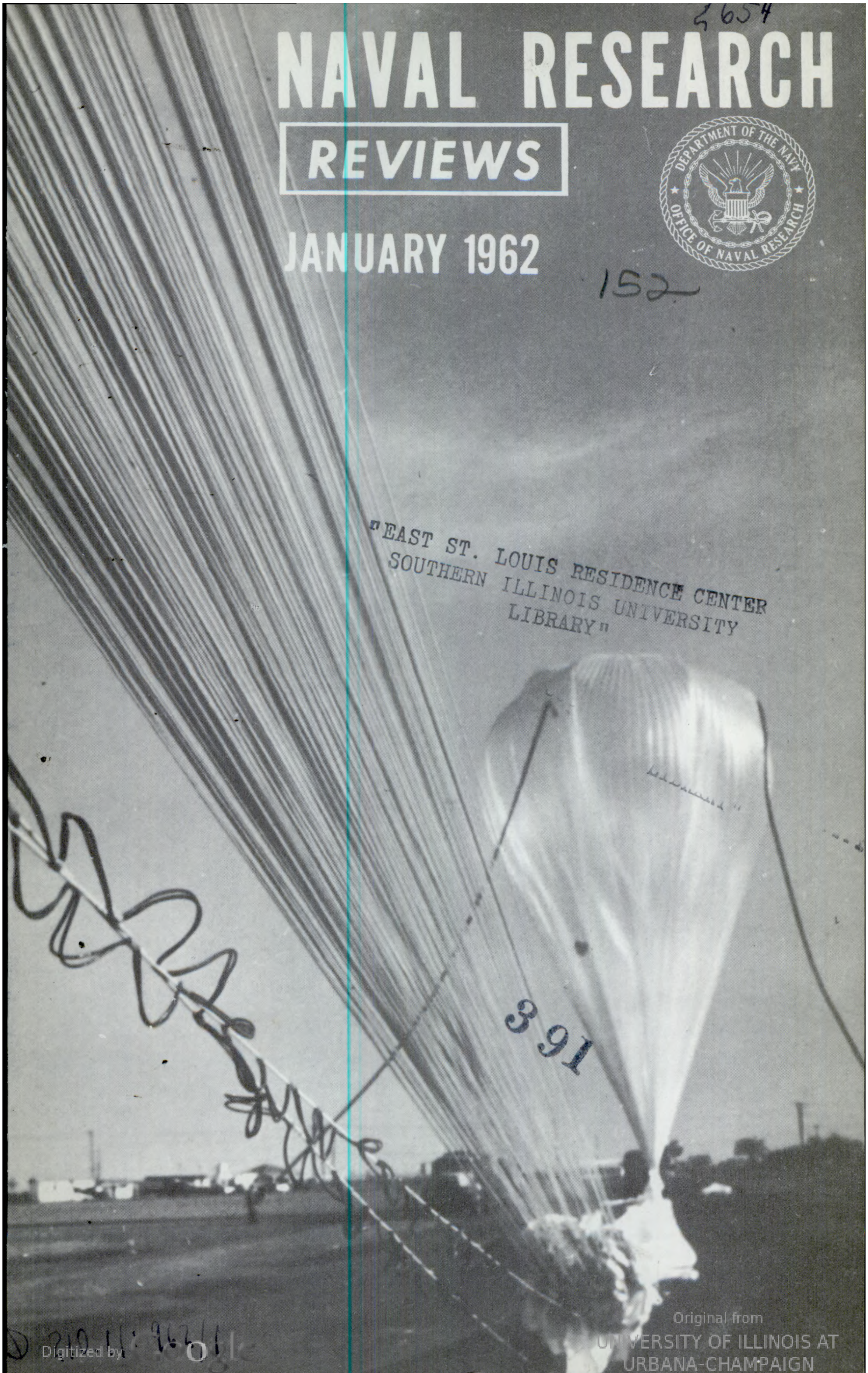
NAVAL RESEARCH

REVIEWS

JANUARY 1962

DEPARTMENT OF THE NAVY · OFFICE OF NAVAL RESEARCH



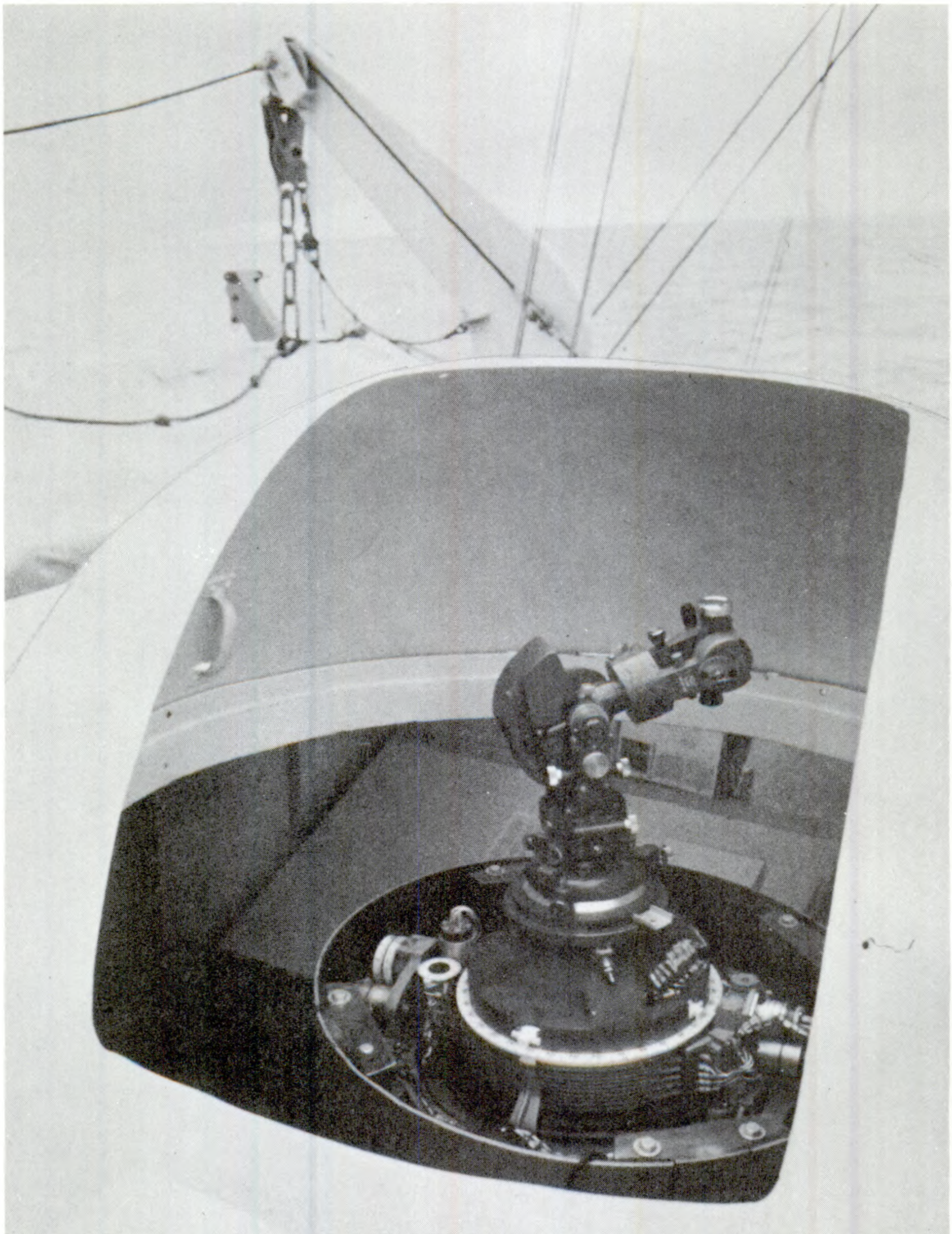


Figure 1 - The equatorially mounted theodolite in position on top of the Mark 19 meridian compass aboard the RV CHAIN. Since the compass is run with its cover off, the observing shelter is supplied with filtered air under slight positive pressure to keep salt particles and soot from entering the slit. (Photo courtesy of WHOI)

Navigation and Leveling at Sea

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Woods Hole Oceanographic Institution

This past spring and summer, a new system of celestial navigation was tried out on board the RV CHAIN of the Woods Hole Oceanographic Institution. Dubbed the GEON (Gyro Erected Optical Navigation system), the system employs a meridian gyrocompass as a level reference plane instead of the present method of using the horizon. In addition, it allows a ship's position to be determined from a single sight on a single celestial body during clear-sky conditions at any time of the day or night. This new system also has interesting level-platform uses.

A level surface is one that lies exactly at right angles to the direction of gravity. On land, it is a comparatively simple thing to determine with fairly high precision the direction of local gravity: one needs only to hang a symmetrical weight (plumb bob) on a string and allow the swinging system to come to rest, or to observe the reflection of one's eye in a quiet water surface, as in a dish, to establish the direction of vertical. And the water surface itself adequately establishes a level plane of reference.

None of these operations, however, may be successfully performed at sea. Still, one might, by considering the sea to be a large-scale approximation of a dish of water, think that the ocean's horizon would be a suitable level reference plane from which to derive the direction of local gravity vertical. But even when the horizon is exquisitely sharp, as it can be on certain very clear days, it is not exactly level (90° from the zenith) because of the effects of atmospheric refraction and the curvature of the earth. In addition, the horizon is not symmetrically displaced from the zenith because of horizontal variations in atmospheric pressure and the regional tilt of the sea surface associated with wind stress, tides, and ocean currents. These last three disturbances, especially the ocean currents, are particularly interesting to physical oceanographers.

To paraphrase C.-G. Rossby's lucid statement* of the latter situation: "The earth's rotation around the vertical, which in a striking way is demonstrated by the slow turning of the plane of the Foucault pendulum, exerts a strong influence on the horizontal streams of the sea which tend to be deflected in opposite direction relative to the earth's own rotation [the Coriolis effect]. Thus, every newly formed ocean current in the northern hemisphere is deflected a little to the right. This deflection causes, in turn, a piling up of water (thus tilting the sea surface), which leads to high pressure on the right side of the stream and low pressure on the left side until the resulting pressure gradient across the current prevents further deflection. This adjustment of the pressure distribution to the state of motion is a fundamental property of

*Adapted from C.-G. Rossby, 1959, "Current Problems in Meteorology," Rossby Memorial Volume, Rockefeller Inst. Press, New York, p. 23.

