



# The Extended Echo Ranging Aural and Visual Support Trainer

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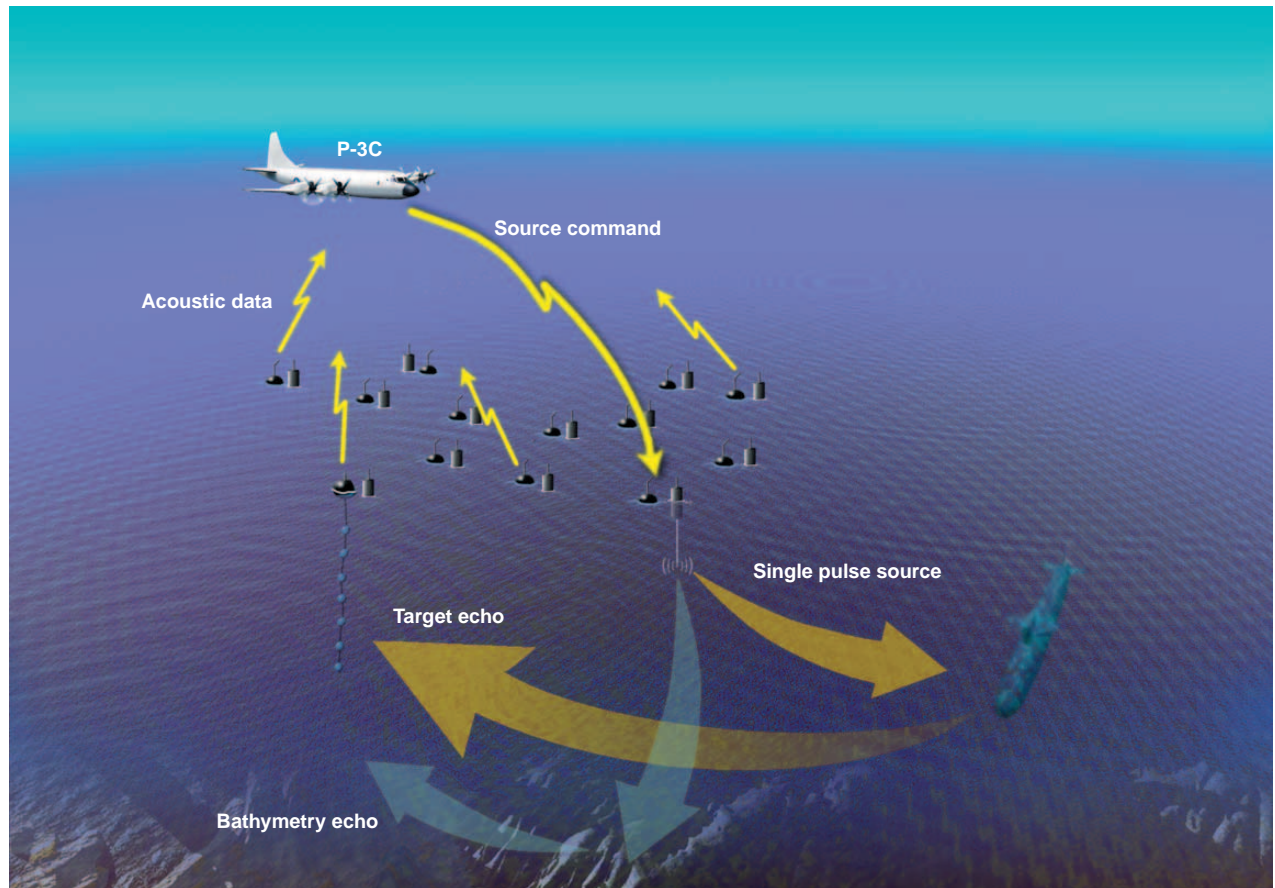
**T**he Extended Echo Ranging (EER) Aural and Visual Support Trainer (AVST) provides signal recognition training for Navy aviation warfare systems operators. EER is an air-deployed active multisensor acoustic system designed for P-3C aircraft. The active system relies on the detection of submarine echoes generated by reflected impulsive acoustic energy generated by underwater sources commanded by the aircraft. Operators, monitoring multiple sonobuoy receivers, attempt to classify any detected echoes. Target recognition, a key element to the success of an EER mission, is complicated by the detection of nontarget echoes, independently generated acoustic transients, and system-induced electrical pops. The AVST provides a database of recorded real-world EER signals tied to automated testing that progressively challenges the operators as their measured proficiency increases. The training software package is hosted on a Navy standard personal computer system and is currently being widely distributed to all patrol aviation squadrons and their associated naval commands.

(Keywords: Air antisubmarine warfare, Extended Echo Ranging, Sonar.)

