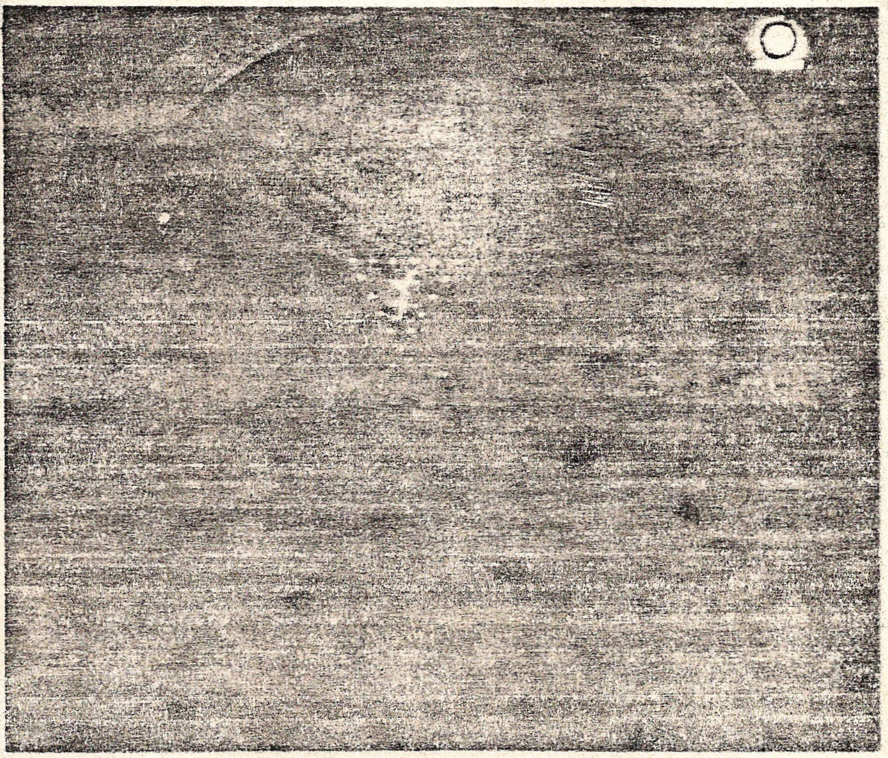
'A-NEW' APPROACH TO AIRBORNE ASW

By LCdr. E. G. Buck, BuWeps

ONE OF THE MOST awesome threats to the security of the free world is the ever improving performance and threatening potential of enemy submarines. Indeed, anti-submarine warfare frequently has been cited as the Navy's "most crucial problem."

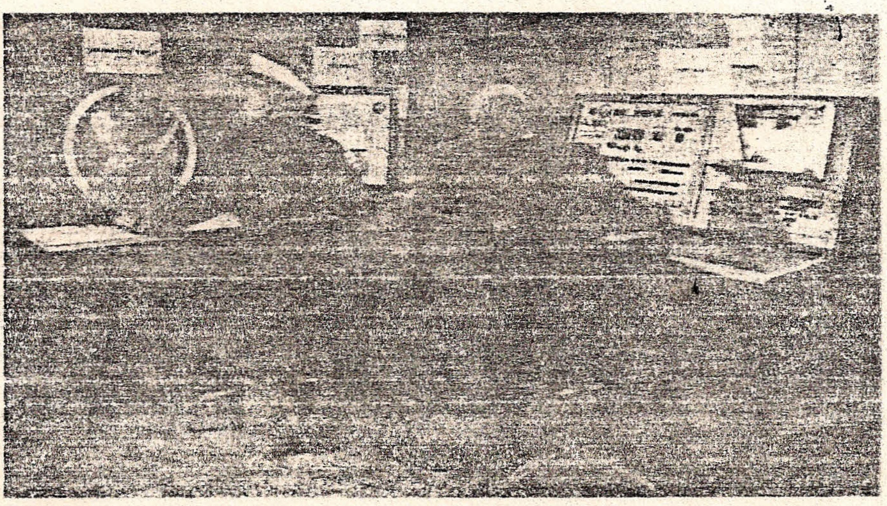
Airborne ASW activities in particular are becoming more complex because of rapidly moving targets. To compound the situation, the demands imposed on the flight crews reduce their efficiency and effectiveness because they have too much to handle. There are too many opportunities for human error and the future will bring evolutionary as well as revolutionary changes in tactical environments.

To cope with this problem, a Navy/Industrial team has been established to advance airborne ASW effectivness. The program is called Project A-NEW with management control and overall direction emanating from the Bureau of Naval Weapons. The name A-NEW is a nickname, not an acronym, that was given to the project during early budget discussions; i.e. WA-(NEW) before it got its present number WA-022. Technical leadership is the responsibility of the Naval Air Development Center at Johnsville, Pa. The Naval Air Test Center, Patuxent River, has flight test responsibility in coordination with the NavAirDevCen.



