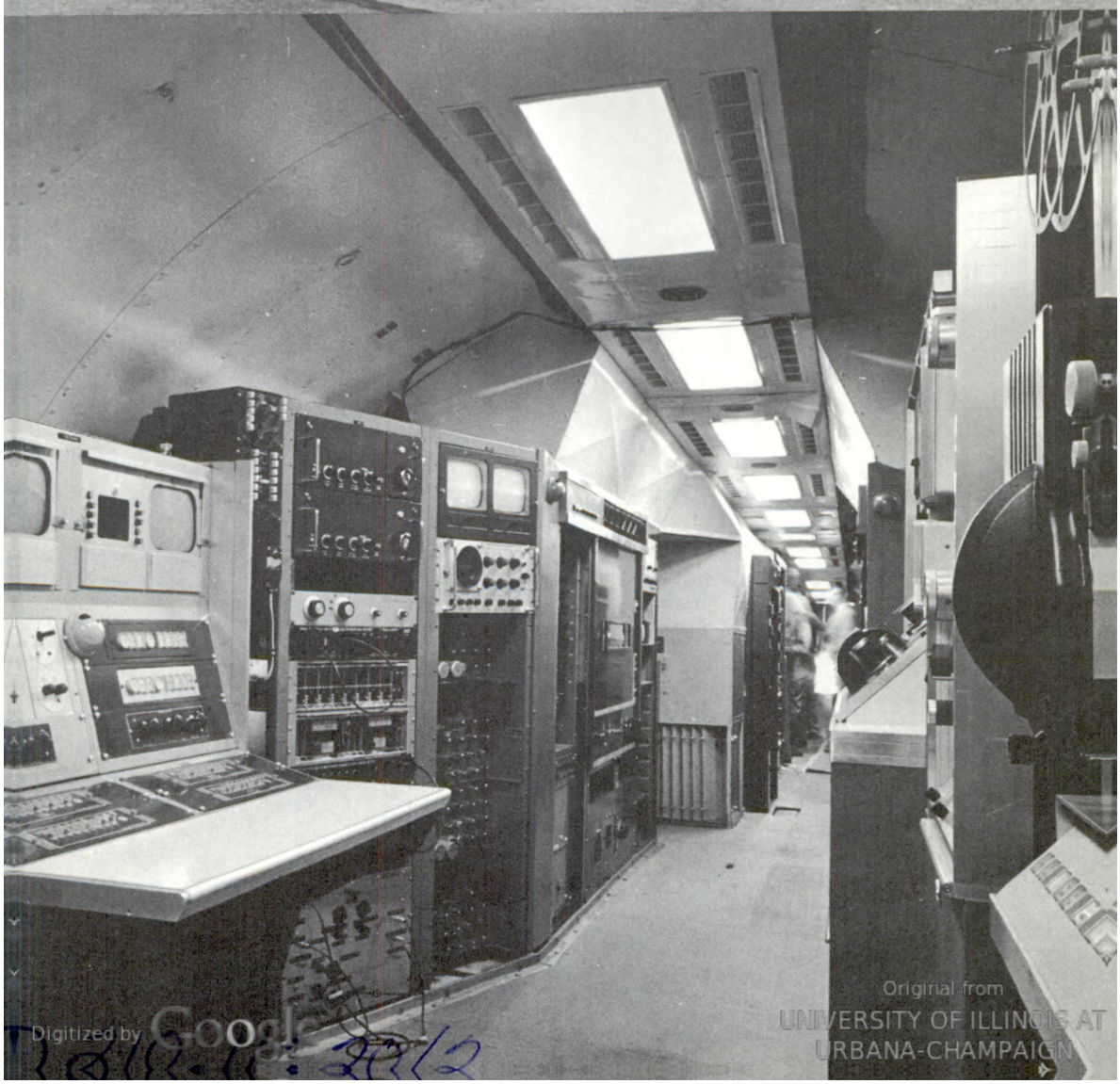
# NAVAL RESEARCH REVIEWS

FEBRUARY 1967



# Random Noise

Dr. John McElhinney has been appointed Superintendent of the Naval Research Laboratory's Nuclear Physics Division. As such, he will administer NRL's broad program of basic and applied research in nuclear physics and related areas. Dr. McElhinney has been a member of the NRL staff since 1955.

Mr. D. K. Pollack, Acting Head of ONR's Information Systems Branch, Mathematical Sciences Division, has accepted a nomination to the United States Naval Academy's Advisory Board for the Computing Center.

Dr. Glenn Bryan, Head of ONR's Personnel and Training Branch, briefed groups within the General Learning Corporation, the Office of Education, and the National Research Council Committee on Naval Medical Research last November on the computer-assisted instruction program of the Navy.

Dr. Maurice M. Shapiro, Chief Scientist for NRL's Laboratory for Cosmic Ray Physics, was appointed to the Visiting Committee of the Bartol Research Foundation of the Franklin Institute. The seven distinguished scientists who make up the committee serve in an advisory capacity to review the scientific program of the Foundation.

Dr. A. C. Zettlemoyer, former principal investigator of a long-term chemistry research project supported by ONR, has been appointed the first Vice-President for Research of Lehigh University, Bethlehem, Pa. Dr. Zettlemoyer has done research at Lehigh for a quarter of a century.

The second Electronic Information Handling Conference will be held at Pittsburgh, April 12-14, 1967. The objective of this conference, which is co-sponsored by the University of Pittsburgh, Western Michigan University, Goodyear Aerospace Corporation, and the Office of Naval Research, is to promote information exchange and to stimulate interest in testing and evaluation of information handling systems.

Mr. L. Petrullo has been designated, effective January 2, as the Director, Psychological Sciences Division, Office of Naval Research. Pending selection of a Branch Head of the Group Psychology Branch, Mr. Petrullo will also continue to serve in that position.

Mr. Richard Wilcox, Acting Head, ONR Mathematical Sciences Division, in December 1966 commenced a two-year term on the U.S. Scientific Manpower Commission. The Commission is concerned with disseminating information and recommending national policies appropriate to recruitment, training, and utilization of scientific personnel.

*The New Microbiology,* by Dr. John E. Flynn, former Chief Scientist of ONR New York, has been recently published by the McGraw-Hill Book Company. The book is made up of a compilation of papers on biological sciences that were selected and edited by Dr. Flynn shortly before his death. Each book section and paper is preceded by an analytical statement by Dr. Flynn.

# Project JENNY - The Navy's Blue Eagle Television Network

**LCDR C. R. Smith, USN**
**LTJG R. A. Rollins, USN**
*Oceanographic Air Survey Unit*
*NAS, Patuxent River*

The mission of Project JENNY is to broadcast radio and television from an airborne platform. The project had its beginnings as far back as 1962 when radio and television equipment was installed in two C-118 aircraft for possible use during the Cuban crisis. In 1965, the Joint Chiefs of Staff directed that these aircraft be replaced with C-121 Super Constellations. Such a change would greatly increase time on station, provide greater flexibility, and increase power and capability. The Oceanographic Air Survey Unit, which was operating C-121 type aircraft at the Naval Air Station, Patuxent River, Maryland, was selected as the parent squadron to command Project JENNY. Technical control is under the Chief of Naval Operations.

Work was begun on the first aircraft, called Blue Eagle One, in May 1965. The plane, a transport configured C-121 in service with the Navy since 1953, was reconfigured as a high power (total output of about 32,000 watts) communications and radio relay station.

Installation and testing was completed during the summer of 1965. In October, Blue Eagle One was deployed, on one day's notice, to South Vietnam to broadcast the baseball World Series and the Army-Navy game to American servicement in Vietnam and in the Pacific by relayed AM and short wave radio. The purpose of the mission, in addition to improving the morale of the servicemen, was to test the system under operational conditions and to evaluate its effectiveness. The term of deployment was to be two weeks, but the system was so popular and effective that it was extended an additional seven weeks. In December, having proven the feasibility and value of the system, Blue Eagle One returned to the United States for overhaul.

Meanwhile, it was realized that television in an area such as Vietnam would contribute greatly to morale. The Navy, through Project JENNY, was assigned responsibility for providing airborne TV coverage until permanent television stations could be constructed and installed. A two-channel system was to be provided, with U.S. programming on one channel and Vietnamese on the other.

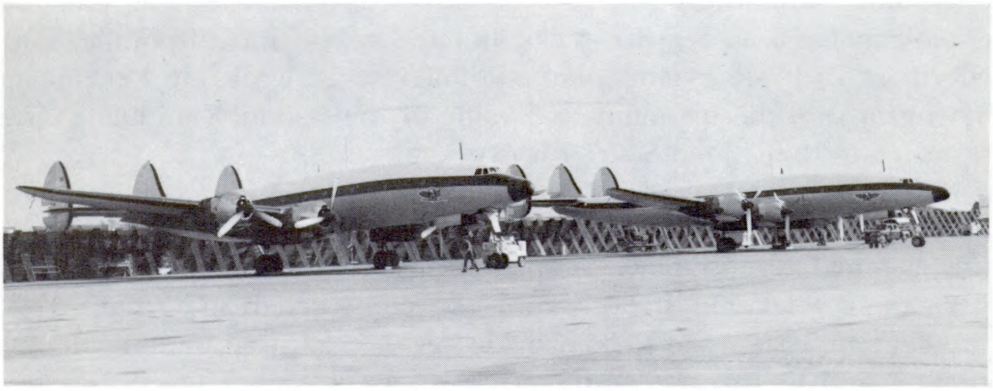
Blue Eagles Two and Three, also Super Constellations on duty with the Navy since 1953, arrived at Andrews Air Force Base on August 25,

1965, to be configured as television, radio and communications platforms. The work was done by a group of Naval officers, aviation electronic technicians and mechanics, submarine and surface electronic technicians, and civilian technical representatives who did a remarkable job of piecing together the various systems. Equipment of a fantastic variety of uses and origins was collected and modified for use on aircraft. Most of it was too heavy and had to be cut down, redesigned and rewired. Some of it was used, some already on the stock shelves—resulting in substantial savings in cost and time to the government. By January 1966, the job was completed and the two aircraft were ready for deployment to South Vietnam.

On January 3, an advance party of four officers and 21 enlisted men arrived at Tan Son Nhut Air Base, Saigon to prepare an operating base for Project JENNY, West Pacific. No working space had been assigned, so the party selected an area between two lines of aircraft and set up headquarters with two tents, scrap lumber, shipping crates and CONEX boxes. The Base provided furniture for their tents and three pickup trucks for transportation.

Blue Eagle One, its overhaul completed, arrived at Tan Son Nhut on January 7, and began to broadcast short wave radio. Blue Eagle Two arrived on January 15 and began a series of test and evaluation flights preparatory to commencing regular television broadcasts. Blue Eagle Three arrived six days later, January 21, and testing continued. The first television program, with speeches by Premier Ky, Ambassador Lodge, and General Westmoreland, was taped in the airport terminal. Cables connected the cameras in the terminal with the recording equipment in Blue Eagle Three.

On February 7, 1966, regular television broadcasting began. The schedule that was arranged called for one hour of Vietnamese programming on channel nine starting at 7:30 p.m. and three hours of U.S.



Project JENNY television aircraft Blue Eagles II and III on station at Tan Son Nhut Air Base, Saigon.

LCDR Chester R. Smith, Electronics Officer, Project JENNY, WestPac (seen at right) and Bruce P. Paret, ETN2 monitor the transmitted signal at the video switching console.

programming on channel 11 starting at 8:00 p.m., seven days a week. Broadcast time was limited, especially on channel nine, because of the short supply of material available. A normal on-station site was established 15 miles southeast of Saigon where the aircraft flew in a tight circle at 10,500 feet. This predetermined location allowed viewers within a 50-mile radius to train their antennas in a fixed position for optimum viewing. Blue Eagles Two and Three alternated nightly broadcasts.

To make sure that a large number of the populace could view the broadcasts, the U.S. Agency for International Development (USAID) provided 500 TV sets to Vietnam. These sets were installed in public squares, in store windows, or other places where a large number of people could watch the programs. And watch them they did. When the Vietnamese programs, which ranged from instruction on new agricultural methods to folk dancing and variety shows, were over, the Vietnamese people turned the sets to channel 11 and watched "Bonanza" and "The Danny Kaye Show."