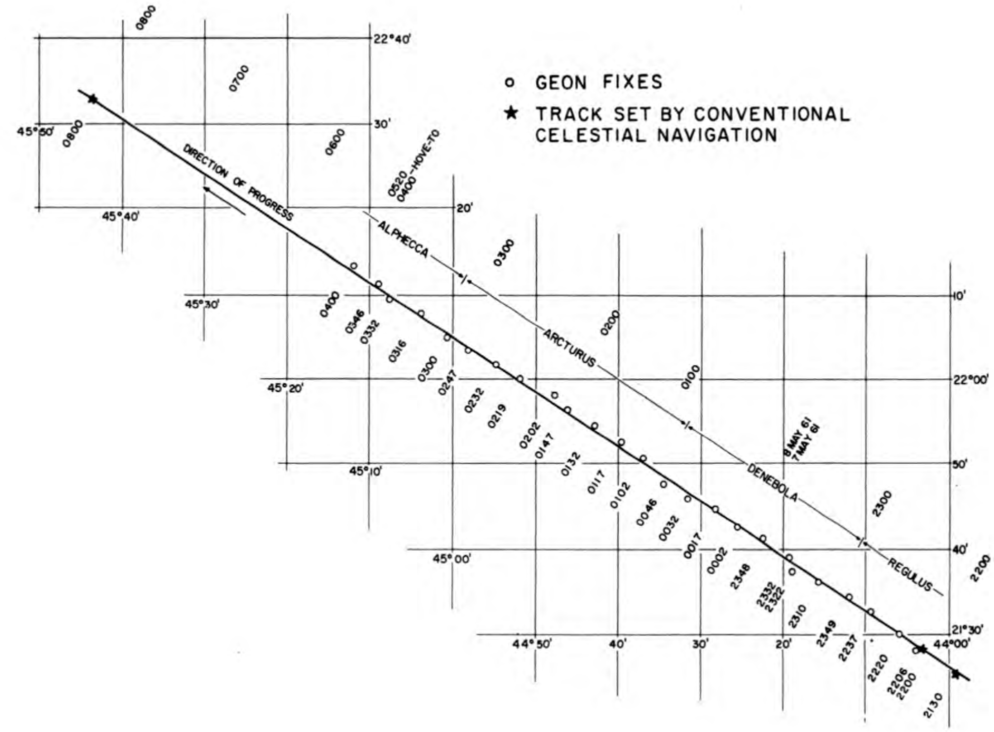


Figure 2 - Consecutive position fixes by the GEON method of navigation compared with the track established by conventional celestial navigation aboard the RV CHAIN (2200 7 May 61 to 0400 8 May 6 course 305. true, speed 13 knots). (Diagram by the author.)

the ocean and leads to the fact that the stream lines of the ocean currents by and large follow horizontal lines of equal pressure; isobars. To the extent that this condition is satisfied, the flow is 'geostrophic.'"

In order to calculate the motion of water in an ocean, oceanographers at the present time measure the temperature, salinity, and pressure of the water at various depths and, from this, calculate the density structure of the ocean. With these data, they then construct, upward from a datum plane, the relative slope of the ocean surface. The datum plane is based on the assumption that a level of no motion—in effect a level surface—exists at a depth of perhaps 1000 or 2000 meters. The trouble with this assumption, however, is that it is an assumption. If the slope of the sea surface could be measured independently, then the necessity of assuming a level surface would be eliminated. This measurement of slope, in combination with the existing techniques of water sampling to determine the relative field of motion as a function of depth, would then permit us to describe in absolute terms the internal field of geostrophic motion (ocean currents) in the sea.

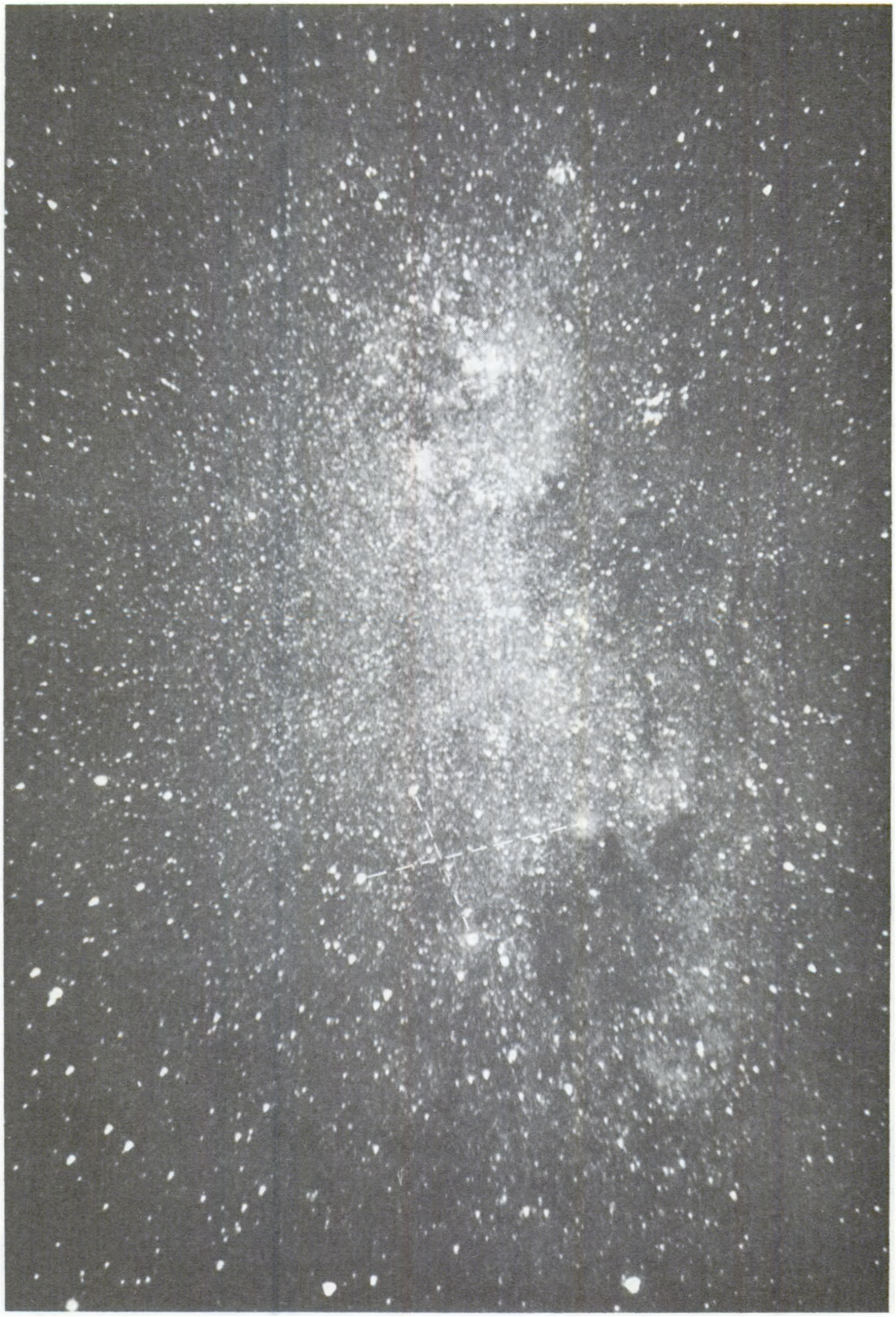
Physical oceanographers have been aware of this possibility for nearly fifty years. One method of studying the change of slope of the sea surface has been to examine tide-gauge records at stations bordering strong currents, such as those straddling the Gulf Stream at Miami,

Florida, and Cat Cay in the Bahamas; or between Charleston and Bermuda. By using these data, one can then determine the variability of sea-level slope but not the difference in absolute level between pairs of stations because we have no means of running a level line across the ocean surface between them.

Work was therefore undertaken to utilize existing gyroscopic systems (which have the property of seeking the vertical at sea) to study the problem of precise leveling across the oceans and related matters. One of these systems, the Sperry Meridian Gyrocompass Mark 19, Model 3a, provides not only approximate vertical information but the direction of geographic north as well. Since the directions of geographic north and of the zenith-point together define the position of the local astronomical meridian, the Mark 19 has been used as a base for a miniature astronomical observatory on board the RV CHAIN. Some experiments were performed with this apparatus during the spring and summer months of 1961. Among these, it was possible to navigate the ship, to photograph star fields, to study the development of trade-wind cumulus clouds, and to measure the optical properties of the horizon. The latter was undertaken with a view to ultimately determining—when more precise verticals can be obtained—the inclination of the horizon circle as an index of ocean-current activity.

Three highly useful possibilities have been indicated by this line of endeavor. First, the meridian gyrocompass permits use of a new system of navigation (GEON), which allows the ship's position to be determined with an accuracy of about one nautical mile from a single sight on a single celestial object at any time of day or night that the skies are clear. Second, by using a more refined version of GEON as an index of astronomical position on the sea surface, and the TRANSIT satellite navigation system to indicate the geocentric coordinates of that same point on the earth's surface, it should be possible to determine the regional slope of the earth at that given point. Then, from a combination of many such slope observations, it should be possible to determine directly some qualities related to the surface shape of the earth's ocean areas. Third, with still more highly refined apparatus than is required for either of the first two problems, it is conceivable that one day we may be able, from ships at sea, to examine the circle of the horizon and establish with high precision its attitude relative to the direction of local gravity.

Thus far, only the first of these three possibilities has been realized: navigation from surface vessels using the Sperry Mark 19 Meridian Gyrocompass. The recent experiments with the Mark 19, mounted on the RV CHAIN, show that it is within the capabilities of present equipment to maintain a vertical reference on shipboard that can be relied upon to a small fraction of a minute of arc and to make a north reference to a small fraction of a degree. The indication of local vertical by the gyropendulum to an accuracy of better than one minute of arc makes it unnecessary to employ the horizon as a reference. By the same token, it is unnecessary to transform the celestial coordinates of a body to the horizon system, or to make separate determinations of latitude and longitude if the plane of the local meridian can be known continuously from shipboard.



Ideally, to reduce the confusion of horizontal accelerations caused by waves and steering, the meridian gyrocompass should be mounted near the ship's metacenter, preferably between the turning center and the intersection of the pitch and roll axes of the hull. As this point lies deep within the ship, the station from which celestial observations are to be made would have to be on another deck. In practice, then, it seemed simplest to accept the effects of large horizontal accelerations and thereby avoid the more difficult problem of correcting angular and torsional misalignments of the two decks on which the master gyro and the remote observing station are mounted. For this reason, the master compass was mounted on the boat deck without specific relation to the metacenter. From this position, it was possible to take observations directly from the compass head.

With the system thus mounted at a level on the ship that provides a clear view of the sky, it is possible to adjust the polar axis and set the hour angle and declination axes of an equatorially mounted telescope well enough to bring the image of a bright celestial object into the field of view in either daylight or darkness.

The equatorially mounted optical train used in these experiments is shown in Figure 1. It consists of a DKM-1 Kern precision theodolite with its azimuth circle set in accurate alignment with the former position of the objective lens of a DKM-2 theodolite. In this impromptu arrangement there are four accurately graduated circles: (1), the azimuth circle of the lower theodolite to calibrate adjustment of the lower trunions, (these should lie parallel to the level east-west line maintained by the meridian gyro), (2), the altitude circle of the lower theodolite to give the altitude of the polar axis or latitude, (3), the azimuth circle of the upper theodolite to serve as an hour circle, and finally (4), the altitude circle of the upper theodolite to serve as a declination circle.

The precision and reliability of the assembly is such that once the lower theodolite is squared on the gyro head (by taking sights on the horizon in daylight) and the azimuth of the lower trunions is adjusted (by taking sights on celestial objects low in the eastern and western sky) it is possible to determine the ship's position to an accuracy of one nautical mile at any time during the following 36 hours. Figure 2 illustrates a comparison of consecutive position fixes by GEON to the ship's track of the RV CHAIN as established by conventional celestial navigation.

The effects of atmospheric refraction and "hunting" of the gyrocompass north point make it desirable to restrict sights to objects near the zenith. This is easily accomplished at night, when the usual navigation stars are accessible, but is less easily done by day. During midday the sun is the obvious target, but in the early morning or late

◀ Figure 3 - A 30-minute time exposure of the Milky Way in the Crux-Argo region made while the RV CHAIN travelled at 13 knots. During the exposure, corrections for variations in latitude and longitude, caused by the ship's motion and the earth's rotation, were made by hand guiding on the star "Spica." The Southern Cross and the "coal sack" appear to the left of center. North is at the left. (Photo by the author using Tri-X film and a Zeiss Biotar 50-mm lens with the diaphragm set at f.2) afternoon it is preferable to choose a bright star or planet higher in the sky. Such objects are more easily seen during the early and late hours of daylight because the brightness of the sky tends to fall off rapidly with increasing angular distance from the solar disk. Under favorable conditions it is possible to observe in full daylight objects generally brighter than magnitude zero with astronomical telescopes having apertures as small as 30 millimeters, and to reach first-magnitude objects with apertures of about 50 millimeters.