THE A-NEW SYMBOL, *signifying the summation of all integrals, is fed into the display console. Several major corporations make up the A-New team, under direction of the NAD Center.*

The A-NEW concept, which originated almost three years ago, is to provide the Fleet with an integrated airborne ASW system capable of handling present and future enemy submarine threats. The concept ranges from study through simulation, laboratory evaluation, and flight testing of prototype systems. All of this will be accomplished prior to freezing of the final production design. Furthermore, analysis of the problem has shown that overall avionic systems development engineering, integration and test prior to establishing specifications for production aircraft are among the most important considerations in the solution of the airborne ASW surveillance and attack problem.



MOCK-UP OF THE EXPERIMENTAL *computer and display shows compactness. Raw data is fed from the test bench (K) to the computer which generates ASW information displayed on the console*

ASW aircraft are some of the most exacting man-machine systems in existence. The avionic system installed on board the typical ASW aircraft is unique among airborne systems because it consists of a great variety of unrelated complex equipments and subsystems. These must be integrated into a completely functioning system without overloading the aircraft.

Most ASW systems have been developed by first purchasing an airframe and then incorporating the avionics equipment. This method has led to some undesirable results owing to performance limits of the aircraft and limited space available restricting the choice of equipments or changes in concept. A major purpose of A-NEW is to specify the avionic system *prior* to airframe design and thereby develop improved weapon systems.

The personnel complements for carrier-based and rotary wing aircraft will probably remain essentially as they are now. This is true because it is efficient to use the crew to greater advantage rather than to reduce its number. By using automatic equipment, the crew is less burdened and more efficient in fulfilling its mission.

The A-NEW program is made up of five broad categories of endeavor, which include: study, simulation, dynamic mock-up, flight test and operation evaluation. This is an orderly plan which will lead to Fleet introduction of new aircraft and systems in the next few years.

• *Study,* as its pertains to the A-NEW concept, includes a constant survey of developmental programs applicable to airborne ASW. Operational analyses have been established. Based on these efforts, a fixed wing A-NEW system has been postulated and recommendations have been published. This phase is under continual review and re-evaluation.

• The *simulation phase* of the program is well underway. Simulation of hardware for analysis and test is being accomplished before delivery of the first experimental system. Test and evaluation at the component level is being made as equipments are made available by the contractor.

• The first *dynamic mock-up* is now in operation. The aircraft portion of this installation approximates a P-3A. A constant updating of the mock-up, as new equipment is delivered, will allow measurements to be made of the relative effectiveness of the various possible configurations. It is anticipated that the great majority of the systems development and integration engineering will be provided through the use of the dynamic mock-up. One of the most important milestones of this part of the program is the phase wherein operational problems are completely simulated in a competitive environment. Known in A-NEW terminology as the "Real World Problem Generator," this digital simulator will be the only such ASW facility of its kind in existence. Its purpose is to pit the A-NEW system against enemy submarine capabilities expected in 1968 and beyond.

• A *flight test phase* is an essential part of the A-NEW program. The YP-3A has been assigned to the Weapon Test Division of the Naval Air Test Center at Patuxent River. Flight testing will be the responsibility of that division. This was done intentionally so that an independent analysis under actual conditions could be separated from the mock-up environment and could provide valid input conditions for the mock-up. Airborne testing is done under actual conditions, so that the system design is being evaluated by experienced anti-submarine warfare personnel and by the design engineers.

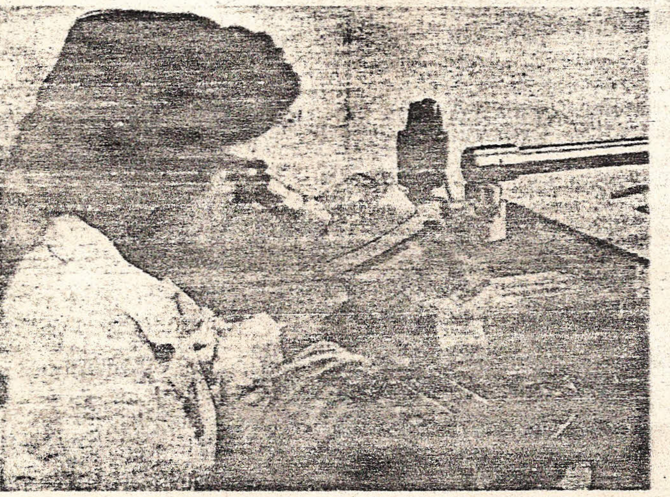
• The results of the *evaluations* will undoubtedly lead to system refinements. The philosophy of A-NEW is to assume, integrate, try; reassume, re-integrate, re-try, etc.

