NAVAL RESEARCH REVIEWS

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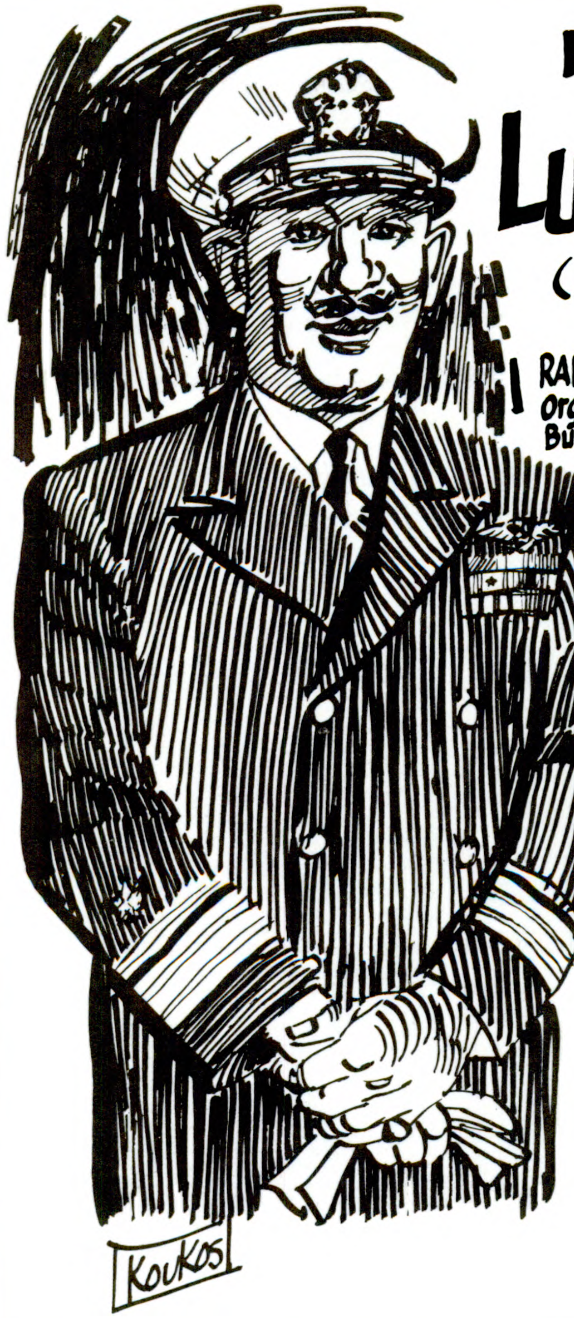
Special Issue on Military Training Devices

Portraits in Science



RADM. Luis de Florez (1889-1962)

RADM de Florez USNR was the organizer and first director of BuAers Special Devices Division which evolved into the Naval Training Device Center. A gratuate of M.I.T., he worked for the Navy as a civilian engineer during W.W.I, turning out 39 inventions for naval aircraft.

In 1939 he went on active duty as LCDR, became successively CDR., CAPT. and finally RADM in 1945, when he was assigned as Assistant Chief of the Office of Research and Inventions.

RADM de Florez received the Legion of Merit for his outstanding services as Director of the Special Devices Division. Also, he received the Robert J. Collier trophy from the National Aeronautics Association for his contributions to aviation.

PREFACE

Captain Jack N. Miller, USN
Commanding Officer and Director
Naval Training Device Center

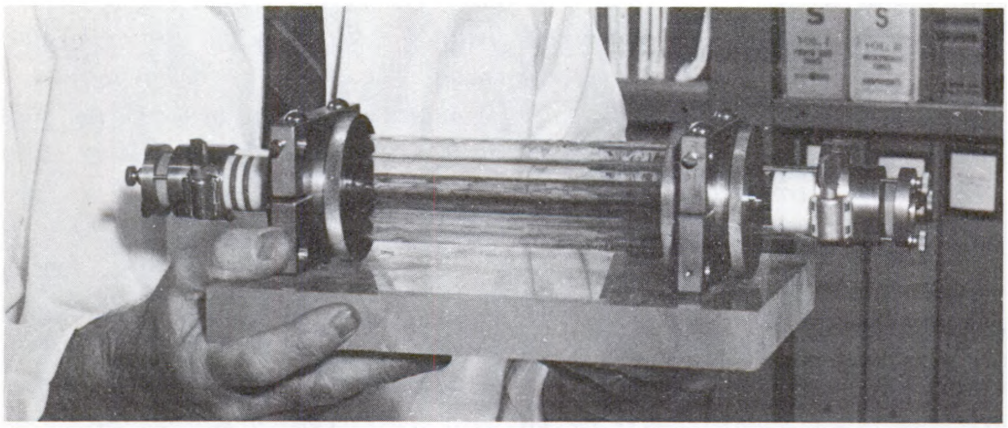
The Naval Training Device Center, which has been in existence for more than 26 years, is responsible for the research, development, production, maintenance, and modification of air, sea, subsurface, land, and space trainers applicable to all types of military situations. The Center provides equipment to improve the effectiveness of training, primarily in the Navy, but also in the other services and in other government agencies. The Army, by formal agreement with the Navy, has had a participating group as an element of the Center since 1950. Although under the command of the Chief of Naval Research since 1946, the Center will transfer to the Chief of Naval Material in July 1968.

Located at Sands Point near Port Washington, Long Island, for 20 years, as well as at two additional locations on Long Island and at Mechanicsburg, Pennsylvania, the Center completed a three-stage move to Orlando, Florida, in July 1967. An authorized personnel strength of approximately 1300 persons, including 50 military, are assigned to the headquarters in Orlando and to four regional and seven area offices. Regional offices are located at Norfolk, Pensacola, San Diego, and Kaneohe Bay, Hawaii. The budget for Fiscal Year 1968, consisting of RDT&E, operations and maintenance, and procurement, totals 123 million dollars.

The Center's mission is to contribute to the operational readiness of the fleet by developing, procuring, and delivering training devices. Due to technological advances, fleet ASW weapon systems have become extremely sophisticated and complex. In order to make the best use of their equipment, fleet personnel must be thoroughly trained and skilled as a team in surface ship ASW attack tactics. As a result of several years' work, the Center designed and produced Device 14A2 (described elsewhere in this issue), which provides for instruction in equipment operating procedures, develops personnel proficiency, and indoctrinates personnel in ASW tactical procedures as well as in the evaluation of tactical situations. Another multimillion dollar device, the Combat Information Center Tactics Trainer, Device 15F6, is used in training crews in tactical situations encountered by various ships such as ASW destroyers, cruisers, and guided missile destroyers. It can present to the trainees a total of 128 imaginary targets over a gameboard area of 127,000 square miles.

The Center is the only activity in government that is concerned exclusively with the unique field of simulation as applied to training equipment of various types. These devices vary in design and use from the very simple to the very complex, and from those intended for mass training to those intended for individual training. In addition to the fleet tactical trainers already mentioned, they include jet aircraft and submarine simulators, space environment and *weapon system trainers, and innumerable radar, sonar, and electronic devices. This training equipment not only contributes to the combat readiness of the Armed Forces but also has proved cost effective in the modern world of complex military equipment and systems.*

A special issue of NAVAL RESEARCH REVIEWS *in November 1964 described the role of NTDC in developing training devices for the military services. It is hoped that this special issue will further acquaint the reader with the work of the Naval Training Device Center.*



High-Intensity Flash Lamp Designed at NRL

The art of producing a solid state laser beam has been advanced with a new high-intensity flash lamp designed and developed by an engineering technician at the Naval Research Laboratory.

Edwin Vincent of NRL's Plasma Physics Division recently received a patent for the device called a coaxial gas discharge lamp with hollow center for pumping lasers. To create a solid state laser beam, a high-intensity light source first excites or pumps atoms within the solid state material. The beam is then produced through an amplification process.

The device resembles a clear fluorescent lamp with a thicker diameter and a hollow center. Two cylindrical quartz tubes, one inside the other, surround the hollow center through which the laser material is placed. When the vacuum-tight space between the tubes is filled with a gas and an external current applied to electrodes at either end, the lamp produces a short duration flash of extremely high intensity—approximately 100 times brighter than a conventional electronic flash lamp.

Because the new lamp completely envelops the laser material, it is now possible to completely and uniformly illuminate the material along its entire length. Also the ruggedness of the lamp's design allows it to withstand extremely high currents which produce high light intensities in a very short time. Laser power output of a solid state material partly depends on intensity of the light source.

By placing a third cylindrical tube around the lamp's outer perimeter, a liquid or gas coolant can be supplied.

Although the lamp was originally intended solely as a bright light source for pumping lasers, it has found applications in other instances where a short-duration, high-intensity flash is required.

Training Devices for a Better Navy

The creation of the Naval Training Device Center some 26 years ago marked the beginning of a new era in the training of military personnel for combat. Before that time, a naval aviator in training first came in contact with the controls of a naval aircraft when he strapped himself in the cockpit. Naval officers and men learned to operate a submarine by going out to sea and making dives. Navy gunners learned how to hit enemy targets by firing live ammunition. Training was slow, wasteful of equipment, and the element of danger was always present.

Today every fighting man of any of the three services has most likely undergone realistic combat training through the use of simulators or synthetic techniques pioneered by NTDC. Now when a man steps into an aircraft cockpit for the first time or makes his first dive in a submarine, he is in familiar surroundings and operates controls he has already handled. The time and cost of training have been sharply reduced. Even more important, a man learning through the medium of a simulator does so without danger to himself or his fellow crew members or damaging expensive equipment.

A simulator is a machine or facility which "simulates" the combat environment to a trainee as realistically as possible, enabling him to perform a combat procedure just as he would if he were in action. Simulators may be as simple as a hand-held device or as intricate as devices which utilize analogue and digital computing machines. They may vary in cost from a few cents to several million dollars.

There is nothing new about simulators as training devices. In the middle ages soldiers trained on mock-ups of battlements prior to attacking the actual fortress. Knights of old learned jousting skills with a teaching machine called a quintain: the knight was required to charge a wooden figure on a pivot. If he struck it squarely in the middle of the shield, it would fall over. If he struck it incorrectly, it would swing around and hit him. Today this is called "reinforced" learning.

World War II brought the need for synthetic training devices sharply into focus. The nation was faced with the problem of taking into the Armed Forces massive numbers of recruits, many of them without technical experience of any kind, and training them to operate complicated equipment in a relatively short time. In an attempt to solve this problem, a special devices desk was set up in the Navy Department's then Bureau of Aeronautics in 1941. The Navy was fortunate in obtaining CDR Luis deFlorez, the dynamic civilian engineer and inventor, to man this desk. CDR deFlorez knew that the British had already made some progress in the development of training devices; so he visited them, studied their methods, and proceeded to develop his own program at a remarkably rapid pace. Within a period of two years, the special devices desk had evolved into a division. Also, nearly 400 different training projects were in various stages of development and 125 training devices were being produced.

The Navy has made great strides forward in technology in recent years. These strides have resulted in greater technological sophistication of naval weapons, vehicles, and other equipment being introduced into the fleet daily. This means that training techniques and training requirements have become correspondingly more complex and sophisticated. Moreover, in addition to the normal requirement for jet plane and submarine simulators and missile, radar and sonar system trainers, the nation has been faced with special new challenges required by operations in places like Southeast Asia. New techniques are needed to train men to maneuver on and over coastal areas, terrain, and waterways totally unfamiliar to them.

Simulators of Today

The basic challenge that has been met by NTDC in the past and must continue to be met in the future is to achieve accurate approximation of the real world of military operations. Current simulators duplicate the cockpit of an aircraft to such a degree that not only does the pilot see his instruments respond, just as if he were in actual flight, but also he hears the sound and feels the pitch and roll of his aircraft. In the case of duplicating the compartment of a submarine, the students training inside it have the realistic impression of being submerged at sea. Their surroundings look, feel, sound and respond in the same way as the real vehicle. The one difference is that under the ocean one mistake can be fatal. In the submarine trainer, however, when a student makes a mistake he simply runs through the emergency situation again until he learns to handle that particular situation almost as if it were routine.

Today, almost every operational aircraft in the Navy's inventory is supported by a matching trainer. Also, operational equipment is supported by many types of part-task trainers. Trainers range from simple mock-ups and models to radar interpretation simulators and complete airborne ASW team trainers.

One example is the ASW Submarine Target, a simulator which can be used in place of a real submarine for training in detection and tracking. This 12-ft long device can operate for two hours, changing course and depth according to pre-programmed instructions. It transmits noise in the frequency range characteristic of a submarine and also picks up a sonar beam and sends back an echo that appears to come from a real submarine. This device, which can be launched and later retrieved from surface vessels, helicopters or submarines, can be used over and over again at a cost of about $50 each time it is used. This compares to a cost of $20,000 to operate a conventional submarine for a one-day training exercise.

Training is very important in reducing the hazard of such difficult maneuvers as night carrier landings. As might be expected, the accident rate at night is consistently higher than during daytime operations. At night the pilot uses the Fresnel Lens or so-called "meatball" as his guide: he must home in on this light located on the carrier's landing ramp. Practice in making carrier approaches and landings under both day and night conditions is necessary. However, it can be hazardous, especially for the novice pilot.

To meet this problem, the Center has under development a Carrier Approach and Landing Trainer in which a high-resolution TV camera focuses on a four-foot model of a carrier. The image of the carrier is magnified and projected against a seascape background. With the camera zooming in on the carrier deck as the pilot approaches, the pilot gets the exact feel of a carrier landing. The Fresnel Lens is simulated to provide realistic training in night landings. This trainer is certain to improve future combat operations of carriers at night as well as in the daytime.

In the case of surface training programs, there are complex team trainers in support of surface forces that allow complete combat crews to go through tactical exercises involving several units of the fleet at one time. Also, undersea simulation programs cover a wide range of trainers. The Fleet Ballistic Missile Trainer, for example, has made possible a state of readiness unequalled in the art of warfare. A training facility, housed in a three-story building at the Submarine School in New London, simulates such areas of a Polaris submarine as the missile control center, the missile compartment, and the navigation center. This permits the crew to practice the complex individual tasks and teamwork required to launch Polaris missiles. The crew can assume the various readiness conditions and go through count-down sequences that they must be familiar with but cannot practice in the actual submarine.

And in the Future

Looking toward the future, the Center is now developing a device for simulating the oceanic environment as encountered by small manned submersibles operating at great depths. In addition to simulating the problem of navigating at those depths, including the dynamic effects of vehicle attitude and motion in all directions, the simulator will provide training in recognizing and interpreting marine bottom topography, flora, fauna, and geophysical phenomena.