As a by-product of the navigational experiments, the meridian gyro also made it possible to take at sea half-hour time exposures of star fields with small cameras mounted on the hour circle box of the upper theodolite. The accompanying photograph of the Crux-Argo (Figure 3) region of the Milky Way were obtained by these methods. The moon, sun, and brighter planets have also been photographed from the gyro head, at a scale of one centimeter per degree.

There are numerous other applications of the meridian gyro to problems in astronomical and meteorological photography and theodolite measurements from shipboard. They may include direct photography of solar eclipses as well as their associated flash and coronal spectra; records of meteor and satellite trajectories; and whole-sky, time-lapse photographs of aurorae or clouds—to name a few. With an observatory on shipboard one has the unusual option of taking observation from those places where geographic and climatic conditions at sea are most favorable, not where ocean islands happen to be situated. It is worth noting that in the vicinity of the magnetic equator there is a marked absence of aurora and air glow, and being far from the smoke and scattered light of populated regions on land, the night sky at sea is so black that faint celestial objects are often unexpectedly easy to observe.

As for the future of these experiments, steps are being taken to improve the optical system of the GEON in an attempt to reduce its own contribution to the errors in astronomical navigation. Plans are being made to re-design portions of the Mark 19 azimuth and leveling servo systems in the hope of improving performance. If these changes permit astronomical navigation by GEON to be improved to an accuracy of one tenth of a nautical mile—the level of accuracy promised for TRANSIT navigation system—it may be possible to combine the two systems to provide information on the slopes of the earth's figure at sea to the order of 10 seconds of arc. While this is far short of the desired precision for the purposes of marine physical geodesy or for the detection of sea slopes accompanying geostrophic motions, much less the wind stress or tides in the open sea, it would be a firm step into an area of investigation for which there are, at present, no direct observations at all to work with.

The ultimate problem of measuring the regional slopes of the sea surface associated with the piling up of water in geostrophic flows is an extraordinarily difficult one and well beyond the limitations of the best inertial systems presently available or even being considered at the moment. Indeed, requirements are so stringent that the goal may never be reached. But the question is so basic to physical oceanographic progress, and its answer would contribute so greatly to our understanding of the transports of energy and substance by the oceans, that even an unsuccessful attempt seems worthwhile—especially since its by-products have already proved to be interesting.

New ASROC Trainer

A million-dollar shore-based trainer for the Navy's ASROC antisubmarine weapons system has gone into operation at the Norfolk Navy Base. The trainer permits Navy missile men to wage realistic practice battles with enemy submarines, and do it all on shore without ships, missiles, or subs.

The device consists of a number of electronic consoles that simulate the equipment used aboard ships to locate and track enemy subs, compute their course, range and speed, aim the ASROC launcher, and fire the missiles. Sonar, computer, fire control, and launcher consoles of the trainer perform as if they were in operation aboard ship, with a variety of electronic systems simulating actual battle conditions. Engineers describe the trainer as a synthesized operational ASROC system with the same external appearances and functional features of the actual equipment, but with computational and equipment responses simulating, rather than duplicating, the operation system.

The trainer was built for the Naval Training Device Center by Minneapolis-Honeywell's Ordnance Division facility at Duarte, Calif.

Fire-Control Console of the new ASROC trainer. The operator's right hand controls the switch that launches the deadly antisub missile. (Minneapolis-Honeywell photo)

Discipline and Practice of Operations Research

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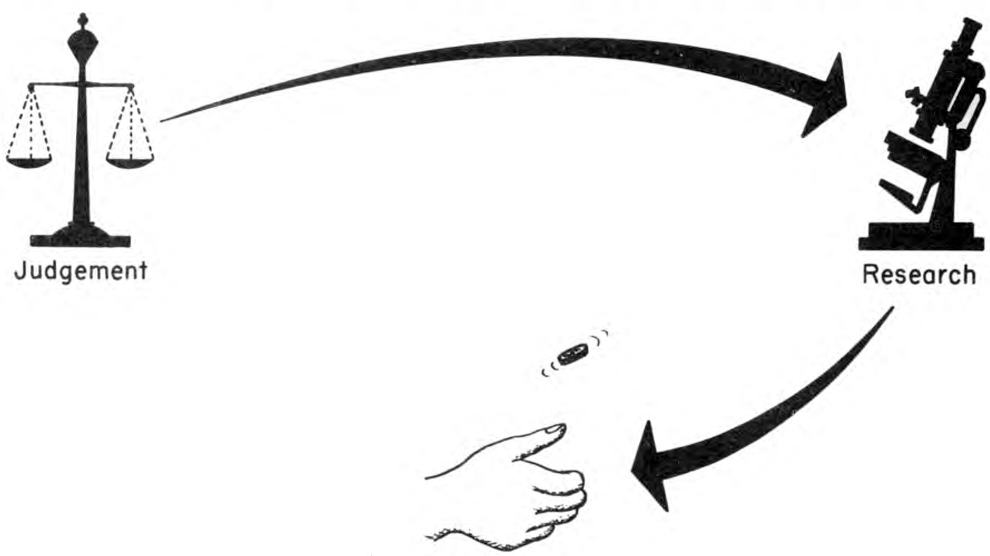
Office of Naval Research

Operations research is the scientific approach used to solve problems in decision making that arise in operations. It has also been defined as the art of giving bad answers to questions to which otherwise worse answers would be given. The significance of this definition is best realized by those who have given a serious look to the world about them. The concept of an operation remains informal and elusive; roughly speaking, it is conceived as a man-machine relationship instituted to achieve given objectives.

Many scientists practice operations research as it applies to operational phenomena connected with their own specialities. Examples of operational problems vary widely in scope. They include, among others, noncongested traffic flow through the Suez Canal or the New York tunnels; optimal methods of refining crude oil according to seasonal needs; sizes of stocks to be kept in inventory to meet fluctuating demands; the search for lost objects (particularly for people in the high seas); the allocation and rotation of crops for an entire country; and the analysis and simulation of military strategy and tactics and effectiveness of weapons.

The pursuit of operations research consists of three phases: the judgment phase (defining the problems), the research phase (solving these problems), and the decision phase (acting on the findings and



The phases of operations research.

eliminating the problems). These phases require the analysis of an operation and the collection of evidence; the (mathematical) formulation of problems; the construction of theoretical models and selection of measures of effectiveness to test the models in practice; and the making and testing of hypotheses as to how well a model represents the problem, the prediction, the refinement of the model, and the interpretation of results (usually as possible alternatives) with their respective values (pay off). The decision maker generally combines the finding of the analysis with his experience and tempers it by the dictates of statesmanship to arrive at a more rational decision than he would otherwise make. The fact that operations often involve people, however, makes it difficult to follow the dictates of simplified logic. It has been neither easy nor desirable to assign worth to people or to their preferences. Note the important role that the analyst's objectivity plays in this process.

To a considerable extent, operations research as a formal discipline is occupied with the construction of models. This is closely related to the analysis of alternatives for decision making. It is generally assumed that having a model to represent an operation is preferable to not having one, even though the model may be oversimplified and perhaps imperfect. The structure of a model may be purely logical (a mathematical formula, for example), or it may be a physical analogue (such as a wind tunnel). In either case, the model provides a coherent framework for coping with the complexities of a problem.

The literature of science is replete with models. This variety enables one to make some interesting observations. For instance, one rarely regards models as unique or absolute, although the choice of a specific model (e.g., a differential equation) may provide unique solutions to problems. A model is formulated to serve a specific purpose. Some models may be suitable for generalization, others may not. These generalizations are more profitably made as extrapolations for scientific purposes and occasionally as useful philosophical observations. A model must be flexible to absorb new information, and hence conjectural processes have broader and richer applicability than deterministic models.

Models are usually formed through a process of successive approximations, and, with each one, refinements are introduced which are based on how good additional information may be and how satisfactory the model is for prediction purposes. This refinement may be described as follows: The accumulation of data, the formulation of a model, and the prediction of results are followed by further data, an adjustment of the model, and further prediction, then by more data, another adjustment of the model, and still another prediction—continued as far as need be.

Among the first desirable properties of models are economy in the number of parameters which describe the essential properties of an operation, general applicability to a variety of problems, and successful prediction. An operations research problem may be remedial in that it seeks to correct malfunctions in an operation. It may be an optimization problem if, for example, the object is to minimize the effort used in

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producing outcomes which are subject to constraints. It may be predictive if knowledge about future behavior is sought or new problems are to be solved by known techniques. Finally, a problem may be hypothetical if the possible occurrence of difficulties and studies are anticipated and a variety of solutions are to be used to prevent a problem from arising.

One observes that operations research tends to regard a problem within the operation as a whole in order to avoid overlooking significant factors which interact with those parts of the operation relating to the problem. An interesting problem solved by operations research methods is that of the flow of traffic through the New York tunnels. The presence of toll booths causes congestion of traffic at the entrances and exits. For reasons of economy, not all booths can be operated at all times, but a thorough study of traffic statistics resulted in a schedule for the number of booths to be operated at different times of the day. In this manner congestion was alleviated, and the frequency of traffic jams was considerably reduced.

Another illustration of operations research is the use of linear programming techniques to obtain optimal mixtures of gasoline ingredients suitable for different climatic conditions and subject to demand constraints on a long-range basis. As still another example, problems of logistics and inventory occupy the attention of many investigators because of the high cost of storing inventory items on shelves or because such items, especially spare parts, may become obsolescent.

Operations research has played a fundamental role in developing war gaming methods for studying possible courses of strategy to be followed in peace or war and analyzing their outcomes. Similar methods also have been developed for business gaming. At present, simulation techniques of operations research are being prepared for use in studying the economy of emergent countries. In such studies the inclusion of information on the national product, investment in various sections of the economy, production from various sections, imports and exports, balance of payments, and so forth, makes it possible to investigate the effect on the economy of varying these different quantities and to recommend certain actions to the decision makers which would improve the growth of the economy over an extended period.

An illustration of an operation research problem for which no model is as yet available is that which occurs in queueing theory. Everyone has observed, and perhaps been irked by, late arrivals to a waiting line, such as before a theatre box-office, who normally would be in line behind the observer but who go to arrivals at the front of line to solicit their cooperation in obtaining service through collusion. Thus the man in line must wait while this additional service is obtained. How long will a person wait if he tolerates such apparently unethical practices, and what can be done to discourage collusion? An ethical means of collusion is car pools, in which the average waiting time may actually be shortened since fewer cars are in use. Moreover, there is no unfair advantage taken of the limited available service. On the other hand, in a long line before a theatre which has only a few remaining tickets for a successful performance, late arrivals going forward to collude with acquaintances in the front of the queue are always a cause for exasperation. Without such collusion the individual has a fair chance of getting in. Otherwise it is more difficult.

Consider for a moment the plight of a customer waiting in a single-channel first-come first-served queue who would not seek an alliance. Collusion among the people in line ahead of him may decrease his waiting time, because less time is consumed in selling one person twelve tickets than in selling twelve persons one ticket each. But customers who arrive after him and ally themselves with customers ahead of him inevitably increase his total waiting time. In fact, if he too were also to accommodate requests for collusion he would spend a longer time in the service facility. Alliances which people can see with their own eyes are generally regarded as unethical. Collusion by telephone, however, although not as obvious, also can be time-consuming.

