify these effects. Through the use of highly sensitive electric strain gages, creep (or slow elongation) has been detected at stress levels as low as 10 percent of breaking strength over a period of only 30 minutes. At low levels of stress, creep increases in direct proportion to stress, but the increase is more than proportional to stress at higher levels. For wood in general, the increasing rate of creep begins to occur at a tensile strain of approximately 0.40 percent. This amount of stretch in wood has been termed the "threshold of set."

It is now recognized that Hooke's proportional limit applies to wood only as an approximation and that both proportional limit and modulus of elasticity vary with duration of load.

Individual species differ greatly in creep when subjected to the same stress, or even when loaded to the same percentage of ultimate strength. It has been shown, however, by means of repetitive loading tests, involving 100 cycles of loading and unloading, that the wood of all these species exhibits a common behavior when creep is related to initial amount of strain rather than to initial stress. The similarity of individual species in strain behavior short of failure stands in sharp contrast to their diversity in strain at failure, which may range from less than 0.8 percent elongation to nearly 1.5 percent. This difference emphasizes the advantage of supplementing tests for ultimate strength properties with rheological techniques for measuring deformation in gaining a deeper insight into basic wood behavior.

The use of highly diversified species in these studies has contributed to the development of a unified concept of the time-dependent strain behavior of wood.

RELATIONSHIPS BETWEEN WOOD AND ADHESIVES

The successful bonding of wood with adhesives has been well demonstrated in the development of plywood, laminated wood, and many new composite products in which wood is combined with other materials. Nevertheless, gluing has been developed more as an art than as a science. Although the fundamental nature of adhesion of wood involving molecular forces (principally the formation of hydrogen bonds between the adhesive and cell-wall substance) has long been recognized, little was known until relatively recently concerning the role of fundamental wood properties in adhesion. The species-by-species approach leading to the characterization of one wood as "easy" to glue, and another as "difficult," illustrates the general state of the art.

As an initial approach to a basic understanding of the factors involved, a study was undertaken to determine the effects of such properties of wood as specific gravity, acidity (pH), and wettability. Little information had previously been available concerning the degree to which individual species vary in pH or wettability. As both of these properties reflect the influence of extraneous constituents of wood, it was expected that they would also reflect certain bonding characteristics of wood. To ascertain the effects, a diversified group of tropical woods was studied. These woods permitted investigation over a range in specific gravity from 0.40 to 1.16, in pH from 3.48 to 5.77, and in wettability from 30° to 90° in their contact angle with water. All three factors were found to influence glue-bond strength to a significant degree. A foundation was thus laid for a more fundamental approach to the problems of wood adhesion.

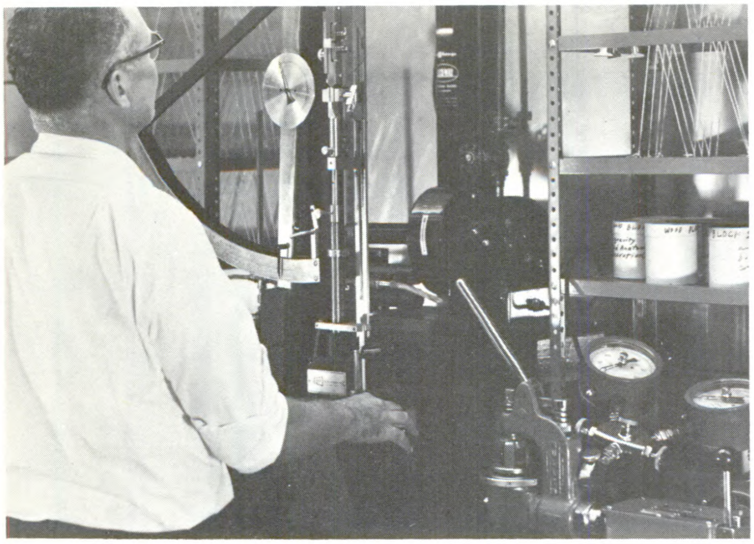
A second study involved the effect of wettability of wood on characteristics of spread adhesives in glue lines over a range of closed assembly times. For this test, species were selected to permit virtual elimination of the influences of specific gravity and pH. The effects of wettability were marked. Glue-line solids content and glue-line viscosity were both increased with the more wettable woods. Surface wettability determined the rate at which adhesive moisture was absorbed by the wood during the assembly period before gluing pressure was applied. Among the advantages that may be gained through these findings is the possibility of controlling gluing operations on a fundamental rather than an empirical species-by-species basis.

WOOD FIBER STUDIES

Wood fiber, when isolated from wood by chemical or mechanical means, serves as the basic material for a wide variety of paper and fiber board products. Although the extent and nature of the influence of wood fiber on the properties of a pulp sheet have been studied for many years and from many approaches, the results have not always proved satisfactory. For example, early studies of fiber dimensions indicated that fiber length was perhaps the most important factor in determining pulp properties, whereas recent studies have revealed that a significant role is played also by fiber width and by other fiber characteristics, such as the thickness of cell walls.

The contribution of these other characteristics can be illustrated by comparing certain thin- and thick-walled fibers when converted to pulp. Thin-walled fibers of large diameter collapse to flattened ribbons, forming a compact pulp sheet with highly effective fiber-to-fiber contact and high burst and tensile strengths. Conversely, thick-walled fibers of small diameter resist collapse and retain their tubular shape to form a bulky sheet. Because of the reduced area of contact between the thick-walled fibers, such sheets have relatively low burst and tensile strengths, but their tear resistance may be better than that of a pulp made from thin-walled fibers. Although these relationships have been appreciated in a general way, they had not before been expressed in exact quantitative terms.

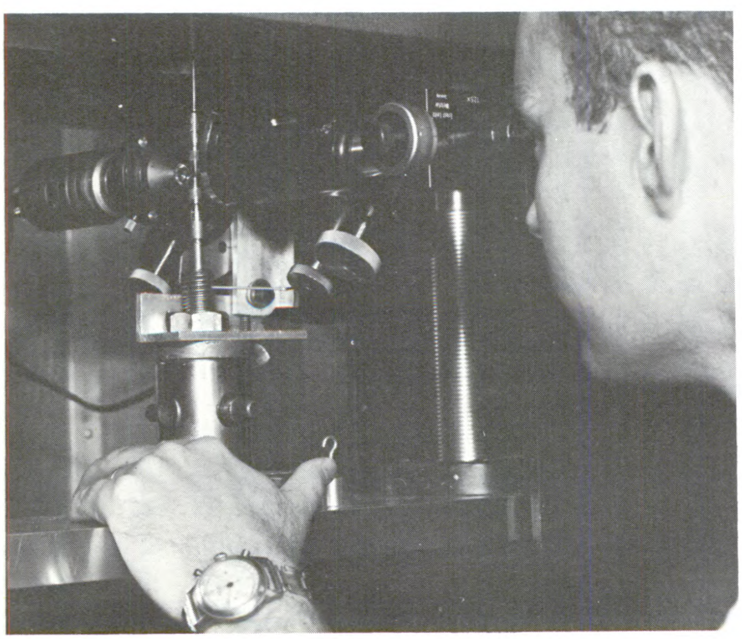
Also having an important bearing on the quality of pulp sheets is the intrinsic strength of the fibers used. But at what stage in the processing of a pulp this characteristic most affects the over-all strength of the pulp was not fully understood until recently. The discovery was made on an ONR supported Yale study concerned with establishing general relationships between hardwood fibers and the properties of kraft chemical pulps at various stages of beating. Eighteen highly diversified