## INTRODUCTION

The Extended Echo Ranging (EER) Aural and Visual Support Trainer (AVST) is an APL-developed desktop computer training system dedicated to training sonar operators in signal recognition. EER is an air-deployed, active multisensor sonar system hosted on a P-3C aircraft. The system emerged in response to the deployment of increasingly quiet Soviet submarines in the late 1970s and 1980s that began to challenge traditionally reliable passive systems.<sup>1</sup> As Fig. 1 illustrates, to detect a submarine (target), the aircraft deploys a

distributed field of sonobuoy receivers and sources. The aircraft then commands a source to transmit (ping) a single burst of acoustic energy. Between pings, the onboard operators monitor uplinked acoustic data from several sonobuoys (see the boxed insert). The intent is to detect reflecting source energy from a target, i.e., detect a target echo. Using the arrival time and bearing (enabled by small-aperture, directional hydrophones) of the target echo, the aircraft can localize the target for prosecution if necessary.<sup>2</sup> Before localization, how-



**Figure 1.** The Extended Echo Ranging System consists of a P-3C aircraft that deploys a field of sources and receivers. Controlled source energy is intended to acoustically illuminate the target to generate a detectable target echo.

ever, the operators on board the aircraft must identify the target echo from among similar, yet discernible, nontarget pulses originating from ocean bottom reflections or other independently generated transients such as whale chirps or electrical pops generated within the sonobuoy or aircraft electronics.<sup>3</sup> To discern a target echo from nontarget detections, operators listen and look for signal clues. Timely and accurate signal classification is key to the success of the EER mission. The AVST bolsters an operator's ability to classify EER signals.

The AVST provides an interactive environment in which an operator can train with a database of EER signals collected from at-sea exercises. The database consists of signals from a variety of areas, environments, and seasons. Each signal may be played through headsets while simultaneously displayed using an emulated EER classification display. The operator can either manually select labeled signals from the database or let the AVST provide the signals in the form of an automated test. When in testing mode, the operator's skill level improves as he or she translates testing feedback into a set of personal rules for signal identification. As testing proceeds, the AVST accumulates statistical

information on operator performance and signal difficulty. It is the signal difficulty statistics that provide the means to build tests of varying difficulty.

## BACKGROUND

The AVST originated from analysis at APL dedicated to exploring tracking and data fusion algorithms intended to enhance automatic target recognition for EER (see Coon in this issue). Value-added measurements for developed approaches required an understanding of the operator's ability to aurally and visually classify a signal. To this end, APL developed a database of signals to test operators. Through testing, it became apparent that performance was strongly related to experience and training. This finding, combined with the Navy's need for cost-effective training, resulted in APL's developing the AVST.

Initial AVST deliveries were hosted by a Sun Sparc system that operated in a classroom setting at two patrol aviation commands: Patrol Wing 11 in Florida and Patrol Wings Pacific in Hawaii. The trainer provided access to labeled signals in a database that instructors displayed on a large-screen TV or projection screen.