An interesting idea that occurs here is that the delay time of a customer in the system also depends on the number of customers arriving after him and on the probability that they collude with him or with customers ahead of him. How to describe and relate the variables entering in the computation of this waiting time is another problem that should be considered.

The problems of operations research have stimulated new developments in several mathematical fields: various aspects of game theory, stochastic processes, calculus of variations, graph theory, and numerical analysis, to name a few. From a theoretical standpoint an interesting and difficult problem is the characterization of the structure of an operation with the view of developing a theory which includes all the elements of the separate theories used so far in the field. This type of coherence is as yet unavailable. The subject of graph theory is receiving considerable attention because of its contribution to the study of flow in networks. Both the concept of flow and the concept of network have immediate bearing on the structure problem.

There are areas in the field of management science where it has not been easy or fruitful to produce theories that are useful in decision making. The complexity of the concepts and structures involved have so far presented investigators with great difficulties. Some continue to attempt formalizing the structure of the field of management science, but there have been no breakthroughs. Often one is limited by the absence of mathematical methods required in this theoretical pursuit.

Areas of advanced planning, policy planning in conflict situations, automation, space problems, psychology, and biology require fresh mathematical interest. For example, decision problems would be better understood with a fruitful formal approach to the psychology of values and, hence, decision criteria. Today the conflicting elements cannot be resolved by existing simplified theories. Yet, with theoretical abstraction, there is greater promise of achievement. It alone saves one from repetitive use of the same inadequate devices.

So far, operations research has utilized the talents of individuals from a wide spectrum of fields ranging from chess players, through physical and social scientists, to mathematicians, both pure and applied. The need for imaginativeness and a good background in technical excellence are the basic elements in this choice of individuals. A significant consequence of all this is an opportunity for broad intellectual contacts and cross-fertilization of ideas.

There are, at present, eleven operations research societies in different countries. There is also an International Federation of Operations Research Societies (IFORS). In addition to the journals published by these societies, a new one, called International Abstracts in Operations Research, comparable to Mathematical Reviews, has recently made its appearance.

At the end of the article, some suggested mathematics courses, which would be helpful in the broad areas of operations research, are given. These are to be taken with the courses grouped at the end of the list. Computers have come to play a significant role in solving complicated mathematical models describing operations, and hence it is desirable to include courses pertaining to computing and computability in the list.

It is best to point out that because a formal structure of operations does not exist the courses proposed provide only useful tools. Experience is still required for a better appreciation of the subject. Fortunately there is no monopoly on how to obtain such experience. By examining the world he lives in, the alert individual can see a number of problems which he would like to see solved. The mathematician, for instance, has the needed intellectual stamina to employ his faculties and his excellence in providing the solution sought. Most of what is required is a little concern about our world and a little daring to change it.

A List of Courses for Mathematicians Training in Operations Research

I. Optimization
   - Calculus of Variations
   - Linear and Nonlinear Programming with Applications
   - Econometrics Models
   - Dynamic Programming
   - Game Theory

II. Probability and Statistics
   - Elements of Mathematical Statistics
   - Introduction to Probability and Stochastic Processes
   - Markov Processes and their Applications

III. Graph Theory

IV. Theoretical and Applied Computation
   - Numerical Analysis
   - Computer Programming and Application

V. Application Courses (to be taught and coordinated with other Departments)
   - Queueing Theory
   - Inventory Theory

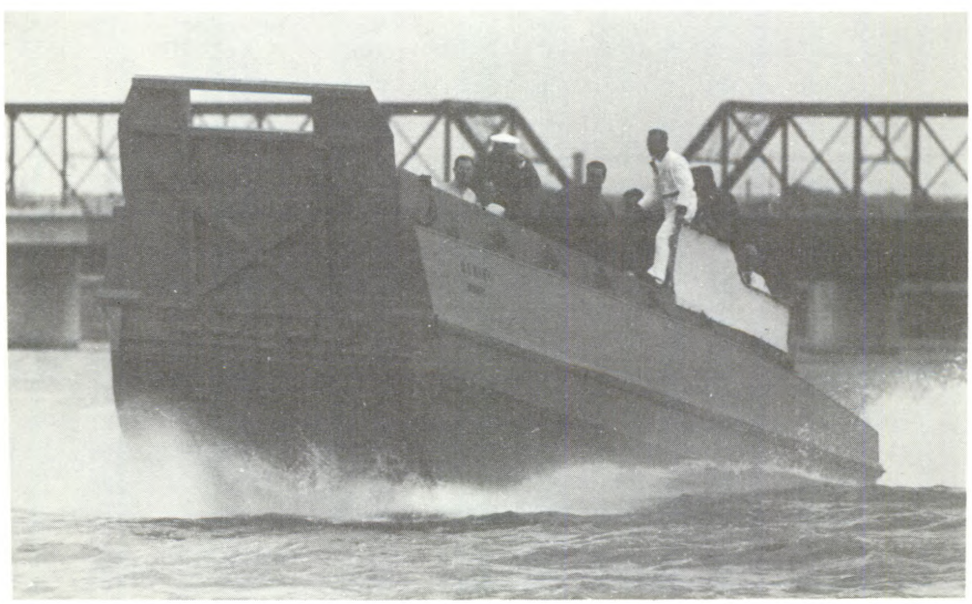
Renewal Processes, Reliability Theory, Testing and Control, etc.
Feedback and Automatic Control Theory (Non-Linear Differential Equations, etc)
Econometrics (to be coordinated with Department of Economics)
Simulation and gaming

VI. Fundamental Mathematics
Modern Algebra
Matrix Theory and Vector Spaces
Real and Complex Variables
Transform Theory
Statistical Mechanics
Differential Equations
Point Set and Combinational Topology
Introduction to Algebraic Topology
Advanced Topics, etc.

New Hydrokeel Landing Craft

The Navy's Bureau of Ships recently demonstrated a new "hydrokeel" landing craft that is capable of doing more than 30 knots.

Although similar in topside appearance to the more conventional LCVP (Landing Craft Vehicle, Personnel), "Big Jim" has twice the power and three times the speed of its World-War II counterpart. The underwater portion of the hull of the new vehicle consists of one center-line keel and two sidewall keels. An air pocket, produced under the hull by blowers located in the rear of the craft, permits the boat to rise on its keels and slide more freely over the water. The new hydrokeel was designed and built by the Anti-Friction Hull Corporation of Laurel, Maryland, under a BuShips contract.



"Big Jim" the new hydrokeel landing craft skims over the Potomac River.

ICEF Experiment Successfully Flown

LCDR John A. Wamsley, USN
Nuclear Physics Branch
Office of Naval Research

On 19 November 1961 the second International Cooperative Emulsion Flight (ICEF), sponsored by the Nuclear Physics Branch of the Office of Naval Research and the National Science Foundation, was launched from Brawley, California (see Figure 1 and cover picture), and was successfully recovered two days later near Hickory, North Carolina. The balloon carried a 2200-pound payload, containing 81 liters of nuclear emulsions, in the longest successful flight of such a large payload.

The purpose of the experiment was to record on sensitive film the interactions of ultra-high-energy cosmic particles ("rays"). Now physicists can analyze the subnuclear particles in the recorded interactions and cascades which result from the collisions of particles with energies between one hundred billion to one million billion electron volts. (By contrast, our largest accelerator can only produce energies of about 30 billion electron volts). To reduce the number of interactions on the emulsion produced by lower-energy particles, the experiment was flown in the southern United States where the earth's magnetic field is effective in filtering out these lower energy particles.

Dr. Koshiba of the University of Chicago was responsible for the preparation of the scientific payload and is in charge of the overall direction of the ICEF project. Mr. Paul Yost headed the launch and

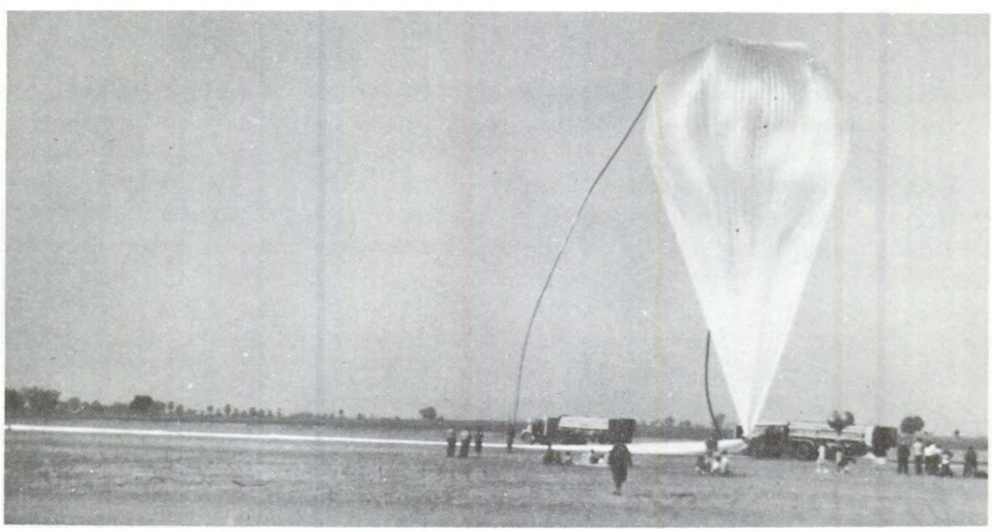


Figure 1 - The November 19 ICEF dynamic-type launching at Brawley, California. Part of the balloon is rising and part of it lies along the ground at the left. It is threaded through a roller fastened to the front of a truck. The payload and the other end of the balloon are fastened to another truck just beyond the picture to the left. (Photo courtesy of Dr. Koshiba)

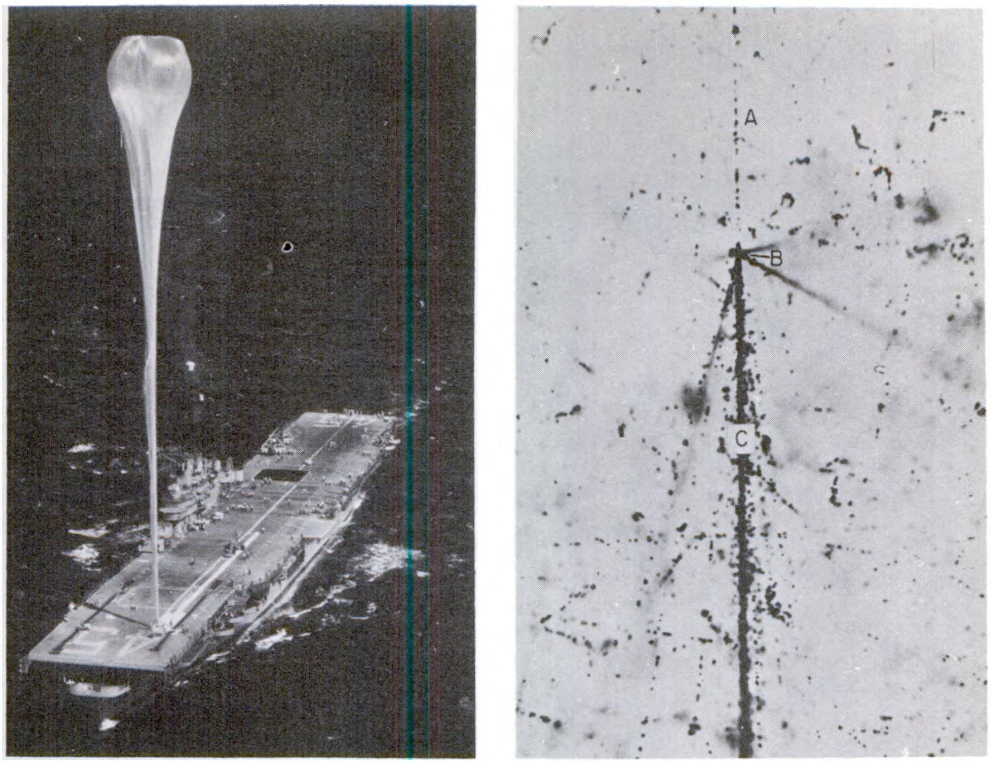
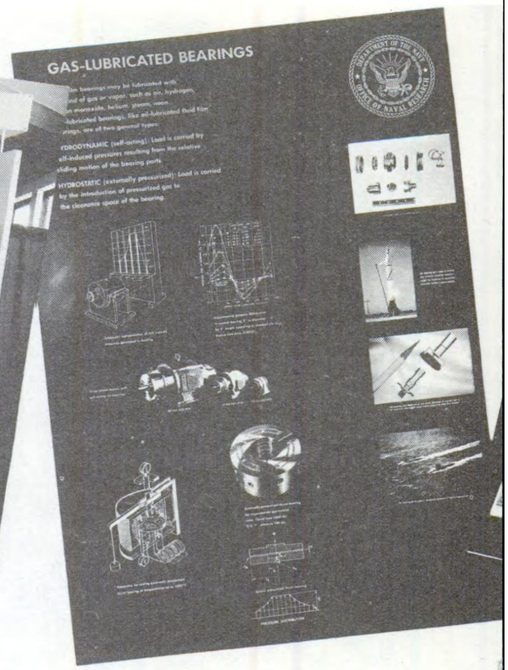