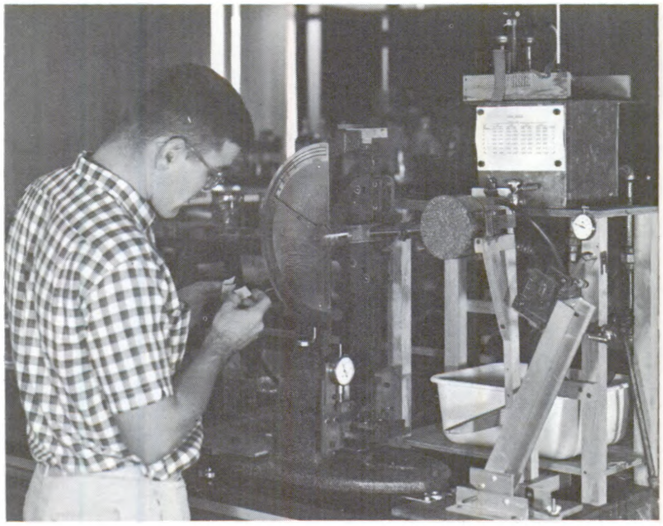
Zero-span tensile testing of pulp-sheet specimen to obtain measure of intrinsic fiber strength. "Zero-span" (refers to spacing of grips attached to speci-men) eliminates transfer of stress from fiber to fiber in sheet.

tropical American and domestic hardwoods were employed in the study. In general, the properties of pulps were found to be related to the dimensions and strengths of the fibers used in making them. In fact, more than 80 percent of the variation which occurred in almost all properties of the pulps examined—including sheet density, tear resistance, and tensile and bursting strengths for both unbeaten and beaten pulps—was accounted for in terms of fiber dimensions and intrinsic fiber strength.

Specifically, the study emphasized the importance of absolute fiber-wall thickness in determining the freeness, or drainage rate, of unbeaten pulps, and of relative fiber-wall thickness (ratio of cell-wall thickness to total fiber width) in contributing to sheet density and tensile and bursting strengths of unbeaten pulps. Intrinsic fiber strength increased in importance as the beating of the pulp progressed. It was



Direct measurement of intrinsic fiber strength by means of individual fiber tensile test. Strain characteristics of fiber are also recorded in this test.



Impact testing apparatus modified to permit determination of energy consumed in cutting veneer. Retardation of swing of the pendulum carrying the test block is the measure of energy consumed.

the key factor in determining tear resistance of beaten pulps. Found to be second in importance in contributing to tear resistance of beaten pulps was the ratio of fiber length to fiber width.

These results illustrate the dependence of the properties of beaten pulps on intrinsic fiber strength. Research was begun in this laboratory several years ago to determine the tensile strengths of individual wood fibers. Such studies of the fundamental unit of gross wood structure are invaluable in advancing basic knowledge of the properties of wood, as well as in the contribution they make toward the development of a sound theory concerning the properties of pulp sheets.

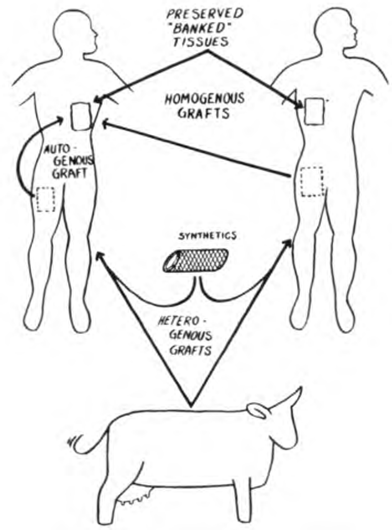
OTHER STUDIES

Other subjects of research now being pursued by individual graduate students include the following:

- The mechanical interaction of wood and other materials such as aluminum and fiberglass-reinforced plastic in stressed beams.
- The dimensional stabilizing effects of plastic and fiber overlays on wood.
- The curvature stress factor in laminated wood beams.
- Energy consumption in the experimental cutting of veneer.
- The chemical resistance of wood.

As each of these studies involves a diversified group of woods, it is hoped they will make contributions to our understanding of wood properties and behavior in broader terms than would be possible if the studies were limited to the wood of but a few common species. Only through such an approach can we expect to increase our understanding of wood to a level comparable to those levels achieved for other important materials, and thus to be in a position to take full advantage of this great natural resource.

The Future of Tissue Transplantation



Joseph F. Saunders, Ph.D.
Head, Medicine and
Dentistry Branch
Office of Naval Research

The principal types of grafts used in reconstructive surgery are the autograft (tissue transplanted from one part to another part of the same person), the homograft (man to man), and the heterograft (species to species).

Several hundred years ago philosopher-alchemists were firmly convinced that each element carried one of the four cardinal qualities of the world—heat, cold, dryness, and wetness. They also believed that each element remained perpetually the same, but reacted with its opposite. The theories of these scholars have since been completely disproven. Oddly enough, however, they still hold some validity for the science and art of tissue transplantation, where the tissues of one human are grafted onto another to help restore that person's function and vitality. Just as these discredited sages theorized, tissue material remains perpetually the same while it is being preserved. However, when it is grafted onto a patient, it reacts. This reaction is the core of the problem of achieving successful permanent transplantations of human tissue.

Since World War II, and especially during the last decade, remarkable progress has been made in the transplantation of tissues as a life-saving procedure. For example, the first tissue bank was established, at the National Naval Medical Center, in 1950. Today, tissue banks exist throughout the world. Techniques have been developed whereby various tissues are acquired, preserved, and stored for reconstructive surgery when the need arises. Clinically, the grafting or transplantation of preserved skin, bone, blood vessels, cartilage, cornea, and other tissues from one individual to another has become almost routine for replacing some tissues that have been accidentally lost or destroyed or whose function has been impaired.

These grafted tissues, however, are not retained permanently by the body but only serve as a temporary "lattice" which bridges the defect until the body can regenerate its own tissue. For example, individuals with more than 50 percent of their bodies covered with third degree burns are being spared death by skin grafts which act as temporary biologic dressings. Preserved human bone and bone substitutes can be translocated or implanted to assist in correcting skeletal deformities and debilitating injuries. Thus, it would seem that the purely surgical and technologic problems involved in the preparation and transplantation of many tissues and tissue substitutes have been solved.

Unfortunately, human "spare parts" which can be indefinitely stocked and used to replace permanently impaired or destroyed parts of the human body are still in the dream stage. Their realization in medical practice depends on further research. At the present time, for example, skin grafts taken from one person to treat severe burns in another seldom last for more than two weeks. However convenient and lifegiving it would be to replace a diseased and irreparable kidney with a "banked" one, the problems associated with permanent grafting have not been resolved. (Success has only been achieved when the donor and host are identical twins.) Further, the means for preserving tissues indefinitely, such as low-temperature biology, or "cryobiology" (Naval Research Reviews, November 1960), are not yet foolproof and continue to confront us with many puzzles.

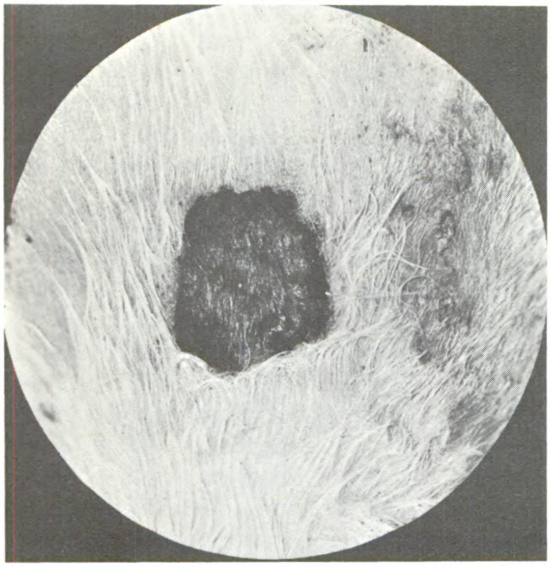
One thing is certain: this is indeed a military problem. Our last two conflicts, World War II and the Korean fighting, produced an

Key to Long-Term Preservation of Whole Blood

In addition to his responsibilities in the field of tissue transplantation, described in the adjoining article, "The Future of Tissue Transplantation," Dr. Joseph F. Saunders has for the past several years directed a research program aimed at achieving a safe, reliable method for preserving indefinitely large quantities of whole blood. His interest in this subject led him recently to search on his own for a substance which, when added to whole blood, would fully protect the blood from harmful deterioration during the freezing, storing and thawing process used for long-term preservation. Currently, 21 days is the maximum time blood can be preserved for transfusions.