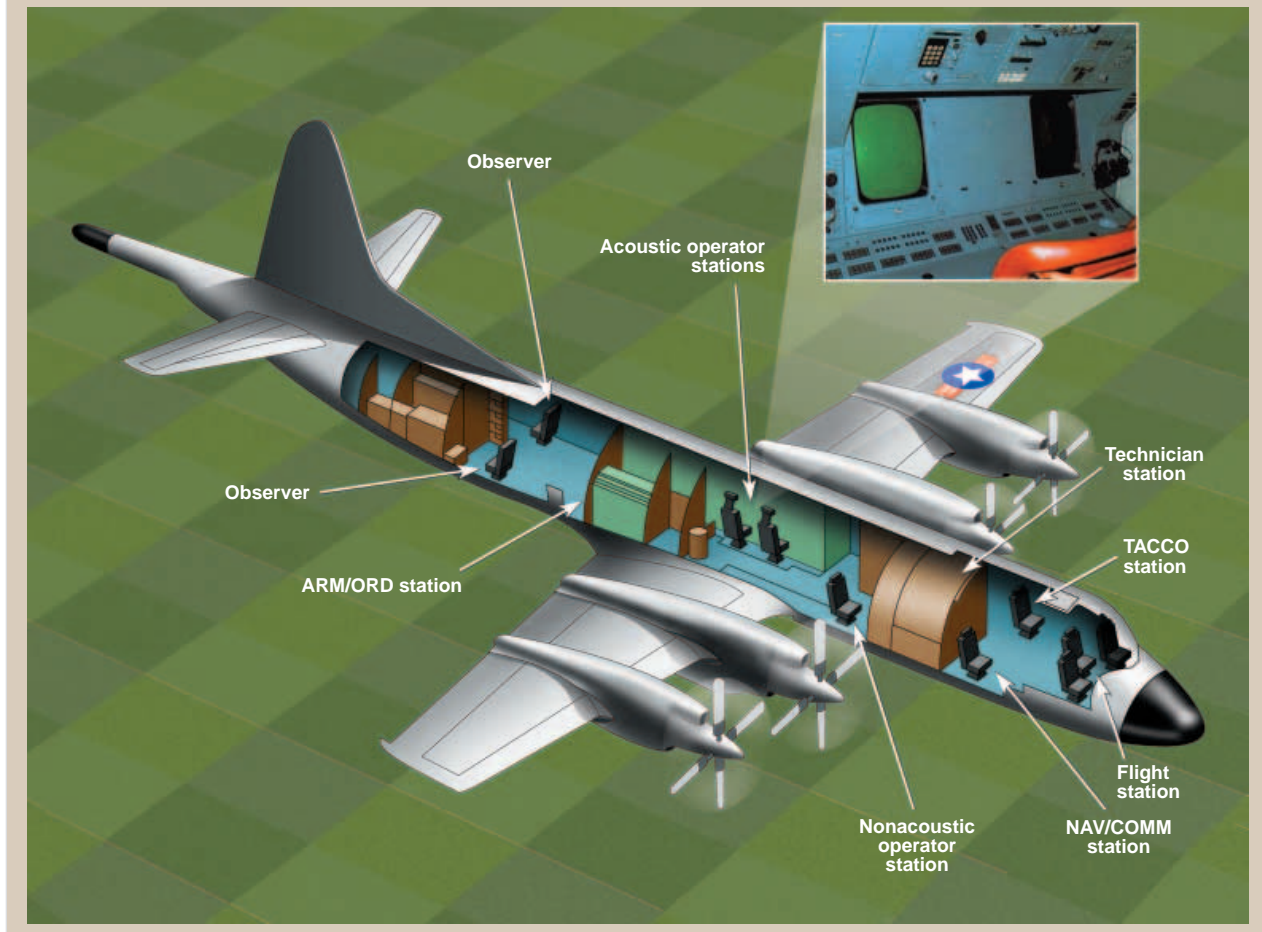
Multiple headsets and speakers provided the audio. This first version was built and delivered in 9 months in close coordination with Navy instructors and specialists in Navy operator-machine-interface design from the Naval Air Warfare Center at Naval Air Station, Patuxent River, Maryland. In addition to training new EER crews, the AVST served, and continues to serve, as an analysis tool at the Naval Air Warfare Center and APL for measuring various aspects of operator performance.

When EER passed its operational testing in the fall of 1995 and became a Fleet asset, the AVST moved from the Sun to a less expensive, more widely available Navy standard personal computer (PC) referred to as the Aviation Multifunction Electronic Warfare Trainer (AMEWT). The AMEWT hosts a number of one-on-one software training packages for naval aviation training. The Naval Air Warfare Center Weapons Division and PMA-205 in the Naval Air Systems Command manage configuration and distribution of the AMEWTs.

### P-3C CREW STATIONS

The P-3C aircraft was designed and built to be operated as an integrated team effort, as illustrated in the figure. The tactical coordinator (TACCO) is responsible for using appropriate tactics to carry out a mission and for coordinating the functions of the entire flight crew. The decision to ultimately call a target detection and transition to localization rests with the TACCO. The acoustic sensor operators (sensor 1 and sensor 2) pass bearing and time-of-arrival information of favorably evaluated detections to the TACCO, who uses the information with a geographical display. The pilot, as aircraft commander, is responsible for all aspects of aircraft safety and coordinates antisubmarine warfare tactics with the TACCO. The mission commander of the crew, either the TACCO or the pilot, is responsible for all phases of the assigned mission. A copilot and third pilot assist the pilot in those responsibilities. The flight

engineer (one or two per crew) performs exterior and interior maintenance checks on the aircraft and monitors engine and other system controls during flight. The navigator/communicator (NAV/COMM) operator is responsible for aspects of navigating and performing tactical communications. The nonacoustic sensor operator (sensor 3) is responsible for the proper operation of the radar and other nonacoustic sensors. The in-flight technician is responsible for in-flight repair of avionics equipment. An observer is also assigned who is typically in training for a primary crew position. At least one crew member is ordnance qualified, i.e., responsible for preparing all internally stored armament and ordnance (ARM/ORD) during a mission. All pilots are qualified naval aviators, and TACCOs and NAV/COMMs are qualified naval flight officers. All other P-3C flight crew positions are filled by enlisted personnel.