Acceptable visual simulation for aviation and undersea trainers has presented a demanding challenge for a number of years. There is wide belief among fleet users of simulators that the inability to generate an acceptable visual environment is the greatest shortcoming of existing simulators.

In an attempt to solve this problem, NTDC engineers are experimenting in the exciting new field of holography, which uses the laser to create three-dimensional photography. They have succeeded in using closed-circuit TV to view holograms of various objects, such as an aircraft carrier, trucks, and tanks. One advantage of holography is that it has the capability of giving the effect of a three-dimensional model, thereby making it unnecessary to construct actual scale models. Another advantage is that the scene can be changed easily and quickly by inserting a different hologram transparency for another training situation.

Many aspects of training are still primitive in the use of technology. However, training in the Navy is receiving more attention today than in any time previously. With the advanced state of operational equipment, the quality and effectiveness of what is taught and what is learned is more important than ever before. Thus, the Center is looking at individual instruction, programmed instruction, and computer-assisted instruction. It is believed that all of these techniques, which can considerably accelerate the learning process, will have a great impact on our military training programs.

The role of training in the Navy is steadily expanding. It appears that the equipment used for future training will be as technologically sophisticated as the operational equipment itself. Indeed, there is a trend towards large training complexes, such as the Fleet Anti-Submarine Warfare School in San Diego. In the next decade, a single master computer at a central location may be used to provide simulation at many different locations simultaneously. The need exists and must be satisfied by imagination, ingenuity, and technical skill.

Random Noise

Dr. James E. Garvey has recently resigned from his position as theoretical physicist in ONR Pasadena. Dr. Garvey plans to establish an institute for adult education in the sciences.

CDR R. R. Lawson, formerly Technical Liaison Officer at ONR Pasadena, has recently retired from the Navy. He has joined the Scientific Department, ONR Pasadena as Naval Applications Coordinator.

Mr. LaVerne S. Birks, Head of NRL's X-Ray Optics Branch, Nuclear Physics Division, was recently selected by the New York Section of the Society for Applied Spectroscopy to receive its Annual Medal Award for 1967.

The Application of Holography to Training Devices

Alfred H. Rodemann
Physical Sciences Laboratory
Naval Training Device Center

Holography has been one of the most exciting developments in recent times. During its short history, it has created more interest than almost any other scientific phenomena with the exception of the laser, which played such a great role in the development of holography. The list of interested groups continues to grow and includes such fields as data storage, quality control, and even medicine.

What does holography have to offer to training devices? It is the only means of presenting a *true* three-dimensional image from a two-dimensional medium without the use of lenses or other optical aids. For true visual simulation it has no equal. The three-dimensional image possesses all of the properties attributed to actual real-world scenes or objects. Parallax, aspect, and focus are all present and indistinguishable from the real world. One can view an image which can be turned around to the other side. Objects hidden from view can be seen by moving around just as in the real world. The limitations of the two-dimensional visual simulation world are overcome without discarding the two-dimensional medium.

In addition to the unique three-dimensional properties of the hologram, it also possesses other attributes which are currently being investigated and may become very useful in training devices:

- The hologram is capable of storing more than one three-dimensional image on the same two-dimensional medium. It is possible to show a sequence of operations, flow diagrams, or built-up skeleton views all in the same visual presentation. These views can be shown separately or in sequence as desired, thus giving a very versatile motion picture to the trainee.
- The hologram can be made to have accurate contours positioned on the three-dimensional image where no contours existed on the original object. These contours can be spaced at any desired interval over the object, even down to less than the resolution of the eye if required. By utilizing these contours on a terrain model in a training device, more information can be transmitted to the trainee.
- The hologram image can be made to change size by moving the light source used in the reconstruction. This can be applied to a simulated approach to an object or scene. The movement can be completely

nonprogrammed and under the control of the trainee, thus providing him with a simulation of his own approach maneuver.

- Within limits the hologram can be made to act as an off-axis optical element to project a scene in any direction, at the same time acting as a fairly clear window for viewing. This gives rise to the windshield type display which can superimpose a generated scene upon an actual scene or lack of it. The hologram in this case is cleared up by bleaching, thereby providing a good see-through capability. By using these windshield displays a trainee can be shown where he should be at all times with respect to where he actually is.

- A real hologram image is in the space out in front of the recording medium. This image, of course, has no substance and therefore presents no problems for objects, such as an optical probe, to pass right through it. Such trainers as landing simulators could get right down onto the deck without any physical constraints associated with a solid model.

What is a hologram? A great deal has been written describing the physics of, and the necessary parameters for, the making of holograms. To avoid undo repetition, the article appearing in the March 1967 issue of the *Naval Research Reviews* by LT Bruce A. Finlayson is referenced as an excellent general discussion of holography. Also, DDC Report No. AD643165 by H. E. Morrow of the Naval Electronics Laboratory Center, San Diego, California, may be of interest. For this article, however, a few brief statements and diagrams are in order.

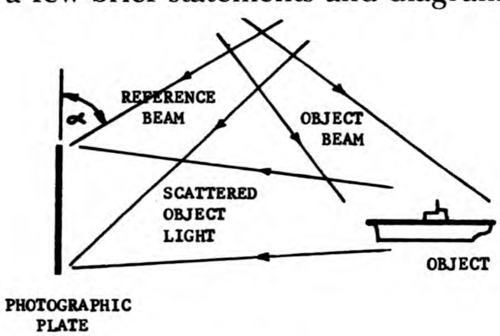


Figure 1

A hologram is the recorded interference pattern caused by the interaction between the light scattered by an object and a reference beam. This pattern is generally recorded on a fine-grain photographic emulsion such as Eastman Kodak 649F. Figure 1 shows a typical setup for the recording of a hologram.

This photographic emulsion is developed in a standard fashion for fine-grain development. The resulting hologram is then reconstructed by illuminating it at the same angle with which the reference beam impinged upon the emulsion. The interference pattern or hologram now acts as a diffraction grating and bends the illuminating beam in such a manner as to re-create the shape of the original beam wavefront which came from the object. When viewing this wavefront, it is practically impossible to tell the difference between it and the original one because it has all of the properties contained in the original wavefront. Figure 2 shows a typical setup for reconstructing a hologram.

One of the missions of the Naval Training Device Center is to develop new and more effective training devices for the Armed Services' schools and personnel. In keeping with this goal, the Physical Sciences Laboratory of NTDC undertook a study of holography to explore its unique properties as applied to visual simulation in training devices. This program has been active for the past two years and many new ideas and concepts such as multi-imaging techniques and contour generation have been explored and developed.

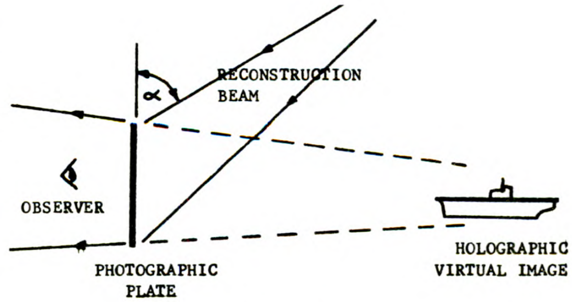
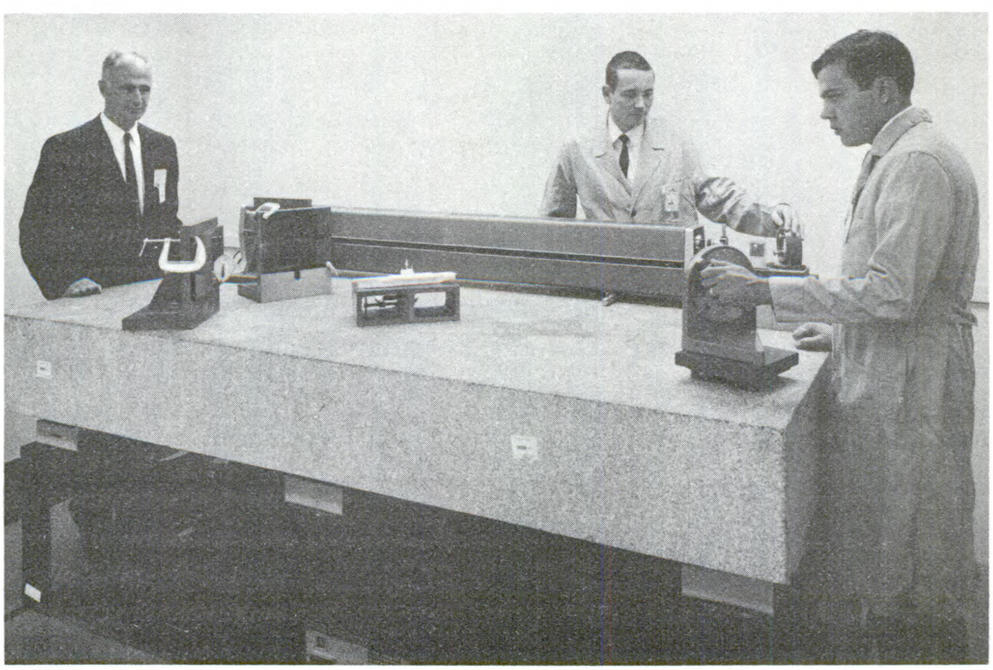


Figure 2

What is in the future concerning holograms and training devices? NTDC feels sure that there is a great promise in applying holography to visual simulation. The work here will continue to expand, covering the many aspects of holography. Some of the future possibilities which are foreseen in training devices include the utilization of three-dimensional holographic motion pictures and television, 360° holograms to be viewable from all directions, and complete landing and docking simulators using holograms as the visual display. As holography grows out of its infancy, many new and better ideas will develop. These ideas will become the basis of future work making better training devices through holography.

Figure 3 - Continuing studies of holography are being made at NTDC



The U.S. Army at NTDC

Bernard L. Sechen
U.S. Army Participation Group
Naval Training Device Center

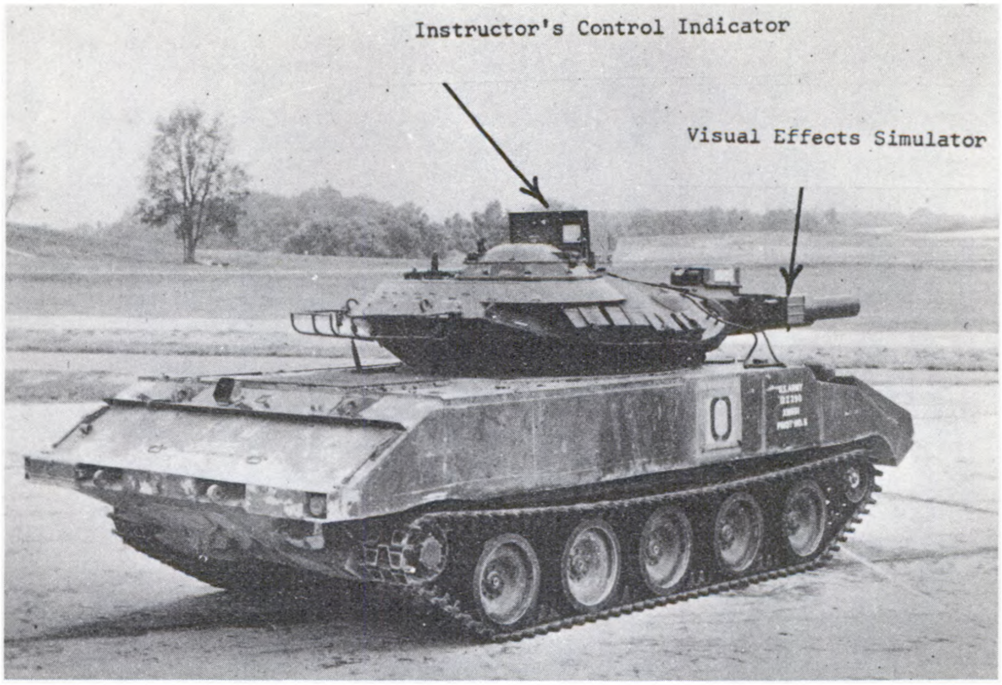
The U.S. Army Participation Group, a vital part of the Naval Training Device Center since 1950, has fielded approximately 4000 training devices consisting of 200 line items. This is indicative of the Army's interest in training devices and their application to all fields of Army training.

Since the U.S. Army Participation Group became a part of NTDC, approximately $10,000,000 has been provided to the Navy for administrative support. The Participation Group, which is an activity of the U.S. Army Material Command, is headed by Colonel Lester H. LeVine, the Commanding Officer, who is also the Associate Director (Army) of NTDC. It consists of 20 civilians and eight military personnel and is broken down into three organizational elements—the Planning Office, Requirements Office, and Procurement Management and Support Office.

The Army utilizes all the administrative, research, engineering, and contractual activities of the Center. Except in the areas of requirements, planning, and support, Army training device development and procurement projects enter the Center's annual work program on the same basis as a Navy or Marine Corps project. Training device requirements come to NTDC in the form of Small Development Requirements (SDR's) which are usually initiated by the U.S. Infantry School, Fort Benning, Georgia.

Since moving to Orlando, the Land Warfare Department was established by the Center to handle all training devices in the field of land warfare for both the Army and the Marine Corps. Close coordination is accomplished between the Army and the Marine Corps at the Center, since most land warfare training device developments can equally serve both services.

The Army's major training device program at the Center is the "Conduct of Fire Trainer" for the Sheridan Airborne Assault Reconnaissance Vehicle (Device 3A101 or XM35) and the M60A1E2 Tank (Device 3A108 or XM38). These simulators, which are identical except for the visual effects portion, are mounted on and interfaced with a vehicle's fire control and missile systems. A target beacon mounted on another vehicle completes the device. The trainer, which is designed to train gunners in the operation of the Shillelagh missile system, is the Army's first attempt to mount a trainer on a combat vehicle. At this writing, the final configuration is still undergoing field tests.