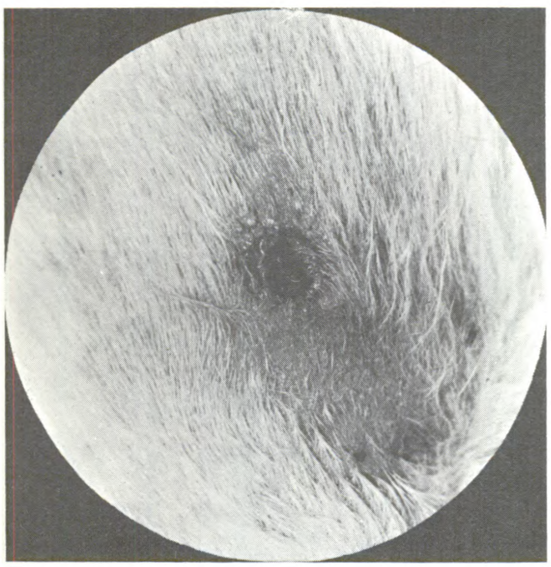
Working largely at home, Dr. Saunders made a detailed study of available information and work previously done in this area. After several months of gradually eliminating various substances, he was able to demonstrate theoretically that a chemical substance called mannitol could be used to satisfy all criteria as an "ideal" blood protector. Used as an additive, he has shown, this substance should serve as an acute blood volume expander, mobilize water in the blood, bind free hemoglobin in the blood, be nontoxic, and not have to be removed before transfusion. Dr. Saunders has determined furthermore that mannitol may be used for the long-term preservation of various human tissue.

The discovery, which is soon to be tested in the laboratory, has been described by RADM L. D. Coates, Chief of Naval Research, as being "of great importance to the blood program, which is in turn of great importance to our national health and survival."



A. Four days after transplantation. The graft is soft and vascularized.

Figure 1--Skin homograft. (Courtesy of Dr. S. C. Mohos.)



B. Eighteen days after grafting. The graft has become a scab and is thrown off.

enormous number of injuries requiring reconstructive surgery. The toll of future disasters from "limited" or nuclear wars is likely to be still greater. That is a challenge we must be prepared to meet. The military services have a responsibility to maintain a firm research program in the fundamental scientific disciplines that will be applicable to the management or prevention of casualties to which military personnel are subject, both traumatic injuries and debilitating diseases.

THE TRANSPLANTATION REACTION

A very useful tool for studying transplantation mechanisms is the skin homograft, which is "sloughed off" by the recipient in about two weeks. (Figure 1A and 1B.) Its destruction is evidence of an immunologic response by the body's natural defense mechanism. Like disease-producing organisms, proteins and certain biochemically complex substances of "foreign" origin, grafts of someone else's tissue confront their hosts with substances that are immunologically foreign to them. The "alien" substances (transplantation antigens) provoke a reaction or a sensitization which results in their rejection by the body acting in self-defense. Once this defense mechanism (the antibody response) of the host is mustered and ordered into combat against the invading transplantation antigens, the state of sensitization becomes generalized throughout the body. This response may be short or long-lasting.

Just what are these so-called "transplantation antigens?" Combined biochemical, genetic, immunologic and transplantation studies have revealed that the transplantation antigens are multiple and determined by genetics. Furthermore, they are extremely complex. It has been postulated that they are combinations of proteins, sugars, fats, and nucleic acids; they are not simply single polypeptides or polysaccharides. Not all of them are of equal strength. As far as is known, they are not tissue specific, rather they are shared in common by all living cells of a single individual. It is impossible, for instance, to differentiate between a patient's thyroid, spleen, skin, or other tissue on the basis of their transplantation antigens. On the other hand, red blood cells—for reasons not yet understood—behave as if they contained no transplantation antigens, allowing blood transfusions to become the most frequent of all human tissue transplants. Consequently, we are faced with a triangular relationship—biologic, biochemical, and biomechanical—of the recipient to the grafted tissue. The biologic interdependence of the two must be such that the recipient or host will accept the graft; biochemically the host must be compatible with the donor tissue; and biomechanically, the grafted tissue must assume the function of the tissue it replaces. The three relationships must operate harmoniously if we are to realize our present endeavor for the "permanent" graft of tissues and organs.

ONR'S APPROACH

The current program in tissue transplantation sponsored by the Office of Naval Research has widened in scope considerably in recent years. It is allied closely to the one in low-temperature biology, so that the information from research in low-temperature biology can be applied to the preservation of various tissues which are commonly transplanted. In ONR's program of tissue transplantation we are trying to learn as much as possible about the transplantation mechanism. In doing this we study the nature of induced tolerance to homografts, the use of biologic polymers as tissue substitutes, the intermediary metabolism of host and donor tissues, and the application of fundamental principles of biochemistry, immunology, and genetics toward the elucidation of the nature of the transplantation antigen and of the "immune reaction." In low-temperature biology we are interested in studies dealing with the preservation of blood, blood components, and certain tissues. We hope that fundamental studies in this field will increase our knowledge of the mechanism of ice crystal formation in biologic systems with the view toward learning more about how the mechanics of freezing may aid us in preventing tissue damage or destruction during the tissue's span in "suspended animation." At present, we are not sure whether the transplanted homograft or heterograft should be "living" or nonliving." Further research may demonstrate a need for having tissue homografts, especially organs such as the kidney and heart, preserved in the viable state. If so, parallel research in low temperature biology may have the solution to such storage when it is needed (Figures 2A, 2B, 2C, 3A and 3B.)

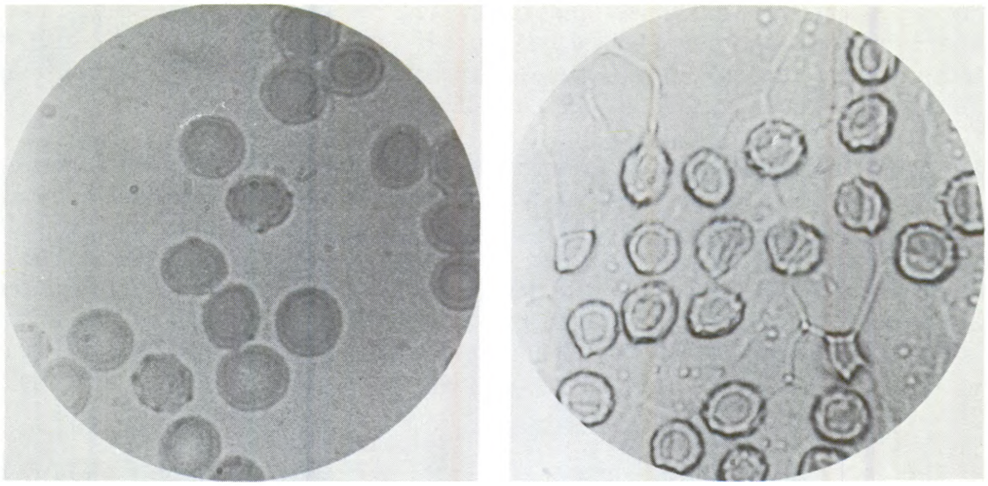
With these objectives in mind, we believe that partial solutions to our problems may be forthcoming. To illustrate our approach, let us examine the following ideas. Dr. G. K. Smelser of Columbia University's College of Physicians and Surgeons is using the cornea of the eye as a medium for studying the "host-donor response." This study holds promise of throwing more light on at least one phase of the host-donor immune reaction, that is, changes that take place in the cellular constituents of the grafted tissue and how the host cells respond to that grafted tissue.