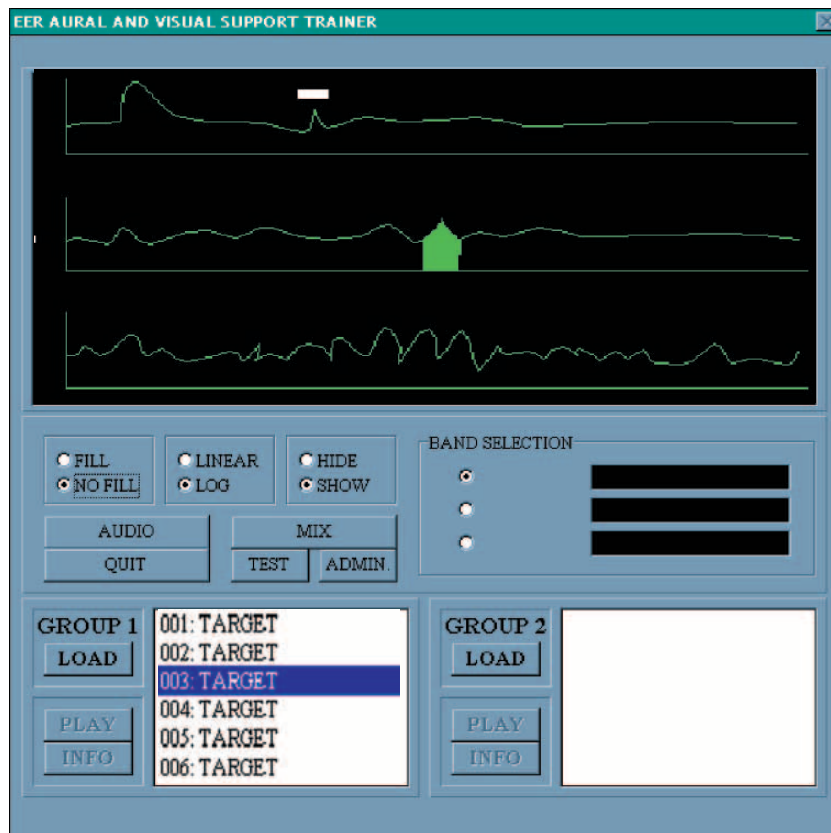
Currently, there are over 460 AMEWTs distributed throughout the patrol aviation community. In addition to the migration of the AVST from the Sun to the PC, Navy emphasis on self-directed study gave rise to the development of an automated testing capability. The first AMEWT software build with automated testing was distributed to the Fleet in June 1996.

## AURAL AND VISUAL SUPPORT TRAINER DESCRIPTION

### AVST Functional Overview

The operator invokes the AVST from a menu of options available on the AMEWT system and logs on. Following logon, the operator loads signals into the AVST for evaluation from a database of real-world signals. Figure 2 shows the main AVST display. The upper part of this display mimics the P-3C EER signal recall display seen on the aircraft; the lower part contains AVST controls. The controls are kept simple and easy to learn so that the operator can focus on developing signal identification skills. The top of the recall display shows an A-scan (amplitude vs. time plot) containing the signal return being evaluated. A white bar above the A-scan highlights the return. Underneath this A-scan is a time-expanded A-scan containing the signal return. The bottom trace expands the signal further in an unprocessed time series format. Figure 2 shows representative data in the display. The top two A-scans appear in the selected EER band of interest (acoustic data are processed over specific bands that depend on the EER environment). The bottom time series trace is unprocessed and left in the widest frequency band available to EER. When the signal is activated for playback with the PLAY button, the expanded A-scan scrolls into view from left to right and is synchronized with the audio output to the operators' headsets. Immediately after this, the bottom time series appears as the signal plays a second time over the shorter interval to emphasize the main portion of the signal. Audio output is played in the widest frequency band available to EER.

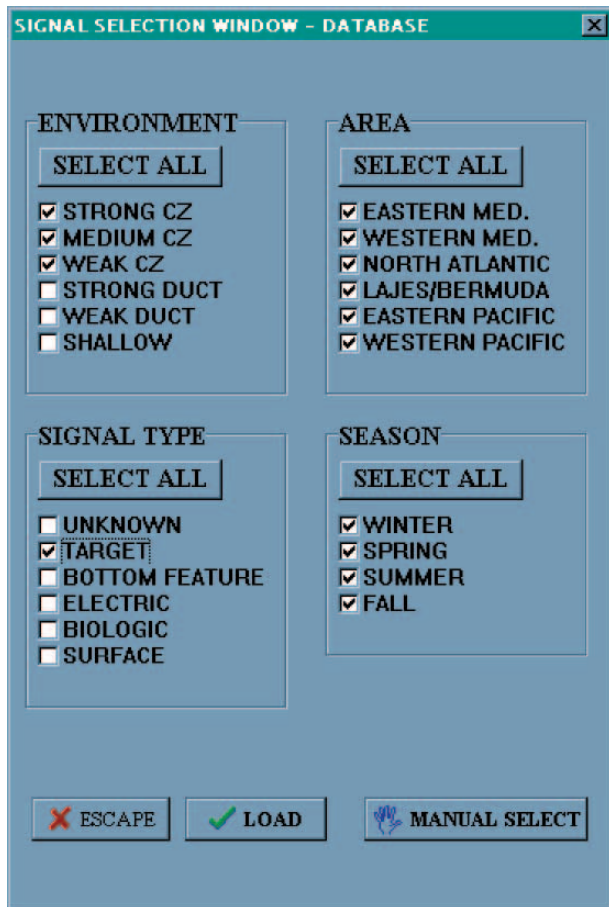
Two distinct sets of signals can be loaded into the Group 1 and Group 2 areas located at the bottom of the main display. They come from a database of 500