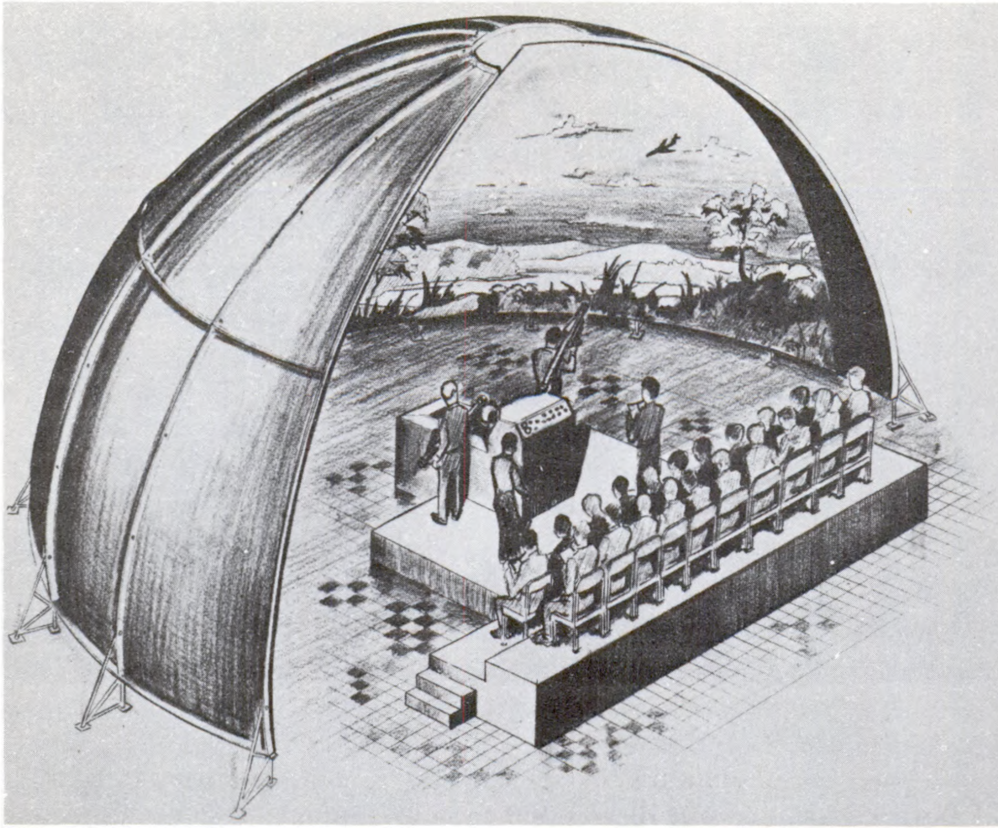


The Sheridan Weapon System (Device 3A101) trains gunners in the operation of the Shillelagh missile system

Device 3A100 or XM40 Weapon System Trainer, which is also being delivered for the Sheridan vehicle, consists of a turret mock-up made of welded steel tubing and wire mesh, thus allowing observers to see the actions of the three-man crew within the confines of the turret. The device simulates the missile firing procedures, including loading and recoil of the gun. A unique film projector arrangement shows a series of tank turrets through the gunner's optics, which allows the tank commander to start, stop, and critique the student gunner at the completion of each gunnery problem.

Another major training device effort for the Army at NTDC is the Redeye Moving Target Simulator. The Redeye is a shoulder-fired, anti-aircraft, heat-seeking missile. The moving target simulator will provide aircraft target on a 20-foot quarterspherial screen to Redeye gunner trainees firing a simulated Redeye weapon. Training is provided in an indoor environment without regard to time of day or weather conditions. This moving target simulator will be used for the new Chaparral and Vulcan air defense weapons.

One of the major training device requirements presently undergoing a concept formulation study is the Synthetic Flight Trainer System for the U.S. Army Aviation School, Fort Rucker, Alabama. This trainer will provide flight and instrument training for three different Army helicopters—the UH-1D Huey, CH-47A Chinook, and AH-56A Cheyenne. Complete simulation will be provided including multi-cockpit operation from one digital computer and adaptive training with



The Redeye Moving Target Simulator (Device X12A11) provides training in an indoor environment without regard to time of day or weather conditions

programmed instruction features. Upon completion, this trainer will represent the latest advancement in the state-of-the-art for rotary wing pilot training.

Another new item of Army equipment which will require training device support is the US/FRG Main Battle Tank-70. The joint U.S.-Federal Republic of Germany tank development program will introduce several features of tank construction which may require some novel approaches to training device development. Some of the new features of this tank are the location of the driver in the turret rather than the hull, a stabilized sight, a suspension system capable of reducing the height of the silhouette, an automatic loader, underwater fording capability, and the capability to operate in a nuclear environment. A training device requirements study is presently underway to determine the types of trainers which will be required to support the Main Battle Tank.

The foregoing are examples of the total Army effort underway in training device development and production to support the Field Army. With the high cost of weaponry and the shrinking land areas available for training, an ever increasing amount of training will be accomplished through the use of complex training devices.

Investigation of Computer Techniques for Radar Landmass Simulation

Alfred Weinrauch
Computer Laboratory
Naval Training Device Center

Since the initial development of airborne mapping radars in the early 1940's, there has been a demand for an effective and realistic radar landmass simulator. In fact, training in airborne radar operation depends upon the use of such simulator-trainers.

Simulators which use entirely different techniques, *e.g.*, ultrasonic, optical, *etc.*, to reconstruct the radar display of the terrain have been developed. However, they have a common fundamental method of operation – a physical analogue: in every case there is a physical model of the terrain which is analogous in some sense to the actual terrain. A physical transducer is moved over the model in a direct analogy to the manner in which the radar is flown over the actual terrain.

Each of the simulation systems based on physical analogy has offered certain advantages and disadvantages. However, as with any physical model, there are limits imposed on the accuracy, resolution, and repeatability of the data that can be derived by coupling a transducer to the model. Indeed, there are physical limits of accuracy with which a model can be constructed: either the mapping scale factor is too large and the model is unwieldy; or the model is manipulable and the accuracy suffers. For these reasons, the equivalent limit on the accuracy, precision, and repeatability with which the operational radars can view their targets has not been attained.

In an attempt to gain improved accuracy and flexibility in reconstructing the simulated radar display, the Naval Training Device Center analyzed other simulation techniques that may be used to store terrain information, *i.e.*, digital or hybrid techniques. The most prominent advantage of digital computation is that, by virtue of the abstract numerical representation of magnitudes of physical quantities, the precision with which a quantity is retained is limited only by the number of digits allowed for that quantity. Also, the repeatability and accuracy of digital devices are inherently better than their analogue counterpart. These apparent advantages led NTDC to initiate a study of the application of digital or hybrid techniques to radar landmass simulation. The results of this study have indicated technical feasibility and a combined analog digital simulation has been proposed.

Physically, the proposed simulator comprises a general purpose digital computer, an analogue computer, and a special purpose interfacing hybrid computer. Functionally, it consists of a vehicle computer, a terrain computer, and a display computer. The vehicle computer calculates instantaneous aircraft velocity and position and antenna orientation relative to the ground. It controls and synchronizes the terrain data generator and display computer with these computed values. The terrain data generator extracts map data from the main memory and transmits information representing height, terrain gradient, reflectivity, specularity, *etc.*, for the region being scanned—the region being a portion of the ground described by a set of numbers stored as a group in the memory.

A complete scan by the radar is simulated in the computer by the successive transmission of data for a number of regions within the range of the simulated radar system. The data is updated continuously to simulate aircraft motion and antenna scan. The entire area that can be scanned is described by the data stored in the main memory tapes. The area actually displayed is controlled by the simulated aircraft course and maneuvers, antenna orientation, and radar range. Information derived from area maps and other intelligence is reduced by mathematical procedures to a set of numbers, stored in digital form, that characterize the terrain and its overlay of man-made features.

Data compression techniques have been developed that may permit the storage of information for a half-million to a million square miles on a standard magnetic tape, depending on the nature of the terrain and cultural features and the resolution desired.

The terrain function generator is a special purpose hybrid device that converts the digital outputs of the terrain data generator to a set of continuous functions. These functions, called profiles, represent height, terrain gradient, reflectivity, *etc.*, and include cultural as well as natural features.

The profiles are combined in the display computer into a single signal representing the radar video. The display computer performs the ground-to-slant-range conversion and shadow computation and simulates radar effects such as noise and antenna pattern. Integration of the separate profiles and the various radar effects is performed with a scan conversion tube. The signal components are stored separately in intensity-modulated form until readout, which occurs at a rate high enough to simulate a real-time display.

The system is designed to simulate radar aboard aircraft flying at any altitude at speeds up to 3600 kt and capable of heading rates up to 5 deg/sec. The radar characteristics include pulse rates up to 1000/sec, range up to 200 naut mi, and scan rates up to 720 deg/sec. Map data compression and storage are designed to provide 100-ft ground resolution.

The technical feasibility of the above described method was verified and demonstrated by a totally digital, non-real-time simulation of the proposed simulator system. This simulation resulted in a series of static displays (the operational simulator will generate displays continuously updated in real-time). Actual terrain was modeled in this work, rather than using statistically generated functions. The demonstration showed the proposed radar simulator's capability to represent realistic returns from a variety of terrain types and cultural features as viewed from different altitudes and aspects. A demonstration area consisting of 1200 square nautical miles centered on Williamsport, Pennsylvania was selected for its varied cultural features and rugged topography. A CDC 6600 computer and SC 4020 Display Scope were used for the demonstration.

A laboratory model of the proposed simulator will be developed at NTDC as a tool for determining the design details and for examining various possible enhancements. This laboratory model is expected to be completed in four years.

Hazardous Oceanography

Scientists and engineers of the U.S. Naval Oceanographic Office, Suitland, Maryland, and the Navy Research and Development Unit (NRDU), Vietnam, have literally gone "up the creek" in support of the fighting forces in the Republic of South Vietnam. The creek, figuratively speaking, is the Long Tau River, the main shipping channel from Saigon to the South China Sea. Most military and civilian supplies enter through this river route to Saigon, which therefore must be kept open to shipping traffic.

Working through daylight and darkness from aboard an armored Navy landing craft (LCM), civilian scientists and engineers have completed an historic and quite possibly the most hazardous oceanographic survey in history.

An oceanographic environmental study was made of the Long Tau shipping channel from Phu An, north of Saigon, to Can Gio where the Long Tau enters the South China Sea. It was a survey of some 35 miles of deep draft channel, conducted under combat conditions with the participants in constant danger from Viet Cong sniper fire and mines.

During the survey, the team tested the water for temperature, salinity, conductivity, currents and sound velocity at some 65 different observation points. Water samples were obtained and analyzed for sediment content. At each point, Navy divers obtained bottom cores or samples of the river bed and performed other underwater measurements such as visibility and bottom hardness. Data was analyzed in a make-shift laboratory at Nha Be and forwarded to the U.S. Naval Oceanographic Office for further analysis.

Seismic and bathymetric profiles were run the entire length of the Long Tau and along both banks. The seismic record revealed the structure of sediments beneath the river bed while the bathymetric record displayed the configuration of the river's bottom. Buried river channels were discovered along with numerous migrating sand ridges or dunes, ranging from 30 to 60 yards in length and six to eight feet in height.

The Navy divers installed current meters on the bottom in various locations which were capable of recording internally the direction and speed of water movements. Considering the speed of the currents (up to three knots) and the zero visibility of their underwater environment. this was a most difficult task.

The civilian scientist in charge for the Naval Oceanographic Office was Mr. Ronald P. Kopenski. He was accompanied by Dr. L. R. Breslau, an oceanographer; Mr. R. C. Burchell, an electronics technician; and Mr. V. L. Williams, a physical science technician.

Visual Simulation for Ship Handling Trainers

Francisco Chea
Visual Simulation Laboratory
Naval Training Device Center

The art of ship handling requires both special training and a great deal of practical experience aboard ships. The utilization of land-based simulators for training may provide a means of acquiring such experience while, at the same time, eliminating problems arising from such factors as bad weather, ship unavailability, and ship damages.

Present trainers for ship handling (docking) provide a bird's-eye view of the maneuver: by means of radio-controlled ship models located within a water tank, command personnel are trained to maneuver within a harbor or in the vicinity of another ship. However, this method is not completely satisfactory, primarily because of the lack of "inside-out" visual cues looking from the bridge which a trainee would need to obtain necessary speed, heading, and relative position information.

The Naval Training Device Center's Visual Simulation Laboratory has been conducting preliminary investigations using an experimental visual display consisting of a wide-angle TV projection system and an analogue computer programmed with a ship's motion equations. Findings indicate that this technique may be successfully applied to both current and proposed ship-handling trainers after noted deficiencies have been corrected.

The experimental visual display is presently being utilized to determine its capabilities as a visual presentation in a training situation, to check out the DD692 class destroyer equations of motion, and to obtain the necessary design criteria and parameters for planned ship-handling trainers.

A system diagram of the experimental trainer is shown in figure 1. The trainee, standing in a mock-up of a DD692 class destroyer's bridge, issues verbal commands to a trainer operator, who is seated at the instructor's station and who will simulate the role of the pilothouse personnel by adjusting inputs to the ship's motion computer. Rudder angle and engine orders are input information which are given as commands by the trainee during the maneuvering problem. Wind speed and direction, water current speed and direction, and water depth comprise variable input information which may be inserted by the instructor depending upon the simulated training problem and harbor. The outputs of the motion computer regulate the position and heading of the wide-angle TV camera which is mounted above the model of a

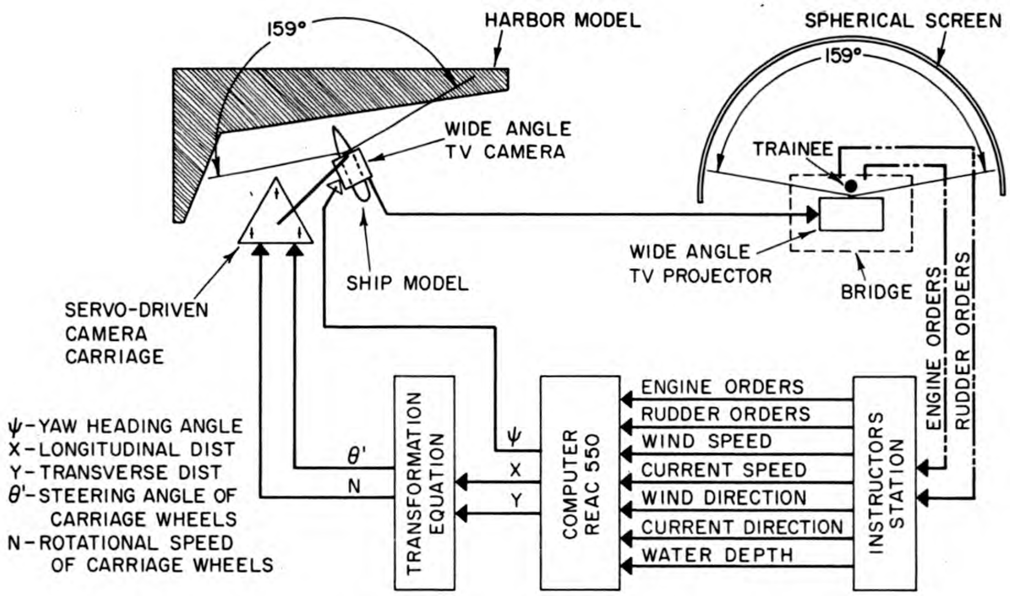


Figure 1 — Diagram of experimental shiphandling visual display

destroyer. Both the camera and destroyer model are caused to move within a model of a harbor which is a scaled replica of a portion of a typical docking facility. The TV camera picks up a picture which is a reproduction in perspective of the scene as it is perceived by a conning officer standing on an actual ship's bridge and observing a real scene. This picture is transmitted by cable to the TV projectors onto a spherical screen which surrounds the replica of the bridge where the trainee stands. The projected picture is in perspective and of such magnification that the stationary trainee will see a moving scene which duplicates what a conning officer sees when observing the stationary harbor of which the model is a scaled replica.