TV viewing became so popular that sets began to appear in downtown Saigon shops. Over 16,000 sets were sold to service personnel in Post Exchanges throughout the Saigon area. USAID promised to deliver more sets for community viewing.

Within a short time, the television broadcasting had settled into an operating routine. Problems of a routine nature arose and were settled in the same fashion. In early April, the Department of Defense authorized a fourth plane for the Blue Eagle Television Network.

On April 12, a Viet Cong mortar attack was made on the Tan Son Nhut Air Base. All three planes were hit and three men were slightly injured. Blue Eagle One, although it needed two propeller changes and suffered several fragment punctures in the wings and fuselage, was back on station in four days. Blue Eagle Three had only a few minor punctures and was able to keep its assignment the next day. Blue Eagle Two, however, took two direct hits—one in the tail and one in the top of the fuselage. There were hundreds of fragment punctures and two propellers were badly damaged. Yet, although many newspaper accounts declared that Blue Eagle Two was completely demolished, maintenance personnel, through long hours and exceptional devotion to duty, completed repairs by May 8—only 25 days after the attack. The plane again took to the air and resumed flying operational television broadcasts.

In late summer, as the Vietnamese elections for a constituent assembly drew near, the Vietnamese government requested Project JENNY to provide additional television programming time. Regular programs on the Vietnamese channel now took a back seat to television campaigning. Broadcasting time ran as long as four hours a night.

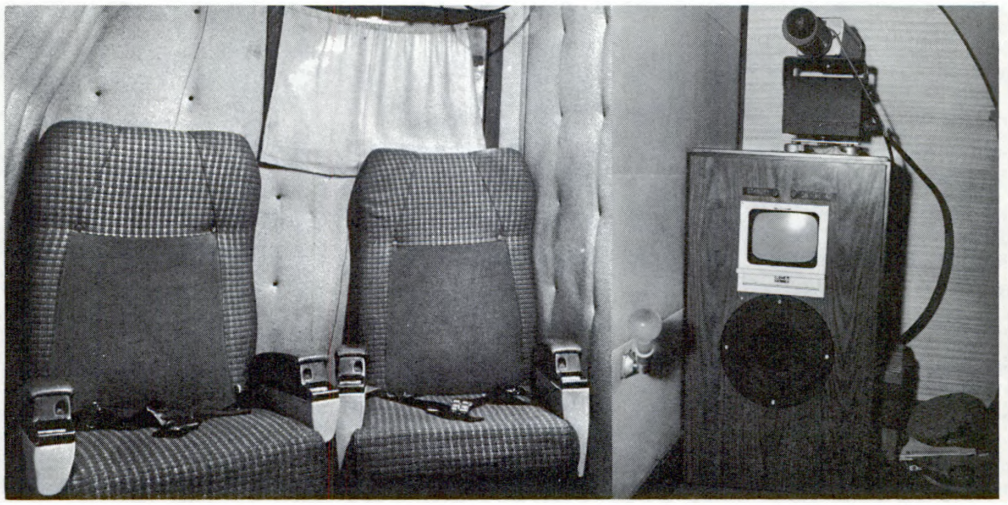
Although most of the candidates were not veteran politicians and probably none had appeared on television to any degree, they quickly adapted to the medium. All appeared on television to speak to the populace and all were afforded equal time. And although the monsoon season was in process, throngs of viewers gathered nightly in public squares to watch and cheer their favorite candidates. The campaigning spirit was high and a downpour could not spoil the enthusiasm. Placards, banners and even street singing raised the tempo—but it was obvious that the most effective medium of all was television, for it allowed the people to see and hear the candidates themselves.

More than a year has passed since the first Blue Eagle flew over South Vietnam broadcasting television programs. Since then, only a few occasions can be cited when there has been no television broadcast, and these can be attributed mainly to the seasonal monsoon weather which exists from May to October and which limits the practicability of flight. The fourth Blue Eagle joined the group in September, shortly before the elections.

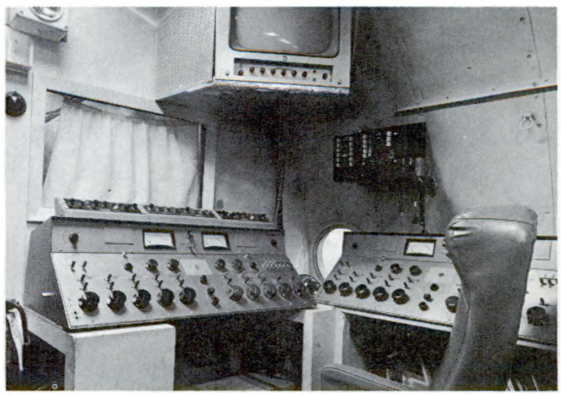
The Blue Eagle aircraft are rotated back to the states for major maintenance checks on a regular basis. In this manner, the latest improvements and developments in electronic equipments can be utilized. Each succeeding aircraft is an improvement over its predecessor.

## Typical Installation

The typical airborne television transmitting installation consists of three entirely independent, two to five thousand watt transmitters operating with both aural and visual outputs feeding into broadband antennas mounted on the underside of the aircraft. The transmitters provide full coverage from channels two through 13. The several sources of program material which may be fed into these transmitters include two video tape recorders, two 16 mm. film projectors, a live studio camera and microphone and numerous audio tape recorders. The dual installation of the equipment provides assurance of smooth "switching" and "fading," as well as a backup system to ensure nearly 100% trouble-free programming. Aural and visual switching consoles, in addition to an elaborate patching system, provide a means of cross-connecting the sources of various signals from pre-amplifiers into line, limiting, and stabilizing amplifiers, and then into the desired transmitters for radiation.



Programming often originates in the studio within the aircraft. Left: Heavily insulated interior blocks out engine and equipment noise. Right: The orthicon camera with its remotely controlled zoom lens and the studio monitor.



View showing two audio-switching consoles, visual-aural monitor (upper center), and aircraft intercommunications outlets. Note picture window looking into aircraft studio.


A view of the antenna installation showing a high-band, double-bay, co-linear array mounted forward of the nose wheel and several low-band hayrake antennas mounted in-line on the underside of the fuselage.

Radiation is accomplished by aerodynamically streamlined antennas mounted on fixed or retractable masts extending from the underside of the fuselage. These antennas are single or double-bay, co-linear arrays with omni-directional characteristics. These strategically located antennas, when elevated to the aircraft's on-station site of 10,500 feet or more, permits "line of sight" viewing and gives the Blue Eagle Television Network an enviable degree of efficiency.

Consistently good viewing has been enjoyed at distance up to 50 miles. Useable signals have been noted as far as the Cambodian capital and in areas nearly 200 miles from Saigon. A "letter of appreciation" has been received from a Cambodian viewer telling of his interest. A young college student in Bangkok reported that he had frequently seen "Blue Eagle Television" at a distance of over 400 air miles—theoretically beyond the line of sight and possible only by means of duct transmission.

The entire television electronics installation is powered by a gas turbine power unit utilizing the aircraft's fuel supply. This unit, which was engineered to meet flight requirements, is compact, light-weight and has a low noise level. Yet it is capable of delivering over 125 kilovolt-amperes of power within the constant voltage and frequency standards required by precision television equipment.

This unique airborne electronics installation with its highly powered and transistorized equipment is cooled by two custom engineered ten-ton air conditioning units. These units, parts of which had to be

mounted in the "baggage" compartment because of the already congested interior, maintain a safe temperature and humidity level.

The crew for this installation consists of a Naval officer with his team of "technical director," video-switcher, aural-switcher, transmitter-technician, and possibly a studio programming assistant. The flight crew is independent of the electronics crew and usually consists of five or six officers and men. A constant communication link is maintained by the flight crew with ground monitors to ensure the quality of the output. Constant on-the-spot monitoring is carried on by the electronics team throughout the flight.

On October 25, 1966, the Armed Forces Radio and Television Service's ground television station in Saigon went on the air. Project JENNY's interim operation in that area was completed.

Ground stations have been built and others begun in different sections of South Vietnam. Project JENNY has now moved to another operating area not covered by present ground stations and is still flying nightly. Its operation will continue indefinitely with many auxillary tasks under consideration for utilization of the aircraft. The possibilities for use of aircraft of this configuration are almost unlimited. The Blue Eagle Television Network expects to be providing valuable service to the U.S. Navy and the free world for many years to come.

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The Northeastern Section of the American Chemical Society was recently honored by the national office of the American Chemical Society for "its outstanding program for the effective dissemination of information enhancing public recognition of the chemical profession within its community." Dr. Arnet L. Powell, Chief Scientist, Office of Naval Research, Boston (right) accepts the award for NSACS from Dr. John C. Sheehan.

# Human Factors Research on Visual Aids to Night Carrier Landing

**Clyde A. Brictson**
**Joseph W. Wulfeck**
*Dunlap and Associates, Inc.*

Ask any Navy pilot to explain the difference between day and night carrier landings and he'll say: "At night it's dark—you can't see." And, since the rate of carrier landing accidents at night is approximately four times greater, that is an important difference.

The fact that aircraft recovery is accomplished routinely in daylight shows that the job can be done. The fact that landing accident rates are significantly higher at night indicates a need for a thorough investigation of the visual aids currently provided to the pilot.

In 1963, three research programs were initiated by the Office of Naval Research to provide the Navy with the best available yardstick for evaluating present and proposed carrier visual landing aids. The first study reviewed the literature on visual landing aids and analyzed landing accident data.* The second took the problem into the laboratory for experimentation.† The third analyzed the problem in terms of the operational environment and implications of night carrier recovery.‡

Conclusions of the third study are especially pertinent to the research reported here. After analyzing the carrier landing domain, the authors stated that: (1) after 58 years of powered flight, no accepted theory exists on the means of making visual judgments about the progress of an approach to landing; (2) no objective measure exists to assess the quality of a final approach and landing; and (3) development of a landing performance criterion must be considered a major research requirement.

In the absence of objective criteria, a detailed analysis of night carrier recovery operating procedure and environment was conducted. Some of the questions that came up during this analysis were:

- What visual information is used in landing aboard ship?
- What critical visual cues are missing or degraded at night?
- What effect does degraded visual information have on landing performance?

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*Office of Naval Research, "Aircraft Carrier Lighting Aids to Night Recovery of Jet Aircraft," Washington, D.C., July 1963.

†Sperry Rand Corporation, "Study of the Role of Visual Perception in Carrier Landing," Great Neck, N.Y., September 1962.

‡Winterberg, R.P., Brictson, C.A., and Wulfeck, J.W., "A Rationale for Evaluating Visual Landing Aids: Night Carrier Recovery," Santa Monica, Calif.:Dunlap and Associates, Inc., February 1964.

- What visual cues should an adequate visual landing aid provide?
- What is the optimum range for a visual landing aid?
- What is the optimum guidance envelope as a function of range from touchdown?
- Are recovery envelopes the same for all aircraft?—in all weather?

Answers to these and a host of other intriguing questions are currently being sought by Dunlap and Associates, Inc., Western Division. The research is jointly sponsored by ONR's Physiological Psychology Branch, with Dr. Gilbert C. Tolhurst serving as contract monitor, and the Visual Landing Aids Branch of the Naval Air Systems Command. The first step in answering these questions involves measurements and description of final approach to landing.

## Landing Criterion

The single most obvious criterion of an adequate final approach and landing is successful aircraft recovery. At present, a successful landing is defined as one without an accident—a criterion useful primarily in a tabulation sense. In the last seven years, the day landing accident rate has been gradually reduced while the overall night landing accident rate has remained almost constant. The existing day/night carrier landing accident ratio is about 1:4. Unfortunately, such an accident rate criterion provides no useful quantitative information about the quality of approach and landing. A precise measure is needed to evaluate the wide performance range between accident and non-accident landings.

An F4 Phantom II jet is about to land aboard an aircraft carrier. In the foreground, the Landing Signal Officer talks the pilot in.



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A VR-21 Transportation Plane, with its tail hook lowered, is about to catch an arresting cable on ship's flight deck.