One salient feature which distinguishes the A-NEW system from any other avionics system is the use of a central digital computer and associated computer generated displays as the heart of the system.

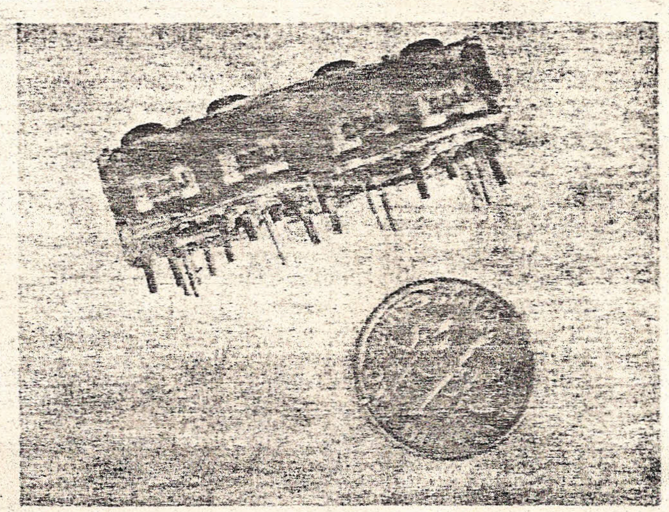
The new systems will have greatly increased computational and coordinating capabilities which will be accomplished through the use of a digital data processing system. In addition, the stored program computer can be made to accommodate new and different tasks allowing considerable flexibility and growth potential. A change in mission is handled simply by a change in the computer program. The computer will be used to improve classification by coordinating data from many sensors, including pre-mission stored data and incoming data from automatic digital data link communication equipment, which will be part of the new system.

The computer will be used to improve navigation by reducing data to latitude and longitude positions, automatically maintaining aircraft and sonobuoy position coordinates. These coordinates will be properly related through new equipment providing exacting data as to positions of aircraft, submarines and sonobuoys.

The computer will assist in the determination of optimum tactical employment of sensors, sonobuoys and

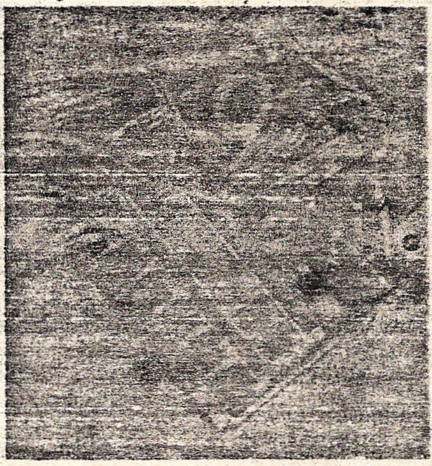


INTERIOR CONNECTIONS *of the basic building blocks are made by resistance welding to ensure high environmental tolerance and reliability.*



A TYPICAL COMPUTER *circuit package is smaller than a pack of chewing gum, but yields a component density exceeding 120 items per cubic inch.*

armament, thereby providing a tracking and attack capability against multiple surface or sub-surface targets. Additional capabilities in handling a large number of targets for search, classification, localization, tracking and attack will be provided where possible by the use of newly developed or improved sensor detection equipment. The data processing system will aid considerably in reducing crew fatigue



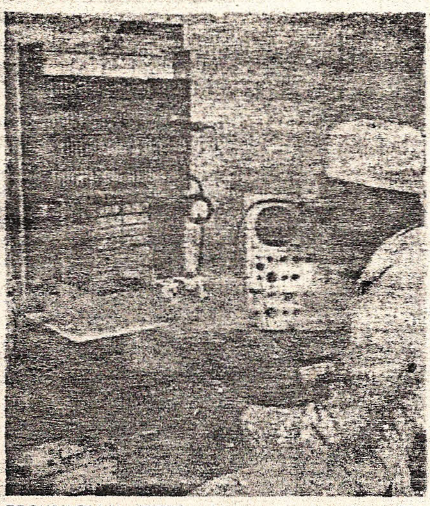
A PARTIALLY WIRED *back panel of a computer module indicates its potential capacity.*

by eliminating tedious, repetitive activities and allowing maximum attention to critical tactical situations.

The presence of a highly reliable digital computer and display system not only enhances tactical capabilities, but also permits in-flight monitoring and a certain amount of actual fault isolation. Provision of test points in the equipment, careful sub-assembly packaging, and the design of test routines for fault isolation will aid in providing a total systems reliability and maintainability far exceeding what we have now.

IN THE DATA integration area two major programs are now being pursued. First, a UHF tactical data link is being developed within the framework of existing Navy programs for rapid automatic interchange between all cooperating units of the ASW problem. As a result, each unit will have access to the data held by all of the other units on an essentially instantaneous basis.