A simplified diagram of the visual pickup and projection is shown in figure 2. The same principle of operation is used for both the cameras and projectors. Images picked up by the camera's three vidicons are transmitted to the projector's three cathode ray tubes, and, by means of large lenses, projected onto the screen. The result is a visual display of three pictures side by side which, as viewed from the center of the screen, cover an area of 159° horizontally and 53° vertically.

A more detailed description of the trainer follows:

• *TV Camera.* The camera, which picks up the scenery from the harbor model and transmits it to the spherical screen via the projector, is mounted at the end of a cantilevered member which is a part of the camera carriage. Motions of the carriage are accomplished by using servo mechanisms and by the output signals from the ship's motion computer. The camera is mounted in such a fashion that the lens is above the ship model and at a scale distance to the ship model to

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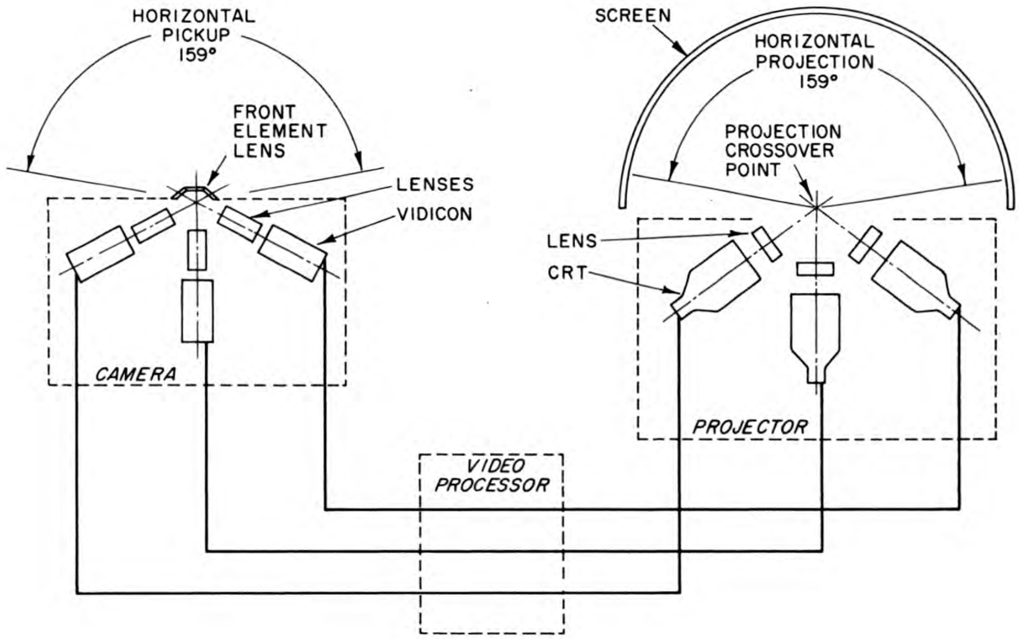


Figure 2 — Simplified wide-angle TV pickup and projection

simulate the real distance of the eye of a conning officer above the bridge of a real ship.

Since the camera horizontal pickup angle is 159°, the camera has to be rotated about 90° in order for the conning officer to see the aft end of the ship when maneuvering alongside the dock.

• *TV Projector.* The images picked up by the camera are received by the TV projector and presented in a realistic life-sized form on the spherical screen. What the trainee sees is a picture of the surrounding scenery in the model harbor which changes as he maneuvers the model destroyer.

• *Spherical Screen.* The screen upon which the TV pictures are projected is a ten-ft-radius sphere. The screen projection capabilities are 280° horizontal by 170° vertical.

• *Harbor Model.* The three-dimensional harbor model is of the Mayport, Florida destroyer docking area. The approximate terrain model size is 22 ft × 8 ft; the model scale, 100:1. The maneuvering area for the model ship is also approximately 22 ft × 8 ft. Removable objects on the harbor model such as buildings, trees, signs, vehicles, groves of trees, navigation landmarks, *etc.,* are standard HO gauge models, scale 87:1.

• *Ship's Motion Computer.* The Reeves Electronic Analogue Computer (REAC) 550 is utilized for the ship's motion computer. The equations of motion for mooring and docking maneuvers of a destroyer class vessel were developed for NTDC under a research contract with the Davidson Laboratory of the Stevens Institute of Technology, Hoboken, New Jersey. Since destroyer docking and mooring are normally done within confined harbors and waterways, the effects of waves and their motions were not considered in developing these equations. The computer's input data is comprised of the following variables: rudder angles, engine orders, wind speed and direction, current speed and direction, and water depth. Its output data (ship's motions) is comprised of ship's speed, ship's position, drift angle, and yaw rate.

Preliminary tests and evaluations of the experimental visual display system have revealed the following deficiencies:

- Projected measured brightness onto the screen was one foot-lambert whereas the objective was ten foot-lamberts, and
- Pictures had a low contrast due to excessive light loss through the camera lens systems which contained 14 air-to-glass surfaces.

Additional research has been recommended to correct these deficiencies.

Proposed Ship-Handling Trainers

Future investigations at NTDC will consider systems simulation of other ship-handling trainers. This work will establish the design criteria and parameters for such trainers.

In this regard, NTDC has conducted a feasibility study of an assault boat coxswain trainer which will utilize systems similar to those used in the destroyer docking trainer outlined previously. However, the effects of waves, surfs, noise, and vibration are to be incorporated into these trainers. Two types have been proposed:

- The beaching and retracting trainer which will utilize the wide-angle TV projection system for visual simulation, and
- The procedural trainer (to train a coxswain in the familiarization and coordination of the boat controls while in the open sea) which will utilize the point light source projection system for visual simulation.

The point light source system will utilize a very small, intense light source to project a display object onto a screen. Appropriate drives and controls will move the light source and display object relative to one another and with an appropriate supporting structure. This movement will provide a corresponding change in visual display which is, in turn, related to control changes by the trainee via the electro-hydra system.

Since anticipated improvements in the present wide-angle TV projector system are expected to provide an acceptable, realistic visual display, the only area which requires further research work is the development of hydrodynamic equations of motion for the particular assault boat to be simulated in the proposed coxswain trainer.

Mileston

DATE	*EVENT*
April 1941	ADM Towers (Chief, BUAER) set up Special Devices desk in Engineering Division under CDR Luis deFlorez. Staff consisted of two assistants to CDR deFlorez.
June 1941	Special Devices desk expanded to Special Devices Section. Limited funds provided for preliminary development work.
Jan. 1942	Special Devices Section workload expansion resulted in shop and lab in Anacostia and space in remodeled garage at 610 H Street, Wash., D.C. Personnel increased to 125 by end of 1942.
Aug. 1943	Special Devices Division became Division of BUAER headed up by CDR deFlorez. Personnel, military and civilian, increased to 290. Over 500 projects were completed by year's end.
May 1945	SECNAV established Office of Research and Invention (ORI), reporting directly to SECNAV and CNO. CAPT deFlorez named Deputy Director of ORI-Special Devices Division moved from BUAER to ORI. CDR Hibbard named to head Special Devices Division. Personnel about 500 military and 100 civilians by war's end.
April 1946	CAPT deFlorez's last official action prior to return to inactive duty was relocation of Special Devices Division from 610 H Street in Wash., D.C. to Guggenheim Estate, Port Washington, N.Y. War's end changed ratio of military to civilian personnel with many naval officers changing hats and continuing their work as civilian employees.
1 Aug. 1946	Office of Naval Research established by Act of Congress—replaced Office of Research and Invention—functions and organization remained substantially unchanged. Name changed from Special Devices Division to Special Devices Center.
13 Aug. 1946	Center officially commissioned U.S. Navy Special Devices Center. CAPT Donald L. Hibbard named as first Commanding Officer and Director.

f NTDC

DATE	*EVENT*
March 1950	Secretaries of Navy and Army sign agreement creating an Army Participation Group (APG) at the Center. APG under direction of Continental Army Command (CONARC). Purpose—to research, develop, procure and evaluate certain Army training aids and devices. CO of APG is Associate Director of the Center.
April 1956	Special Devices Center redesignated U.S. Naval Training Device Center. No change in mission.
April 1962	Army reorganization placed Army Participation Group under Army Materiel Command instead of Continental Army Command (CONARC). Personnel count in APG about 20 civilian and military handling training requirements for AMC and its major subordinate commands.
Nov. 1964	SECDEF directed relocation of Center to OAFB, Orlando, Florida. Move necessitated by Center's need for more space and facilities for expansion to enable fulfillment of its ever-growing workload.
Sep. 1965	First contingent, about 200 NTDC personnel, reported for duty at Orlando, Florida. Organization set up as NAVTRADEVCEN Orlando Detachment. Command remained in Port Washington.
Aug. 1966	Second contingent, about 400 Center personnel, reported to Orlando. CO and Dir came aboard with the Command. Command changed to Orlando; Port Washington became detachment of NTDC.
July 1967	Third and final contingent of Center personnel report to NTDC, Orlando. Port Washington detachment ceases to exist. NTDC physical move to Orlando completed.
July 1968	Command and support of NTDC will be transferred from ONR to the Naval Material Command.

A Modern Weapon System Trainer

Jimmy H. Burns
Edward J. Cmar
Attack Trainers Division
Naval Training Device Center

The A-7A Weapon System Trainer (Device 2F84), which simulates the A-7A Corsair II, single-place, light-attack, jet aircraft, is used to train jet pilots in the procedures and techniques required to establish and maintain maximum A-7A weapon system capabilities.

The device, which is housed in an air-conditioned, relocatable enclosure, provides a self-sufficient facility. In addition to the basic device and associated hardware, the enclosure includes a maintenance workshop with spares storage area, lounge, rest room, briefing room, office, and equipment room (see figure 1). The equipment room contains a 30-ton air-conditioning unit. Zones within the enclosure are individually controlled by thermostats and humidistats in order to maintain comfortable conditions throughout. Heating is accomplished through the use of electrical units in the air ducts. The air-conditioning system is designed to maintain desirable conditions in the enclosure over an outside ambient temperature range of −35°F to +115°F.

The enclosure's floor contains metal-covered trenches which serve as raceways for the trainer's interconnecting cabling and return air ducts for the air-conditioning system. The 20-foot-high ceiling in the cockpit area allows space for possible future visual attachments. The metal walls are bonded to the reinforcing rods of the concrete slab so that the entire enclosure acts as an electromagnetic interference shield for the trainer equipment.

Features incorporated in the device permit a thorough and intensive training program, including cockpit familiarization, instrument flying, in-flight planning, normal and emergency procedures, radio and dead reckoning navigation, communications procedures, special weapons delivery, and safe escape techniques. When integrated with the tactics portion, the device provides radar landmass simulation for the AN/APQ-116 Radar, and simulation of Electronic Countermeasures (ECM), such as the Radar and Identification Device (RAID) and the AN/AIR-15 Receiving Set. Features incorporated in the Tactics portion permit thorough and intensive training in Radar Scope Interpretation, Radar Navigation, Tactical Penetration and Electronic Countermeasures procedures.

The Radar Landmass Simulator utilizes two 18-inch photographic transparencies. One transparency contains terrain elevation information and the other contains cultural detail such as lakes, rivers, towns,

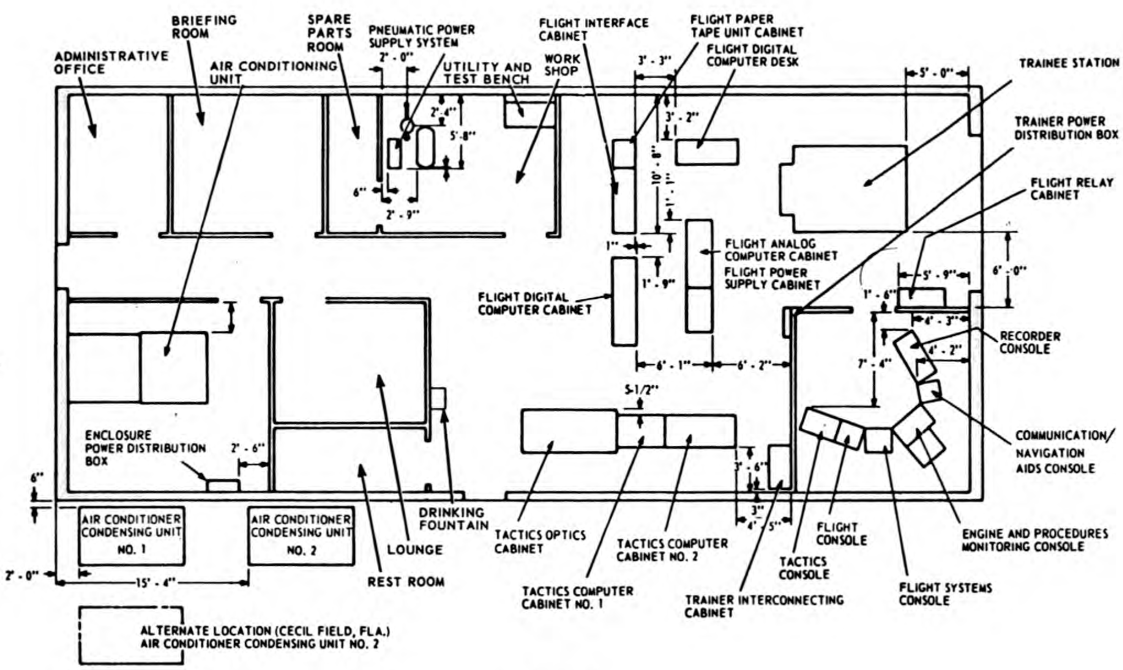


Figure 1

bridges, forests, *etc.* Since the transparencies are scaled at 1:5,000,000, it is possible for each to contain complete terrain details of an area equal to more than 50 percent of the United States.