The research described in this article approached the criterion problem in an operational context by looking at the pilot, aircraft and carrier as components of a system designed to land airplanes on ships, day and night. At night the existing accident ratio represents a system reliability of .9996. On the average, a night accident will occur every 2500 landings. Despite the relatively low ratio, the high cost and potentially catastrophic nature of a landing accident requires that this ratio be reduced. A logical start is to measure landing quality during final approach and recovery, day and night. With landing data in hand, landings under day and night conditions can be compared and contrasted, and the results used to describe the differences which exist between day and night recoveries. Equally important, the data can be analyzed and evaluated for insights into the causes of certain kinds of night carrier landing accidents.

## Landing Measures

An attempt to measure and thereby to define the nature of day and night landings was the subject of a field experiment* conducted aboard

*Brictson, C.A., "Measures of Pilot Performance: Comparative Analysis of Day and Night Carrier Recoveries," Santa Monica, California:Dunlap and Associates, Inc., June 1966.

USS Kitty Hawk (CVA-63) off the coast of Southern California. The landings of 21 experienced Navy pilots who were carrier-qualified in the F4 Phantom aircraft were recorded. The two principal measures were altitude and lateral error measured as a function of range from touchdown. Validity of the measures was based on the assumption that the degree of pilot control in final approach to landing was indicated by measures of his altitude and lateral error from a prescribed glide slope and centerline, respectively. A shipboard instrumentation system recorded in-flight geometry using twin precision radars that tracked the aircraft during final approach. The same pilots, aircraft and aircraft carrier were used for both day and night landings. Shipboard visual landing aids, including red and white floodlights, drop lights, centerline strobe lights and the Fresnel lens optical landing system (meatball) were used in their normal configuration.

For all recorded day and night landings, a relatively consistent environment was observed. During day landings a full sun and practically cloudless skies were predominant. All night landings were made under moonlit and cloudless skies. A clear and distinct horizon was available during all day and night landings. No crosswind or stack gas interference was reported. In summary, landing conditions day and night were considered ideal—a calm sea, steady deck and unlimited ceiling and visibility.

## Comparison of Day and Night Landings

Day and night landing data collected aboard Kitty Hawk were compared and contrasted primarily in terms of lateral and altitude error.

*Lateral Error.* Measures of day and night lateral error indicated no significant difference between day and night landings. In a practical sense, the data show that lateral (lineup) control is about the same during day and night recoveries.

*Altitude Error.* A comparison of day and night altitude error as a function of range from touchdown indicated an increased variability in night altitude error. Night variability measures are at least twice the day figures at each range. An analysis of variance of altitude error resulted in a statistically significant difference between day and night altitude error at 1/4 mile ($p < .01$) and 1/8 mile ($p < .05$) from touchdown.

Combined plots of altitude and lateral error for day and night environments at 1/4 mile and 1/8 mile from touchdown indicated the following:

At 1/4 mile, 32 percent of the night approaches were low, compared to three percent during the day. Twenty percent of the low night approaches resulted in bolters. (See figures 1 and 2.)

At 1/8 mile, 26 percent of the night approaches were low, compared to less than two percent of the day approaches. Thirty-one percent of the low night approaches resulted in bolters. (See figures 3 and 4.)

In general, for the last half-mile of final approach there was a consistent tendency to fly above the glide slope during the day while about 1/4 of the night approaches were low.

True air speed, sink speed, wind-over deck, deck pitch and wire arrestment data also were collected to provide the basis for a thorough description of final approach to landing. An analysis of wire arrestment data showed that, at night, with four available wires, about 40 percent of the aircraft caught the number four wire while only 18 percent caught it during the day. Five percent of the night recoveries hit the number one wire, compared to 17 percent of the day landings. A review of the landing records indicated a greater tendency to "dive for the deck" during the day, which resulted in higher sink speeds and earlier wire engagement. At night, aircraft appeared to approach "ramp shy" and tended to catch a wire farther up the deck.

In summarizing the differences between day and night landings, there was a tendency to approach slower and higher, and land harder and shorter by day than by night with greater night variability in all measures.

## Operational Implications

The landing data described here are based on a relatively small sample of final approaches of one aircraft type over a short period of time and should not be considered the final word on carrier landings. On the other hand, some interesting trends can be obtained from this information.

No one should be surprised to find that the main difference between day and night landings was in altitude control even though the landing data were obtained under relatively consistent weather conditions using the same pilots, ship, aircraft, and visual landing aids. The major difference was day and night. Clearly, the amount and quality of visual information available to the pilot day and night influence altitude control in landing.

Significant differences in day and night altitude error at 1/4 and 1/8 mile begin to quantify the way that a visually deprived night environment effects altitude control. During the day, the pilot apparently uses visual information other than the Fresnel lens to judge his vertical

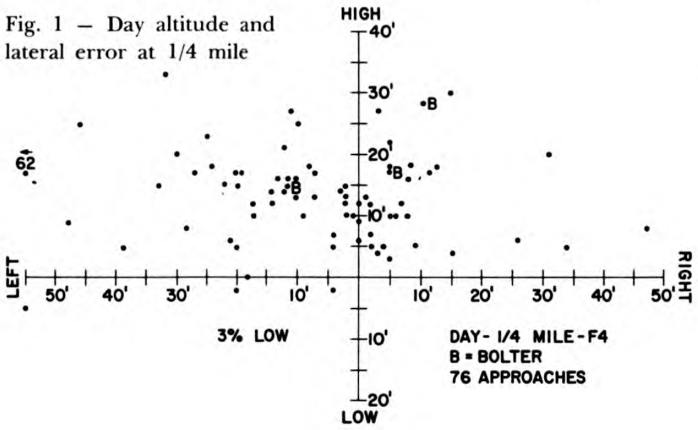


Fig. 1 — Day altitude and lateral error at 1/4 mile

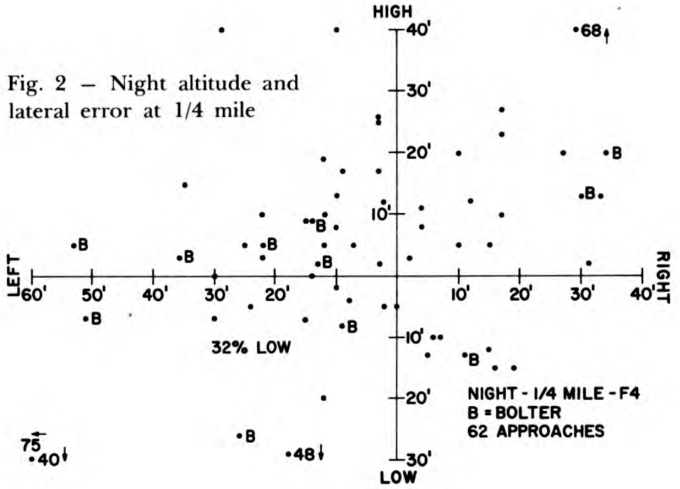


Fig. 2 — Night altitude and lateral error at 1/4 mile

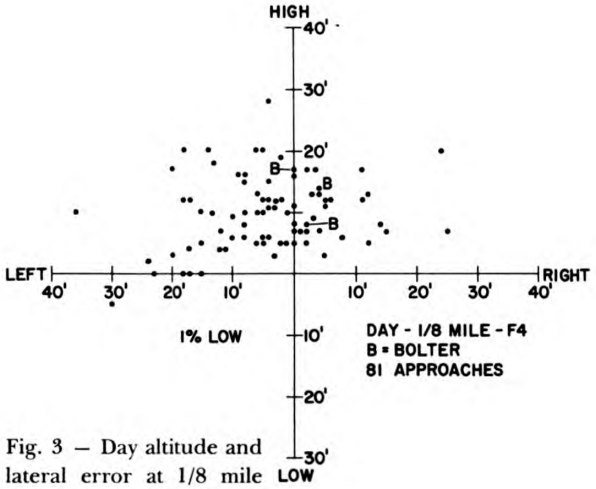


Fig. 3 — Day altitude and lateral error at 1/8 mile

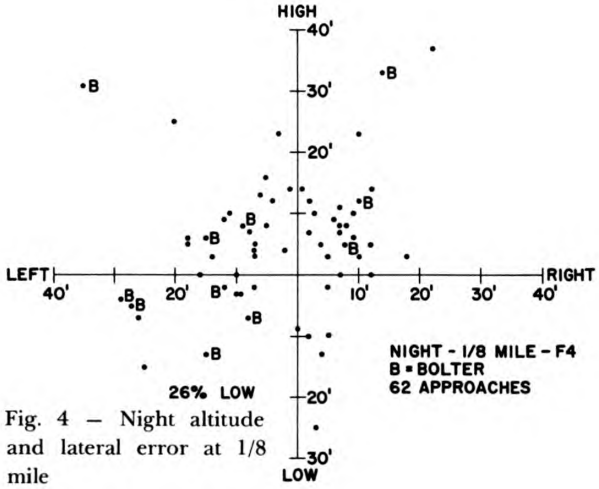


Fig. 4 — Night altitude and lateral error at 1/8 mile

position. That information, as indicated by previous research,* may include surface texture to identify the ground plane, expansion patterns, peripheral streaming and a three-dimensional view of objects of known sizes and shapes to assist in judging lateral displacements, distance and altitude. At night, reduced visual cues may force the pilot to rely almost exclusively on the "meatball" for altitude information. Lack of surface texture gradients to define the ground plane and probable absence of peripheral streaming at night resulted in extreme altitude control variability compared with day altitude control. More bolters also were recorded at night and a higher percentage of pilots (40 percent *vs* 18 percent) caught the number four wire.

Relatively large control variability at night increases the probability of large, last second corrections to salvage a poor approach. More bolters and number four wire engagements at night indicate somewhat poorer approach techniques that result in long landings or overshoots. The fact that about one-fourth of all night approaches were low may be related to some of the reasons given for some types of night carrier landing accidents, *e.g.,* ramp strikes, where proper altitude corrections were not made. Conversely, overcorrecting for a "low in the groove" condition is often mentioned as a contributing factor in hard landings and bolters. It is suspected that being low at night is exactly what the pilot wants to avoid. A ramp 60 feet above the water is very unforgiving of low approaches. Yet, at night, approximately 25 percent of all recorded recoveries were low compared to four percent during the day.

The main consequence of a visually impoverished night environment clearly seems to be the pilot's apparent inability to estimate his altitude position accurately. Improved visual sources of height guidance information would appear to be important if the pilot is to judge his altitude position more precisely. Better quality altitude information should assist the pilot in judging altitude at night, thereby reducing approach and landing variability and the dangerous tendency to fly low approaches.

On the other hand, pilot lateral error control day and night was very similar, which, on the surface, would seem to indicate that lateral guidance information available at night was of sufficient quality to allow the pilot to duplicate his daylight performance. Similar lateral error means and variability measures lend support to that assumption.

## Future Research

The research described evolved from an attempt to establish the feasibility of an objective scheme to evaluate carrier visual landing aids. Initial research results, because of their encouraging nature, have

**Ibid,* Winterberg, *et al.*

prompted expanded collection of landing performance data for all carrier-based jet aircraft. Recently, a team of scientists boarded a carrier in the Gulf of Tonkin in order to measure landing performance under actual combat conditions. Roughly 1000 A3, A4, A5, A6, and F4 aircraft recoveries were recorded after day and night strikes against heavily defended targets in North Viet Nam. The effect of combat operations on night landing performance is one of the areas of prime concern. In an attempt to determine the influence of combat flights on landing, pilot flight frequency and mission duration data will be correlated with landing measures taken during prolonged combat flying cycles.

Continued development of final approach envelopes depends on collection of additional landing data in order to describe fully and to understand the recovery characteristics of each model aircraft. With an adequate sample of landing data, a better index of landing control and quality can be developed from statistical distributions of various final approach variables. Variability measures will be used to establish a flexible performance criterion for each model aircraft which will reflect realistic pilot control tolerances based on individual aircraft handling qualities and existing visual landing aids. For example, F8 altitude error tolerance might be less than that for the A4 because of different drag, maneuverability, and damping characteristics. Different carrier sizes may also influence the criterion performance envelopes.

Collection, analysis and evaluation of empirical measures of landing quality will continue. While overnight solutions to the complex problem of night carrier landing accidents are not expected or entertained, additional data collection and description promises a better understanding of night carrier landings. Empirical data will provide the basis for developing much needed criteria for improved visual landing aid design. In addition, pilot and Landing Signal Officer selection and training requirements should benefit substantially from an empirically based knowledge of carrier landing performance in different types of jet aircraft.