**Figure 2.** Aural and Visual Support Trainer (AVST) main display showing a list of loaded signals. The P-3C-emulated signal recall display is controlled with AVST functions below the signals. The data shown are representative of EER signal data.

signals collected from a variety of sea tests around the world. By clicking one of the LOAD buttons on the main display, the operator activates a database search template, shown in Fig. 3. Signals are parsed by environment, area, signal type, and season. Figure 3 shows a database search setting for all target signals, in any convergence zone environment, from any area, and from any season. Figure 4 illustrates the chain of steps followed at APL to build the AVST database. APL digitizes multitrack analog tapes and uses various digital signal processing tools, along with geographical and signal analysis display aids, to detect, classify, and archive EER signals.

In addition to the PLAY button, the AVST controls on the main display include an INFO button, which brings up displays shown in Fig. 5. These displays show a signal's characteristics, the sound velocity profile for its ocean environment, and a sonobuoy field plot showing the location of the source and receiver. If the signal is a target return, the field plot also shows the target's position and bearing. Other options from the main display include FILL/NO FILL and LINEAR/LOG, which are display format controls; AUDIO, which provides volume control; MIX, which randomly mixes the order of the loaded signal list; and HIDE/SHOW, which

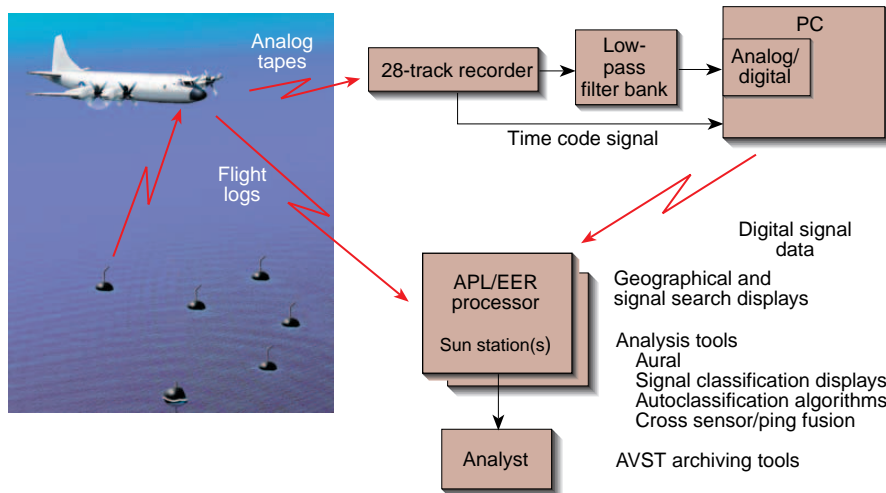


**Figure 3.** The operator can select Extended Echo Ranging signals from the database. The signals are partitioned by environment type, area, signal type, and season. The search template is set to find all target signals, in any convergence zone environment, from any area, and from any season.

hides signal types and numbers in the group areas. The last two options, when used in conjunction, provide a means for the operator to manually generate tests. Alternatively, the TEST button provides an automated testing option for the operator.