In the weapon system trainer mode, the student pilot flies an integrated mission utilizing both the flight and tactics portions of the device. The trainer may be operated in an independent mode (switch selected) in which a student pilot may execute a flight problem utilizing all systems except radar and ECM. At the same time, a second student may "fly" a radar problem utilizing a joy stick at the instructor's console and operating the instructor's radar indicator. These two problems are completely independent and may be entirely different. In the independent mode, power may be removed from either the flight or tactics portion for maintenance purposes while the other portion is being utilized for training.

The cockpit is a full-scale replica of the A-7A cockpit section with all controls and instrument characteristics fully simulated (see figure 2). Simulation of the aircraft systems includes complete synthesization of all electrically, hydraulically and pneumatically actuated devices, including flight controls, control surfaces and automatic flight control system, refueling probe, wing fold, brakes, landing gear, nose gear steering, catapult launch bar, tail hook, and the thermal radiation shield. The fuel system is completely simulated, including in-flight refueling procedures, fuel dump, and external tanks. Cockpit systems simulation includes monitoring of the ejection procedure and activation of the anti-g suit and oxygen system using compressed air. The cockpit is also provided with a separate air conditioner controlled by the pilot.

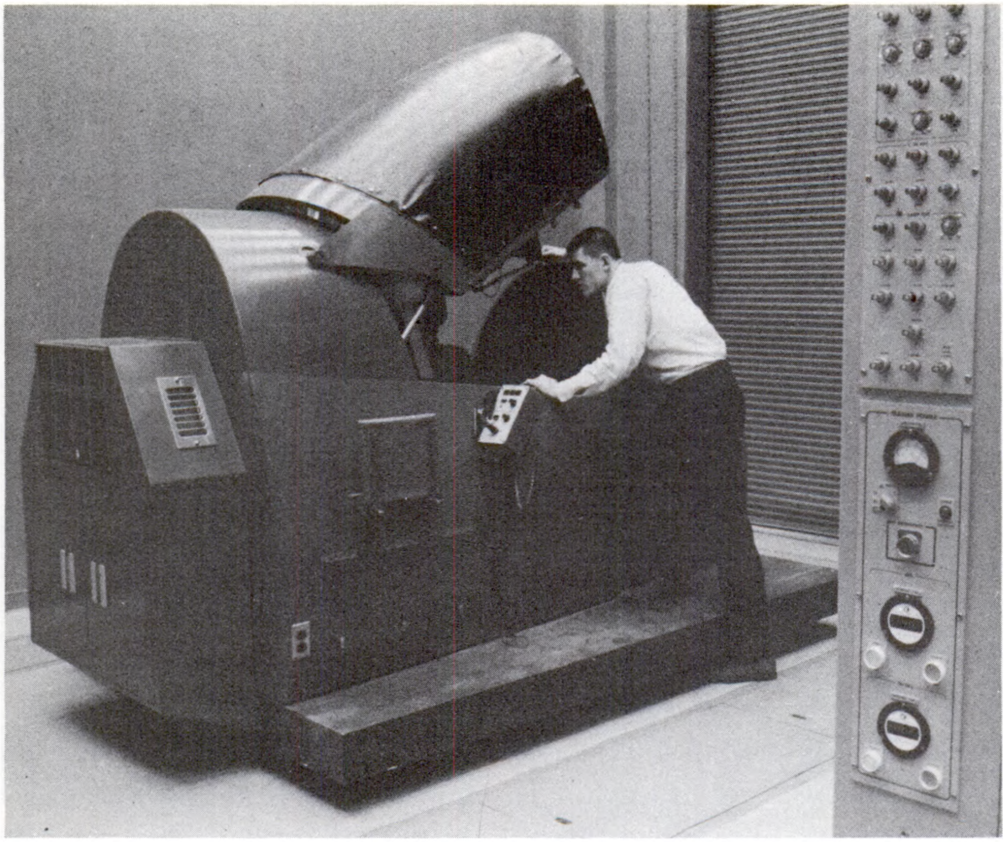


Figure 2 — The A-7A cockpit section is fully simulated

Simulation of the armament systems includes the selection and release of all external stores and their effects on the aerodynamics of the aircraft. Simulation of the AN/AWE-1 weapon release programmer is provided and the instructor may load or jettison any or all external stores during a training session to provide for additional training flexibility.

The AN/ASN-41 navigation system and the AN/ASN-67 roller map navigation system are completely activated and perform their function exactly as in the operational aircraft. Automatic and manual modes of the AN/ASW-25 Data Link system are simulated in the automatic carrier landing and precision bombing modes. Certain pre-programmed radio station locations are used as the aircraft carrier and bombing targets for the data link simulation.

Computer Handles 50 Radio Stations

Radio communication and navigation training may be accomplished through the use of the simulated TACAN and UHF radio systems. Fifty radio stations may be programmed in the computer by the instructor's utilization of a programming panel at the instructor's station. The station parameters may then be transferred to a paper tape to provide for rapid reloading of the same stations. A 30-inch square plotting board provides polar and rectangular grids, cross-country and approach modes, and scale selection from one to 60 nautical miles per inch. Map correction is accomplished in the computer, and 12 different charts may be preprogrammed from the instructor's station.

In addition to the usual controls, displays, and repeater instruments, the instructor's station contains a trainee monitoring system which permits the instructor to monitor the pilot's proficiency in performing specific squadron procedures for normal and emergency situations. The system uses a 35-mm slide projector to display, through a series of lights coinciding with the procedure, the various normal and emergency procedures on a screen above the instructor's panel. Each procedure is broken down into individual substeps in a preprogrammed sequence. Emergency procedures appear automatically when the instructor inserts an emergency malfunction.

The steps of each procedure are programmed through the use of a patchboard. This scheme allows simple reprogramming of procedures to meet individual requirements of different commands utilizing the device.

A DDP-224 digital computer is programmed to solve the aerodynamic and problem parameters and to respond to the modifying and updating inputs of the pilot and instructor. The computer serves advantageously in a dual purpose role when used as a trouble-shooting and maintenance tool. A Daily Operational Readiness Test routine is incorporated in the main operational program for checking the complete system and major subsystems of the device. Self-check diagnostic tapes are provided for checking the computer. Computer operation and program modification may be accomplished at the remote control console which consists of a desk with a control panel for setting or reading the various registers and a typewriter which serves as an input/output device for the computer.

Modifications, design improvements or additional simulation may be incorporated into the device by updating the computer program. These changes can be made in aerodynamics or power plant characteristics, radio and navigation simulation, or in any system utilizing the computer for simulation.

The entire trainer system was designed with ease of maintenance in mind, and good accessibility is provided for all components. A test bench, which is installed in the maintenance room to provide storage and troubleshooting space, contains a voltage test panel which allows any trainer module to be activated and tested.

Device 2F84 is currently installed at NAS Cecil Field, NAS Lemoore and MCAS Beaufort.

PHOENIX Missile Control Officer Trainer

Gerald L. Murphy
Air Defense Trainers Division
Naval Training Device Center

The primary function of the PHOENIX Missile System in the F-111B aircraft is the achievement of air superiority through the detection and tracking of targets and the capability of performing simultaneous attacks against various targets using long-range missiles. Secondary mission functions provided by the PHOENIX System include air-to-air visual identification, radar navigation, air-to-ground weapon release, and terrain avoidance. The Radar subsystem functions as the primary and the Infrared (IR) subsystem as the secondary target sensor. In the radar air-to-air modes the high Pulse Repetition Frequency (PRF) doppler radar provides continuous area target detection, ranging and angle measurement. The system is also capable of tracking single targets from electromagnetic radiation. It may also be operated in a conventional low PRF mode. The IR subsystem provides a secondary means of target detection and tracking, furnishing additional system capabilities.

The controls and displays subsystem permits the Missile Control Officer control of all PHOENIX modes while displaying pertinent data. Sensor data from the Radar, IR or Identification Friend-or-Foe subsystems are displayed in one of several operator-selectable formats.

Device 15C8, which realistically simulates the AN/AWG-9 Airborne Missile Control System, is used in training F-111B PHOENIX Missile Control Officers. It presents the trainee with variable-geometry situations within ECM environments such as the PHOENIX system is designed to experience.

Every operational mode of the PHOENIX missile system is simulated in Device 15C8, including missile launch. The student operator has all the necessary controls and displays required to accomplish tracking of targets and launch of missiles against the targets. Training exercises range from simple fundamental operating problems for initial procedural training to sophisticated and complex tactical exercises.

The trainer has positions for an instructor, a missile control officer, a pilot and three observers. A typical tactical situation can be formulated by the instructor and preprogrammed. The trainer has a record and playback feature that allows the instructor to "freeze" the training exercise and return to some previous point in the exercise in order to point out some error or alternate solution to the trainee. The device weighs 18,000 pounds and is housed in a permanent type building occupying a space 30 × 30 × 9 ft.

Simulation of Heavy Weapon Firing by Laser

Peter Camarata
Armament Trainers Division
Naval Training Device Center

The basic training of combat tank gunners becomes an extremely expensive problem when one considers the cost per round of live 90 and 105 mm ammunition and the amount of land required to permit live firing. An alternate approach is to use simulation techniques which will permit the gunnery trainee to acquire the same basic skills (*e.g.*, laying the sights on the target, tracking the target, firing the main weapons, and visually adjusting the lay of the weapon on the target).

One simulation technique which has been developed by NTDC is Device 3A102B (Weapon Firing Simulator (Laser)) which substitutes a laser for the main tank weapon. This device, which is currently undergoing service tests by the Army at Fort Knox, Kentucky prior to distribution to Army user activities, consists of a laser type simulator, a blower assembly, a blower hose assembly, targets, interconnecting cables, a power supply, and a carrying case.

The simulator is installed in the vehicle's M73 machine gun mount. Each time the main weapon firing circuit in the vehicle is activated, the simulator provides a single, bright burst of intense red light, which is visible through vehicle optics as a momentary red spot on the target. This spot enables the crewman to determine accurately how well he is laying his gun sights and tracking the target. Also, it allows a supervising scorer to observe just how accurately and proficiently the crewman is operating the vehicle main weapon system.

The simulator optics can be focused to adjust for a spot one-half inch in diameter at a range of 200 feet. A scribe mark is engraved on the focusing mechanism, and a knurled locking ring is used to retain the focus after it is set for 200 feet. However, after installation the vehicle optics must be boresighted to the laser beam before the simulator can be used. Each simulator contains an integral boresight for this purpose.

The power supply for the simulator is mounted on the vehicle floor during operation and has an input of 24 volts DC from the vehicle's electrical system. It has the following controls and indicators:

- Power "on-off" switch which energizes and deenergizes the simulator;
- Safety "on-off" switch which inhibits laser operation in the "on" position;

• Safety "on" indicator lamp which indicates that safety switch is in the "on" position and laser operation is inhibited;

• Power "on" indicator lamp which indicates that 24 vdc vehicle power is applied to the simulator power supply; and

• Ready indicator lamp which indicates that simulator is ready to be fired by vehicle main weapon firing circuit.

An intake blower with ducting provides cooling for the laser simulator. The blower is located on the vehicle floor adjacent to the power supply. A carrying case with handles is provided to carry or store the simulator, power supply, blower, cables and blower air-hose assembly when they are not mounted in a vehicle.

In addition to the above components, three types of targets are provided to operate the training device:

• A zeroing silhouette target with five circles four inches in diameter with crosslines in each circle;

• An initial lay target with five bull's-eyes consisting of concentric circles four inches and eight inches in diameter; and

• A moving target with 15 identical geometric patterns six inches high and eight inches wide, separated by one foot on either side and seven inches top and bottom. A two-inch high number is inscribed in the center of each pattern.

The moving target is mounted on a device which provides the motion. All targets have reflecting surfaces.

One problem inherent in the laser device is safety. Since laser radiations can damage the eye, the U.S. Army Surgeon General has imposed several restrictions on the use of Device 3A102B:

• It must be used outdoors *only;*

• It must not be used at any range less than 200 feet in length;

• It should not be used in any weather condition which could produce undesired reflections; and

• If used at night, it may only be used with suitable infrared viewing devices.

Within the above limitations, the Laser Weapon Firing Simulator will provide a valuable, inexpensive tool for more effective training of Army tank personnel.

The Second International Conference on Vacuum Ultraviolet Physics will be held at Gatlinburg, Tennessee, May 1-3, 1968. Additional information on this conference, which is sponsored by the ONR Physics Branch, may be obtained from Dr. E. T. Arakawa, Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tenn. 37830.

Surface Ship ASW Attack Trainer

Edward J. Wrobel
ASW Tactics Trainers Division
Naval Training Device Center

Due to technological advances, fleet ASW weapon systems have become extremely sophisticated and complex. In order to utilize this equipment effectively and efficiently, fleet personnel must be thoroughly trained and skilled as a team in surface ship ASW attack tactics. In recognition of this problem, the Navy, through the Naval Training Device Center, instituted a program to develop an electronic, digital-computer controlled, Surface Ship ASW Attack Trainer (Device 14A2).

In June 1964, NTDC contracted with Honeywell to produce such a trainer. Installation and checkout were completed at the Fleet ASW School in San Diego during May 1966 – ahead of schedule. The first user, USS ENGLAND (DLG-22), had this to say about the device:

> "The training derived from the 14A2 trainer is considered to be outstanding...The trainer is capable of presenting excellent simulated at-sea environment..."