Second, the airborne digital computer being applied during the experimental phases is one which also provides compatibility with other systems, both in hardware and software.

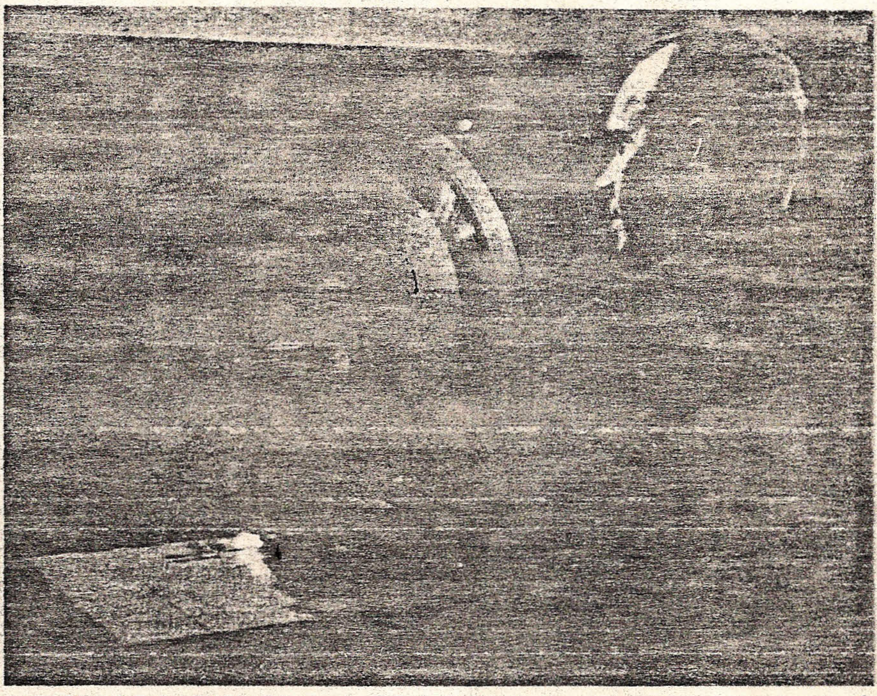


TECHNICIAN TESTS *the magnetic thin film memory stack before inserting into housing.*

In addition to the new computing, communicating, and automatic signal detection equipments, it is anticipated that improved radar, ECM, MAD and sonar detection and sonobuoy communication and control systems will be available.

A specific Navy/Industry team has been established to fabricate and integrate the first experimental A-NEW system with its Digital Data Processing System. The principle team members at present for this effort include the UNIVAC Division of the Sperry Rand Corp. for the computer and software, Loral Electronics for consoles and interface equipment, Dunlap and Associates for human engineering, Lockheed Aircraft Co., and Grumman Aircraft Co., for system requirements and configuration studies, and General Dynamics/Electronics for the tactical display.

The program is being managed technically, both systems-wise and equipment-wise by the United States Navy. The materializing of a system in its technical aspects must be coordinated from one strong central authority and cannot be achieved by the dispersion or relinquishing of authority with the hope that cooperative effort will then effect successful integration. Only with Navy management will various competitive contractors contribute their best efforts and latest knowledge freely to the overall benefit of the entire system development. By utilizing the Naval Air Development Center and the Naval Air Test Center engineering personnel, the "know-how" in the technology of micro-miniaturized, solid state, highly reliable digital systems will rapidly accrue to the Navy. This technology will be in great demand across the spectrum of airborne systems in the years of development that lie ahead.



A RECOMMENDED SONOBUOY *pattern, calculated by the computer, appears on display console and is studied by a technician. This is a prototype model used to test the data processing system.*

Navy Seeking Improved ASW Integration

By Michael L. Yaffee

Moorestown, N. J.—Systems integration and modification of information handling techniques will be the focal points in a study by Radio Corp. of America's Systems Engineering, Evaluation and Research (SEER) organization of means to improve the Navy's anti-submarine warfare command support centers.

The Navy primarily wants a capability to obtain an integrated, multi-dimensional picture of an ASW situation so that the service can use its available anti-submarine resources more effectively. Specifically, the Navy wants RCA's SEER group here to suggest a number of ways—and the cost of each—in which current and future ASW sensors, communications and signal processing equipment and displays, and information handling and extraction techniques can best be integrated into the design of more efficient ASW command support centers.

Preliminary studies by RCA, which has put a great deal of its own money into ASW work, indicate that a well-equipped, integrated and automated command support center could increase the effectiveness of the Navy's ASW effort at the convoy, fleet and Continental U.S. levels by a factor of two and, conceivably, as high as 10. Such increased effectiveness might be measured in terms of cost per actual submarine contact.