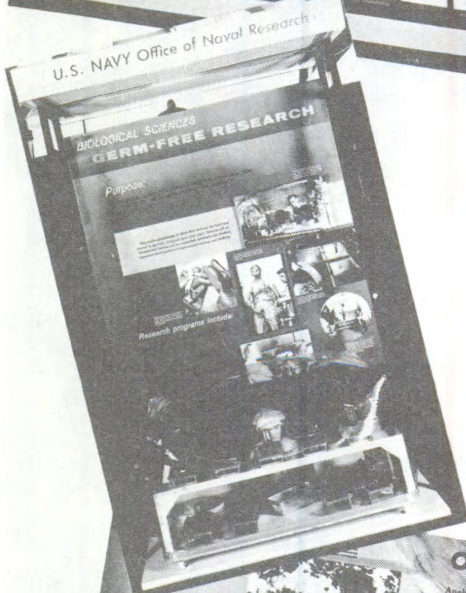
Figure 2 - (Left) Launching of the first ICEF flight in January 1960 from the carrier VALLEY FORGE in the Caribbean. (Right) A photomicrograph taken in one of the emulsions flown during this flight. Track A was made by an incident alpha particle which struck a nucleus in the emulsion at B. This collision then produced a jet of particles (C). Farther on, the jet enlarged into a cascade of millions of particles (not shown). (Photomicrograph courtesy of Dr. Koshiba)

tracking crew of Raven Industries, while CDR Sparkman and Mr. Evanick assisted in obtaining weather information and Navy logistic support. The balloon used was a 10-million cubic-foot capped type fabricated by Winzen Research, Inc., The balloon, along with the instrumentation prepared by Raven, performed exceptionally well producing a level flight at about 110,000 feet. The flight was terminated after 38 hours by a timer cutdown.

In January 1960, the first ICEF stack of emulsions was flown in the Caribbean from the carrier VALLEY FORGE under ONR and NSF sponsorship (Figure 2, left) but this was a much shorter flight at lower altitudes. This stack was cut up and sent for study to many of the best cosmic-ray laboratories in about 18 different countries. American participants in the ICEF program are: Dr. Maurice Shapiro's cosmic-ray group at the U. S. Naval Research Laboratory and similar groups at the Universities of Chicago, Washington, Rochester, and Louisiana State. By analysis of interactions on ICEF plates, such as the one shown in Figure 2 (right), scientists have learned much about nuclear forces and the characteristics of sub-atomic particles.


U.S. NAVY OFFICE OF NAVAL RESEARCH
LONG RANGE HIGH-SPEED RECOVERY
Men and Materials


GAS-LUBRICATED BEARINGS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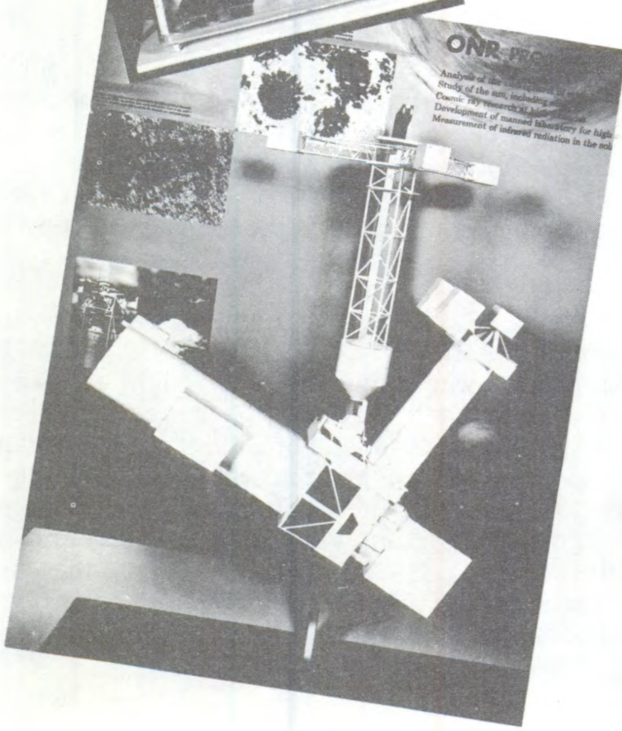

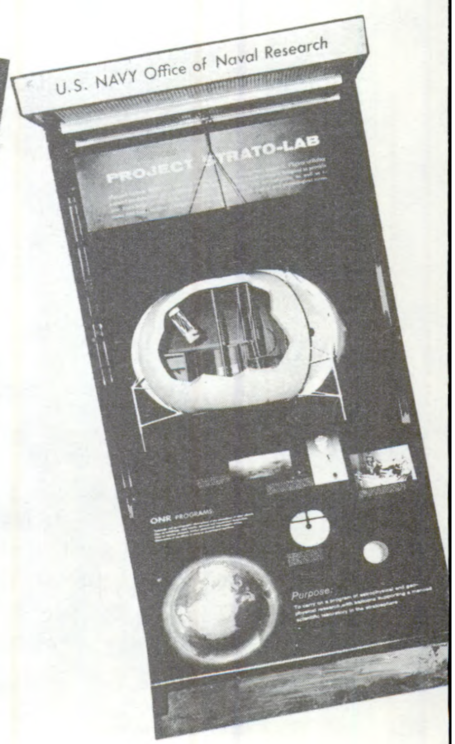
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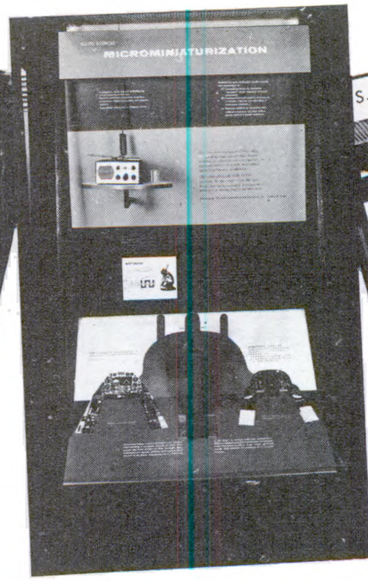
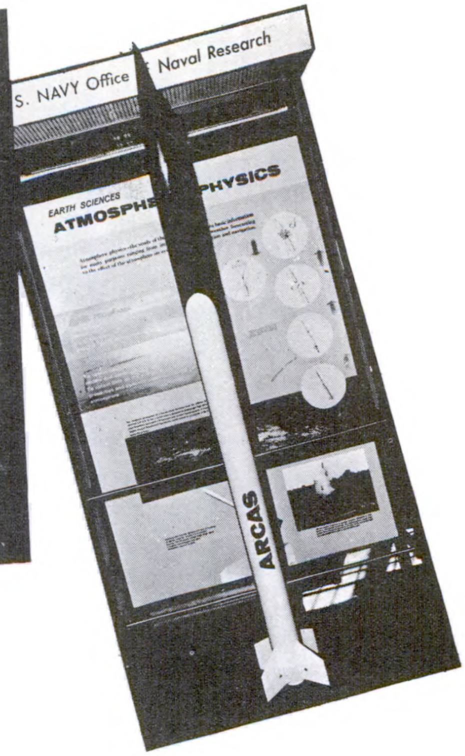
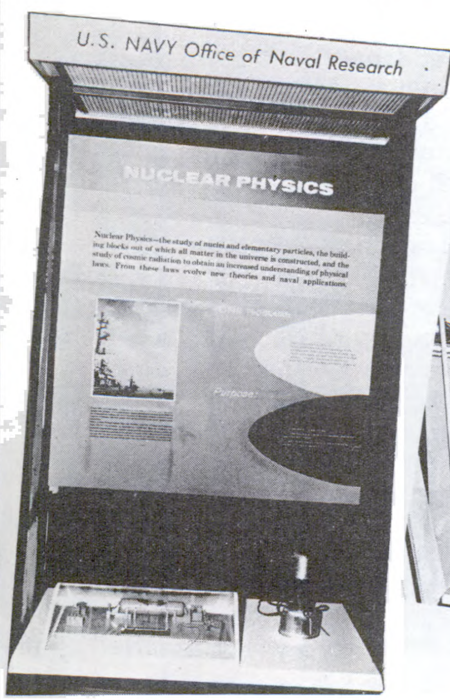
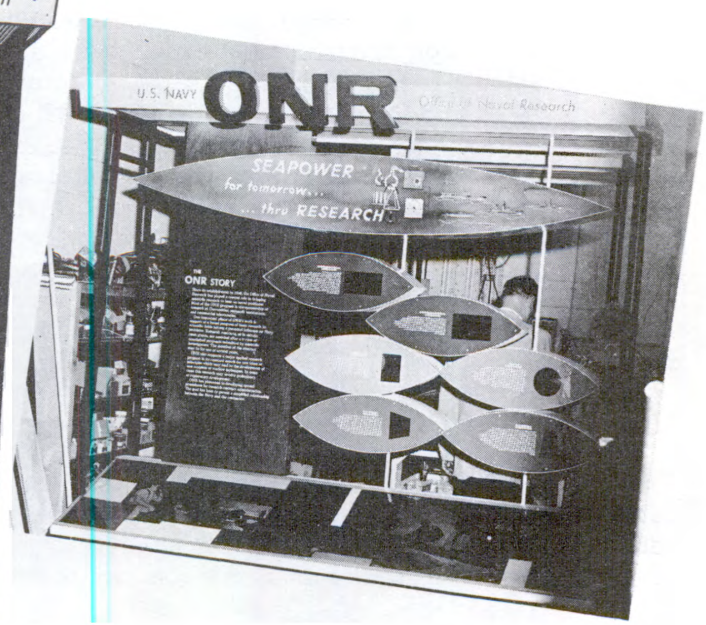




ONR ON DISPLAY – These are typical of ONR Exhibits describing various Naval Research Programs which can be made available for display at scientific and technical meetings.