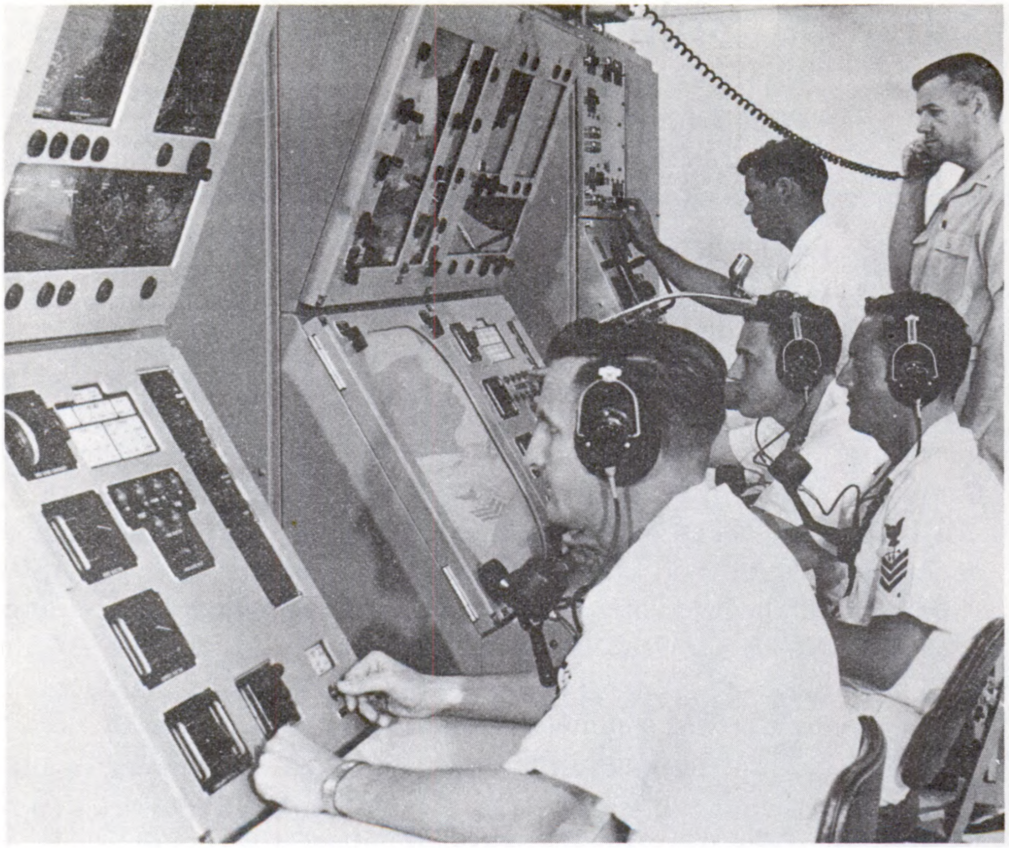
Device 14A2 duplicates the physical configuration of major operational compartments and equipments of surface ship ASW attack weapons and simulates their functional operation and responses such as target detection, fire control solution, and weapon launching and tracking.

The device provides for instruction in equipment operating procedures, develops personnel proficiency, and indoctrinates personnel in ASW procedures and in the evaluation of tactical situations. The trainer is also used in developing and planning advanced naval defense tactics. Typical training problems include target acquisition, tracking, weapon firing, and hit evaluation.

The 14A2 training device, which occupies over 3000 square feet of floor space, is divided into six operating areas:

- Underwater Battery Plot
- Combat Information Center
- Launcher Captain's Control Station
- Conning Station
- Computer and Projection Equipment Room
- Problem Critique and Display Room

An ASW attack problem begins in the Underwater Battery Plot (UBP). This station contains highly realistic simulation of sonar, fire control and associated communications equipment. Training in sonar target acquisition and tracking is provided by a simulated AN/SQS-23B Sonar Set. Simulated Attack Console Mk 53 and Position Keeping



Trainees man positions at the Fire Control and Sonar stations in the Underwater Battery Plot area of Device 14A2

Computer Mk 143 units of the Mk 114 Fire Control System provide weapon capability for the Anti-Submarine Rocket (ASROC), Mk 37, Mk 43, Mk 44, and Mk 46 over-the-side torpedoes and the Drone Anti-Submarine Helicopter (DASH).

Additional units available in UBP are simulated AN/WSA-1 Control Indicators and FANFARE Control Units. The AN/WSA-1 system generates symbols for tracking data to Radar Plan Position Indicators located in the Combat Information Center. The FANFARE Control Unit provides training in the use of the towed acoustical noise generator designed to distract enemy homing type torpedoes.

The Combat Information Center (CIC) is the area for collection, evaluation, dissemination and display of the own ship overall tactical situation. CIC is equipped with plotting and status boards, a Mk 6 Dead Reckoning Tracer, two radar repeater units, the DASH Controller Unit, a NC-2 Plotter, and two fiddle boards containing communications, course, speed and wind indicators.

Trainees at this station gather information to maintain plots of targets, own ship, and other vehicles in the problem. Range and bearing information of submarine targets is reported from sonar in UB Plot. Surface vehicle information is furnished by simulated radar.

The NC-2 Plotter provides a visual display which is a plot of the true relationship of the sonar target, DASH vehicle, and own ship. This allows the DASH Controller to observe the position of the DASH vehicle during a simulated attack.

The primary function of the Launcher Captain's Control Station is to provide training in operating the Launcher Captain's Control Panel Mk 199. This unit supplies information concerning the ASROC missile and launcher status to the trainee Launcher Captain. In the event of trouble at the Attack Console in UBP, controls on the panel permit the Launcher Captain to position the simulated launcher, select a launcher cell, select a depth charge or torpedo payload, and complete auxiliary firing. A simulated Relay Transmitter Mk 43 is also included at this station.

The trainee Officer of the Deck (OOD) directs own ship movements in the Conning Station. The OOD maintains communications with other units by radio-telephone and with internal stations by sound-powered circuits. Also he monitors information displays. Incorporated in this area is the Position Indicator Mk 78 which displays target position and weapon status. Before a simulated weapon can be fired by trainees in UB Plot, the OOD must give approval by operating the proper controls.

Using the helm control unit in the Conning Station, the trainee helmsman maneuvers the ASROC ship by manipulating controls to set in speed, course and rudder angle orders.

The heart of Device 14A2 is a general-purpose digital computer. Vital functions performed by the computer include position and motion data generation for problem vehicles, simulation of various weapon characteristics, and system functional tasks such as track projector time-sharing or display selection. The trainee operates the simulated shipboard operational equipment; the computer provides the required data to the equipment to permit display in accordance with existing parameters.

A significant part of the computer peripheral equipment is the diagnostic panel, designed to monitor computer inputs and outputs. This panel displays data flow throughout the system and facilitates checkout and malfunction isolation. Utilizing switches and controls on the diagnostic panel, the operator is able to initiate functions in the trainer system while panel displays indicate marginal operation or system malfunctions. This rapid checkout method significantly reduces trainer "down" time.

To enable the instructor to keep track of problem progress, a display system, consisting of an automatic plotting system and projection screen, is located in the Problem Critique and Display Room. This room is capable of accommodating an audience of about 40 observers.

A three color projection system receives multiplexed inputs and projects a distinctive image and track for each vehicle in the problem.

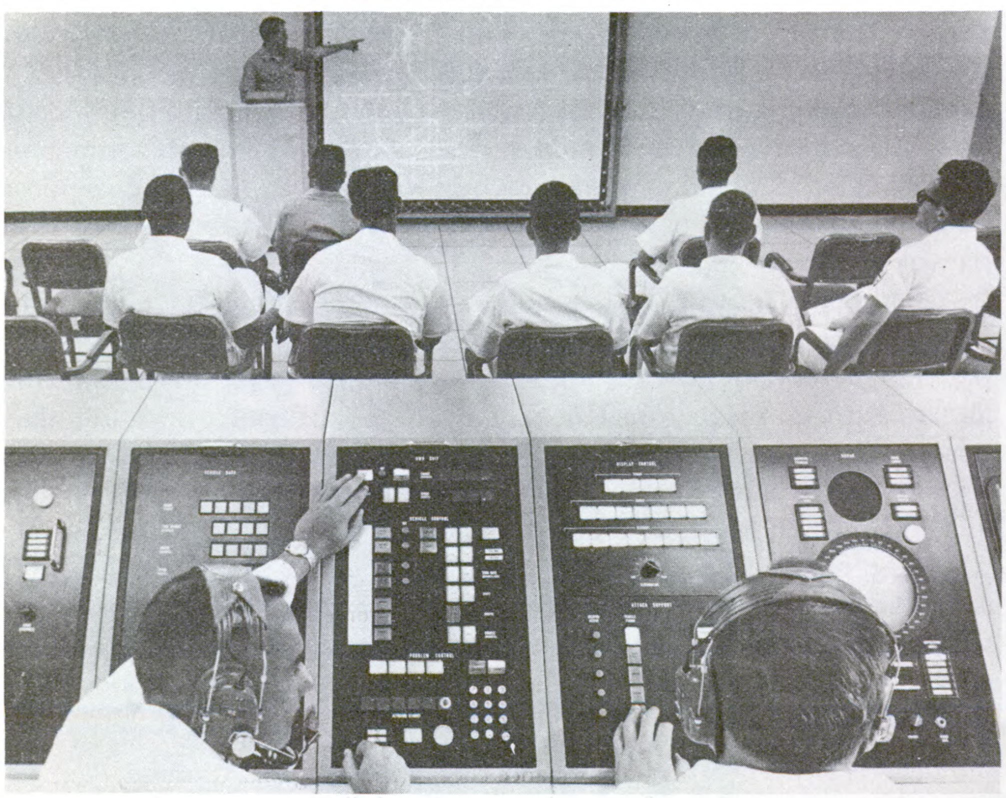
The Instructor's Console, located in the Problem Critique and Display Room, is usually manned by three or more instructors. To set up a training situation, the instructors select the appropriate ocean problem area, wind direction and velocity, and course and speed of the target submarines, support units, and aircraft. When all problem factors are set, the instructor starts the problem.

Displays showing radar and sonar data, support and target vehicle position information, and weapon operation are part of the instructor's equipment. Team performance is monitored by the instructor and he may "freeze" the problem at any point for critique.

A training problem may involve one ASROC ship, a destroyer, two support units, either destroyers or cruisers, and two target submarines, either nuclear or conventional. Three aircraft units, either fixed wing or helicopter, may be involved. One of these is used for the DASH vehicle.

To broaden the scope of training and increase realism, various simulated malfunctions of the ASROC missile, its payload, or launcher cells can be controlled by the instructor at his console. This feature helps train crews to react quickly to compensate for malfunctions which

Instructor holds critique session following a tactical exercise. Appearing in foreground is a portion of the Instructor's Console.



may occur at sea. Also, target submarines have their own weapon capability, to further increase realism.

When the own ship has delivered a weapon, the instructor measures the effectiveness of delivery, and by an automatic indication from the computer, notes whether a kill has been effected.

The use of a central, general-purpose digital computer permits great flexibility of design in Device 14A2. New subsystems can be easily added to the trainer. Present plans call for the addition of the AN/SQS-26 and AN/SQQ-23 PAIR sonar capability in the near future.

The Fleet Training Center at Newport, Rhode Island, and the Fleet Sonar School at Key West, Florida, will receive 14A2 trainers in early 1968. Installations are also planned for Long Beach, California and Pearl Harbor, Hawaii.

The 14A2 device at San Diego has been fully utilized since its installation—many times for multi-shift operation. During this period the training device has displayed an exemplary reliability record. A substantial number of commendable comments from fleet users have been received.

The 14A2 device provides effective, realistic and economical ASW tactical team training. Its inherent flexibility permits addition of new weapons and ASW systems in the future, thus preventing obsolescence and providing a training device with an extremely useful function and long service life.

NRL Frequency Monitoring System Planned for Shipboard Installation

Increasingly precise and accurate presetting and control of equipment and system frequency, time, and timing is required to achieve the needed speed, accuracy, and reliability of the radio communication, detection, location, identification, and weapons control facilities used in modern naval operations. Special instrumentation suited to the naval environment is required for this purpose: specifically, frequency and time standards of very high precision and certainty, and appropriate ancillary devices that make possible utilization of the reference standards for operational control, check, and maintenance of shipboard electronic installations.

Recently electronic engineers in NRL's Radio Division developed techniques and equipment for on-the-air measurement of multiplex sideband signal subchannel frequency and modulation and installed experimental equipment on several ships of the First Fleet. The success of the experimental installations has now resulted in a plan by the Naval Ship Engineering Center Afloat Communication Management Office (NAVSECACMO) to outfit approximately fifty ships for quality monitoring, using the type of equipment developed by NRL.

Since the units in question are not commercially available, the NRL Engineering Services Division will perform the complete production including diagrams, receiver conversion kits, spare parts and performance checks (including final circuit adjustments) on all units. The estimated time for complete outfitting of all ships is six months.

Hand Grenade Simulator

A. A. Chester
Missiles and Infantry Division
Naval Training Device Center

Some time ago, the Marine Corps submitted a requirement to the Naval Training Device Center for the simulation of the M26A2 Hand Grenade. The goal was to develop an economical, refurbishable simulator that would produce noise, fireball, smoke, and a fragment pattern approximating the operational unit. It had to look, feel, and function in the same manner as the operational equipment, and yet not be hazardous. By using such a device, the trainee would learn to overcome his initial fear of the weapon, throw it accurately, and be prepared for the detonation. Also, he would learn how effective the hand grenade can be and how to protect himself in combat situations.

Proposals from a number of qualified companies were submitted to NTDC. After careful evaluation, Special Devices, Incorporated, Newhall, California, was selected to produce the trainer. In due time, the Hand Grenade Simulator, Device 3F65, was developed and tested by the manufacturer. These tests included dropping the device from a distance of 40 feet onto sand, rock, wood, steel and concrete at temperatures ranging from 140°F to −40°F. In all cases, the device stood up exceedingly well.

The grenade body is made up of two sections, an upper and lower shell, which are cast or forged identically. The shells, which each have 28 symetrically spaced dye ports, are held together by a hollow stem located in the center of the grenade. A cartridge containing the scoring-dye-propellant and the noise, flash, and smoke composition is loaded into the stem in the same manner as a shotgun shell is loaded into a gun barrel. A rubber tube, attached at each end of the stem, forms the bladder for expelling the scoring dye. The bottom of the stem, which is turned to form the base of the grenade, is blended into the body contour.

The cartridges are supplied in two colors—red for the high sound level and blue for the low. The high sound level selected was 160 db at 25 feet; the low, 150 db at 25 feet.

The torus-shaped dye sack is made of polyethylene plastic bag material. The scoring fluid is a thixotropic mixture of Cab-O-Sil, propylene glycol, distilled water, red food coloring dye, and a trace amount of phenol perservative. The glycol prevents freezing at −40°F, while the phenol prevents fungus growth. The sack holds about 47 grams of this red-colored solution, which is sprayed out through the ports in the casing when the unit explodes.