Threat Probability

These new centers should enable the ASW tactical coordinator to assign more precise and reliable threat probability levels for submarine signal contacts and to sort out more rapidly true contacts from spurious signals, according to SEER.

The improved capability should, in turn, reduce the number of false contacts which must be checked out by ASW vehicles and the time needed for these vehicles to investigate the contact. The tactical coordinator will know, for example, which of his available sensor platforms will be most effective and whether two or more platforms have the same contact under surveillance.

In effect, this means that the same number of ASW vehicles will be able to check out a greater number, at least double, of "real" or high-credence-level contacts, destroy a greater number of enemy subs in wartime, or keep a larger area of the ocean under surveillance.

The contract awarded by Navy's Bureau of Ships to SEER calls for a systems study of a highly integrated and automated ASW command support center. The present $100,000 Phase 1 contract covers a nine-month period. If RCA's final report substantiates earlier studies as to significant improvements in present ASW efforts that appear possible and economically feasible, there could be follow-on contracts of substantially greater value.

There might be a Phase 2 contract for further research and development as suggested in the Phase 1 report and for preliminary design of an ASW command support center. This also might be followed by contracts for actual construction and implementation of one or more command support centers.

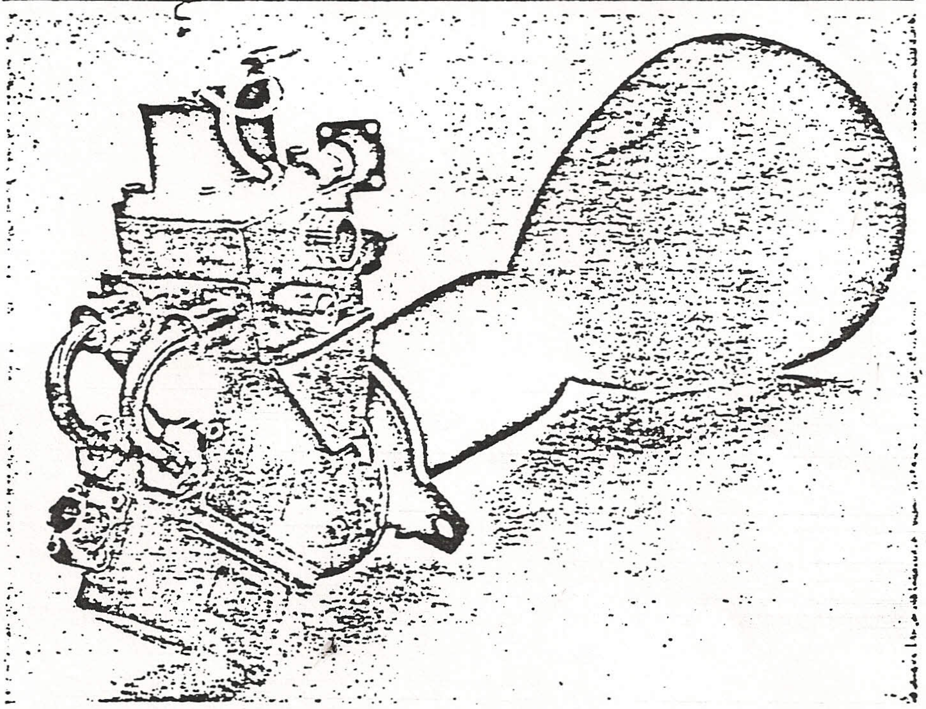
Eventually, this country's ASW effort, which has been steadily climbing up the priority ladder, is expected to rival the present multi-billion-dollar U.S. air defense program in cost and probably will surpass it in technical complexity, according to the SEER systems analysis manager, Norman S. Potter.

In any future, integrated ASW effort, Potter adds, fixed-wing aircraft, helicopters, satellites, missiles and rocket-propelled torpedoes can be expected to assume even greater importance in detection, surveillance and destruction of enemy submarines.

New Approach

Perhaps the most significant aspect of the present study contract, SEER scientist Dr. Charles Lohman says, is that it represents a fundamentally new approach by the Navy to the problems of anti-submarine warfare. Until now, each ASW sensor platform generally has functioned as an independent unit for detection, preliminary filtering and evaluation, surveillance and, often, command decision-making.

With Project A-New (AW&ST July 8, 1963, p. 64; Mar. 1, p. 36), the Navy



Bell Tests 100-lb.-Thrust Maneuvering Engine

Advanced-design, 100-lb.-thrust, radiation-cooled maneuvering rocket engine has been successfully tested by Bell Aerosystems Co. at the company's Buffalo, N. Y., test center. Measuring 17 in. in length and weighing less than 6 lb., the engine demonstrated a 5:1 stable and reproducible throttling capability from 100 down to 20 lb. thrust. Test engineers reported pulses as short as 40 millisec. The engine has a specific impulse of 295 sec. with a nozzle expansion ratio of 40:1. Fuel is nitrogen tetroxide and 50-50 blend of hydrazine and unsymmetrical hydrazine.