Finally, if actual flight performance envelopes will allow quantitative evaluation of existing or proposed visual landing aids, such information will be a valuable adjunct to pilot opinion data for command decisions regarding acceptability of visual landing aids for operational use.

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**The Third Annual Conference on Laser Technology** will be held at the Naval Air Station, Pensacola, Florida, during the period April 18-20, 1967. The conference is being co-sponsored by the Department of Defense (Advanced Research Projects Agency), and the Departments of Army (Army Research Office), Navy (Office of Naval Research), and Air Force (Headquarters USAF). Additional information may be obtained from Mr. T. B. Dowd, Office of Naval Research Branch Office, 495 Summer Street, Boston.

# ICO Initiates Federal Ocean Buoy System Study

The Interagency Committee on Oceanography (ICO) is sponsoring a study that may result in an interagency system of buoys for exploring, explaining and exploiting the seas. The purpose of the study, which is jointly supported by the Departments of Defense, Commerce, Interior and Treasury, the National Science Foundation, and the Atomic Energy Commission, is to determine national needs for oceanographic and marine weather information which can best be acquired by buoy systems and to formulate plans for meeting these needs. The U.S. Coast Guard, as the "lead agency," announced the award of a contract for the ten-month study to the Traveler's Research Center of Hartford, Connecticut.

The use of buoys to collect ocean and meteorological data has been of great interest in recent years, and was one of the major factors considered by the ICO's Ocean Engineering Panel which recommended the study. The ICO Panel recommendation anticipated the President's Science Advisory Committee's report "Effective Use of the Sea," which called for a major national buoy effort. (See *Naval Research Reviews* issue of January 1967.)

The ICO Panel, chaired by Dr. John P. Craven, Chief Scientist of the Navy's Deep Submergence Systems Project, reviewed the buoy plans and programs of agencies having primary interest in ocean buoy systems and found that hard requirements for such systems existed in many of them. These requirements are listed below.

### Department of Defense

*The Office of Naval Research* is concerned with the development of buoys and buoy networks useful in support of oceanographic research for the Navy contract-supported laboratories. This includes all aspects of physical and chemical oceanography and marine meteorology.

*The Naval Oceanographic Office* supplies the Navy with a major portion of R&D required to support the Anti-Submarine Warfare Environmental Prediction System (ASWEPS) Program. Since ASWEPS forecasts are largely based on real-time oceanographic information, requirements are for the development of highly reliable platforms to acquire and relay information for forecasting purposes.

*The Naval Ordnance Systems Command* in a cooperative effort with the Bureau of Standards developed the NOMAD buoy system. This group was assigned responsibility for the development and operation of a highly reliable meteorological platform for use in operational weather

forecasts. The hull design has been completed and the NOMAD group is now concentrating on the development of meteorological sensors.

*The Naval Material Support Command* is concerned with the response of materials and structures to controlling factors in the ocean environment. Each factor of the marine environment has its own peculiar effect on any foreign object introduced into it. Controlled tests on structural materials must be accompanied by monitoring significant variables such as temperature, pressure, oxygen content, salinity, and other chemical concentrations. Such a task, in the open ocean, can only be accomplished on a cost-effective basis by buoys.

*The Army Corps of Engineers,* because of its charter to investigate the estuaries and shorelines, has been relatively successful in using shoreline facilities to monitor ocean conditions. Its desire to use buoys in the offshore areas, however, has been damped by limited funding and the high cost of useful buoy systems.

## Department of Commerce

*The Environmental Science Services Administration* requirements include those of the Coast and Geodetic Survey and the Weather Bureau.

- *The Coast and Geodetic Survey* has traditionally been responsible for the monitoring of coastal and estuarine currents. Present efforts are directed towards the development of stationary telemetering buoys for use in this work. The present level of effort is commensurate with the staff capabilities. Long-term requirements would involve larger permanent networks. Additionally, C&GS is responsible for the development and operation of tidal and tsunami prediction which involve buoy systems and has developed a stable underwater platform for geomagnetic and other observations.
- *The Weather Bureau* is responsible for the systems design for the overall World Weather Watch observation network. Their preliminary specifications cover three classes of buoys, but at present these are of very general design and concept. At least 54 ocean platforms are contemplated initially with 350 to 400 such stations comprising the final network.

*The Maritime Administration's* interest in buoy networks stems from the need for better sea state forecasts required by newer types of ocean transportation, such as ground effect vehicles and hydrofoils. Present prediction methods are inadequate for full utilization of these craft.

## Department of Interior

*The Bureau of Commercial Fisheries,* as part of its research on fisheries and its services to the fishing industry, requires real-time synoptic



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oceanographic information. Its present effort is limited to ten free-floating buoys with limited range telemetering facilities. Since BCF is interested in the gradients as well as the absolute distribution of salinity and temperature, fixed buoy networks are required. Agency funding is not sufficient to support this program although it is highly cost-effective in terms of scientific information and increased fish catch.

*The Bureau of Sport Fisheries and Wildlife* has a goal similar to BCF's, as applied to game fish. BSF&W's need for real-time data is closely associated with sport fisheries research and the development of prediction techniques. Buoy programs are not contemplated in the near future.

*The Federal Water Pollution Control Administration* has been operating a buoy network in the Great Lakes as part of its pollution studies. As this project is phased out, other operations will begin in East Coast estuaries and nearshore areas. Although termination of the Great Lakes study will release several buoys for other use, new networks covering broader areas will be established. Greater sensor capabilities will be needed to handle some of the chemical variables.

## Department of the Treasury

*The Coast Guard* handles over 22,000 navigational aids consisting primarily of buoys. However, most of these devices are moored in shallow water and are not instrumented. As the Coast Guard expands its oceanographic mission, it will increase its use of deep ocean buoy systems in support of its weather observation ships. Eventually, these ships will be entirely replaced by long-lived moored ocean station platforms.

Three specific programs are underway for the use of buoys for other than aids to marine navigation:

- A network of about eight buoys is required on the Grand Banks of Newfoundland to telemeter surface and subsurface temperature and current data for Ice Patrol analysis.
- The Coast Guard is planning to establish a three-buoy temperature and current measuring system in the vicinity of ten offshore light stations.
- The Coast Guard is planning to use large buoys in lieu of light ships and offshore stations as unmanned aids to navigation. Oceanographic and meteorological sensor systems are included in the planning for such buoys.

## National Science Foundation

An oceanographic buoy with a complex oceanographic capability was designed in support of the MOHOLE project. The unit was designed to monitor the ocean conditions in the area of the proposed drilling site.

## Atomic Energy Commission

The Atomic Energy Commission has two areas of interest involving buoys. The first concerns the development of low power isotope generators for marine use. One such system (60 watts) is powering a NOMAD buoy currently anchored in the Gulf of Mexico. The second is the provision for buoys in the radiation monitoring program of AEC-supported researchers.

In addition, the national oceanographic institutions, because of their responsibility for the fundamental base of scientific knowledge and theory on oceanic behavior, have a continuous requirement for networks and deployments of buoy systems to conduct large scale experiments on the large scale dynamic phenomena of the ocean.

The Panel noted that, in spite of the hard requirements for buoy networks, only one major system was now in existence—the Coast Guard aid to navigation system. The lead time to implement any other system was both long and indefinite.

Three major categories of buoy networks were outlined by the Panel:

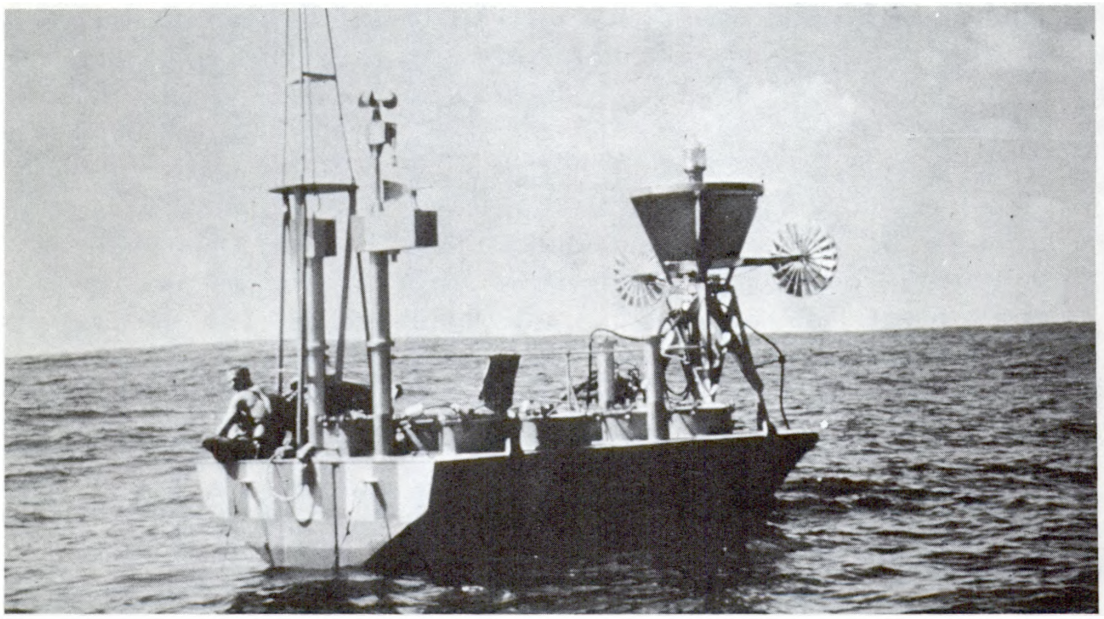
- A highly sophisticated multi-purpose, long-life, broad ocean buoy capable of being an element of a sophisticated network;
- A low or moderate cost limited purpose buoy meeting military specifications or equivalent which requires low maintenance and has high reliability;
- A low cost, ingenious, special purpose, expendable buoy for specific experiment or "one shot" application.

The first category, the Panel stated, is being characterized by the ONR-Convair buoy development. (See *Naval Research Reviews* issue of January 1967, "The Monster Buoy.") This 40-foot diameter disc buoy is designed to be capable of survival in extreme sea states, to be long-lived, high-powered, and equipped with high data rate recording and telemetry systems.

The second category is best characterized by the Coast Guard aid to navigation buoys, the NOMAD buoy system, and recent buoy developments by Litton Industries and Sanders, Inc. The Coast Guard buoys represent a continuous evolutionary development over the years and as a result are low-cost, long-lived and highly reliable. The NOMAD development also took place over a number of years, but has not had enough numbers or deployments to establish reliability. The Litton and Sanders developments are recent and will be competitively tested with the NOMAD buoys in broad ocean tests.

The third class of buoys are best represented by those developed for the Scripps Institution of Oceanography, the Woods Hole Oceanographic Institution and the Bureau of Commercial Fisheries. Each was designed for specific missions: the Scripps manned buoy (FLIP)

Left: The "Monster Buoy," developed for the Office of Naval Research by Convair. Below: Unmanned buoys such as this NOMAD will be used increasingly in the future to augment oceanographic survey ships.



for measurements of the Pacific, the Woods Hole buoy for measurements of the Gulf Stream, and the BCF buoy for measurements of ocean gradients.

Despite the differences in cost, reliability and level of sophistication, the various buoy systems have much in common. All have problems of hull stability, resistance to currents and weather, power systems, lifetime, maintenance, and communications. Sensors are invariably present for temperature and usually for currents and salinity. Other moderately common sensors are gravity, magnetism, heat flow, evaporation, oxygen content, and photo chemical activity.

A particularly significant aspect of buoy systems is data storage, retrieval and communication. The majority of users require or desire real time or nearly real time acquisition of data. This requires transmission and perhaps relay of acquired data. At present, single side band offers the greatest promise of long-range electromagnetic propagation although the international allocation of frequencies does not now allow for any extensive world-wide system. An attractive alternative is the development of a form of satellite interrogation, storage and readout system.

In summary, the ICO Panel concluded that (1) a hard requirement for buoy systems existed in various agencies; and (2) development programs existed, over the range of sophistication, but not at an adequate level to permit early introduction of any major system. The reason for this, the Panel felt, was because of the limited support the buoy systems received in each of the various agencies concerned. Further, the Panel indicated that the value of the buoy network system might well justify its development and deployment on the basis of the national interest as a whole.