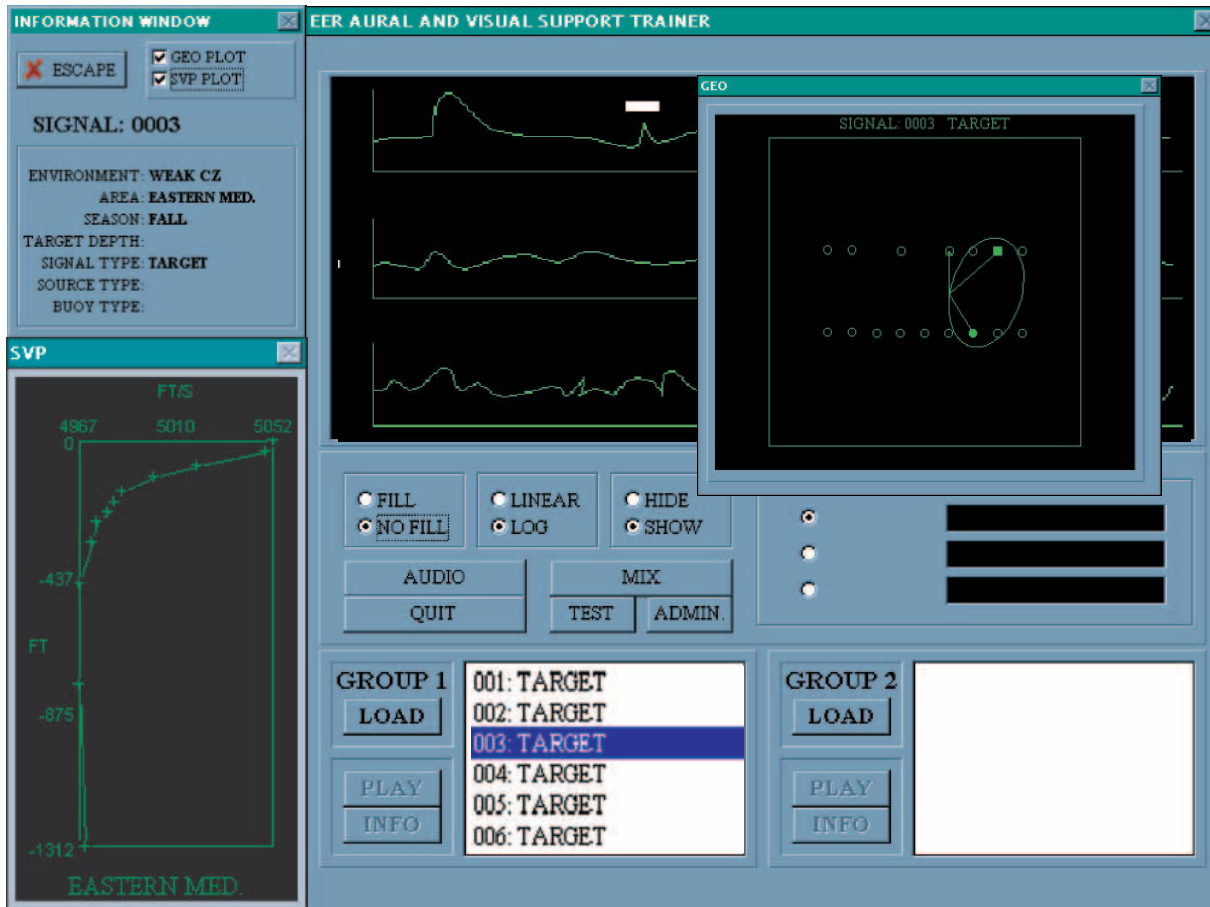
Under automated testing, operators may take either practice tests or real tests. To take a real test, in which the testing results are logged by the system, an operator identifies himself to the system by entering his own unique password. This allows the AVST to maintain operator-specific performance statistics. Once the operator begins automated testing, he or she sees the display shown in Fig. 6. The AVST generates a test that consists of a sequence of eight signals drawn from the database. For each signal, the operator selects TARGET or NONTARGET. He can replay a signal any number of times, but excessive delay, as indicated by the clock, penalizes the operator (the tiebreaker for high score is based on testing time). Each signal presented has a 50/50 chance of being a target, preventing the operator from using any knowledge he has about the proportion of targets to nontargets in the database to influence his decisions.

Operators are given proficiency levels ranging from 0.0 to 10.0, with new operators beginning at level 0.0. With seven or more correct answers on a test, the operator's level rises by 0.1; with six correct, the operator's level stays the same; and with five or fewer correct, the operator's level falls by 0.1. As the operator's level increases, the testing becomes more difficult. Database signals are divided into 10 equal groups, or deciles, based on their difficulty. Difficulty is estimated with relative frequency of incorrect classification computed from system-wide operator testing results. An

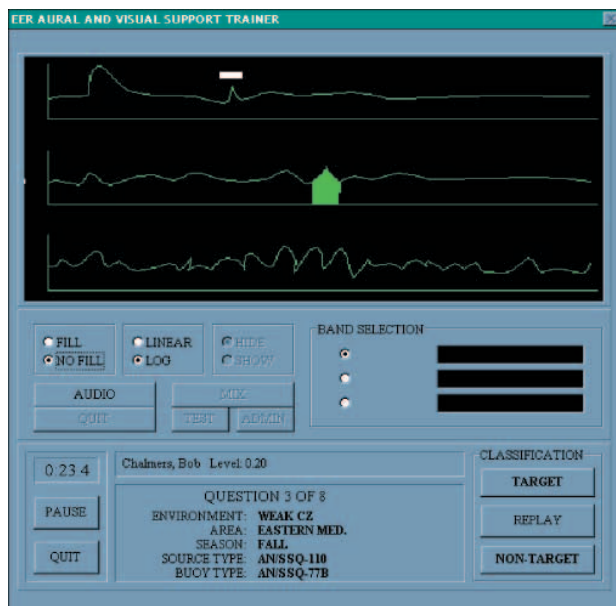


**Figure 4.** To build the Aural and Visual Support Trainer (AVST) database, APL analyzes and extracts signals collected from at-sea Extended Echo Ranging (EER) exercises. Analog tapes, flight logs, and submarine truth data combined with signal and information processing algorithms help analysts to identify signal types.