The hibernation process in animals may provide further elaboration of the mechanism of immunologic unresponsiveness of skin homografts. Studies by S. C. Mohos, at the University of New York's College of Medicine, have indicated that the physiologic slow-down induced by natural hibernation may give us clues to understanding how we can induce tolerance to skin grafts and perhaps other tissues so that the grafts can be retained longer by the recipient.

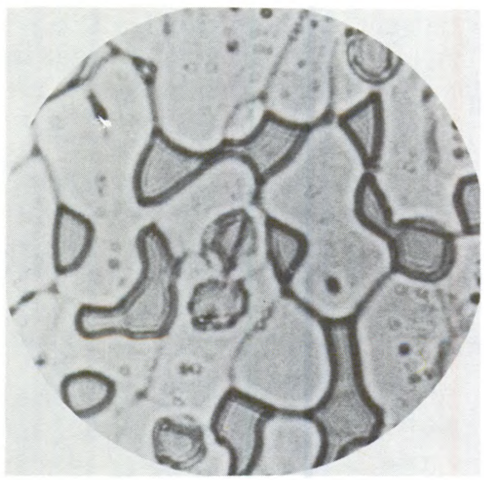
At the University of Padua in Italy, Prof. G. Dogo has made significant discoveries with another approach. In lieu of hibernating animals, he uses "hibernating skin," that is, skin removed from the body and placed in a nourishing medium at a temperature lower than that of the body. The complete absence of any immune phenomena was evident. Grafts of the dermis layer of skin persisted for three months, whereas the epidermic graft was eliminated in 25 days. The technique of "tissue hibernation" developed in this study has fascinating possibilities and could prove to be a very significant accomplishment in tissue transplantation and low-temperature biology.

In another study, at the University of Texas Medical Branch by Drs. T. G. Blocker, Jr., and W. W. Nowinski, the role of energy production and energy requirements in the process of wound healing and tissue regeneration is being explored. Their findings suggest a metabolic block in the injured tissue which prevents the conversion of glucose to pyruvic acid and subsequent production of energy. This demonstrates the complex intermediary metabolism that results from traumatic injury such as occurs in burns. Metabolic behavior of this kind does not occur in normal tissue. This indicates that such injuries can deplete the body's energy stores which we know are vital to life. The results of this study could lead us to means for artificially replenishing the body's natural energy.

Sometime in the distant future it may be possible to use plastic materials as tissue substitutes more efficiently and more effectively than preserved human tissues. Thus, research on the utility of biologic polymers for this purpose constitutes a major facet of the transplantation program. Such polymeric materials as Vinyon-N, Orlon, nylon, gelfoam, Ivalon, and methylmethacrylate are receiving considerable attention. The latter is the material used for fabrication of the plastic



A B



C

Figure 2--Slow supercooling of blood cells. (Courtesy of The Linde Company.)

A. Before freezing at -8° C.

B. Start of slow freezing.

C. Four minutes after initiation of slow freezing: DESTRUCTION.

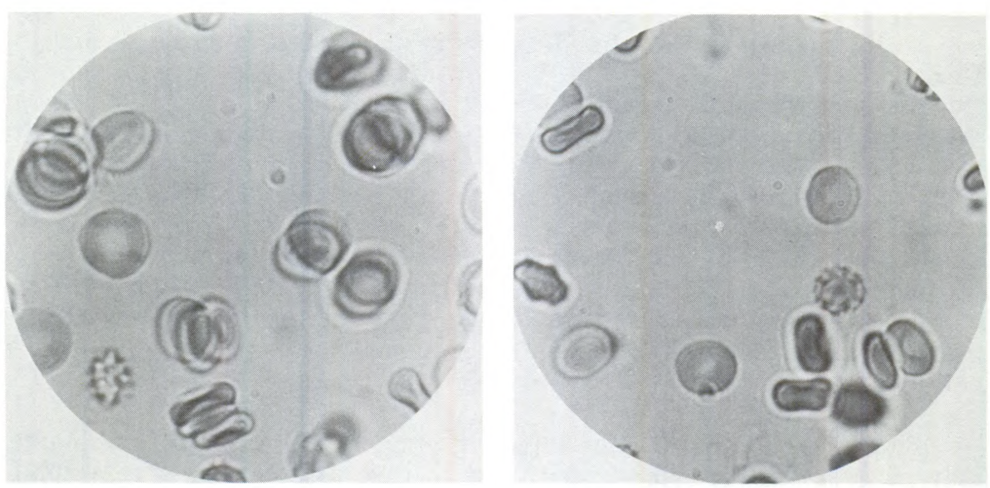


Figure 3--Rapid freezing of blood cells. (Courtesy of The Linde Company.)

A. Before freezing at room temperature.

B. After rapid freezing and thawing: NO CHANGE.

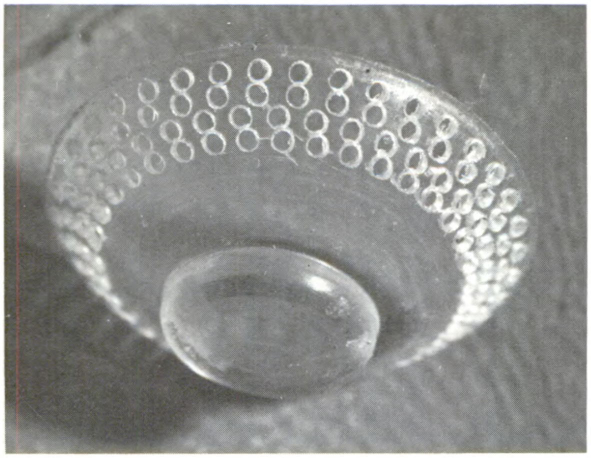


Figure 4--The plastic artificial cornea. (Courtesy of Dr. William Stone, Jr.)

cornea devised by Dr. William Stone, Jr., at the Massachusetts Eye and Ear Infirmary (Figure 4). These "artificial corneas" have been tolerated by rabbits for more than four and a half years (Figure 5). This achievement led to implantation of the plastic cornea in the eyes of rhesus monkeys with a tolerance to date of slightly more than two years. There is no overgrowth by host tissues and vision has been restored in the animals. In view of these results, the application of this type of replacement therapy will be tried in those hopelessly blind human volunteers who happen to be unsatisfactory subjects for eye bank corneal transplantations.

Dr. G. O. Kruger of Georgetown University has recently shown that boiled defatted animal bone is accepted by the host as an inert substitute for human bone. The boiling and defatting of the bone destroys the species difference between man and animal, which would normally cause rejection of fresh heterografts. Although this bone does not meet the standards of human bone, it is easy and inexpensive to prepare and would fulfill some of the requirements of an emergency bone material for treating mass casualties.