Research Notes

A Schoolgirl Named Notty

Last spring, the Naval Ordnance Test Station, China Lake, California, commissioned Marineland of the Pacific, Palos Verdes, California, to catch and train a porpoise. Their catch, a six-foot, 180-pound female, is now owned by the U. S. Navy (see March 1961 NavResRev). Her name, Notty, was derived from the first letters of the Station's name. Those who observe and work with porpoises (dolphins) are usually impressed by their childlike habits and reactions. Notty herself has proved to be so frolicsome and mischievous, that Mr. Tom Lang of NOTS, China Lake is planning studies of her behavior.

A friend of Lang's, Mr. Humphrey, is the principal of a Los Angeles elementary school who specializes in teaching retarded children. He is especially clever and experienced in fanning the sparks of intelligence in children. Humphrey visited Notty and, intrigued with her behavior, was easily enlisted in an experiment in communication with another species. So last summer, Humphrey, without benefit of experience in porpoise training, spent 10 days with Notty and tried his school approach. As a means of communication, an inexpensive underwater speaker was purchased from a local retailer of swimming pool equipment. Then the teacher spent several days in familiarization and in testing school techniques on Notty. After that, a brief period was spent in teaching her word recognition. She quickly learned to identify the following words: ball, hat, ring, and stick. These items would be retrieved from across the pool on voice command.

Humphrey now thinks of Notty more as a normal child subject to the frustrations of solitary confinement than as an intellectually retarded child. Lang believes that this is the first time an educator has worked with a dolphin and possibly the first time that the voice has been transmitted for communication with a dolphin. Although Dr. Lilly (Director of the Communications Research Institute in the Virgin Islands) makes reference to the possibility of vocal commands to dolphins in his new book "Man and Dolphin," there is no record of similar experiments.

Dr. Lilly also visited Notty at Marineland of the Pacific, Palos Verdes, California, where she is housed. Lilly, who has worked with the Atlantic bulbous-foreheaded dolphin (Tursiops truncatus), was quite impressed by the beauty and sleek characteristics of Notty, a Pacific light-sided dolphin (Lagenorhynchus obliquidens). At the time, Notty was giving her attention to a sick whale and ignoring three matronly dolphins.

ANATOMICAL STUDIES

Dr. Lilly cited many experiences and data indicative of possible dolphin intelligence. For one, the mammal has lived at sea, completely removed from land forms, for 60,000,000 years. Thus, it is about as alien to mankind as any mammal on earth. Its forehead is oil filled and contains complex sound-generating devices. Underwater sound is produced within the body with mouth and blowhole closed so that no air bubble appears. Tests indicate that the dolphin is sensitive to sound at frequencies up to 120 kilocycles. Whereas human vocal cords pulsate at 60 to 120 cycles per second with about 50 selective harmonics, the dolphin's pulsate at about 600 cycles per second with a choice of many more harmonics. Then, too, the dolphin has at least two separately controlled, independent sound mechanisms.

The dolphin's brain, located aft of the blowhole, generally exceeds the human brain in weight, and has a many-convoluted cortex that weighs about 1100 grams. Research indicates that, in humans, 600 to 700 grams of cortex is necessary for a vocabulary. Absolute weight of the cortex, rather than the ratio of brain weight to total body weight, is thought to be indicative of intelligence potential. (Large-headed humans usally have large sinus regions rather than proportionally larger brains.) In this regard, the sperm whale's 9000-gram brain could raise some interesting speculation. The dolphin apparently enjoys equal visual acuity in air and water, a remarkable feat when one considers the refraction index involved. Porpoises sleep with only one eye closed at a time for a maximum length of 30 seconds (between breaths). Their sleep totals about three hours out of each 24. (Space research has indicated that man's sleep requirement reduces to this figure when he is kept in water to eliminate energy expended in supporting himself against gravity).—B. J. Cagle, ONR, Pasadena.

Thunderstorm Activity Studied

In one of the most ambitious attempts to uncover new basic information about thunderstorm activity since Benjamin Franklin sent his kite aloft, a team of scientists atop Mt. Withington, New Mexico, recently completed an intensive investigation of atmospheric phenomena. The instruments in use ranged from cloud-physics radar equipment and an instrumented aircraft to old Coast Guard brass cannons and modified garbage cans. One part of the work involved stretching six miles of fine wire between Mt. Withington and a number of other peaks in the vicinity.

A number of research organizations and institutions cooperated in the venture. The Arthur D. Little Company of Cambridge, Massachusetts, one of the principal investigating agencies on the project, operated under a contract funded by the U. S. Navy's Office of Naval Research and Bureau of Weapons and the National Science Foundation. Other experiments under the same sponsorship were conducted by scientists from the New Mexico Institute of Mining and Technology in Socorro, New Mexico. NMIMT is planning to establish a permanent laboratory on nearby Mt. Baldy as soon as facilities and easy access can be constructed.

Besides the obvious implication, for increasing the accuracy of thunderstorm forecasts, the project holds promise for aiding both military and civilian aircraft operations by improving knowledge of flight hazards connected with these storms. Mt. Withington was chosen as the site of the project because, during the thunderstorm season, a stationary thunderstorm forms almost daily, thus providing a unique cloud laboratory. The mountain is located about 50 miles southwest of Socorro, New Mexico.

One of the general questions the investigators explored is: What makes rain fall? It has been hypothesized that ice crystals form around freezing nuclei in clouds and melt as they fall toward earth. The principle of cloud seeding is based on this hypothesis. However, engineering procedures presently used by cloud seeders have produced somewhat questionable results. Therefore, by concentrating on the basic aspects of precipitation and thunderstorm phenomena, scientists hope to be able to lay the groundwork for a better understanding of the precipitation process.

Another area of investigation concerned the origin of charge separation in a thunderstorm. There are several conflicting theories on how charge is accumulated. One theory holds that the falling precipitation separates the charge that causes lightning. Another theory holds that electrification is a preliminary process that precedes the precipitation. In attempting to settle these questions, scientists investigated the origin of electrification in clouds.

A large portion of the Mt. Withington work was under the direction of Dr. Bernard Vonnegut and Mr. Charles Moore, both of the A. D. Little Company. Part of this work involved introducing corona discharge into the atmosphere from electrically charged wires which were strung between Mt. Withington and neighboring peaks. In putting up these wires, the men secured one end at the Mt. Withington site, and a helicopter carried the rest of the package across to the next peak, playing out the wire with a winch as the aircraft traversed the valley. Upon reaching the peak, the helicopter dropped the remainder of the bundle by parachute. A waiting ground crew then picked up the package and raced it to the spot where it was to be secured, making the line taut before it could fall into the valley and snag in the treetops.

The purpose of these wires was to put an electrical charge onto aerosol particles in the atmosphere, which were then carried up into the cloud by convection currents. The scientists also used helium-filled, tethered balloons to fly instruments and wires from atop the mountain. The wires, which trailed from the balloons, released an electrical charge into the atmosphere. By both means, investigators hoped to explore the possibility of modifying the electrical characteristics of clouds.

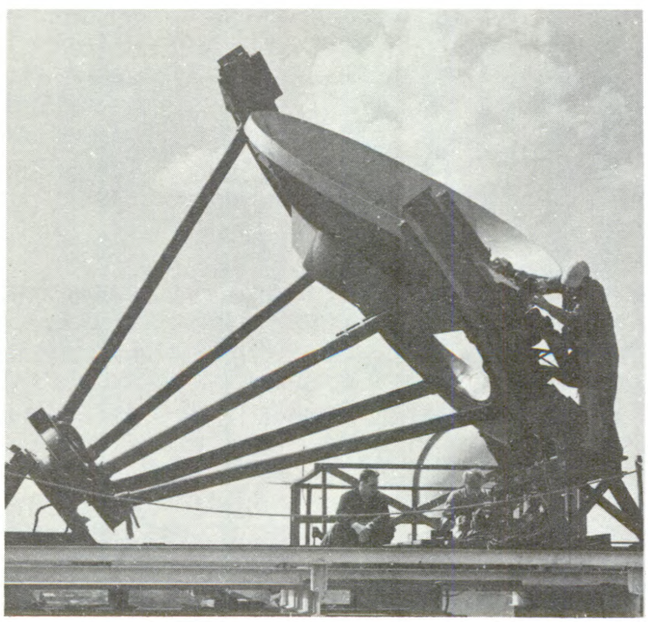
One of the more spectacular aspects of the program revolved around attempts to bring down lightning strokes at pre-determined spots. To do this, scientists fired projectiles with attached grounded wires up into storms and cloud formations. Because the danger of forest fires in the surrounding area made "hot" firings impracticable, two alternative types of missiles were used. One of these—called the "Cricket"—was propelled by compressed carbon dioxide and acetone, and the other was fired by a black powder charge from old brass cannons formerly used by the Coast Guard for rescue operations. The launchings carried these missiles to 1,500 feet. In this manner, a conductive wire was carried rapidly up into the storm to bring down a lightning stroke at the desired spot. Instruments set up in the area analyzed the stroke, a process which heretofore could not have been arranged in advance.

Several other pieces of equipment also were in operation. Navigational-radar equipment borrowed from the Navy was modified and used for cloud physics work. A specially instrumented P-38 aircraft made measurements inside the storm itself. Microphones protruding from the ground recorded the intensity and accoustical spectrum of thunderclaps. Modified, garden-variety garbage cans were also put into service as rain gauges to catch the rain so that the electrical charge on raindrops could be measured.

The Surface Layers of the Moon

When astronauts finally alight on the moon, what will they find underfoot? Without actually going up there and digging a hole, NRL radio astronomers have deduced that the moon's outer surface is sand-like dust perhaps 1/2 centimeter deep. Beneath that thin outer layer lies rock, most likely, but there may also be an in-between layer of heavy, closely packed soil. These deductions were made public by NRL's John E. Gibson at the 12th International Aeronautical Congress, held last October in Washington, D. C.

The decisive measurements were obtained by repeated scans across the full moon during a total eclipse (of the moon) that occurred between



NRL's ten-foot, precision, parabolic telescope used in scanning the surface of the moon.

12:30 a.m. and 5:00 a.m. on March 13, 1960. The eclipse data were then compared with scan records of the moon in its ordinary (un-eclipsed) phases. The comparative data were then analyzed in conjunction with brightness-temperature measurements made previously by many different observers at varying wavelengths.

The NRL observations were made at 8.6 mm wavelength. Combined with the prior data, they indicated that the average lunar surface is stratified in at least two, possibly three layers. The results indicate that the topmost layer has thermal and electrically conductive properties that might apply to a loose granular substance like dust or sand. Underlying this top layer is a substratum having higher electrical conductivity, as does many of our heavier terrestrial soils. That the deeper subsurface is still harder—rock—is supported by infrared measurements for some of the lunar craters. Such measurements, made at Mount Wilson and Lowell Observatories, indicate that solid rock is very close to the surface of the crater floors.

The lunar measurements were made with the 10-foot, precision (surface tolerance to 0.004 in.) parabolic antenna (see photo). The detected radiation was fed to a rapid-comparison, crystal superheterodyne receiver.

Project SQUID Goes From Princeton to Virginia

The management of Project SQUID, the Navy's major long range research program in aircraft, missile and space propulsion, will be transferred from Princeton University to the University of Virginia, effective October 1, 1962. The program, which has been in continuous existence since 1946 under the sponsorship of the Office of Naval Research, is concerned with exploring new ideas and turning up new knowledge rather than developing hardware. Involved in the program are as many as 20 research laboratories at one time, mostly universities and non-profit research organizations. Each laboratory concentrates usually for several years on a specific research task related to jet and rocket propulsion.