operator's proficiency level maps to a difficulty decile (i.e., operator levels 0.0–0.9 map to decile 1, operator levels 1.0–1.9 map to decile 2, etc.). Five of the eight signals in each test come from the decile corresponding to the operator's current level. Two other signals are drawn from tests the operator has taken in the past. The first comes from one of his two most recent tests, and the second from any of his past tests. This feedback ensures that the operator continually refocuses on both early and advanced skills. Another signal is drawn randomly from the entire database. Operator



**Figure 5.** Selection of INFO brings information displays that show the loaded signal's attributes, the corresponding sonobuoy field geometry, and the related sound speed profile as a function of depth.

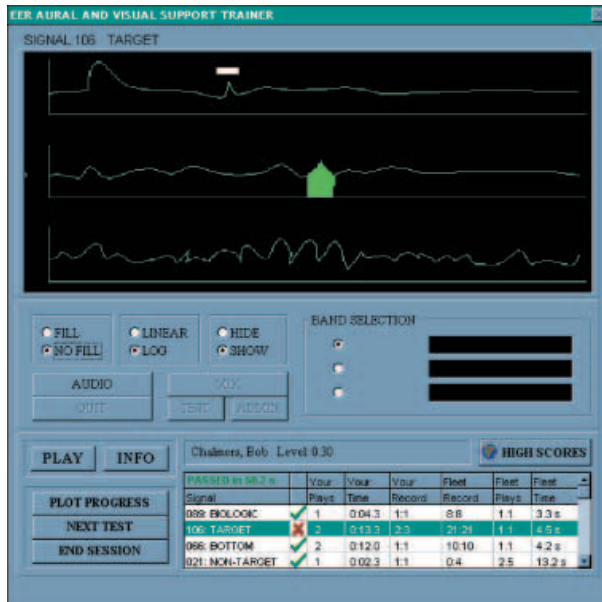


**Figure 6.** Aural and Visual Support Trainer testing display showing one of a sequence of eight signals brought up for evaluation during an automated test. For each signal, the operator selects TARGET or NON-TARGET.

performance recorded for this random signal provides the means to measure signal difficulty and provides an estimate unbiased by operator level.

After a test, the AVST displays the results as shown in Fig. 7. This display shows the correct classifications for the test signals, the operator's answers, and the operator's new proficiency level. In addition, the operator sees his or her number of plays, time taken, and historical success rate for each signal. To benchmark his performance, he also sees the most recent information on number of plays, time taken, and success rate for all operators currently training with the AVST throughout the Fleet.

Before beginning another test, the operator can play and display any of the signals he missed (or correctly identified) to correct (or reinforce) his understanding of signal identification. Controls available to him include PLAY and INFO, which operate as described before. PLOT PROGRESS calls up a graph of his proficiency level plotted against time. The graph also shows average levels for any squadrons, wings, or the Fleet. The HIGH SCORES button lists operators with the top scores. Feedback between tests provides infor-



**Figure 7.** Aural and Visual Support Trainer display showing the results of an automated test, including the operator's answers, the actual answers, and the operator's new proficiency level. In addition, the display shows values for the number of plays, time taken, and success rate for both the operator and the Fleet.

mation and motivation for the operator to improve performance. When the operator is ready to continue, he selects NEXT TEST. To exit automated testing, he clicks END SESSION.

The AVST may be run at either an administrator level or a student level. If the operator is logged in as an administrator (which requires a password), he has access to the ADMIN button and the main display. By using options under ADMIN, the administrator can add or modify operator testing passwords, examine the progress of any operators on the system, and print out usage and performance metrics useful for building status reports.

In addition to signal difficulty information, the AVST stores data for each test taken, parsed by operator and signal number. This information is merged into a larger database composed of information from all AVST sites. APL currently serves as the central facility for collecting, merging, and distributing performance statistics (high scores and signal difficulty levels). A simple administrator function downloads and uploads AVST statistics to a floppy disk.