The fuze body with a four-five second delay charge in place is procured from the current M26A2 grenade fuze manufacturer (less the detonation cup). A charge cup containing a pyrotechnic output charge is cemented and crimped in place over the output end of the fuze. When the simulated grenade is thrown, the handle flies off, releasing the pivot firing pin arm in the fuze. The firing pin strikes the primer, which in turn ignites the delay composition. Within four or five seconds, the delay composition burns through and ignites the pyrotechnic output charge at the end of the fuze. This, in turn, opens the bottom of the charge cup and ignites the cartridge.

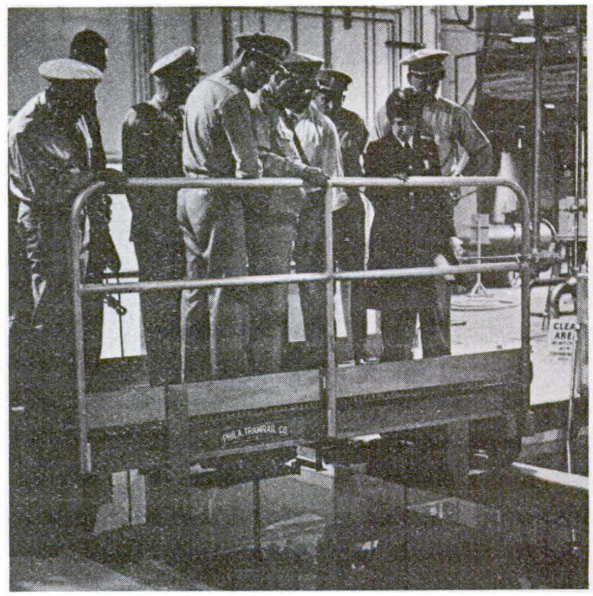
When the cartridge explodes, the scoring dye propellant produces a gas pressure of approximately 200 psi. The gas expands the bladder which expels the dye—to a distance of about 20 feet—through the 56 ports located on the outer shells. As the propellant burns, a piece of quick match fuze is ignited which transfers the ignition to the smoke, noise, and flash compositions within a few milliseconds.

One thousand Hand Grenade Simulators have recently been delivered to the Marine Corps and the Army. They are currently being evaluated by units at Camp Lejuene and Camp Pendleton.

The 16th National Infrared Information Symposium will be held at Fort Monmouth, New Jersey, May 7-9, 1968. Additional information may be obtained from Dr. T. B. Dowd, ONR Boston, 495 Summer Street, Boston, Mass. 02210.

On the Naval Research Reserve

NRRC 3-9 Plans Second Weekend Seminar at Brookhaven



Attendees at Brookhaven seminar view spent fuel rods from High Flux Beam Reactor

The Reserve officers who attended last year's weekend seminar sponsored by NRRC 3-9 at the Brookhaven National Laboratory will have a second opportunity to visit the unique facility. Plans are currently being made to hold a second weekend seminar on June 8-9, 1968. The subject of the seminar will be "Recent Advances in Nuclear Research."

During last year's seminar, Reservists toured facilities located at the Laboratory and heard a number of excellent presentations on the work being conducted there (see *Naval Research Reviews* issue of December 1967, "Brookhaven Briefs the Navy"). They were particularly interested in seeing the world's most powerful generator of concentrated high energy, Brookhaven's Alternating Gradient Synchrotron (affectionately referred to as "Agnes" by Brookhaveners), and the High Flux Beam Reactor which is entirely encased in a pressurized metal sphere to contain any radiation that might leak out.

Forty-two officers, including several from NROS and Air Reserve Units, attended the 1967 seminar. However, CAPT Victor Bond, USNR, Commanding Officer of NRRC 3-9, reports that arrangements are being made to accommodate as many as 60 officers during the 1968 seminar.

LCDR Schickler Cited by COMASWFORLANT

LCDR Edward R. Schickler, USNR-R, Commanding Officer of NRRC 3-4, was commended recently by VADM Paul Masterton, Commander Antisubmarine Warfare Force Atlantic Fleet for his suggestion to improve sonobuoy plant spacing during the CODAR phase of submarine localization. While studying high-speed motion picture film in connection with his work on sonobuoys at General Dynamics Electronics Division, Rochester, New York, LCDR Schickler noted that random orientation of the sonobuoy rotochutes in the launcher tubes interjected a noticeable error in impact spacing because of resultant variations in the time required for the rotochute to reach its terminal rotational velocity. When the rotochutes in the launcher tubes were uniformly oriented, there was no apparent variation in sonobuoy deceleration time.

LCDR Schickler's suggestion was submitted in response to a call for ideas issued by COMASWFORLANT. It is currently being investigated.

NRRC 3-17 Report

Members of NRRC 3-17, New York have recently had an opportunity to hear a number of stimulating presentations which not only have helped to keep them abreast of developments in naval research but also form a valuable background to the personal development of their civilian careers. These presentations included discussions on:

- Practical accomplishments that may be achieved by studying the oceans by satellite and manned aircraft—CAPT Benjamin T. Brooks, Jr., USNR-R, an officer of William H. McGree and Company;
- Meaningful leadership studies of unmotivated men locked in unimaginative assembly line procedures—CDR William Kendall, USNR, an officer of the Psychological Corporation;
- Development of underprivileged children in the New York City schools—LCDR Margaret Clancy, USNR(W); and
- The new frontiers of food preservation through gamma ray radiation—LCDR John Korth, USNR, an executive of the Corn Products Company.

NRRC 3-17 holds its biweekly meetings in the Older Grads Room of the Columbia Club in midtown New York City. LCDR Philip De Vries is the Commanding Officer.

Selected Contract Research Reports

The contract research reports listed below have been extracted from U.S. Government Research & Development Report 67, No. 24 of December 25, 1967 and 68, No. 1 of January 10, 1968. 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 USGRDR 67, No. 24 and 68, No. 1.

For non-DDC users, most reports may be purchased from the Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, Springfield, Virginia 21151.

ASTRONOMY AND ASTROPHYSICS

Solar Models; Princeton; Dicke; AD-659 884

Measurement of Cosmic Background Radiation at 3.2-cm Wavelength; Princeton; Roll *et al;* AD-660 058

Photometry of the Planets; Ariz. U.; Gehrels; AD-660 779

A Theory of Dust Comets; M.I.T.; Finson and Probstein; AD-660 652

ATMOSPHERIC SCIENCES

Theory of Ion Collection by a Supersonic Sounding Rocket in the D-Region; M.I.T.; Sonin; AD-660 650

Satellite Observations of VLF Emissions and Their Association With Energetic Charged Particles; Iowa U.; Gurnett; AD-661 240

Earth's Particles and Fields; IIT Research Inst.; Davies *et al;* AD-661 316

The Energy Dependence of the Fragmentation Parameters and Interaction Mean Free Paths in Nuclear Emulsions for Heavy Cosmic Ray Nuclei; Minn. U.; Cleghorn; AD-659 992

Microburst Phenomena. An Association Between Electron Microbursts and VLF Chorus; Iowa U.; Oliven and Gurnett; AD-660 195

Microburst Phenomena. Auroral Zone X-Rays; Iowa U.; Oliven *et al;* AD-660 196

Microburst Phenomena. Auroral Zone Electrons; Iowa U.; Oliven *et al;* AD-660 375

Solar Radiation and Atmospheric Absorption in the mm Wave Region; Calif. U.; Silver and Welch; AD-660 426

BEHAVIORAL AND SOCIAL SCIENCES

Actual vs Ideal Time Allocations Reported by Managers: A Study of Managerial Behavior; Pittsburgh U.; Haas *et al;* AD-660 693

Relevance Disagreements and Unclear Request Forms; Institute for the Advancement of Medical Communications; O'Connor; AD-660 918

Communication, Cooperation, and Negotiation in Culturally Heterogeneous Groups; Ill. U.; Fiedler and Triandis; AD-660 674

A Learning Test Approach to Predicting Classroom Performance; Wash. U.; Wordrop; AD-661 276

Communications Effectiveness in Developing Countries; HRB-Singer, Inc.; McKendry *et al;* AD-660 694

Pilot Study for Basic Indices: Trends in International Social Change; Stanford; North and Choucri; AD-660 427

Impression Formation as a Measure of the Complexity of Conceptual Structure; Douglass Coll.; Streufert and Driver; AD-659 962

Research in Sensory Threshold Measurement; John Tracy Clinic; Lowell; AD-660 011

Cost, Profit, Certainty and Failure; Purdue; Streufert and Kliger; AD-660 392

Effect of Distributed Practice on Paired-Associate Learning; Northwestern; Underwood and Ekstrand; AD-660 469

Studies of Distributed Practice: Differentiation and Proactive Inhibition; Northwestern; Underwood and Ekstrand; AD-660 470

Word Frequency and Accumulative Proactive Inhibition; Northwestern; Underwood and Ekstrand; AD-660 476

BIOLOGICAL AND MEDICAL SCIENCES

Conversion of Reduced Nicotinamide-Adenine Dinucleotide Dehydrogenase into Reduced Nicotinamide-Adenine Dinucleotide-Ubiquinone Reductase; Calif. U.; Salach *et al;* AD-659 899

Significance of the Amino Acid Composition of Proteins. Composition of Hemoglobins and Myoglobins in Relation to Their Structure, Function and Evolution; St. U. of N.Y.; Atassi; AD-660 527

The Influence of Diet-Induced Hyperphenylalaninemia on Molecular Neurochemistry and Learning Behavior in the Rat; York U.; Mottin and Gaito; AD-661 206

Molecular Psychobiology Laboratory: Development and Progress; York U.; Gaito; AD-661 207

Marenzelleria Wireni Augener—A Polychaete Found in Fresh Waters of Northern Alaska—With Taxonomical Considerations on Some Related Spionid Worms; Arctic Inst. of N. Amer.; Holmquist; AD-660 643

A Stochastic Model for the Attachment and Detachment of Antibodies to Virus; Stanford; Gani and Srivastava; AD-660 716

Physiological and Biochemical Aspects of Spore Formation and Germination; Texas U.; Rode; AD-660 718

Hippocampal States and Functional Relations With Corticosubcortical Systems in Attention and Learning; Cal. U.; Adey; AD-661 125

Synodic Monthly Modulation of the Diurnal Rhythm of Hamsters; Northwestern; Brown, Jr. and Park; AD-660 232

Altered Pulmonary Hemodynamics Following Experimental Decompression Sickness; Harbor General Hospital; Cockett and Kado; AD-659 901

Vision Research in Military and Government Laboratories; Kansas St. U.; Brown; AD-660 034

Application of the ISO Standard Reference Zero (Audiometric); National Academy of Sciences; Davis; AD-659 970

The Effects of Gaseous Ions on Living Organisms; Cal. U.; Krueger; AD-660 028

Aging, Noise, and Choice; Syracuse U.; Goldman; AD-660 382

Effects of Hyperbaric Oxygenation on Metabolism. Time Sequence of Biochemical Changes at 5 Atmospheres 100% Oxygen; Duke U.; Sanders and Hall; AD-660 473

Recovery From Oxygen Poisoning in Drosophila; Rochester U.; Fenn *et al;* AD-660 477

CHEMISTRY

Infrared and Nuclear Magnetic Resonance Studies of Some Germanium Phthalocyanines and Hemiporphyrazines; Case Inst. of Tech.; Esposito *et al;* AD-659 934

Metallo Semi-Inorganic Polymers; Olin Mathieson Chemical Corp.; Pitts and Hurley; AD-660 367

The Preparation of Pentaborane-11 in Bench Scale Quantities; Aerojet General Corp.; Ditter *et al;* AD-660 369

Alkyl-and Arylaluminum Complexes. Polymerizations of Diethylaluminum-2-Aminoethoxide and Diethylaluminum-3-Aminopropoxide; Olin Mathieson Chemical Corp.; Scruggs *et al;* AD-660 400

Lyman-Alpha Radiation Resulting From Ion Collisions With Molecular Gases; Wash. U.; Zyl *et al;* AD-659 841

Thermodynamics With Internal State Variables; Mellon Inst.; Coleman and Gurtin; AD-659 896

Structure and Properties of Metallic Solutions; Chicago U.; Barrett and Kleppa; AD-660 027

Enhancement of the Conductivity Modulation Effect in Salt Solutions; Georgia Inst. of Tech.; Bonham, III and Rivers, Jr.; AD-660 032

Applications of Molecular Beams to the Measurement of Collision Cross Sections and to the Determination of Intermolecular Forces; M.I.T.; Amdur; AD-660 042

Interaction of Atoms and Molecules With Solid Surfaces; Syracuse; Trischka; AD-660 217

Fluctuation Phenomena and Phase Transitions in Condensed Systems; Syracuse; Brumberger; AD-660 222

14N Hyperfine Structure of Triphenylaminium Radical Ions; N.Y. U.; Mohammad and Sundheim; AD-660 254

Effect of Pressure on the Dissociation of the (LaSO4) (+) Complex Ion; Scripps; Fisher and Davis; AD-660 496

Turbulent Flow Properties of Viscoelastic Fluids; Delaware U.; Seyer and Metzner; AD-660 788

Properties of the Fokker-Planck Equation; Cornell; Liboff and Fedele; AD-660 606

Calculation of Three-Body Ionic Recombination Rate; M.I.T.; Landon and Keck; AD-660 649

Vibrational Relaxation of Anharmonic Oscillator Molecules; M.I.T.; Bray; AD-660 651

A New Analysis of Data Obtained With Galvanostatic and Coulostatic Single Pulses; N.Y. U.; Kooijman; AD-660 692

Rigid-Lattice NMR Moments and Line Shapes With Chemical Shift Anisotropy; Ill. U.; VanderHart and Gutowsky; AD-660 787

Chemical Exchange and Transient Effects in an AB-Type NMR Spectrum; Ill. U.; Gore and Gutowsky; AD-660 789

The Electrical Conductivity of Aqueous Tetra-Alkylammonium Halide Solutions Under Hydrostatic Pressure; Little (Arthur D.), Inc.; Horne and Young; AD-661 218

EARTH SCIENCES AND OCEANOGRAPHY

Biofouling Studies Off Panama City, Florida. The Two-Mile Offshore Station; Texas A & M; Pequegnat *et al;* AD-661 239

Topographic Changes in the Surf Zone Profile; La. St. U.; Sonu and Russell; AD-661 169

Oceanographic Observations During the Line Islands Expedition, February-March, 1967; Hawaii Inst. of Geophysics; Wyrtki; AD-661 208