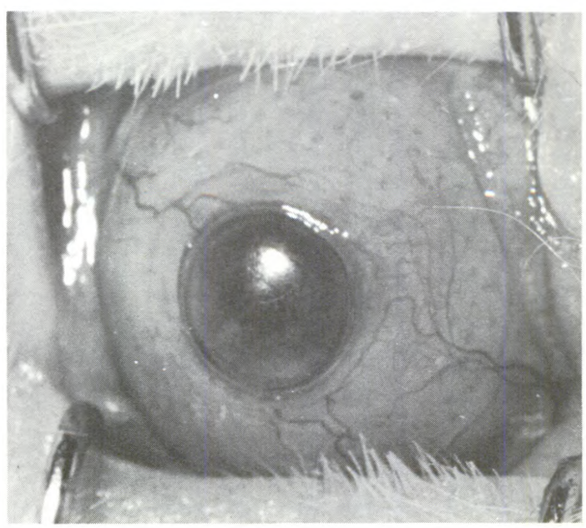


Figure 5--Plastic artificial cornea implanted in rabbit's eye. (Courtesy of Dr. William Stone, Jr.)

FUTURE RESEARCH

Two of the most provocative questions in biology today are: How can the basic immunologic mechanism be elucidated? How can it be modified to permit tolerance of grafted tissue? In an effort to understand the transplantation mechanism, it is hoped that the ONR program can shed light on the isolation of the "transplantation antigen." We then hope to achieve isolation of the transplantation antigen in order to identify and characterize specific components of the antigen complex. If we can isolate these components, we may then be able to develop means for possible immunization of individuals to a specific tissue graft. In the meantime, efforts to learn more about the mechanism of induced tolerance to homografts and heterografts are mandatory. Through studies of hibernation and other biologic phenomena such as parabiosis, it may be possible to isolate, perhaps through low-temperature biology, those substances which interfere with the permanent tolerance to homografts. This may lead to means for modifying the graft. Studies of bio-polymers are also necessary in view of their possible utilization as tissue substitutes.

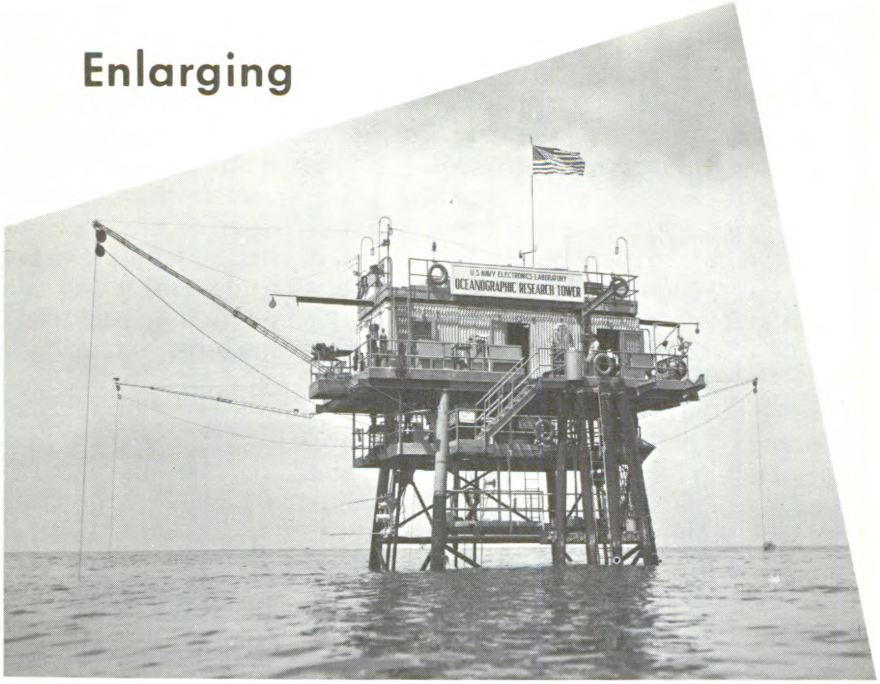
Just as we reject the attribution of a disease to black magic, so we must dispel our confidence in an empirical approach to the therapy of a disease or to the restoration of an injured part of the body. Specifically, advances toward the reality of the dream of "permanent" tissue transplants can only be the fruit of ceaseless, painstaking fundamental research integrated with modern instrumentation and sophisticated laboratory methodology.

In transplantation research, there is the tendency toward specialization in a given area. Yet, if we are to succeed, a diametrically opposite approach is required. Each of the specialties must be converged upon a given focus, and a concerted effort in the basic scientific disciplines must ensue. Suppose we are seeking an explanation of what can be done to modify, suppress, or paralyze the transplantation reaction in kidney transplants. To obtain this answer, we must call upon the biochemist, the immunologist, the physiologist, the geneticist, the pathologist, the surgeon, and others for their contribution to this complex problem. As the various findings of each pertinent specialty become relevant, they can be combined to formulate a solution.

If we again refer to our friends, the alchemical philosophers, we will recall their theory that in a composite body there are three collaborators—elemental matter, form, and temperament. A thing must have form to be what it is; but temperament is the key to understanding its puzzling ways and its mysterious work. Again, we can make an analogy to tissue transplantation. The elemental matter is the fundamental composition of a tissue, the form is the skin, and temperament is the behavior of a graft.

If we continue to pursue the concerted, interdisciplinary research required to solve these problems, military and civilian medicine will always be prepared. The dream of the future will become a reality, and the aspiration of the alchemists to transmute metals to gold will transpire, but in a different form. The preserved, "banked" tissue (the alchemists' metal) for grafting will "turn to gold" when it can be used as a permanent graft to save a life.

Enlarging



E. C. LaFond
U. S. Navy Electronics Laboratory
San Diego, California

an Oceanographic Research Tower

In recent years the science of oceanography has been expanding at such a rapid pace that unusual demands are being put upon its research facilities. The result has been that many of these facilities have failed to keep pace unless constantly modified and enlarged. An example of such growth and accompanying "growing pains" is to be found a short distance off the coast of southern California near San Diego. There, on steel piers in 60 feet of water, stands a "new" research tower that is already undergoing modification and enlargement. Built two years ago for the study of the coastal marine environment, its working space was filled so quickly, more space has already been added to it (the enlarged tower is pictured above), and still more would soon be occupied if only it existed.

Originally, the tower supported a single 13- by 15-foot room, called the Instrument House, on a cement deck 30 feet above the water line. To this house have now been added two rooms, mounted on cantilever structures, on the tower's north and south sides, respectively. The first room was designed as a combined biological laboratory and dormitory, and the second for the installation of automatic recording and processing equipment. The additional roof area provided by the new construction allowed more space for meteorological instrumentation. In addition, small platforms were built below the Instrument House, or main deck, furnishing space for new oceanographic equipment.

THE RAILWAY-TRACK SYSTEM

The most popular as well as most successful of the tower's built-in equipment for studying the shallow water environment is its railway-track system, which operates on three sides of the tower between the main deck and the sea bottom, 60 feet below the surface. Three similarly designed cars for carrying underwater sensors and other instruments to various water levels are used, one for each of three sets of rails. As the cars are securely fixed to rigid tracks, they provide firm references for underwater motion studies. The design of the cars is such that various sensing instruments may be installed or removed easily. Linked to the vertical railway-track system are the data recorders, which are located in the Instrument House for easy monitoring.

Mounted on one of the tower cars are motion-picture and television cameras, used mainly in the study of biological populations in the water "column." After being lowered, the television camera transmits its pictures to a television monitor in the laboratory tower where they can be viewed and the organisms studied. To obtain a permanent record, the motion picture camera is switched on or a filmed record is taken directly from the monitor.

Attached to the camera car in front of the two cameras is a reference grid from which nylon-yarn streamers are suspended. The streamers, which respond to the slightest movement of the surrounding water, indicate water currents and turbulence caused by surface and internal waves. The changes in position of the streamers on the grid reference are recorded on motion picture film. The amount of movement is then accurately measured.