As a result of the Panel's findings, the Traveler's Research Center will undertake a two-part study. The Coast Guard, because of its experience in the engineering and logistics of buoys, will act as contracting manager. The first part of the study will be an analysis of national needs, the cost of a buoy system or systems to meet these needs, and the cost effectiveness of such systems, with a clear identification of the system elements which should be developed and deployed. The second part of the study will be a study of agency missions and capabilities with recommendations for the agency or agencies to be assigned development and procurement responsibilities and the agency or agencies responsible for operation and maintenance.

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**A Ship Silencing Symposium** will be held at the Navy Electronics Laboratory, San Diego, California, during the period June 6-8, 1967. Additional information may be obtained from Mr. James E. Finley, NAVSHIPS, Room 3207 Main Navy, Washington, or Mr. H. L. Urquhart, Navy Electronics Laboratory, San Diego.

# Research Notes

## Magnetic Studies of the Ocean Floor

New studies of the varying magnetic properties in oceanic crustal rocks and oceanic sediments have recently been reported by scientists of Lamont Geological Observatory, Columbia University. The research, carried out under the direction of Dr. James R. Heirtzler, senior research associate at Lamont, has been supported by the Office of Naval Research and the National Science Foundation.

The studies have revealed a "striking and remarkably perfect" symmetry in the linear magnetic anomalies on either side of mid-ocean ridges. In addition, the presence of polarity reversals in the remanent magnetism of deep-sea sediments has been shown. Two controversial theories are strongly supported by these new findings.

One says the magnetic field of the earth has "flipped" many times in past ages, reversing the polarity of the North and South poles periodically. A reversal takes a few thousand years—just a fingersnap in geological time. Scientists say the latest reversal took place 700,000 years ago. During a general period of 1.7 million years before that, they say, the field was reversed and compass needles presumably would have pointed to the South Pole.

Support for this "magnetic flip" theory is found in paleomagnetic studies of deep-sea sediment cores based on a technique perfected recently at Lamont. A research team, led by Neil D. Opdyke, senior research associate, has charted the last five million years in the history of the earth's magnetic field. It has been found that sediments retain the same magnetic orientation as the earth's magnetic field at the time the sediments were deposited. The scientists measured and identified distinct alternating periods of normal and reversed magnetic orientation, working downward from the youngest layers of sediments at the top to the oldest (five million years) at the bottom of the cores. These findings agree with paleomagnetic work done previously on terrestrial lavas by the U.S. Geological Survey at Menlo Park, California.

The other theory says that the mid-ocean ridges have been formed by a continuing process in which hot rock constantly moves upward from the earth's interior over the geologic ages, cools as it nears the ocean bottom and spreads out laterally along the ocean floor on either side of the raised ridge. The theory, presented by F. J. Vine and D. H. Matthews of Cambridge, states that when this material cools below a certain temperature (570 degrees centigrade), it becomes magnetized in the direction of the earth's magnetic field at that time. The cooling takes place at the ridge. Each geomagnetic polarity epoch in the past, therefore, is "frozen" into alternating normal and reversed magnetized bands of rock parallel to the ridge axis which are constantly moving away from the axis.

This theory is substantially supported in the new Columbia studies by the almost perfect symmetry found in the pattern of these magnetic reversals on either side of some mid-ocean ridges. The sequence of parallel thick and thin bands with their varying intensities of normal and reversed magnetism on one side of the ridge has been found to be the exact mirror image of the sequence on the other side. The theory is further strengthened by the work of the Opdyke team, for when its vertical chart of dated magnetic periods in sediments is turned sideways and placed against the horizontal magnetic profile of the ocean floor, the patterns match.

Scientists note the age of a particular band of ocean floor by its magnetic "tag" and then measure its distance from the ridge axis where it had become magnetized many hundreds of thousands or millions of years earlier. With these figures the scientists can compute the rate at which the ocean floor is spreading.

The most striking new data has emerged in Columbia's studies of the Pacific-Antarctic Ridge, which lies between New Zealand and the tip of South America. There, magnetic profiles of the ocean floor were made over a span of more than 300 miles from each side of the ridge, a distance representing 10 million years in each direction. Nearly perfect mirror-image symmetry was found in the two halves of the 600-mile profile and further symmetry was indicated beyond that. Analysis of these data indicates that spreading rates of nearly two inches per year have persisted in this area for many tens of millions of years.

Similar evidence supporting the theory of upward convection movement of material within the earth was found in magnetic profiles across the Reykjanes Ridge, which lies in the far North Atlantic Ocean near Iceland, between Greenland and the British Isles. Other magnetic profiles over the Indian Antarctic Ridge south and southwest of Australia and over the mid-Atlantic Ridge in the South Atlantic Ocean indicate that these areas may yield further support for the theory of ocean floor spreading.

There is a body of scientific knowledge, however, which has not been reconciled with the ocean floor movement theory. Scientists have not found ocean sediments disturbed as they presumably should be by such ocean floor movements.

"Most geophysicists," said Dr. Heirtzler, "have thought the earth's crust incapable of such global motion without severe earthquakes or cataclysmic upheavals in the ocean floor. That the earth's crust is in smooth but large scale flow requires a rewriting of many geophysics and geology texts. Now that it is known how to study this motion, the patterns of motion can be studied in great detail."

## Bahamas Scene of Oceanographic Tests

As part of a "fail-safe" program to avoid losing valuable underwater testing devices, the U.S. Naval Oceanographic Office recently conducted exhaustive tests in ocean depths adjacent to the Bahama Islands.

Working from aboard the research vessel, USS LITTLEHALES (AGS-15), engineers experimented with newly developed recovery methods for several costly devices normally used in oceanographic work. The first of these was a flotation system for the recovery of an acoustic transducer usually towed behind a ship at depths of about 100 feet, a distance which is necessary to avoid interference from normal ship's noises.

These costly sonar devices are packaged in a streamlined "fish" measuring nine feet in length. The recovery apparatus consists of two rubber flotation bags that are released automatically if the towing gear parts. To aid in recovery, a signal light flashes on and a pinger commences to operate. All recovery systems must function instantly in order to avoid having the 2000-pound instrumentation housing plummet to depths near 500 feet. At such pressures, outside forces would not allow the recovery bags to inflate.

Experimental testing was also conducted on a "Monopropellant Gas Generator" which is designed to have the capability of inflating the flotation bags under great pressures. Hydrazine gas, which was used to assist in the recovery of the H-bomb lost off the shores of Palomares, Spain, was used in the experiments. This generator would be effective to depths of 20,000 feet.

An expendable bathythermograph (BT) was also tested to ascertain if a body in free fall, in ocean waters, falls at a constant rate. An expendable BT is an electronic instrument of about 1-1/2 pounds that allows a temperature profile to be made at speeds up to 30 knots in any sea state.

Other special-use BTs and a Precision Fathometer Recorder, which is an electronic device designed to provide the oceanographer with a bottom profile, were tested.

Final results and analysis have not as yet been compiled, but the overall results have been labeled successful.

## Long-Range Viewing by Sound Underwater

A new underwater acoustic imaging technique that promises to provide the most practical system of its kind yet to come within range of development is being perfected for the Navy by Litton Systems Research Laboratories, San Carlos, California.

Acoustic imaging, itself, is not new. Since 1950, several workable systems have been developed and tested by General Electric, Vitro Laboratories, and other firms. However, all of these systems have relied upon complicated signal-processing methods. The Litton concept, called "Hydrocon," which was developed under a contract with the Office of Naval Research, is the first to convert the acoustic signal into a standard television signal.

Standard underwater television is quite limited for seeing in water because light energy is severely scattered in that medium. In clear sea water, for example, most of the light is lost after it has traveled only 10 or 20 feet, and in turbid or muddy water, in much shorter distances. Although sound energy also is scattered to some extent in water, the scattering effect is considerably less than that of light, permitting signals to be received miles from the point of transmission.

In the Hydrocon system, the object to be viewed is "illuminated" by a sound source. The reflected signals are received by a matrix of individual transducer elements, which are then amplified and fed to electrodes on the face of a modified orthicon tube. The electrodes are scanned at a television scan rate and then transmitted through a video cable to a standard television monitor. Viewing, therefore, is done in real time.

A major attraction of the new system is its low cost, which is made possible not only by the use of standard television equipment but also by new technology that permits the mass production of miniaturized integrated circuit amplifiers. By providing a sufficient number of transducer elements and appropriate magnification of imaging optics, a high-quality television picture can be obtained.

Another type of acoustic imaging system that is based on a somewhat different image-conversion procedure is in an early stage of development by the Missile and Space Division of Lockheed Aircraft under an ONR contract. This contract also calls for a comparison of long-range, low-frequency operation with short-range, high-frequency operation.

## Navy Installs Anti-Sub Trainer, Orders 2 More

The U.S. Navy has put another shore-based trainer into use to teach surface ship crews how to sink enemy submarines on a make-believe ocean and has contracted for two more of the economical training devices.

The latest addition to the Navy's growing anti-submarine warfare (ASW) training facilities is a $3.5-million attack system installed at the fleet's anti-submarine warfare school in San Diego, California.

The trainer was designed and developed by Honeywell, Inc.'s California Ordnance Center at West Covina, California, under contract to the Naval Training Device Center, Orlando, Florida. It is one of two trainers making up a $12-million complex dedicated recently by the school.

Vice Admiral L. P. Ramage, USN, commander of the U.S. First Fleet, called the two trainers a valuable addition to the Navy's ASW training facilities. He said, "They will provide savings in both time and money by giving our operating forces a most realistic means of rapidly achieving and maintaining a high level of proficiency in this important aspect of naval warfare."

The device is designed to instruct combat crews—from ASW task group commander to petty officer—in the operation and tactical use of the anti-submarine rocket (ASROC) and other ASW weapons, such as the over-the-side Mark 46 torpedo and Drone Anti-submarine Helicopter (DASH) vehicle.

The computer-controlled battles are fought with moving symbols on a make-believe sea that is displayed on a large projection screen. Six operating areas encompass 3000 square feet of floor space—conning station, combat information center, underwater battery plot, problem critique and display room, launcher captain's control station and computer and projection equipment room.

Dr. Theodore F. Hueter, general manager of Honeywell's West Coast ordnance operations, reported that production of two similar surface ship ASW attack trainers has begun under a $4.2-million NTDC contract received in June.

The first trainer will be installed at U.S. Naval Base, Fleet Training Center, Newport, Rhode Island, with acceptance testing scheduled in February 1968. The second trainer will be delivered to U.S. Naval Station, Fleet Sonar School, Key West, Florida, for acceptance testing in June 1968.

Trainee displays progress of mock anti-submarine battle on plot board in combat information center of ASW trainer installed at fleet ASW school in San Diego. Earphones and microphone add realism to exercise.

## OSCILAB and SEADOPOD

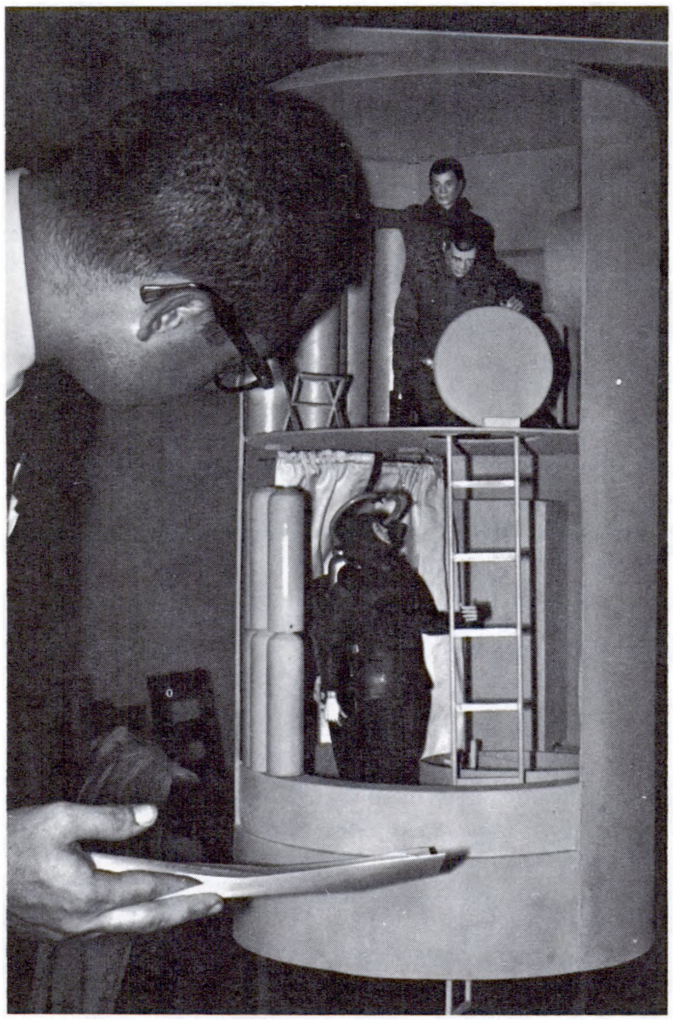
The Navy is studying a plan for establishing the first undersea habitat to be devoted exclusively to the scientific study of the ocean bottom. A detailed report outlining the design feasibility of a dwelling of this type and the facilities required to support it has been submitted to the Office of Naval Research by the University of New Hampshire's Engineering Design and Analysis Laboratory.