The emphasis of Project SQUID is on the investigation of the physical and chemical processes associated with the conversion of energy into thrust, which includes preliminary exploration, analysis and evaluation of potential new aerospace propulsion systems. Projects undertaken in recent years include pioneering theoretical studies in the new field of magnetohydrodynamics and the basic mechanism of solid rocket propulsion

The program was initiated by ONR in 1946 when several universities agreed to join in a cooperative research effort to increase basic knowledge of the phenomena of jet propulsion. Princeton University was assigned to serve as overall coordinator and then in 1951 was designated program manager and prime contractor. Dr. John B. Fenn of Princeton has been Director of Project SQUID since 1952. He will be succeeded next October by Dr. John E. Scott, Jr., Professor of Aeronautical Engineering at the University of Virginia.

Typical of the accomplishments of SQUID is the ducted rocket or ram-rocket cycle, which has the static thrust advantage of the rocket and the fuel economy at high speed of the ramjet. Although large-scale development of the ram-rocket has never been undertaken, there is active interest in the closely related ram-turbo-rocket, which grew out of early SQUID studies on turbo-rocket cycles and research on monopropellant rockets.

SQUID pioneered in the design, construction and operation of the "blow-down" wind tunnel, which has proven to be the most economic means of achieving very high Mach numbers. For a long time one of these tunnels developed at Princeton using helium was the only source of hypersonic test data.

One byproduct of SQUID's research activity has been the training of students in those fields related to aircraft and rocket technology. In 1957 it was estimated that student participation in SQUID research totaled 600 man-years, comprising a substantial contribution to the country's pool of trained manpower available for research, development, and application in jet and rocket propulsion and related fields of national interest.

Current research tasks include studies which are expected to have a significant impact on the application of magnetohydrodynamics to power generation, propulsion and missile control systems. Many proposed systems depend upon the interaction between electromagnetic fields and ionized gases or plasmas moving at high velocity. One task is studying the properties of partially ionized gases when electromagnetic fields are present in order to determine the correct set of equations which govern the behavior of such gases.

Another task in this area is aimed at throwing light on unsolved problems resulting from the coupling of electrical and fluid mechanical forces. The approach is to accumulate fundamental information through simplified experiments which permit isolation of the various effects of joining these two types of forces. Such data are considered necessary before practical magnetohydrodynamic power generation and propulsion systems can materialize or even be evaluated.

Other research tasks now underway are gathering basic information on the mechanism of solid propellant combustion which could lead to a better selection of solid propellants and designs of solid propellant motors. One promising avenue to achieving this is the use of substantial amounts of powdered metal in the propellant formulation. In addition to providing more energy, these metals often eliminate instability in a way that is not presently understood.

To learn more about how this occurs, studies are being made on the rate and mechanism of metal burning. One research task is investigating the burning of single particles injected into flame gases. Another research laboratory is investigating the chemical reactions of metals with oxidants as opposed to the purely physical processes.

The study of metal combustion in the past has largely ignored the chemistry of the reaction, and this research task is a new departure.

Other areas of research that fall within the scope of SQUID include energy conversion and generation, transport properties, the study of the behavior of gases at very high temperatures and at extreme pressures, fluid flow, heat transfer, plasma physics, chemical kinetics, and ion formation and neutralization.

> In keeping with the established policy of the Office of Naval Research, Project SQUID establishes its program on a selective basis as opposed to direction and assignments. Thus, any scientific investigator who is seeking support for research within the scope of Project SQUID is invited to submit a proposal. In this connection the SQUID program for the year beginning 1 October 1962 is being formulated currently. Those investigators wishing to seek SQUID support, should submit their proposal to the current Project SQUID, Headquarters at Princeton University on or before 29 January 1962.

Magnetic Axis of Jupiter

The successful determination of the angle of the magnetic axis of the planet Jupiter was recently reported by Drs. G. J. Stanley and David Morris of CalTech's Owens Valley Radio Observatory. The angle was established by observing the apparent variation in the intensity of the polarized component of Jupiter's radiation (960 and 1390 Mc) and was then correlated with the planet's period of rotation. The amplitude of the resulting sine curve gave the degree of inclination (9°) of the magnetic axis from the axis of rotation. The results also show (a) that the shape of the planet is elliptical and (b) that the shape varies little between 960 and 1390-Mc frequencies. The latter result is regarded as proof that the radiation is produced by the synchrotron mechanism. (see p. 7, Aug. 61 NavResRev).—Dr. G. J. Stanley

Undertows Found Not Dangerous

True undertows are not dangerous to swimmers. So says Dr. John Zeigler of the Woods Hole Institute of Oceanography, who has been conducting studies of shoreline processes off Martha's Vineyard Island this past summer. In addition, he states that no one has been able to measure this alleged current, and it is very unlikely that it is actually present. The so-called "undertow" (more properly called "the seaward flow at mid-depth") is weak and "could not pull one under and out to sea." The real danger to swimmers, in his estimation, are the longshore and rip currents. These are surface currents, however. They may carry a swimmer seaward, but unless he panics and tries to fight back to shore, he can easily extricate himself by swimming parallel to to the beach until he is free of the current. The backwash from breaking waves is also commonly mistaken for undertow. Such backwash is strong, depending on the size of the waves and the amount of water trying to run back to sea, but it only lasts for a few seconds before the next wave sweeps in.

The measurements in this study were made from a tower constructed off the south shore of Martha's Vineyard. In order that the tower would not have to be manned, and that tower-instrument servicing could be accomplished in foul weather, the recording equipment, power supplies, etc., were all mounted on the beach in a surplus army squad tent with cables running out to the measuring instruments. Equipment was also devised and constructed to attempt to measure orbital velocities of particles in the waves. The work was supported by the Office of Naval Research and the National Science Foundation.—M. C. McLean of ONR Boston and Dr. John Zeigler of WHOI.

"Frog's Eye" Spots Radar Target

An experimental machine employing processes patterned after those used by a frog in spotting and capturing insects is capable of distinguishing targets from background noise on a radar screen. This machine was described in a paper delivered before the Second Annual Bionics Symposium at Cornell University here by Alfred J. Cote, Jr., who did the work for the Navy's Bureau of Weapons at the Applied Physics Laboratory of the Johns Hopkins University, Silver Spring, Maryland.

Cote revealed how studies of the visual processes of a frog provided the basis for developing machines capable of fully interpreting radar displays. The method by which such an interpretation device processes signals represents a fundamental departure from present techniques employed to perform this function by high speed digital computers. In partial simulation of the proposed system, the experimental machine combined two television cameras and associated electronic circuitry which filtered out noise from the radar screen to a degree where only targets were visible.

By interconnecting numerous but relatively simple electronic components, a machine can be perfected which will interpret from spots of light on a radar screen the speed and direction of aircraft. The machine will also be able to determine which of a number of aircraft will first reach a certain critical point. Such a machine also will be potentially applicable to the automation of air-traffic systems. Development of an operational unit is not yet economically feasible because of the large number of components required to simulate the nerve fibers which relay signals from the frog's eye to its brain.

Atomic Physics Data Center

A center for the collection and evaluation of data on atomic-transition probabilities and cross sections has been established at the National Bureau of Standards, Washington, D. C. The center will compile atomic data in those areas where experimental or theoretical investigations are being conducted at NBS. This compilation has been started as part of a research program, sponsored by the Office of Naval Research and the Advanced Research Projects Agency, which seeks to supply the data needed for current and future research in plasma physics and astrophysics.

The first phase of the data compilation program has been completed with establishment of a card file and a collection of reprints of publications pertaining to atomic transition probabilities. The center is now prepared to supply, on a limited basis, bibliographies of publications on transition probabilities of particular elements. Numerical values for specific transitions are now being assembled and will appear in appropriate NBS publications. Work on the ten lightest elements is in progress and will be published during the latter part of 1962. Limited individual requests for some of the data on the first ten elements can be handled now.

Also being assembled at the Bureau is a complete collection of papers containing information on low-energy cross sections for elastic and inelastic processes and for photoionization. Once the collection is complete and up to date, the pertinent cross sections will be compiled, evaluated, and made available. In the near future, the program will be extended to include collisional excitation and other processes.

In order that the data center may be as effective and up to date as possible, authors are urged to send preprints and reprints of pertinent publications to: The Atomic Physics Data Center, Far West Building, National Bureau of Standards, Washington 25, D. C.

CONTRACT FOR ALUMINAUT

The Reynolds Metals Company has signed a contract with the Electric Boat Division of General Dynamics Corporation for two million dollars for the construction of the all-aluminum, deep-diving submarine ALUMINAUT (see Nav Res Rev, Jan., 1960). A leasing agreement between the Reynolds Metals Company and the Woods Hole Oceanographic Institution is being negotiated, and it is expected that the craft will be operated out of Woods Hole. The 50-foot vessel will be able to go down to 15,000 feet, cruise at about 4 knots for 80 miles and remain submerged for about 72 hours. She will carry a crew of three, a pilot and two scientists. Delivery of the craft is expected early in 1963.

The hull will be constructed by "bolting together" large one-piece cylindrical sections of high-strength aluminum forgings. The thick aluminum hull will be less compressible than water and will be able to stand the tremendous pressure at great depths in the sea, yet will be light enough to remain afloat without external buoyancy tanks. The vehicle will descend from the surface where there will be an excess of weight over buoyancy, and will not descend all the way to the bottom unless water ballast is added. Thus the sub will be able to descend to a selected depth and remain in equilibrium where the buoyancy equals the weight.—M. C. McLean, ONR, Boston

On the Naval Research Reserve

Winners of National Awards

The two winners of the first national competition among the 114 Research Reserve Companies were announced by RADM L. D. Coates, USN, Chief of Naval Research, on 4 December 1961. The Award for General Excellence was won by Naval Reserve Research Company 13-6, Idaho Falls, Idaho, and the A. Hoyt Taylor Award went to Naval Reserve Research Company 3-9, Upton, Long Island, New York. The designation of these two winning companies has been approved by Commander, Naval Reserve Training Command, Omaha, Nebraska. Handsome award plaques will be presented to the winning companies at a later date for permanent retention. In addition, large plaques appropriately engraved will be displayed in the Office of Naval Research and will bear the designation of all companies adjudged winners over the years to come. Annual national competition among Research Reserve Companies was established by the Chief of Naval Research on 9 August 1960 in order to provide incentive to companies to improve training and to encourage good administration. Heretofore, competition among Research Reserve Companies had been on an intradistrict basis only.

AWARD FOR GENERAL EXCELLENCE

The Award for General Excellence was based upon company achievements for the Fiscal Year ending 30 June 1961. In a letter to CAPT Thomas J. Wadsworth, USNR, Commanding Officer of NRRC 13-6, the

CAPT R. C. Gossom, USNR, Deputy Chief of Staff for Naval Reserve, Ninth Naval District (second from right) presents the Commandant's Rotating Plaque to CDR W. J. Stadelman, USNR, former C.O. of NRRC 9-7, designated the outstanding Research Reserve company, Ninth ND for FY 1961. Witnessing the event were CDR L. P. Hoskins, USNR, Reserve Assistant, ONR Chicago, (holding the first place plaque); CDR K. C. McLaughlin, USNR, C.O. of NRRC 9-7; and CAPT J. W. Jockusch, Jr., USNR, (far right), Special Assistant to the Chief of Naval Research (Research Reserve).