A hydrophotometer is mounted on a second car. With this instrument, determinations are made of the light scattering and absorption of water and its contents. The intake of an underwater pump has also been installed on this car (at the same depth as the hydrophotometer) to bring water to the tower deck where it can be filtered through nets and millepore filters to establish specific causes of water transparency changes.

The tower's third car is being readied for the installation of an acoustic transducer for oceanographic research.

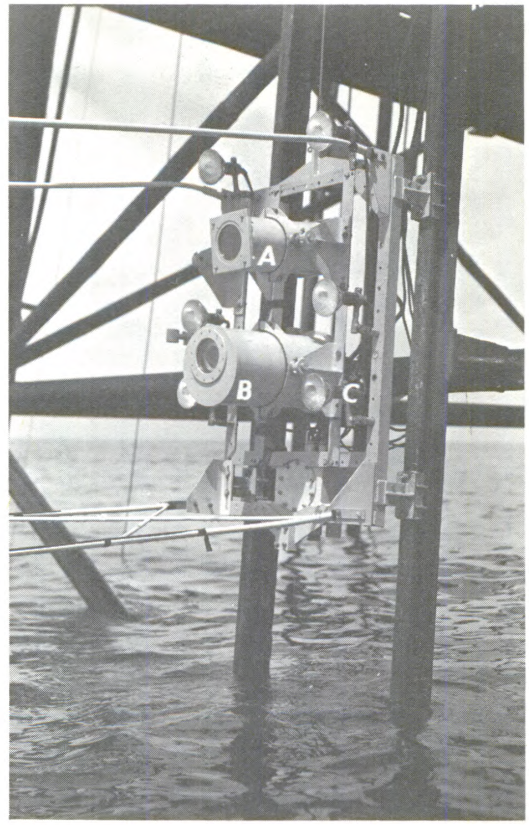
A WIDE RANGE OF STUDIES

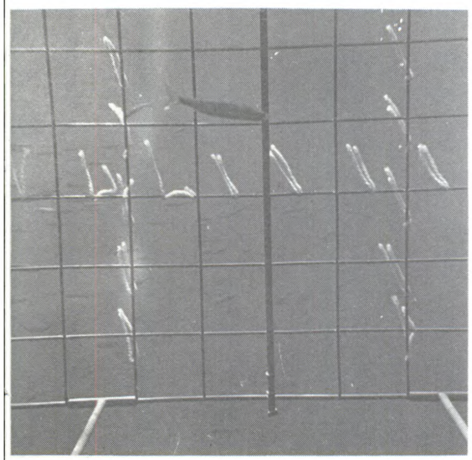
An important new task in which the tower was recently employed involved the study of sea-water foaming properties. This program was conducted by a visiting Japanese oceanographer* during the summer of 1961. The foaming properties of sea water are related to the phenomenon of internal waves, which are also continuously recorded by three isotherm followers suspended from 40-foot-long booms projecting from the NEL tower.

*Dr. Tomosaburo Abe, Oceanographic Laboratory, Meteorological Research Institute, Japan.

South car on USNEL Oceanographic Tower:

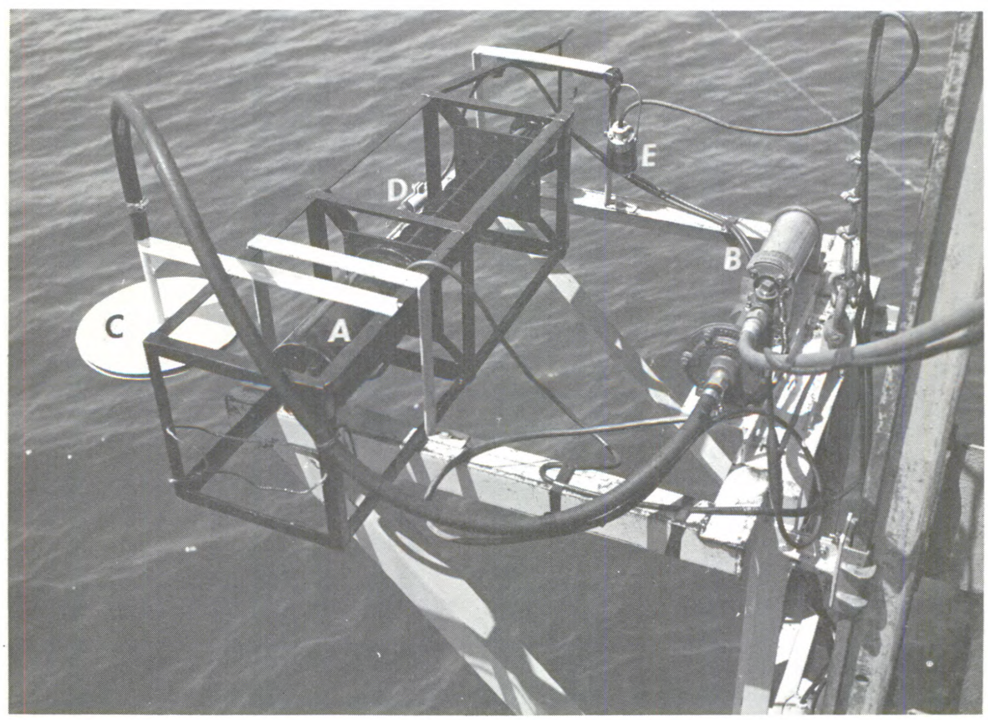
A, movie camera
B, television camera
C, floodlights





Grid and nylon streamers used on south car with cameras.

West car on Tower: A, hydrophotometer (alpha meter); B, underwater pump; C, water intake guides; D, temperature sensor; E, pressure (depth) transducer.



Among the many studies that are included in the ever-widening range of oceanographic research programs that need the unique facilities of the NEL tower are the following:

- Chemical properties of the ocean
- Acoustic transmission and scattering
- Geological properties of the sea floor and its changes
- Surface and internal waves
- Meteorological variables and their relation to heat budget and surface phenomena
- Fouling and corrosion of new materials
- Biological populations and their effect on light and sound transmission

ADVANTAGES OVER A SHIP

For many kinds of oceanographic research a fixed platform such as the NEL tower has several advantages over a ship anchored in the same location.

One of these advantages is the tower's stability. A ship is constantly in motion owing to the action of waves, wind and current, and it is frequently subjected to vibrations by these same elements or by its own power plant. The tower, on the other hand, is structurally rigid and firmly attached to the ocean bottom, and thus does not move. Instruments such as television and motion-picture cameras may be stabilized in depth and orientation, which is necessary for their successful use in many underwater studies. Stability is also required for most acoustic studies and, for example, the photographing of sea-surface and sea-floor changes by time-lapse movies. None of these investigations can be conducted satisfactorily from the ship.

Another advantage of the tower is that it permits long-period, uninterrupted measurements to be made readily and economically. Tower instruments may be suspended in the water or mounted on the structure and allowed to record continuously in the Instrument House. This makes possible the recording of oceanographic variables for periods of weeks or months. Because of its firm footing (its supporting pins are embedded 63 feet in the ocean floor) the tower can operate efficiently even when the sea is high—a time when a research ship could not anchor safely off the coast.

A further advantage of a tower over a ship for the types of studies conducted here is its economy of operation. The NEL tower, for example, can be operated by two or three technicians tending the recorders and maintaining instruments only periodically. A ship, on the other hand, requires a regular crew in addition to instrument personnel. Even though little work is required of the crew while the ship is anchored, the crew must remain aboard and their salaries must continue. If the ship operates day and night, as does the NEL tower, it must also maintain watches, which entail a considerable number of crew members. Furthermore, the maintenance of the ship itself and the provisioning of the ship and its crew are very expensive.