The report concludes that one or the other of two distinctly different systems would best serve the purpose. The first, which has been designated "OSCILAB," is a non-propelled vessel in which six men would live and work continuously at a maximum depth of 300 feet for periods as long as two weeks. The vessel would be cylindrical,

nine feet in diameter, and 40 feet in length. The OSCILAB would lower and raise itself, with the divers on board, by winching along an anchor line. Access to the sea would be through a 48-inch-diameter wet-room trunk. The OSCILAB would be towed from site to site by a surface support ship.

SEADOPOD, the second system, would require the permanent installation of a habitat on a surface support barge, the habitat being maintained during operations at the same ambient pressure as that of the ocean floor to be investigated. Periodically, a submersible delivery capsule, the interior pressure of which also would be kept the same as that of the ocean-bottom research site, would be mated to the SEADOPOD to receive as many as six diver scientists. Upon separation from SEADOPOD, this capsule would be lowered from the barge to the ocean bottom to enable the scientists to make observations. The capsule would be capable of sustaining operations underwater for as many as six hours. The surface barge would be towed from one research site to another according to the scientific schedule.

Both OSCILAB and SEADOPOD would provide the two basic essentials needed for conducting many scientific undersea programs. They would enable scientists to spend considerable periods of time beneath the ocean, and they would permit the examination of different geographical areas in rapid succession. ONR is planning to conduct model tests of the two systems to determine which is most efficient.



Model of the SEADOPOD delivery capsule

# Fully Instrumented Submersible Housing (FISH) Unit Tested by Scripps

A highly complex, electronic, sea-floor mapping instrument and its accompanying underwater navigation system has been successfully used by San Diego's Scripps Institution of Oceanography.

Towed at ocean-bottom depths from a research vessel, the instrument can map the fine structure of the sea bottom in more detail than has previously been possible. The navigation system is used to find the position of the instrument.

"The development of these two systems culminates several years of design study and is an outgrowth of U.S. Navy requirements for observing and mapping sea-floor topography at close range, as well as our basic interest in submarine geology," said Dr. Fred N. Spiess, associate director of Scripps and director of the Institution's Marine Physical Laboratory.

"MPL engineers and technicians designed and built the systems under contracts with the Office of Naval Research and the Navy's Deep Submergence System Projects Office. The mapping and navigation system will give the Navy far better capability to cope with problems such as were posed by the search for the submarine THRESHER in the North Atlantic in 1963 or for the hydrogen bomb earlier this year off the coast of Spain," Dr. Spiess said.

The 1200-pound, four-foot-long, metal-encased mapping instrument is called FISH, short for Fully Instrumented Submersible Housing.

For its topographic assignments, it uses upward-, downward-, and side-looking electronic sonar devices that measure how deep the FISH is and how far off the ocean bottom it is being towed in order to tell the scientists what the bottom looks like. The side-looking sonars can resolve objects as small as six feet and as large as 600 feet on each side of FISH.

Scripps scientists recently returned from a five-weeks' expedition, "Tow One," from San Diego to Honolulu and return aboard the research vessel THOMAS WASHINGTON. The expedition mapped in detail a ten-mile square section of the deep-ocean floor north of Honolulu. Geological features as small as ten yards across were located and measured. FISH was towed close to the ocean bottom in an attempt to provide Scripps scientists with answers to several puzzling questions in the areas of geology and geophysics. Also, by measuring detailed structures of the ocean floor, they obtained data about sea-bottom slopes that are important to the performances of anti-submarine warfare systems.

In Expedition Tow One, FISH was towed at the end of a five-mile-long cable with a single center electrical conductor. Commands and power from the ship and replies from the FISH were carried along the cable to commanding and recording instruments in the ship's laboratory. FISH was towed as close as 100 feet off the ocean bottom in water as deep as 15,000 feet.

Because of the importance of knowing exactly where FISH is when measurements are being taken, a new system of navigation had to be developed. Three sonar beacons were placed on the ocean floor to provide navigation with an accuracy of 100 feet. These acoustic beacons, called transponders, "reply" to calling sound pulses sent out by the towed FISH. By measuring the time taken for the sound pulses to travel from FISH to the transponder and back, the distance between FISH and the transponder can be determined.

The beacons were placed five miles apart in a triangular array and used to locate the ship and FISH during maneuvering operations, even though FISH was two miles beneath the ocean surface. After determining FISH's position, the scientists mapped the geological formations "seen" by the FISH's sonars and transmitted to recording devices aboard ship for subsequent topographic analysis.

# On the Naval Research Reserve

## NRRC 6-1 Plans Weekend Seminar

Naval Reserve Research Company 6-1 and 3251 United States Army Reserve R&D Unit, both of Atlanta, Georgia, are planning a Southeastern Research Reserve seminar for all the services in the month of April 1967.

This seminar, which will be held over a weekend in Atlanta, Georgia, is expected to feature tours of the Lockheed-Georgia Company research center and manufacturing areas, the new nuclear reactor facility at Georgia Institute of Technology, the U.S. Public Health Center Communicable Disease Center, and Scientific Atlanta, Inc., manufacturer of precision microwave and servo equipment. The seminar will also feature a session of technical papers by Atlanta area scientific and engineering leaders, and a banquet at which a distinguished speaker will be presented. The seminar is planned for dogwood blossom time, for which Atlanta is famous. It is hoped that an early game of the Atlanta Braves will be played on the Sunday afternoon following the close of the seminar.

After official approval for this weekend seminar is given, full details will be published so that interested units in the Southeastern area may make application for group active duty for training at this seminar.

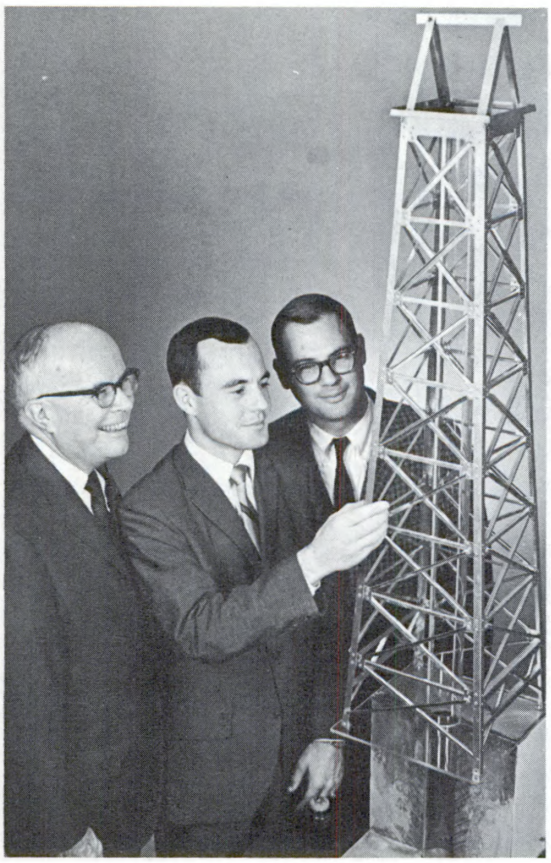
## Member of NRRC 6-2 Wins National Prize

Ensign John Leo, USNR, a member of NRRC 6-2, Auburn, Alabama, and a student of Auburn University, topped students from twelve other leading Schools of Engineering. He won the first place student paper award during the recent conference of the American Society of Mechanical Engineers in New York City.

Ensign Leo's winning paper was developed from his preliminary design for a zero-gravity test facility for studying problems of manned craft in space. The facility, as designed by Ensign Leo, would involve a high tower for dropping test packets in free flight under conditions simulating the absence of gravity, the state of weightlessness which affects men aboard spacecraft as well as such components as liquid fuel or water.

The tower method of testing would provide data needed before flight without the time-consuming and expensive alternatives of testing at high altitudes or in outer space, Ensign Leo explains. Thus far, Ensign Leo has only a working model of his tower, but plans are under way to construct the testing facility on the campus at Auburn. Humble Oil Company has donated a 137-foot tower to be used in the project.

Ensign Leo received his bachelor's degree at Auburn in April. This project has been the basis for his master's degree which he hopes to obtain next August.



ENS John A. Leo, III, points out details on his design to Dr. Donald M. Vestal (left) and Dr. R. I. Vachon. Dr. Vachon was Leo's senior project adviser.

## Commandant's Inspection of NRRC 6-3

The annual Commandant's inspection of the Naval Reserve Research Company 6-3, Oak Ridge, Tennessee, was conducted by LCDR J. H. Dunroe, USNR, Research Reserve Program Officer for the Sixth Naval District, on October 26, 1966. The military inspection was followed by a dinner and the regularly scheduled drill. The inspection was well attended by company members.

The company was fortunate to have as guests LCDR O. B. Sharpe, USN, Commanding Officer, U.S. Navy and Marine Corps Reserve Training Center, Knoxville, Tennessee, and CDR Burl Gilliland, USNR, Naval Reserve Group Commander, 6-11(S), Knoxville, Tennessee.

In addition to remarks made by LCDR Sharpe and CDR Gilliland, LCDR Dunroe presented an interesting and informative talk on current affairs in our Naval District. He also made suggestions on

resolving general problems as well as those peculiar to Research Reserve Companies. The highlight of the evening was the presentation of a plaque by LCDR Dunroe to NRRC 6-3 in recognition of its attainment of first position among Research Reserve Companies of the Sixth Naval District in the proficiency competition for Fiscal Year 1966.

CDR P. P. Holz, USNR (left), CO of NRRC 6-3 for FY 1966, receives plaque from LCDR J. H. Dunroe, USNR for attainment of First in annual competition standings among Research Reserve Companies in Sixth Naval District. LCDR W. J. Leonard, USNR (center), present CO of NRRC 6-3, observes.

## NRRC 6-3 Sponsors 16th Nuclear Science Seminar

The Oak Ridge Naval Reserve Research Company, in conjunction with the U.S. Atomic Energy Commission, sponsored the 16th Nuclear Science Seminar, held in Oak Ridge, Tennessee, November 28 to December 9, 1966. Forty-one reservists from the Navy, Army, and Air Force attended. Scientists from Union Carbide Corporation, Nuclear Division, representing the Oak Ridge National Laboratory, Y-12 and K-25 plants, comprised most of the technical speakers for the seminar.

Dr. Peter King, Deputy and Chief Scientist of the Office of Naval Research, opened the seminar with a most informative luncheon address. Dr. W. G. Pollard, Executive Director of the Oak Ridge Associated Universities, made several presentations. Active duty personnel addressing the seminar were CAPT D. J. Marker, USNR, and CDR R. M. Springer, USN, of the Office of Naval Research; CAPT W. C. Raposa, USN, head of the Chief of Naval Operations Anti-Air Warfare Division; and CDR G. J. Mische, USN, of the Defense Atomic Support Agency (DASA).