Photographic Beach Measurements; La. St. U.; Dolan; AD-661 171

The Geomorphology of Beach Ridges in Tabasco, Mexico; La. St. U.; Psuty; AD-661 194

Coastal and Fluvial Landforms: Horry and Marion Counties, South Carolina; La. St. U.; Thom; AD-661 195

River and Delta Morphology; La. St. U.; Russell; AD-661 196

Studies of Submarine Canyons and Fans Off Southern California; U. of S. Car.; Gorsline *et al;* AD-661 246

Geography and the Properties of Surfaces. Proposed Solution for the Minimum Path Problem; Harvard; Lindgren; AD-660 193

Preliminary Catalog of Tsunamis Occurring in the Pacific Ocean; Hawaii Inst. of Geophysics; Iida *et al;* AD-659 991

Oceanographic Observations During 1965-1967 in the Hawaiian Archipelago; Hawaii Inst. of Geophysics; Wyrtki *et al;* AD-659 995

Underwater Acoustic Wavefront Variations and Internal Waves; Woods Hole; Wagar *et al;* AD-660 218

An Investigation of Sea Surface Temperature Patterns in the Gulf of Mexico as Determined by an Airborne Infrared Sensor; Gulf South Research Inst.; Drennan; AD-660 366

Geography and the Properties of Surfaces. The Identification of Mixed Hexagonal Central Place Hierarchies With Examples From Finland, Germany, Ghana and Nigeria; Harvard; Woldenberg; AD-660 194

Developments in the Application of Earth Observation Satellites to Geographic Problems; N.A.S.; Risley; AD-660 140

Arctic Research; Arctic Inst. of N. America; Bader *et al;* AD-660 372

Mineralogy and Petrology of Some Mid-Atlantic Ridge Sediments; Woods Hole; Siever and Kastner; AD-660 517

Project ADD; Woods Hole; Hess; AD-660 067

Investigations of Tropical and Subtropical Seas, 1966-1967; Miami U.; Drost-Hansen; AD-660 220

Atlantis Cruise No. 251, Track Charts, Bathymetry, and Location of Observations, North Atlantic Ocean, Blake Plateau, November 4, 1959-December 2, 1959; Woods Hole; Dunkle and Bumpus; AD-660 516

Inelasticity of Crystalline Rock at High Pressure: Application to Tidal Friction and Seismology; Yale U.; Gordon; AD-659 988

Seismic Refraction Measurements in the Southern Indian Ocean; Scripps; Francis and Raitt; AD-660 519

ELECTRONICS AND ELECTRICAL ENGINEERING

Second Supplementary Report on the Control System Shipboard Data Processing and Control System (ODPCS) Aboard the Research Vessel Chain, October 1963 to December 1966; Woods Hole; Bowin *et al;* AD-659 960

The PDPMAP Assembly System; Pa. U.; Johnson and Wolfberg; AD-660 048

A Comparison of Convolutive and Sequential Schemes for Signal Processing; Johns Hopkins U.; Cohen; AD-660 228

The Effect of Autoregressive Dependence on a Nonparametric Test; Johns Hopkins U.; Wolff *et al;* AD-660 229

Robust Two-Input Correlators; Johns Hopkins U.; Wolff and Gastwirth; AD-660 230

The Theory of Coupled Linear Antennas and Transient Response; Harvard; Padhi; AD-660 373

Anharmonic, Thickness-Twist Overtones of Thickness-Shear and Flexural Vibrations of Rectangular, Atcut, Quartz Plates; Columbia; Mindlin and Spencer; AD-661 197

A Quantum Optical Phenomenon: Implications for Logic; Bolt, Beranek and Newman, Inc.; Ring *et al;* AD-661 089

Representation and Analysis of Signals. Statistical Estimation of Intrinsic Dimensionality and Parameter Identification; Johns Hopkins U.; Trunk; AD-661 210

Representation and Analysis of Signals. Properties of Non-Gaussian, Continuous Parameter, Random Processes as Used in Detection Theory; Johns Hopkins U.; Pierre; AD-661 211

Minimum-Redundancy Linear Arrays; CalTech; Moffet; AD-660 920

ENERGY CONVERSION (NON-PROPULSIVE)

Stream Powered Generator; Philco-Ford Corp.; AD-660 009

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The Study of Alloy Surfaces by Low Energy Electron Diffraction; Yale; Robertson; AD-660 719

Studies of Stress Corrosion Cracking by the Mossbaüer Effect; Mithras, Inc.; Terrell *et al;* AD-660 038

Phase Stability Considerations, Structural, Mechanical, and Electronic Properties of HCP Transition Metal Alloys in the Group Number Range 6.8 to 8.4; Battelle Memorial Inst.; Jaffee *et al;* AD-660 425

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Residual Variance Scaling and Matrix Approximation; Wash. U.; Horst; AD-660 035

Bayesian Design of Single, Double, and Sequential Stratified Sampling for Estimating Proportion in Finite Populations; Stanford; Zacks; AD-660 045

Measures of Global Relative Curvature; Stanford; Feder; AD-660 682

Infinite Dams With Inputs Forming a Markov Chain; Stanford; Khan and Gani; AD-660 715

Surveillance Problems: A Program for Obtaining Optimal Costly Surveillance Strategies for a Poisson Production Process; Fla. St. U.; Russell; AD-661 198

Approximate Small-Sample Distributions for Multivariate Two-Sample Nonparemetric Tests; Fla. St. U.; Patel and Bradley; AD-661 199

The Limiting Distribution of the Likelihood Ratio Statistic Under a Class of Local Alternatives; Fla. St. U.; Davidson and Lever; AD-661 200

Convergence Rates for Empirical Bayes Two-Action Problems. Discrete Case; Stanford; Johns, Jr. and Van Ryzin; AD-661 250

Convergence Rates for Empirical Bayes Two-Action Problems. Continuous Case; Stanford; Johns, Jr. and Van Ryzin; AD-661 251

Necessary Conditions for Almost Sure Extinction of a Branching Process With Random Environment; N. Caroline U.; Smith; AD-661 300

Some Estimation Problems Related to a Geometric Distribution and a Sum of Two Independent Nonidentically Distributed Random Variables; Stanford; Sclove and Van Ryzin; AD-660 684

Estimation of Probability Density and Distribution Functions; Purdue; Kashyap and Blaydon; AD-660 690

A Search for Simple Groups of Orders Less Than One Million; CalTech; Hall, Jr.; AD-660 717

A Strong Mixing Condition and a Central Limit Theorem on Compact Groups; Cal. U.; Rosenblatt; AD-661 173

Calculation of Gauss Quadrature Rules; Stanford; Golub and Welsch; AD-661 217

Theorems About Beurling's Generalized Primes and the Associated Zeta Function; Ill. U.; Hall; AD-661 238

On Large Deviations of Linear Rank Statistics; Stanford; Woodworth; AD-659 994

New Results on Periodic Surfaces and the Averaging Principle; Calif. U.; Diliberto; AD-660 052

On the Distribution of Products of Independent Beta Variables; Wash.; Lomnicki; AD-660 189

Improved Estimators for Coefficients in Linear Regression; Stanford; Schlove; AD-660 215

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An Intrinsically Determined Markov Chain. A Test for Suboptimal Actions in Markovian Decision Problems; Cal. U.; MacQueen; AD-659 838

Reducing Concave Programs With Some Linear Constraints; Cal. U.; Geoffrion; AD-659 839

Proper Efficiency and the Theory of Vector Maximunization; Cal. U.; Geoffrion; AD-659 989

The Empirical Determination of Indifference Curves; Cal. U.; MacCrimmon and Toda; AD-659 990

Production Smoothing With Stochastic Demand and Related Inventory Problems; Stanford U.; Sobel; AD-659 993

Two Algorithms for Solving the Independent Multi-Dimensional Knapsack Problem; Carnegie; Green; AD-659 996

An Algorithm for Integer Linear Programming by Parametric Modification of an Added Constraint; Cal. U.; Eto; AD-660 007

Multicommodity Steady State Inventory Model Subject to Linear Restrictions; Cal. U.; Hueda; AD-660 008

Some Experimental Non-Constant-Sum Games Revisited; Yale; Shubik and Stern; AD-660 204

Minimum Concave Cost Solution of Leontief Substitution Models of Multi-Facility Inventory Systems; Varian Associates; Veinott, Jr.; AD-660 214

Minimax Results for IFRA Scale Alternatives; Cal. U.; Doksum; AD-660 376

A Markovian Replacement Model With a Generalization to Include Stocking; Stanford; Ross; AD-660 403

A Generalized T Test and Measure of Multivariate Dispersion; North Carolina U.; Hotelling; AD-660 528

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Survey of Methods of Analysis for Plastic Deformation of Structures Under Dynamic Loading; Brown U.; Symonds; AD-659 972

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On Two Time-Scales in Linear Systems With Special Reference to Adaptive Control; Yale U.; Narendra and Shapiro; AD-660 514

Advanced Aerodynamic Test Facilities and the 'Slingshot' Concept; Polytechnic Inst. of Brooklyn; Perry; AD-660 511

Stereoscopic Representation of Bathymetric and Magnetic Profiles; Scripps; Harrison and Mudie; AD-660 520

Aerial Measurement of Sea Surface Temperature in the Infrared; Woods Hole; Saunders; AD-661 157

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Top Management Reporting at the Aviation Supply Office—Practice and Possibilities; Pa. U.; McNulty and Thrash; AD-478 499

Remarks on Renewal Theory When the Quality of Renewals Varies; N. Carolina U.; Smith; AD-661 299

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Underwater Speech Communication; Fla. U.; Hollien *et al;* AD-661 244

Preliminary Measurements of Pressure Response to Low Frequency Signals in Shallow Water; Fla. U.; Hollien *et al;* AD-661 245

A Study of Low-Noise Broadband VLF Receiving Techniques; Stanford; Rorden; AD-660 050

The Effect of Predesignation Information Upon Target and Checkpoint Recognition Performance; Autonetics; Sturm *et al;* AD-481 740

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Echoes From Hollow Aluminum Spheres in Water; Texas U.; Diercks and Hickling; AD-660 522

A Study of Lithium Fluoride Etch Morphologies Using Silica Gel; Mcmaster U., Hamilton (Ontario, Canada); Ives and McElroy; AD-660 381

A Field-Electron Emission Determination of the Work Function of the Tungsten (211) Plane; Notre Dame; Dinan *et al;* AD-660 210

The Surface Physics of Simple and Complex Electron Emitters; Notre Dame; Coomes and Petrauskas; AD-660 211

Experiments on Free and Impinging Underexpanded Jets From a Convergent Nozzle; Aeronautical Research Associates; Snedeker and Donaldson; AD-461 622

Experiments on Turbulent Boundary Layers Along a Circular Cylinder With and Without Separation; M.I.T.; Fernholz and Gibson; AD-660 017

Solution of the Time-Dependent Navier-Stokes Equations for the Flow of Dissociating Gas Over a Circular Cylinder; General Electric Co.; Scala and Gordon; AD-660 037

Pressure Fluctuation Measurements in Dilute Polymer Solutions; Hydronautics, Inc.; AD-660 049

The Stability of Parallel Flows of Fluids With Memories; Mich. U.; Mook and Graebel; AD-660 374

The Effect of Dilute Solutions of Drag Reducing Polymers on Radiated Flow Noise; Minn. U.; Killen and Crist; AD-660 387

Modified Weissinger Lifting Surface Method for Calculating Aerodynamic Parameters of Arbitrary Wing-Canard Configurations; Air Vehicle Corp.; Yager *et al;* AD-660 423

Stimulated Raman Emission and Self-Focusing of a Laser Beam in Non-Linear Media; Cornell; Abbi; AD-660 031

Continuous-Wave Stimulated Raman Emission; Perkin-Elmer Corp; Tobin and Barrett; AD-660 212

Deviations From the $I(I+1)$ Law in Deformed Nuclei; Carnegie-Mellon U.; Landowne and Mariscotti; AD-659 968

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Nuclear Deformations in the Pairing-Plus-Quadrupole Model. Justification of the Model; Carnegie-Mellon; Baranger and Kumar; AD-660 041

Measurements of the Polarization of Protons from Deuteron Photo-Disintegration; Stanford; Liu *et al;* AD-660 073

Gamma-Ray Calibration Energies; CalTech; Marion; AD-660 419

ALBERT: A Package of Four Computer Programs for Calculating General Relativistic Curvature Tensors and Equations of Motion; CalTech; Thorne and Zimmerman; AD-660 044

Theories of Gravitation; Queens Col.; Harvey; AD-660 053

Couple-Stresses and Singular Stress Concentrations in Elastic Solids; CalTech; Sternberg; AD-660 023

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Mechanical and Thermodynamic Considerations of an Assemblage of Homogeneous Elastic-Plastic States; Brown U.; Rubin; AD-659 943

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Structural Study on Bobatrachotoxin, a Potent Venom

The most poisonous nonprotein material known comes from the skin of the South American kokoi frog found in Colombia. Native Choco Indians tip their arrowheads with the toxin and use it in game hunting. The action of the poison is to instantly paralyze the muscles, the central nervous system, and ultimately the heart; however, the flesh of the animal can be consumed safely. No antidote is known.

A team from the National Institutes of Health, aided by native Indians, collected about 4000 frogs in Colombia and prepared extracts of the venom on the spot. Purification and isolation was carried out at NIH over a period of several years. Unfortunately the purified active material was not stable and the amount of material available after purification was of the order of micrograms, much too small a quantity to determine the molecular formula of the material by chemical means. Chemical derivatives were made which proved to be stable in air and light and ultimately minute crystals of the derivative were grown. The largest of these, $0.05 \times 0.03 \times 0.15$ mm, was used by scientists at NRL's laboratory for the Structure of Matter for an x-ray diffraction analysis. It was possible to collect sufficient diffraction data of this noncentrosymmetric crystal to perform a complete structure analysis. All 39 atoms of the derivative were located and the molecular formula and stereoconfiguration were established. With the knowledge of the molecular configuration of the derivative, it will now be possible to determine the molecular configuration of the poison itself and perhaps sythesize the material. Furthermore, the unusually potent physiological activity can be correlated with the molecular configuration.

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Military Training Devices

The mission of the Naval Training Device Center, Orlando, Florida is to contribute to the operational readiness of the Armed Forces by developing, procuring, and delivering training devices that are applicable to all types of military operations. This training equipment not only contributes to the combat readiness of the military but also has proved cost effective in the modern world of complex military equipment and systems.

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