Of course there are disadvantages, too. The main one is the tower's immobility, which renders it unadaptable to geographic oceanography. The only way additional area coverage can be obtained is by the use of booms and the anchoring of sensors at short distances from the structure.

The basic purpose of the U. S. Navy Electronics Laboratory Oceanographic Research Tower is the same as that of the more familiar research ship—to advance knowledge of the fundamental processes at work in the ocean. In carrying out its particular mission, the facility has been more successful than was anticipated two years ago when it was originally erected, hence the need for the modification and enlargement described here. But the "success story" has not yet ended. The expectation is that it will continue as the increased potentialities of the tower are realized.

Bug Batteries

The discovery that microbes produce electricity has opened up a surprising approach in the search for new sources of power. Bacteria are figuratively harnessed to an electrochemical system which produces useful and significant amounts of electricity. The exact manner in which the microbes contribute to the conversion from chemical to electrical energy has not yet been established. Obviously, the process involves the ingestion of chemical foodstuffs, i.e., "fuels." Metabolic action then produces chemical changes catalyzed by enzymes contained in the microbes. Basically, this involves the movement of electrical charge, which manifests itself as electricity. Such biochemical activity may either augment the performance of common electrochemical systems, or induce systems of like electrodes.

The particular advantage of the bug battery over other fuel cells is that its operation may be established in the bugs' own native habitat—for instance, open water or a sewage disposal plant. Or the electricity could be obtained in a closed-cycle system into which nutrients are fed.

Credit for recognizing the potentialities of this bio-cell goes to LCDR Frank W. Anders, of the BuShips Advanced Concepts Division, and Dr. Gilson H. Rohrback, of Magna Products, Inc. They developed the initial technical details collaboratively, in effect borrowing on Dr. Frederick D. Sisler's previous work in the late forties. Magna later contracted with BuShips for further development and demonstration of the principle and capabilities for biological electrical energy production. Dr. Sisler has resumed his study in this field with the General Scientific Corporation. Dr. John Welsh and his group at Flow Laboratories, Inc., has also taken up the challenge of these problems. The Navy is also directly participating in active research at the Naval Research Laboratory, primarily to develop an understanding or hypothesis for the mechanics of the bug battery's operation in terms of electrochemistry and electrical transport phenomena. ONR has acted to insure that long-range basic-research on this problem is not neglected.

Research Notes

Sonar in Nature

No strangers to Naval Research Reviews' readers are the little brown bat Myotis and the fishing bat Noctilio whose unusual behavior has been the subject of considerable research sponsored by the Office of Naval Research and reported here over the past several years. These creatures have interested investigators because of the sonar system they utilize to fly blind with great precision and to catch very tiny insects or fish while in flight. In comparison with man-made sonar systems, those employed by Myotis and Noctilio and other bats have been considered sufficiently remarkable to have warranted much quantitative study. Motivating this interest is the strong possibility that through investigation of such techniques developed by nature through evolution, ingenious mechanisms may be discovered which could prove of much value to designers of electronic systems.

In an open letter from the Director of the Lincoln Laboratory, Massachusetts Institute of Technology, to the Chairman of the Joint Services Advisory Committee, a brief description of past and present studies of the bat's sonar capabilities, reported in a recent Lincoln Laboratory seminar, are described. The Director, Carl F. J. Overhage, writes as follows:

"The fact that bats employ high-frequency sonar was first established in 1938 by Professor Donald Griffin of Harvard University, then an undergraduate, several years before sonar itself was declassified by the Navy. The bat was subsequently found to employ frequency-modulated pulses, a new technique in World War II for underwater sound. From recent studies to determine how a bat can accurately detect and avoid wires only about one millimeter in diameter with sound pulses a foot or more in length, it now appears that the bat may employ a relatively sophisticated system of pulse compression, a subject of considerable interest in modern radar. Finally, in investigating the bat's remarkable resistance to noise jamming, a carefully designed experiment shows that the bat approximates the counter-countermeasure capability of an ideal bistatic receiver. Add to these behavioral capabilities the fact that the bat automatically adjusts its pulse repetition rate, pulse length, and frequency modulation pattern to search or attack modes and to the closing range on a target, and it is evident why the bat's performance deserves scrutiny.

"We are working closely with Professor Griffin on instrumentation and measurements to shed light on the bat's methods of signal design and signal processing. The principal subject is the little brown bat (Myotis) which is very common in New England, but the studies extend to less familiar species, such as the tropical Noctilio that makes his living by gaffing fish apparently detected by his echo-ranging apparatus. Behavorial studies are correlated with detailed measurement and analysis of the signals employed for various functions, and signal processing is the subject of both analytical and physiological investigations.

"A valuable by-product of this project, with possible applications in many other fields, is a high-speed motion picture camera, synchronized with a strobe flash unit, with a sound track that records at ultrasonic frequencies. This device makes it possible to take sound motion pictures of high-speed events involving the emission of ultrasound, and then to display the events at viewable speeds and audible frequencies. A speed reduction of 32-to-1, with a corresponding drop of five octaves in pitch, is employed in this research. The camera has already revealed significant new facts about actions that are quicker than the eye can see, and about the ultrasonic signals that guide and direct them. This instrument, and the exploratory research which stimulated its development, are yielding results of interest and potential value far beyond the very modest level of effort invested in them."

Research on Helicopter Instrumentation Continued

An Army-Navy research program on instrumentation that will permit helicopters to operate day or night in all kinds of weather has been given a $1,146,000 contract renewal for 1962, its eighth year of continuous activity. Funds provided by the new contract will be used specifically to develop an airborne flight test vehicle equipped with the new instrumentation and simplified control system developed earlier in the program. The research, conducted by the Bell Helicopter Company, Fort Worth, Texas, is sponsored jointly by the Army Signal Corps and the Bureau of Naval Weapons and is administered by the Office of Naval Research.

The rotary-wing instrumentation research is being carried out as part of the Army-Navy Instrumentation Program (ANIP), which includes comparable efforts on the part of Douglas Aircraft to adapt the instrumentation for use in fixed-wing aircraft. The program was initiated in 1953 by ONR's Air Branch and the Systems Presentation Branch of the Bureau of Aeronautics (now Bureau of Weapons). In 1954 the Army joined in the early activities by expanding the program to include adaptation of the simplified instrumentation for use in rotary-wing aircraft. (Naval Research Reviews, January 1960 and July 1958.)

The ANIP provides for a flight instrumentation system consisting in part of two basic displays—one set vertically and the other horizontally in front of the pilot. A path-like representation of the plane's prescribed course appears on the vertical screen against a presentation of the sky and ground. When the plane is exactly on course, this "pathway in the sky" stretches ribbon-like in front of the pilot, just as a road appears when driving a car. If the pilot veers off course, the pathway appears at one side or above or below him. The horizontal screen displays a map of the area, showing navigational position, fuel range, ground track, and the relation of the vehicle to its proper course. Raw data from the same sources that feed data to the dials of conventional instrument panels are converted to simple pictures by a computer capable of making 15,000 computations a second.

The first airplane equipped to test the new instrumentation carried a crude contact analog display. Using this display, even pilots who were not trained to fly by instruments were able to take off, hover, and land. A second flight test vehicle outfitted with a microwave RAILS (Remote Area Instrument Landing System) enabled pilots to locate, approach, and land in a remote area marked by a portable transponder beacon even under zero-zero weather conditions. In addition, a unique six-degree-of-freedom dynamic flight simulator has been designed for the program and is being used in human factors studies of displays and controls.