The seminar emphasized specific applications of nuclear science and technology. The presentations ranged from present-day reactor systems to advanced concepts such as breeder power reactors, space

reactors, and desalinization reactors. Biological experiments utilizing radioisotopes were reviewed by members of the Medical Division of Oak Ridge Associated Universities and the Biology Division of the Oak Ridge National Laboratory. Recent lunar surface photographs were analyzed by Dr. P. R. Bell and the intricate steps being taken to obtain lunar samples for detailed analysis were explained. Research and development programs leading to advanced materials for space utilization were presented by Dr. J. M. Googin, Senior Scientist of the UCCND Y-12 Development Division. In addition, the seminar attendees were introduced to many unusual devices for nuclear and space application which have presented extremely difficult technological obstacles.

Dr. Clarence E. Larsen, President of the UCCND, addressed the seminar at a dinner meeting. The topic of Dr. Larsen's speech was "The Impact of Industrial Science on Society." He discussed some of the major patterns of scientific research and noted that there was no single formula which has given us the standard of living we enjoy or the basic knowledge we can apply to solving new problems.

LCDR O. B. Sharpe, USN, Commanding Officer of the Navy and Marine Corps Training Center, Knoxville, Tennessee and his staff provided assistance to the seminar staff. LT W. C. McWhorter, USNR, a member of NRRC 6-3, was Chairman of the seminar.


Dr. G. E. Boyd (right), ORNL Assistant Director, discusses the Oak Ridge seminar program with LT W. C. McWhorter (left) and CAPT W. T. Zumwalt, both members of NRRC 6-3.

## NRRC 6-6 Report

NRRC 6-6, Chapel Hill, North Carolina, has a membership of twenty officers, most of whom are associated with the University of North Carolina. Also represented in the unit are North Carolina State University, Duke University, the Research Triangle, and the local business community. Areas of research in which the members are active include botany, zoology, chemistry, medicine, public health, geography, city planning, educational television, electrical engineering, computer science, law, literature, and library science.

The universities at Chapel Hill, Durham, and Raleigh have been instrumental in the development of the Research Triangle, which has attracted industries and agencies oriented toward research and development such as Chemstrand, IBM, and the new Federal Environmental Health Center. The universities have recently installed an IBM 360 computer system in the Research Triangle, with input/output facilities on each campus. They also share their excellent library facilities and their research laboratories in many fields. The combined resources of the three universities make the Research Triangle area an impressive research complex and an excellent location for a Naval Reserve Research Company.

Commanding Officer of NRRC 6-6 is LCDR Howard M. Harper, Jr., USNR. The unit meets 24 times a year, during the fall and spring terms of the universities. Meetings are held at 1800 on Mondays in the NROTC Building on the UNC Campus, except for occasional field trips to various research facilities in the area.

## Success in Recruiting for NRRC 6-9

NRRC 6-9, Athens, Georgia, has shown a 30% increase in its membership since the beginning of the fiscal year 1967. Major contributing factors to the success that the company is currently enjoying are the talent and the facilities available to it because of its unique location.

Athens, the home of the University of Georgia, is a major research center. Among all southern state universities, Georgia, although it does not have a school of medicine or of engineering attached, is exceeded in funds spent annually for research only by the Universities of Florida and Texas, both of which do have schools of medicine and engineering. This pool of varied research talent is regularly utilized in providing programs of unusually high caliber for NRRC 6-9.

In addition to the facilities of the University, the U.S. Naval Supply Corps School, Athens, also makes available both its facilities and its staff.

Examples of recently scheduled programs include presentations by CAPT Stuart Smith, USN, Commanding Officer of the Navy Supply Corps School; CAPT Clarence J. Smith, USNR, director of the University's honors program and recent staff member of the Naval War College; COL Warren A. Thrasher, USA, Professor of Military Science; COL Robert P. Crow, USAF, Professor of Airspace Studies; and Dr. Robert Anderson, Vice President for Research, University of Georgia.

Although no credit is received for competition purposes, four Coast Guard reservists make major contributions to the programming and the effectiveness of the company.

## Diverse Topics Highlight NRRC 6-17 Fall Programs

Being located in Huntsville, Alabama, NRRC 6-17 finds its programs heavily slanted towards missile and space research. This past quarter has brought a variety of other topics, including "Quality Control in Japanese Industrial Plants," "Manned Undersea Stations," and "Evaluation of Reports of Unidentified Flying Objects."

One of the outstanding programs recently presented was a talk on "Microelectronics Research," presented by Dr. A. M. Holladay of the NASA Marshall Space Flight Center's Astrionics Laboratory. He reviewed the basic physics involved in solid-state electronic devices; and outlined how solid-state phenomena are employed in complex integrated circuits, how such circuits are manufactured, and the pitfalls in their production.

Dr. Holladay pointed out that a major factor leading to the rapid acceptance and application of integrated circuits in space vehicle hardware has been their significant contribution to improvement in reliability. Further, their small size, low power requirements, and potential for reduced cost insure their expanded use in many other types of applications. At the present time, economical production can be achieved only in large quantities; however, new fabrication techniques hold promise of low cost production of specialized integrated circuits even in small quantities. Dr. Holladay went on to observe that we are just beginning to learn how to produce and exploit these devices to their full potential.

## Field Trips Form Part of Training Program of NRRC 6-18

NRRC 6-18 of Nashville, Tennessee schedules one uniform drill each quarter to visit various industries in the area. Such drills have included visits to the Ford Glass Plant, Vanderbilt University Computer

*— Continued on inside back cover*

# Selected Contract Research Reports

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

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

## ASTRONOMY AND ASTROPHYSICS

*Investigation of O and B Spectra of Stars;* Arizona University, Tucson; B. M. Middlehurst; AD-642 144

*Observations of Galactic and Extragalactic Emission at 408 MC/S. The Determination of the Accurate Positions of Radio Sources by the Lunar Occultation Technique. Observations of Emission from Flare Stars;* Jodrell Bank (England); C. G. T. Haslam *et al.;* AD-642 307

*Study of the Albedo of the Earth;* Alaska University, College; Wallace B. Murcray; AD-642 356

*New Determinations of the Faraday Rotation for Extragalactic Radio Sources;* Calif. Inst. of Technology, Pasadena; G. L. Berge and G. A. Seielstad; AD-642 106

*Measurements of the Flux Densities, Positions and Angular Widths of Planetary Nebulae at 10 CM and 21 CM Wavelengths;* Cal. Inst. of Tech., Pasadena; A. R. Thompson *et al.;* AD-642 165

*The Radio Source 3C17;* Cal. Tech.; A. T. Moffet, M. Schmidt, *et al.;* AD-642 166

## ATMOSPHERIC PHYSICS

*Amplitude Statistics of Lightning Discharge Currents and ELF and VLF Radio Noise;* Sylvania, East Waltham, Mass.; Janis Galejs; AD-642 539

*Several Observations of Low-Energy Protons and Electrons in the Earth's Magnetosphere with OGO 3;* Iowa U., Iowa City; L. A. Frank; AD-642 629

*The Hook Whistler—A new Equatorial Whistler Observed by INJUN 3;* Iowa U.; D. A. Gurnett *et al.;* AD-642 631

## BEHAVIORAL SCIENCES (HUMAN FACTORS ENGINEERING)

*Symposium on Project Cadillac;* New York U., N.Y., AD-642 023

*The Utilization of Human Factors Information by Designers;* Bunker-Ramo Corp., Canoga Park, Cal.; D. Meister and D. E. Farr; AD-642 057

## BEHAVIORAL SCIENCES (PERSONNEL SELECTION, TRAINING AND EVALUATION)

*Scientific Personnel, A Bibliography;* Library of Congress; M. H. Eller and J. Weiner; AD-642 013

*Effectiveness of Ejection Seat Training with Special Reference to SDC Device No. 6EQ-2;* Richardson, Bellows, Henry and Co., Inc., New York; C. S. Rhoads; AD-642 247

*The Development of an Evaluation Procedure for Training Aids and Devices;* Richardson *et al.,* New York; H. A. Edgerton and D. H. Fryer; AD-642 312

*Army Marksmanship and Gunnery Training. I. Training Requirements for Individual Weapons;* Tufts U., Medford, Mass.; R. S. Hirsch and E. V. Saul; AD-642 391

*Training by Television, the Comparative Effectiveness of Instruction by TV, TV Recordings and Conventional Classroom Procedures;* Fordham U., Bronx, N.Y.; R. T. Rock *et al.;* AD-642 396

*Specific Recommendations for New Training Aids and Devices Developed at the Marine Supply Schools, Camp Lejeune, N.C.;* Richardson *et al.,* N.Y.; D. H. Fryer *et al.;* AD-642 504

*Training for Anti-aircraft Artillery Gunnery;* Ohio St. U., Columbus; J. E. Horrocks; AD-642 505

*Training by TV, A Study in Learning and Retention;* Fordham U., Bronx, N.Y.; R. T. Rock *et al.;* AD-642 526

*Light Anti-aircraft Tracer Observation and Fire Control with Specific Reference to the Training Problem;* Ohio State; J. E. Horrocks *et al.;* AD-642 527

*Attitudes of Psychologists Toward Their Jobs;* Texas Christian U., Fort Worth; S. B. Sells and D. P. Will; AD-642 580

*Training 90 MM AA Gun Crews. Appendix I. History of the Project;* Ohio State U.; J. E. Horrocks *et al.;* AD-642 586

*Training 90 MM AA Gun Crews. Appendix II. Statistical Analysis;* Ohio State; J. E. Horrocks *et al.;* AD-642 588

*Training 90 MM AA Gun Crews. Appendix III. A Recommended Program for Advanced Individual Training in Anti-aircraft Artillery;* Ohio St.; J. E. Horrocks *et al.;* AD-642 589

*Training 90 MM AA Gun Crews. Appendix V. Follow-up Study of Recommended Procedures and Training Aids;* Ohio St.; A. Goldman; AD-642 590

*Study of Training Requirements for Tank Tactical Training;* Ohio St.; J. E. Horrocks and W. C. Fotheringham; AD-642 595

*Study of the Present Status of Training Aids and Devices in the Army Field Artillery Training Program;* Ohio St.; J. E. Horrocks *et al.;* AD-642 596

## BEHAVIORAL SCIENCES (PSYCHOLOGY) (INDIVIDUAL AND GROUP BEHAVIOR)

*Compliance to Threats Directed Against Self and Against an Innocent Third Person;* Columbia U., N.Y.,; H. A. Hornstein *et al.;* AD-642 062

*Timed Phrases;* Kenyon College, Gambier, O.; J. W. Black; AD-642 311

*Techniques of Inducing Cooperation Between Adversaries;* Columbia U.; M. Deutsch; AD-642 423

*Basic Research on Selection and Classification Problems;* Educational Testing Service, Princeton, N.J.; H. Gulliksen; AD-642 442

*General Theoretical Problems Related to Organizational Taxonomy: A Model Solution and its Assumptions;* Texas Christian U., Fort Worth; S. B. Sells; AD-642 496

## CHEMISTRY

*Decomposition Chemistry of NF2 Compounds;* Texaco Experiment, Inc., Richmond, Va.; P. L. Goodfriend and H. P. Woods; AD-642 190

*Research on Metal Mercaptides;* U. of Western Ontario, London; D. C. Bradley; AD-642 139

*Alkyl and Aryl Aluminum Complexes. I. The Reaction of Trialkyl and Triaryl Aluminum with Bidentate Ligands;* Olin Mathieson Chem. Corp., New Haven, Conn.; T. J. Hurley *et al.;* AD-642 608

*Fluctuation Phenomena Near Phase Transitions in Condensed Systems;* Syracuse U., N.Y.; H. Brumberger; AD-642 086

*Boltzmann Equation Approach to Transport Phenomema;* Oregon U., Eugene; Shigeji Fujita; AD-642 399

*Electrostriction and the Dehydration of Ions Under Pressure;* Arthur D. Little, Inc., Cambridge, Mass.; R. A. Horne; AD-642 528

*The Behavior of Non-ionic Detergents in Non-Polar Solvents;* Cornell U., Ithaca, N.Y.; P. Debye and C. Gravatt; AD-642 604

*Electric Field Effect on the Critical Opalescence. II. Relaxation Times of Concentration Fluctuations.* Cornell U.; P. Debye *et al.;* AD-642 606

## EARTH SCIENCES AND OCEANOGRAPHY

*Sound Structure and Directionality in Orcinus (Killer Whale);* Woods Hole Oceanographic Institution, Mass.; W. E. Schevill and W. A. Watkins; AD-642 443