CAPT W. C. Hilgedick, USN, C.O. of ONR Boston, (left center) representing the Commandant, First Naval District, presents the Commandant's trophy to LCDR W. M. Hagist, USNR, C.O. of NRRC 1-2. Looking on are CAPT J. W. Jockusch, Jr., USNR, ONR, Washington, D. C., and CDR P. F. Merenda, USNR, C. O., NRRC 1-2 for FY 1961.

Chief of Naval Research stated, "Winning of the award is a real achievement since the Company was in competition with others designated as outstanding by each of the Naval Districts in the continental United States." A panel was established to review the records, inspection marks, and other material used as criteria, and to recommend the winning company. The panel was composed of the following officers: CAPT Scott Burns, Jr., USNR, Assistant for Naval Reserve Policy, Office of the Assistant Chief of Naval Operations (Naval Reserve); CAPT Harry M. Cocowitch, USN, Director, Military Services Division, Office of Naval Research; and CDR Edward L. Huie, USNR, Specialist Programs and Special Projects Officer, Bureau of Naval Personnel. Other Research Reserve Companies nominated for this award by Naval District Commandants are listed below along with their respective Commanding Officers:

NRRC 1-2, Providence, R. I.	CDR Peter F. Merenda, USNR
NRRC 3-9, Upton, L. I., N. Y.	CDR Jere C. Austin, USNR
NRRC 4-1, Princeton, N. J	CAPT Charles W. Logan, USNR
NRRC 5-2, Blacksburg, Va	LCDR David P. Barnett, USNR
NRRC 6-16, Patrick Air Force Base, Fla	CDR Charles A. Hoffman, USNR
NRRC 8-13, Stillwater, Okla	CDR Roy W. Jones, MSC, USNR
NRRC 9-7, Lafayette, Ind	CDR Wm. J. Stadelman, USNR
NRRC 11-8, Point Mugu, Calif.	CAPT Elmer M. Holk, USNR
NRRC 12-5, Berkeley, Calif	CDR Harold C. Ries, USNR

It was noted that two of these Research Reserve Companies were also designated as the outstanding specialist company in their respective

CDR George B. Glave, USNR, representing the Commandant, Sixth Naval District, presents a plaque and letter of commendation to NRRC 6-16 in recognition of its designation as the outstanding Research Reserve Company in the District. Receiving the plaque for the Company is CDR Charles A. Hoffman, USNR, C.O. CDR Robert N. Jennings, USNR, Research Reserve Assistant for the Sixth ND looks on.

naval districts. NRRC 1-2 received this honor in competition with 29 companies in the First Naval District and NRRC 13-6 won a similar honor among 39 in the Thirteenth Naval District.

A. HOYT TAYLOR AWARD

NRRC 3-9, a company of 36 members which meets at Brookhaven National Laboratory under the command of CDR Jere C. Austin, USNR, was designated winner of the first A. Hoyt Taylor Award. This award is based on scientific achievement and is named for the late Dr. A. Hoyt Taylor, a retired Naval Reserve officer, who was for many years superintendent of the Radio Division of the Naval Research Laboratory. Dr. Taylor supervised the small group of radio engineers who developed radar in this country (see inside back cover).

The award was based on a scientific study entitled, "An Evaluation of the Need for Filtration Systems for Protection of Personnel in Structures Against the Acute Hazards of Radioactive Contamination of the Atmosphere." Members of the panel which considered scientific and technical studies submitted by Research Reserve Companies were as follows: CAPT Walter H. Keen, USN, Assistant Chief for Research, ONR; CAPT Joseph P. Pollard, MC, USN, Special Assistant for Medical and Allied Sciences, ONR; and Dr. Lewis L. Larrick, Executive Assistant (Scientific Information), ONR.

NRRC 8-2 Activated

Effective 1 July 1961 NRRC 8-2 was activated at Baton Rouge, Louisiana. LCDR O. M. Brown, USNR, is serving as Commanding Officer. Nine officers are members of the new unit, which will meet at the U. S. Naval Reserve Training Center, 500 South First Street, Baton Rouge, Louisiana.

NRRC 5-12 Visits Goddard Center

Naval Reserve Research Company 5-12, located at the Naval Weapons Laboratory, Dahlgren, Virginia, recently devoted a Saturday to an all-day visit to NASA's Goddard Space Flight Center in Greenbelt, Maryland. Five-twelve was the first Naval Reserve organization to visit the new installation.

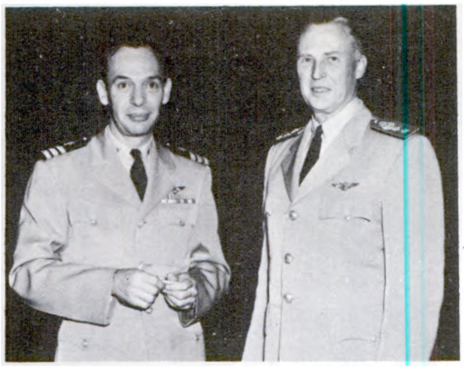
Leaving Dahlgren by Navy bus shortly after 0730, the officers arrived at the Space Flight Center about 0930. By lunch time, everyone had been guided through the Flight Control and Range Operations Laboratory, the Space Sciences and Applications Center, and the Test and Evaluation Center.

Probably the most interesting devices seen were prototypes of several space vehicles: Vanguard III, Explorer X, Explorer XII, and Echo (all of which are now in orbit), and the proposed Nimbus. The microminiature equipment now being manufactured for use in planned space vehicles also attracted considerable attention.

A particularly fascinating area was the Operations Control Center. Here, information is displayed showing the progress of a space vehicle in flight. Data are received from stations located all around the world. Adjacent to the Center are three computers, two of which are fed identical inputs to avoid "aborted" or lost information should one of them fail. The status board, located in the Center, indicated some 29 orbiting satellites. Guides briefed the officers on other interesting aspects of the Goddard Space Flight Center, and concluded with a description of the ultimate installation planned.

CDR Ross Receives Award

CDR Malcom D. Ross, USNR, was awarded a gold star in lieu of a second Distinguished Flying Cross for his participation in the record-breaking flight of 5 May 1961. Presentation of the award was made by RADM L. D. Coates, USN, at a meeting of NRRC 5-8 at the National Academy of Sciences, Washington, D. C., on 21 September 1961. CDR Ross, who at the time of the flight was a physicist with the Office of Naval Research, was the pilot of the flight which went 113,733 feet after the launching from the flight deck of the USS ANTIETAM. CDR



CDR Ross and RADM Coates at award presentation

Ross is now Head of the Environmental Systems Research Laboratory of General Motors at Warren, Michigan, and has continued his membership in the Research Reserve by associating with NRRC 9-3, Ann Arbor, Michigan.

The guest speaker for the drill meeting at which the presentation was made was CAPT J. W. Jockusch, Jr., USNR, Special Assistant to the Chief of Naval Research (Research Reserve). He gave a highly informative and interesting talk on the Reserve program over the years.

NRRC 9-21 Meeting

Mr. M. R. Lipman, ONR Resident Representative, Lawrence, Kansas, addresses NRRC 9-21, Denver. Mr. Lipman's visit was a timely one during which he briefed the company on the overall operations of ONR and his responsibilities as a field contract administrator. The Company was activated in February 1961 with its membership drawn largely from the Denver Research Institute and Denver University.

Sixth Navy Science Symposium

The Symposium will take place on May 2-3, 1962, at the U. S. Navy Radiological Defense Laboratory, San Francisco, California. There will be about 20 papers presented on the subject "Weapons and Weapons Effects."

Research Reserve Statistics

The following figures were compiled from data submitted in the annual reports forwarded by Research Reserve Companies for Fiscal Year 1961:

Companies	113
Panels	1
Members	2,402
Ready Reserves (percent)	82
Standby Reserves (percent)	18
Attendance at drill meetings (median percent)	88
Earned satisfactory federal year	2,005
Selected for promotion	247
Promoted	187
Received active duty for training	1,026
Captains	74
Commanders	296
Lieutenant Commanders	344
Lieutenants	254
Lieutenants (j.g.) and below	58
Completed Correspondence courses	1,419

LT Wheeler Appointed Chairman

LT. John L. Wheeler, USNR, a member of Naval Research Reserve Company 3-4, Rochester, New York has recently been appointed Chairman of Subcommittee TR-27.3 on Data Transmission of the Electronic Industries Association. Subcommittee TR-27.3 is working closely with committees of the American Standards Association, International Electrotechnical Commission, and the International Telegraph and Telephone Consultative Committee, in the formulation of national and international standards on data transmission. LT Wheeler, is the manager of the Rochester, New York, operation of the Information Technology Division of General Dynamics Electronics. He is also the Chairman of the Rochester Section of the Institute of Radio Engineers.

The Navy and the Civil War

The Navy will participate in a number of events commemorating its role in the Civil War during a four-year (1961-65) program in cooperation with the Civil War Centennial Commission. During the Centennial, the Navy will attempt to dispel a widely held belief that naval forces played a minor role in helping the Federal cause.

The Civil War also witnessed the birth and utilization of more technological changes and scientific developments in naval warfare than any previous period in history.

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Albert Hoyt Taylor

Pioneer of high frequency electronics, Dean Emeritus of naval radio research, President's Medal for Merit.

Dr. Albert Hoyt Taylor, the man whose vision and leadership did so much to bring high-frequency radio and radar into the United States Navy, died on December 12 at the age of 83, in Claremont, California.

First as a naval officer, then as a civilian scientist, Dr. Taylor served the Navy continuously from 1917 to 1948. From 1923 until his retirement, he was at the Naval Research Laboratory, successively as Superintendent of the Radio Division, and finally as Chief Consultant for Electronics. In 1944, F. D. Roosevelt selected Taylor for the President's Medal for Merit, the highest honor the Nation can award a civilian, for "the research and experimentation resulting in the discovery and development of radar."

Taylor was a native of Evanston, Illinois, and a graduate of Northwestern. Until World War I, he taught physics at various midwestern universities, taking time out to earn his doctorate at Goettingen, Germany, in 1909. Throughout his teaching career his major research interest was radio.

In 1917 he accepted a commission as a Lieutenant in the Navy. Advancing to the rank of Commander, he was at one time Superintendent of Trans-Atlantic Communications and, ultimately, Officer-in-Charge of the Navy's Experimental Radio Division at Hampton Roads. When he returned to civilian life, he was given the directorship of the Naval Aircraft Radio Laboratory in Washington. He established many public broadcasting techniques; for example, he arranged the first nationwide presidential broadcast—Harding's dedication of the Lincoln Memorial—in 1922. In 1923, Taylor's laboratory was moved to the about-to-be-established Naval Research Laboratory and became the nucleus for NRL's Radio Division.

Prior to moving to NRL, Taylor and his colleagues found that a moving ship could be detected by radio. In 1930, airplanes were also detected by radio, and a project was set up at NRL to investigate the possibility of a military radio detection system. Subsequent development led to a provisional system by 1934, and successful prototype shipboard radar in 1938. Meanwhile, in the 20's and 30's, Taylor led pioneering experiments in high-frequency, crystal controlled radio communications. These developments not only did much to improve the range and reliability of naval radio but gained world-wide recognition for the quality of the research at the Navy's young laboratory.

Among the many distinctions Taylor earned while at NRL were the Presidency of I.R.E. (1929); the Morris Liebman Medal of Honor (1942); the John Scott Medal of the Franklin Institute (1942); and Fellowships in the I.R.E., A.I.E.E., and the American Physical Society. He was the author of 35 papers on radio wave propagation and similar subjects, and the holder of 54 patents.

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

ICEF-Project balloon and rigging shortly before a recent launching; see pp. 14 and 15. (Photo courtesy of Dr. Koshiba)

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