Navy Relies on Variety of ASW Sensors, Platforms

Because water is an extremely poor medium for transmission of electromagnetic signals, no single underwater detection device has been developed with the range and effectiveness that radar offers against airborne targets.

As a result, the Navy must use a variety of sensors and sensor platforms in its efforts to detect enemy submarines, keep them under surveillance and, in wartime, destroy them.

Most of the Navy's current operational ASW sensors are mobile devices. The principal platforms or carriers for these devices are shore-based aircraft, carrier-based fixed-wing aircraft and helicopters, CVS aircraft carriers, destroyers, destroyer escorts and submarines.

Now comparatively minor, the ASW role of satellites is expected to grow significantly. The Navy presently is considering use of a manned orbital space platform as an ASW detection and control center.

Among the more important ASW sensors now being used and developed by the Navy are:

- Project A-New, a computerized, integrated, airborne ASW system that incorporates a variety of sensors (AW&ST July 8, 1963, p. 64; Mar. 1, p. 36). Currently under development for shore-based aircraft, the present system is too large for the smaller, carrier-based, ASW aircraft which are already overloaded with electronic gear.
- Trident, a broad-based research and development program designed to investigate fixed-site, acoustic and non-acoustic search and detection systems.
- Artemis, an old but still active ASW development program concerned with fixed-site, active surveillance systems composed of several different sensors (AW&ST July 31, 1961, p. 72; Feb. 5, 1962, p. 68).
- ASWEPS (anti-submarine warfare environmental prediction system), a multi-sensor, data collection system that is still in the development stage but beginning to show promise and expected to lead shortly to the development of actual hardware. ASWEPS is intended as a fixed-site or mobile system for operation in remote locations. The system is designed to collect data on constantly changing environmental parameters in order to help an ASW tactical coordinator pick submarine contacts out of their physical background.
- Sea Hawk, an integrated ASW system composed of computerized command and control subsystems whose prime function is the correlation and presentation of data. Still in the subsystem development stage, Sea Hawk is designed to be carried by currently operational as well as future high-performance ASW surface ships. Originally, the goal of the Sea Hawk project was to design from the keel up a new type of high-performance destroyer escort for ASW operations. But the Navy was blocked by lack of the basic technology required to develop such a vessel.
- Frisco, an ASW system similar to Sea Hawk but designed to be carried by submarines.
- AN/SQS-23 and AN/SQS-26, two new, mobile, active sonar devices that are now operational onboard surface ASW ships. Both make use of convergence zone and bottom bounce to send and receive acoustical signals over long distances. A multi-ton unit, SQS-26 is somewhat larger than SQS-23 and has a greater range.
- Variable-depth sonar (VDS) devices, similar to SQS-23 and -26, but dangled from the ends of cables to improve the reception of acoustical signals.
- AN/SSQ-38 Jezebel, a long-life, lightweight (approximately 10 lb.) sonobuoy carried by shore- and carrier-based aircraft. Jezebel, a passive sonobuoy, will not detect objects that are not making noise. Jezebel sonobuoys are operational, and improved versions are under development.
- AN/SSQ-42 Julie, also a small, lightweight sonobuoy that can be carried by all aircraft. Julie, however, is an active sonar device that employs explosive echo ranging. The presently operational Julie sonobuoy carries the AN/SSQ-23A designation. Smaller, lighter, less expensive and more reliable Julie Minibuoys, designated SSQ-46 and -47, are under development.
- Magnetic anomaly detection (MAD) devices—passive, non-acoustical units which are designed to pick up distortions in the earth's magnetic field caused by the presence of a submarine. Small enough to be transported by carrier-based aircraft, MAD devices are operational and in continuing development.
- Sniffer sensors, also passive airborne devices. They are designed to detect exhaust gases of snorkeling subs and thus are located ahead of the aircraft engine exhausts. Effective range depends upon wind and other environmental factors. Improved sniffer sensors are under development.
- Infrared (IR) detection equipment, presently carried by all fixed-wing aircraft but not helicopters. It picks up thermal trails in ocean water heated by submarines. The major problem in the past with IR equipment (AW&ST Mar. 16, 1964, p. 84) was the slow response of such detectors, which made it necessary to use lighter-than-air rigid vehicles as sensing platforms.
- AN/SLR-2 Electronic countermeasures equipment, which can be used on any ASW sensor platform. It is designed to intercept and home on electronic signals emanating from enemy subs. The equipment is operational, with improvements under development.
- Visual sensors, namely the eyes of human observers, either in direct sightings or by television or camera link. These remain among the best devices for detecting and evaluating potential submarine threats. RCA and other companies currently are studying image intensifiers, or scotoscopes, which are expected to improve visual detection of submarines greatly.