*Circulation over the Continental Margin of the Northeast Gulf of Mexico;* Texas A&M U., College Station; R. D. Gaul; AD-642 087

*Rare Earth Fractionation in Hawaiian Volcanic Rocks;* MIT, Cambridge; J. Schilling; AD-642 344

*Seismic Reflection Investigations in the Vicinity of the Hawaiian Ridge;* Hawaii Inst. of Geophysics, Honolulu; L. W. Kroenke and G. P. Wollard; AD-642 039

*The Keweenaw Current, a Regular Feature of the Summer Circulation of Lake Superior;* Wisconsin U., Madison; R. A. Ragotzkie; AD-642 020

*Aerial Survey of Hudson Bay Surface Temperature—1965;* Wisconsin U.; W. M. Wendland and R. A. Bryson; AD-642 018

*Characteristics of the Surface Layer in the Northeast Pacific Ocean;* Scripps Institution of Oceanography, La Jolla, Cal.; L. F. Giovando and M. K. Robinson; AD-642 581

*Development of a System to Measure the Density of Drifting Snow;* Washington U., Seattle; O. Hollung *et al.;* AD-642 260

## ELECTRONICS (COMPUTERS)

*Elements of Instrumentation, Electric Modifiers (Electric Information Processing Elements);* MIT, Cambridge; K. S. Lion; AD-642 059

*The PDP-5 as a Satellite Processor;* Pennsylvania U., Philadelphia; P. R. Weinberg and M. S. Wolfberg; AD-642 255

## ENERGY CONVERSION (NON-PROPULSIVE)

*Turbine Performance Prediction: Optimization Using Fluid Dynamic Criteria;* Rocketdyne, Canoga Park, Cal.; O. E. Balje and R. L. Binsley; AD-642 767

*Research Program on Application of Jet Compressors to Magnetoplasmadynamic Electrical Power Generation. Phase II;* Martin Co., Baltimore, Md.; W. B. Bienert; AD-642 769

## MATHEMATICAL SCIENCES

*An Approach to the Time-Varying Sensitivity Problem;* Stanford U., Calif.; B. D. O. Anderson and R. W. Newcomb; AD-642 151

*Upper and Lower Probabilities Generated by a Random Closed Interval;* Harvard U., Cambridge; A. P. Dempster; AD-642 548

*Approximation Formula for Physical Data;* General Motors Research Labs, Warren, Mich.; J. R. Rice; AD-642 584

*Robustness of Bayes Decisions Against the Choice of Prior;* Stanford U., Cal.; G. Elfving; AD-642 613

*Admissible Bayes Procedures and Classes of Epsilon Bayes Procedures for Testing Hypotheses in a Multinomial Distribution;* Stanford U.; C. Morris; AD-642 636

*Bibliography of Schlicht Functions;* New York U.; S. D. Bernardi; AD-642 657

*Optimal Operating Policies for Stochastic Service Systems;* Calif. U., Berkeley; D. P. Heyman; AD-642 277

*Scheduling Several Products on One Machine to Minimize Change-overs;* Cal. U., Berkeley; C. R. Glassey; AD-642 278

*Queueing Network Experiments with Varying Arrival and Service Processes;* Cal. U., Los Angeles; R. T. Nelson; AD-642 424

## MECHANICAL AND MARINE ENGINEERING

*Compliant Water Wave Absorbers, Part 2;* MIT, Cambridge; J. H. Milgram; AD-642 117

*Shipboard Systems Costs: A Functional Analysis of Work Aboard Ship. The SS Hawaiian Citizen, A Containership in the U.S. Pacific Coast-Hawaiian Service;* National Academy of Sciences; AD-642 515

*Shipboard Systems Costs: A Functional Analysis of Work Aboard Ship. The SS President Lincoln, A Dry Cargo Ship in the Trans-Pacific Service;* NAS; AD-642 518

*Human Factors in the Design of the Submarine Diving Control Station;* Dunlap and Associates, Stamford, Conn.; F. W. Trabold *et al.;* AD-642 738

*Performance of Controllermen in the Propulsion Cubicle of Guppy Submarines;* Dunlap; J. D. Coakley; AD-642 739

*The Human Factor in the Design and Layout of Submarine Equipment. The Kollmorgen Any-Height Periscope;* Psychological Corp., N.Y.; M. A. Tolcott and R. Channell; AD-642 734

*The Human Factor in the Design and Layout of Submarine Equipment, Kollmorgen Any-Height Periscope, Human Factors in the Operation of;* Psychological Corp., N.Y.; AD-642 735

*The Human Factor in the Design and Layout of Submarine Equipment: Analysis of Equipment Ratings and Proposed Layout of Submarine Attack Center;* Psychological Corp., N.Y.; R. C. Channell and M. A. Tolcott; AD-642 736

*The Human Factor in the Design and Layout of Submarine Equipment: Analysis of War Patrol Reports and Interviews;* Psychological Corp., N.Y.; R. C. Channell and M. A. Tolcott; AD-642 737

## METHODS AND EQUIPMENT (RELIABILITY)

*The Optimal Burn-in Testing of Repairable Equipment;* MIT, Cambridge; J. M. Cozzolino; AD-642 105

## NAVIGATION AND COMMUNICATIONS

*Some Theoretical and Experimental Aspects of Analysis with the Sound Spectrograph;* Michigan U., Ann Arbor; H. K. Dunn *et al.;* AD-642 058

*Loudness of Speaking: The Effect of the Intensity of Side-tone Upon the Intensity of the Speaker;* Kenyon College, Gambier, O.; C. Lightfoot and S. N. Morrill; AD-642 189

*Intelligibility in Voice Communication;* Kenyon College, J. W. Black; AD-642 386

*Effects of the Mode and Rate of Transmitting Messages Upon the Relationships Between Their Intensity and the Intensity of Repetitions of Them;* Kenyon College; C. Lightfoot; AD-642 387

*The Effect of Vocal Frequency and Intensity of Hearing Sustained Tones While Reading;* Kenyon College; J. W. Black *et al.;* AD-642 390

*Precision of Articulation in Repeated Phrases;* Kenyon College; J. W. Black; AD-642 481

*Natural Frequency, Duration, and Intensity of Vowels in Reading;* Kenyon College; J. W. Black; AD-642 506

*The Relation Between Message-Type and Vocal Rate and Intensity;* Kenyon College; J. W. Black; AD-642 508

*The Effect of Room Characteristics Upon Vocal Intensity and Rate;* Kenyon College; J. W. Black; AD-642 509

## PHYSICS

*Far Field Sound Radiation from Randomly Vibrating Structures;* J. G. Engineering Research Associates, Baltimore, Md.; J. E. Greenspon; AD-642 413

*Heat Flow in Crystal Lattices;* MIT, Cambridge; L. M. Magid; AD-642 498

*Wave Vector Dependence of the Raman Effect in Crystals;* New Mexico State U., University Park; O. Theimer and A. C. Saxman; AD-642 557

*Tabulation of Failure Reports of the AN/APA-56 Installation for Project Cadillac;* New York U., N.Y.; D. M. Goodman; AD-642 022

*Research on Electromagnetics for Project Defender;* Polytechnic Inst. of Brooklyn; R. G. Hutter; AD-642 271

*Magnetic Ordering in MN (HCOO)2·2H2O and Related Compounds;* Carnegie Inst. of Tech., Pittsburgh; R. D. Pierce and S. A. Friedberg; AD-642 364

*Large Eddy Structure of a Turbulent Wake;* Pa. State Univ.; F. R. Payne; AD-642 298

*Effect of Polymer Coiling on Drag Reduction;* Western Co. of North America, Dallas; G. T. Pruitt *et al.,* AD-642 441

*Separation of Turbulent, Incompressible Flow from a Curved, Backward-facing Step;* MIT, Cambridge; G. R. Nice *et al.;* AD-642 521

*Linearized Flow in Rotating Systems;* Brown U., Providence, R.I.; F. E. Bisshopp; AD-642 578

*Thermal Optic Distortion;* Westinghouse, Baltimore, Md.; E. P. Riedel and G. D. Baldwin; AD-642 540

*Control of Metastables by Optical Methods and Its Application to Gaseous Lasers;* Columbia U., New York; T. C. Marshall and B. Pariser; AD-642 710

*Cyclotron Lab Quarterly Progress Report;* Harvard Univ., Cambridge; AD-642 597

*Deuteron Production in Proton-Proton Collisions from 1.5 to 3 GEV;* Michigan U., Ann Arbor; D. E. Pellett; AD-642 585

*Note on Langmuir Probe Method for a Plasma Having Small Amplitude Oscillations;* Cornell U., Ithaca, N.Y.; P. C. T. DeBoer; AD-642 044



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*Simple Force Multipoles in the Theory of Deformable Surfaces;* Cal. U., Berkeley; M. M. Balaban *et al.;* AD-642 130

*Some Results of Finite Amplitude Elastic Waves;* Cal. U., Berkeley; M. M. Carroll; AD-642 131

*Magnetic, Superconducting and Other Phase Transitions Within the Metallic State;* Chicago U., Ill., M. H. Cohen; AD-642 142

*On the Thermodynamic Properties of Several Solid Phases of the Compound INSB;* MIT, Cambridge; A. K. Jena *et al.;* AD-642 147

*The Structure of Mercury;* Chicago U.; D. Weaire; AD-642 267

*Fermi Surface of Copper;* Chicago U.; E. I. Zornberg and F. M. Mueller; AD-642 273

*The Knight Shift in Lead Telluride Via Relativistic APW Functions;* MIT, Cambridge; P. T. Bailey; AD-642 519

*Solid-State and Molecular Theory Group;* MIT, Cambridge; AD-642 566

**SPACE TECHNOLOGY (ASTRONAUTICS)**

*Gas-Surface Interactions;* General Dynamics/Convair, San Diego, Cal.; D. McKeown *et al.;* AD-642 094

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*On the Naval Research Reserve—Continued from page 33*

Center, Baird Ward Printing Company, Gates Rubber Company, Genesco's Johnson and Murphy Shoe Manufacturing Plant, Ferro Corporation's Fiberglas Division, Aladdin Industries' Vacuum Bottle and Electronics Division, and the Metropolitan Nashville Water Treatment Plant and Pumping Station.

These field trips have given unit members a new insight into the research conducted at the many diversified industries of the community and have also served to make the community aware of the Naval Reserve Research Program. The tours have proven to be well received by both unit members and industry representatives.

NRRC 6-18 meets in the Social Religious Building of Peabody College and is commanded by Charles W. Hawkins, III, LCDR, USNR.

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## High-Speed Hydrofoil Boat Found Suitable for Oceanographic Work

Tests performed during recent months have shown the feasibility of using high-speed hydrofoil boats in making echo soundings for hydrographic survey work, according to the Naval Oceanographic Office.

Data analysis indicates that equipment worked favorably in shallow and deep water, over seaweed, rock, and sandy bottom. Speed of the hydrofoil was varied, with no adverse effect on readings.

The tests were aimed at determining the practicability of using a sonic depth-measuring system in high-speed hydrofoil boats. To conclude the matter, numerous factors had to be resolved. Such items as the effect of waves and swells upon equipment performance were satisfactorily settled, as was the effect of kelp upon the operation of the system.

The echo sounder was also a departure from traditional types used in hydrographic surveying. Instead of relying on measurement of the transit time for single sound impulses, it was a continuous wave frequency modification principle.

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**NAVAL RESEARCH REVIEWS** publishes highlights of research conducted by Navy laboratories and contractors and describes important Naval experimental facilities. Manuscripts submitted for publication, correspondence concerning prospective articles, and changes of address, should be directed to Code 109, Office of Naval Research, Washington, D.C., 20360. The magazine is listed for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Subscription price: $1.50 per year in the U.S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. The issuance of this periodical approved in accordance with Dept. of the Navy publications and printing regulations.

*Editor*: BEATRICE M. EIESLAND

NAVSO P-510

*The Navy's Blue Eagle Television Network broadcasts radio and television from an airborne platform. Above: Blue Eagle Three at OASU, NAS, Patuxent River, after a recent overhaul. Below: Interior view looking aft showing the video-switching console (lower left), waveform and picture monitors (upper left), CONRAC receivers, sync. generators, high-band television transmitter, and the air conditioning unit. See article beginning on page 1.*