Ice Island T-3 to be Reoccupied

In an article describing the Navy's arctic drift station ARLIS II (Naval Research Reviews, September 1961), the author stated that the "Air Force's T-3 (Fletcher's Ice Island) ... is now aground off Pt. Barrow, virtually abandoned." Since then, T-3 has refloated itself and has drifted north and west into the Arctic Ocean. For a while it was "lost," but early in February a pilot spotted it while on a routine flight to ARLIS II.

Since grounding and relaunching, T-3 has decreased to about half its former size, but the slab still contains the former camp buildings. On February 17, the Navy landed a radioman and two Eskimos by plane to reoccupy the floating piece of real estate. Dr. Max Britton, of ONR's Geography Branch, says that plans are going forward to use the island this summer—and perhaps on through the winter--for various ONR projects in the fields of acoustics, gravity, seismography, and magnetism. The landing strip will also serve as a way-stop in flights to and from ARLIS II, which is drifting farther and farther from Pt. Barrow but is only about 400 miles from T-3.

The question of resupplying ARLIS II brings to mind a near tragedy that occurred last fall.

The Arctic Research Lab's R4D flew to the island, was refueled from jerry cans previously landed there, and took off again for Pt. Barrow—carrying, among others, Max Brewer (Director of ARL) and John Beck, Station Leader at ARLIS-II. By error, the plane had been topped off with fuel oil instead of gasoline, but the mistake was not discovered until the engines conked out, with the plane high over the ocean in the Arctic night. Fortunately, the pilot was able to make a safe landing on a bare ice floe. Within a few hours another plane was flown in and rescued all hands.

On the Naval Research Reserve

Research Reserve Companies Hear Naval Attaches

Research Reserve companies in the Washington area are privileged to have close at hand many governmental agencies, a number of universities, and several scientific organizations from which to select excellent speakers for their reserve programs. One source not very often tapped consists of the naval attaches from the embassies of the various foreign countries. During Fiscal Year 1961, Naval Reserve Research Company 5-10, Bethesda, Maryland, arranged for a number of these attaches to discuss the development of science and technology within their respective countries and the areas of science in which each country was conducting research.

The following persons made presentations to NRRC 5-10: Mr. R. V. Alred, Royal Navy Scientific Service, British Defense Staff; CDR Roberto P. Grigera, Naval Attache, Embassy of the Argentine Republic; MAJ Yehuda Arbel, Assistant, Military, Naval and Air Attache, Embassy of Israel; Mr. J. R. Longard, Defense Research Member, Canadian Joint Staff; and CDR Nils Dellgren, Assistant, Naval Attache, Embassy of Sweden.

Since these programs proved to be most successful, NRRC 5-8, Washington, D. C., has scheduled a number of similar programs for their drill schedule this quarter.

Navy Contract Law Correspondence Course

Some Research Reservists are now authorized to receive promotion point credit for completion of the correspondence course "Navy Contract Law," NAVPERS 10988. This course is limited to officers whose designators are 3105, 1625 or 5105. Although this restriction still stands, special consideration has been given by the Chief of Naval Personnel to allow certain Research Reservists with qualifications in research contract administration to receive credit for the course. It is well to note that a part of the mission of the Research Reserve Program is to provide individuals qualified in "research contract administration."

This arrangement was requested of the Chief of Naval Personnel by the Office of Naval Research branch office, Chicago, because that office conducts a planned training program for officers whose primary mobilization potential is in the contract administration department of the ONR branch office. It was considered that the correspondence course "Navy Contract Law" would provide highly valuable supplemental training for these officers, if restrictions because of designator could be waived.

The Chief of Naval Personnel concurred in the request and has established procedures by which Research Reservists may qualify for the course provided that the officer concerned has a primary mobilization potential in contract administration for the Office of Naval Research. The approving letter from the Bureau of Naval Personnel stated in part:

"The recommendation . . . that those officers pre-selected to fill mobilization billets in the Contract Administration Department of the Office of Naval Research be granted promotion point credit for satisfactory completion of subject course, is concurred in. Because of the small number of officers concerned, it is considered desirable that those not specifically entitled to receive promotion point credit in accordance with the provisions of [BUPERS INSTRUCTION 1570.4] for completion of subject course, be required to submit a formal request for promotion point credit via official channels to the Officer in Charge, Reserve Officer Recording Activity, Omaha 11, Nebraska. Only in cases where the forwarding endorsement by the cognizant Commanding Officer of the Office of Naval Research Branch Office specifies that the officer requesting credit has been pre-selected to fill, or whose primary mobilization potential lies in billets in the Office of Naval Research Branch Office, Contract Administration Department, will appropriate promotion point credit be authorized."

Change of Date in Ft. Detrick Seminar

The convening date of the Research Reserve Biological Defense Seminar at Fort Detrick, Frederick, Maryland, has been changed to September 10, 1962. The date has been advanced from the original October 1 date due to a conflict of schedules for some of the speakers. Also, for some members of the Research Reserve who are associated with universities, the new date is more likely to be preferable.

Promotions to Captain and Commander—Staff Corps

The March and April issues of Naval Research Reviews listed the line officers of the Research Reserve who were selected for promotion to the grades of Captain and Commander. On March 20, 1962, the President approved the report of the Selection Board for staff corps officers, and the Chief of Naval Personnel released the names of the officers selected. Congratulations are extended to the following Research Reserve officers who were on the list:

FOR CAPTAIN
MEDICAL SERVICE CORPS

E. G. Rietz	9-1
L. E. Rozeboom	5-4

FOR COMMANDER
SUPPLY CORPS

E. E. Anderson	1-1

FOR COMMANDER
MEDICAL SERVICE CORPS

H. T. Eigelsbach	5-3
L. J. Greenbaum	5-10
L. V. Hankes	3-9
M. E. Hawthorne	1-1

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Promotions to Lieutenant Commander

Twenty-two Research Reserve Lieutenants were among the 1,280 officers of the Naval Reserve selected for promotion to the grade of Lieutenant Commander. The Board which made these selections convened on March 6, 1962, and its report was signed by the President on April 12. Congratulations to all.

L. D. Berner, Jr.	5-8	D. S. Hepler	5-9
G. Camougis	1-5	R. Hood	9-4
J. Chambers	11-2	D. P. Martineau	5-10
R. W. Cloyd	6-3	G. D. McDonald, Jr.	11-2
A. J. Curtis	11-3	A. C. Morris, Jr.	6-3
D. A. Davis	8-4	R. E. Oesterreich	9-1
S. A. De Mars	6-16	D. A. Patterson	5-9
R. H. Dinegar	8-9	S. B. Spangler, Jr.	11-6
R. G. Fleddermann	5-4	P. H. Stern	13-1
L. T. Frohman	8-1	R. E. Walker	13-1
R. F. Griner	6-17	C. G. Westendorff, Jr.	6-3

A Few Statistics

Some statistics have been drawn from the records of the Research Reservists selected from promotion:

DATE OF RANK		DESIGNATOR	YEAR OF BIRTH	
Earliest	7-1-44	1105 - 10	Earliest	1912
Latest	9-1-56	1355 - 5	Latest	1930
Median	8-1-55	1405 - 3	Median	1925
		1455 - 1		
		1515 - 2		
		1675 - 1		

A Reminder on Promotion Requirements

- Officers selected for promotion must qualify within one year from the date on which the President approved the report of the Selection Board in order to receive pay and allowances, if applicable, from that date.

- The physical examination may be taken as soon as the official letter of notification of selection has been received.

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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. The issuance of this publication approved by the Secretary of the Navy on 1 March 1961.

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Canada's hydrofoil craft Bras d'Or in foilborne condition. See article beginning on page 1.