Hold George down!

took its first step in developing an integrated ASW system and operation for shore-based, patrol aircraft. Now, with SEER and other contracts (AW&ST Nov. 2, p. 19; Dec. 14, p. 19), the service is trying to extend this integrated systems approach throughout its entire ASW effort.

Under its present contract, which involves no hardware development, RCA's SEER group is concerned with integrating inputs from all ASW sensors and sensor platforms (see box, above), automating the handling and filtering of these data where feasible, improving them and displaying or interfacing the outputs so that an ASW tactical coordinator in a central command post can improve significantly the deployment and operation of available resources.

The initial and fundamental premise in this work, Lohman says, is that it is financially impossible, at an estimated cost of $1,000/sq. mi., for either the U.S. or Russia to keep the whole ocean under surveillance, or even that part of it extending 2,500 mi.—the range of the latest fleet ballistic missiles—from the shore or potential target areas. Thus, ASW forces will never be able to do a completely effective job of keeping the entire ocean under surveillance.

The principal task of present research and development work in this field, Lohman adds, is to improve current effectiveness of ASW forces as much as is possible, or at least to the point where the Navy can be assured of getting the maximum return for each dollar that it invests in ASW efforts.

Until recently, the major ASW problem work has been information acquisition, or detection of subs. But a great deal of progress has been made in this area, Potter says, with the result that the main ASW problems today involve extracting significant information from the matrix of sensor inputs and processing these data as systematically and rapidly as possible, preferably on a real-time basis.

The technology to do this, he adds, has and is continuing to increase greatly.

At one extreme, Potter says, there is the choice of turning an individual sensor platform, such as an airplane, into a completely self-contained submarine hunter-killer—"impossible, because ASW aircraft are already overloaded with electronic gear," he notes. At the other extreme is a large, quiet, well-equipped and expertly staffed shore installation, into which can be fed raw data from all sensor platforms without any attempt at preliminary filtering or threat evaluation. The latter alternative is "impossible due to the need for rapid processing of the information into commands that can be promptly executed within the limited communications bandwidths that are or will be available," Potter says.

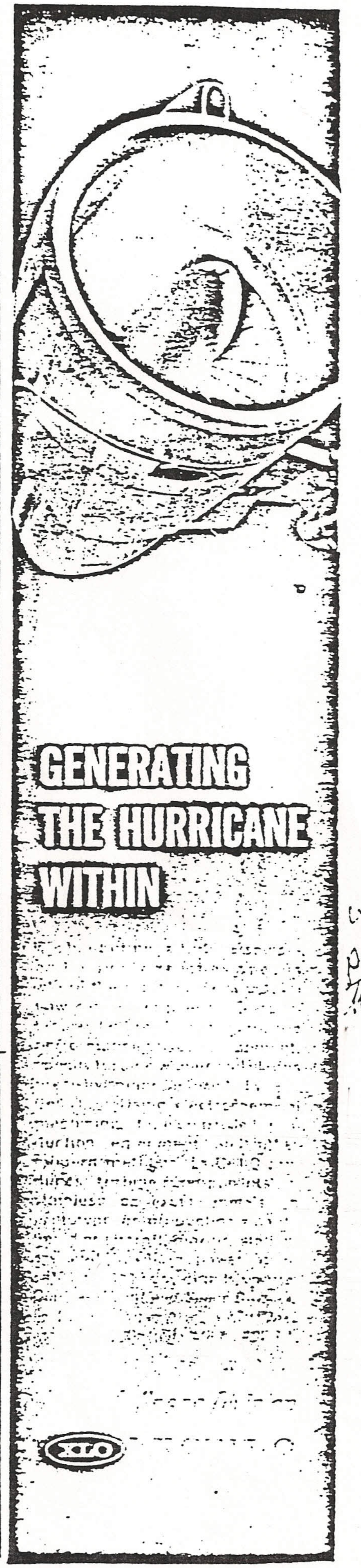
Somewhere between these impractical extremes, he says, there is one best spot, in terms of maximum cost-effectiveness, for an ASW command support center. SEER's job is to find this spot.

The initial problem in designing a more effective ASW command support center, as Potter sees it, is to determine just which types of information and sensors a tactical coordinator really needs and how best he can use it. Findings from preliminary studies indicate several potentially rewarding improvements along these lines:

- **Increasing the number** and variety of sensors, sensor platforms and data inputs.
- **Extending the nature of the data** now available to the coordinator. The Navy already is collecting more magnetic, acoustical and infrared data on the underwater physical environment, including such factors as the location and extent of major thermoclines which distort acoustical signals. It also is increasing its collection of identifying signatures of submarines, sunken wrecks, oil drums and similar objects.
- **Cataloging and storage** of this information on high-speed magnetic drums. The next logical step, according to SEER scientists, will enable an ASW battle commander in a large, well-equipped command support center to use high-speed digital computers to differentiate between sonar signals from, for example, a sunken oil drum and a submarine hull with half-full fuel bunkers beyond the hull. This might be accomplished despite possible distortions caused by ocean environmental factors such as sea noise and reverberations.
- **Improving and increasing** the number of automatic aids—special-purpose digital and analog computers—for filtering and weighing sensor inputs so that the tactical coordinator will be able, for the first time, to attach quantitative credence levels to contacts. Signal-recognition computer systems now under development will be able to handle many more sensor inputs much more rapidly than human operators, matching identification points or characteristics of input signals against the library of signatures stored on magnetic drums. Although in most cases the sensor inputs and signatures are not expected to match perfectly, the computer system will be able to make value judgments and tell the coordinator, for example, that there is a 75% chance that his contact is an enemy submarine and a 25% chance that it is an oil drum.
- **Increasing the percentage** of raw data going to the tactical coordinator and the amount of preliminary filtering that is done at the ASW command support center compared with the amount now being performed onboard the sensor platform. Generally, Potter says, it will prove more effective to have highly trained personnel in a quiet, large, well-equipped center who filter and weight raw data than an observer in, for example, a cramped, noisy aircraft who sees only that data that exceeds his equipment's preset threshold.
- **Improving the allocation** of ASW functions and responsibilities between sensor platforms and the command support center. While it is obvious that a large, quiet, command center can be better equipped to process large amounts of information rapidly and provide a multi-dimensional ASW picture, Potter says, it is also obvious that some preliminary data filtering and evaluation must be done onboard the sensor platform itself. Available communications bandwidths are not large enough to send all raw sensor data back to a command post. Also, there is no machine more effective than the eyes of a human observer in a forward aircraft for making and evaluating visual contacts.

For the time being at least, Lohman adds, a human still far excels any machine in making certain subtle judgments and picking individual features out of a complicated visual scene. Even with these limitations, however, there is still substantial room for improvement in arriving at an optimum division of ASW functions Potter says. SEER's task here, he adds, is to determine more precisely the values of potential trade-offs. For example, will the advantages of a television link between an aircraft and a command support center offset the weight penalty added to the aircraft?

- **Optimizing the deployment** of ASW sensor platforms. SEER is investigating different sizes and types of computers that might aid the ASW battle commander in deploying his available resources. For example, Lohman says, a tactical coordinator planning a routine



surveillance of the shallow waters in Chesapeake Bay, can call upon the computer's stored data on this area. That information might warn him against interference by sounds of certain animals in the region and that he should deploy only sensors not affected by such sounds.

• Increasing, improving and integrating special-purpose, signal processing and display equipment. This would enable the coordinator to examine more sensor inputs, Lohman says, and thereby substantially improve his chances of correctly identifying the signal, particularly amid a noisy background. Moreover, Lohman points out, with these integrated systems at his disposal, a tactical coordinator at an ASW command support center would be better able to determine whether his sensor inputs are coming from one or more objects while observers in two different sensor platforms might be looking at the same contact and not realize it.

At this point, Lohman cautions, SEER is not certain that further automation and integration in ASW will pay its own way "or, for that matter, buy anything at all." Potter, however, believes strongly that integration and automation can definitely and substantially aid the ASW tactical coordinator in processing and evaluating the threat of sensor contacts and in making more effective command decisions on deployment of his resources.

The future ASW command support center, as envisioned by Potter, would be a highly integrated but flexible and basically self-sufficient unit that could be designed on a modular basis for use on a destroyer escort, as a major shore installation to interface with the Continental U.S. air defense command center, or for operation at almost any level in between.

Obviously, the more room available, the more a command support center can be expected to do, Potter says. But an integrated center can be designed to operate at any level with improved information gathering and processing systems and techniques, he adds.

USAF Contracts

Contracts awarded recently by USAF's Aeronautical Systems Div., Wright-Patterson AFB, Ohio, include:

Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio.—Scientific and technical service of the radiation effects information center. (Contract AF 33(615)-2124 dtd 1 Mar 65)—$99,970.

Lear Siegler, Inc., Instrument Div., 4247 Eastern Ave., Grand Rapids, Mich., 49508.—Investigation for sensing linear acceleration using the squeeze film technique. (Contract AF 33(615)-2261 dtd 2 Mar 65)—$57,000.

Technical Operations, Inc., South Ave., Burlington, Mass.—Hypervelocity gun acceleration studies. (Contract AF 33(615)-1333 dtd 2 Mar 65)—$43,550.

Monsanto Research Corp., Dayton Laboratory, P.O. Box 8, Station B, Dayton, Ohio.—Applied research in materials applications