## Theoretical Background

The design of the AVST automated trainer is based on an analysis of the task being trained, namely, developing and maintaining a sensor operator's ability to accurately classify a variety of signal returns target or nontarget. The analysis involves modeling the operator's task in terms of his or her goals and subgoals. It

also involves an assessment of the knowledge the operator needs to achieve these goals.<sup>4</sup> This knowledge takes the form of declarative knowledge, which is the understanding of how the AVST works as well as the current state of the system, and procedural knowledge, which is the understanding of how to use the system to achieve the goals.<sup>4</sup> This modeling of a task in terms of goals and required knowledge is often referred to as a cognitive simulation model. Such a model gives an abstract human mental process a realization that aids in the creation of a machine to train that process.

Operators in an automated training environment progress most rapidly when they are constantly motivated by obvious goals, both near-term and long-term. In addition, they respond positively when they see that the application of their current skill set has an immediate effect on their training environment.<sup>5</sup> Their responses are further heightened when the sequence of training exercises is customized based on the current state of their knowledge base (adaptive sequencing).<sup>5</sup> The challenge with the AVST is to provide this stimulus and feedback to students when the cognitive simulation model outlined previously suggests that there is really but one goal to be achieved and a limited variety of feedback that is possible.

The answer to providing the stimulus lies in creating a rich set of subgoals by taking advantage of the natural human tendency to be competitive, both for oneself and for one's unit. These goals include passing a test; becoming best in the squadron, the wing, or the Fleet; or having one's squadron become best in the wing or best in the Fleet.

Feedback is provided by dividing the training experience into short increments (eight-question tests), which form the heart of the AVST automated training system. An operator never has to wait very long to see the effect of his or her actions. The short test also provides a convenient vehicle for adaptively sequencing exercises unique to each operator, by choosing relevant signals for the test. Grouping several signals together in a test format also takes advantage of another human tendency to compare and contrast related items. By forming associations between one test signal and another, the operator can observe rules to expand his knowledge base and can learn more quickly.<sup>5</sup> Care was taken not to make the test too long, which reduces opportunities to provide adaptive sequencing and also bores the operator, nor to make the test too short, which deprives the operator of productive association of the signals. In addition, certain mathematical considerations having to do with the expected test results for random guessers and operators at various proficiency levels were kept in mind as the length of the test was determined.

An operator uses his declarative knowledge base for reference as he seeks to achieve his training goals. The AVST is designed to be almost completely intuitive, so

that little time is spent learning and remembering how to operate the trainer or interpret its displays. The state of the system consists of variables the operator may rapidly read from the screen, such as his current proficiency level, his current screen display settings, and other parameters seen on the main, information, and test displays. These representations are limited in scope and focus on the information that is most pertinent to training the specific signal identification skill.

An operator's procedural knowledge base develops as he or she proceeds with automated training. Fundamental to the development of this knowledge base is what is known as a production memory, as well as a set of precepts known as production rules.<sup>6</sup> As an operator encounters signals during testing, he is continually observing mappings of audiovisual experiences to target/nontarget classifications. This experience enters his production memory. Production rules are really elementary "if-then" statements that are acted upon during testing based on the contents of the production memory.<sup>7</sup> The operator's procedural knowledge base, or knowledge of how to reach his goals, grows as he comes up with new production rules and solidifies old ones. These rules influence and improve his behavior, and are the essential building blocks of his skill base. An example of a simple production rule might be the statement: "If the aural playback of a signal is a very short clicking sound, then it is an electrical glitch."

Production rules are developed more rapidly when the operator is in a goal-oriented environment. The AVST system is designed to return the operator again and again to conditions under which he or she must assimilate production rules, without making the process tedious. As the operator strives to achieve goals, such as passing tests, raising his proficiency level, and beating other operators, he unconsciously maximizes the number of signals he hears and sees. As the tests grow more challenging, he is driven to hunt for ever more obscure production rules, primarily new clues for signal identification, to boost his performance. He instinctively makes use of the full functionality of the AVST to meet his goals. Intervention by the automated testing system is limited to the success or failure of the operator's past and present attempts to classify signals to encourage operator experimentation and allow for a diversity of rule-forming styles.

### AVST Hardware and Application Software

The original AVST package was hosted on a Sun workstation. The Fleet, however, chose to rehost the AVST on a more mobile and affordable AMEWT PC available to the Fleet for training. The AMEWT is a Naval Air Systems Command-standardized IBM-compatible PC. Its most common configuration includes a 486/DX50 central processing unit, 8 Mbytes of random

access memory, a CD-ROM drive, and a 16-bit sound card. It does not have an internal hard disk drive but instead runs from a 150-Mbyte removable Bernoulli cartridge. This allows it to remain an unclassified system, while the cartridge can hold classified information separately when not in use.

Before June 1996, the AMEWT was delivered strictly as a DOS-based system. Current system software Bernoulli cartridges, however, include MS Windows 3.1 as an available operating environment. For many operators, the opportunity to train with an operating system they are already familiar with provides an immediate level of comfort. Previously, operators were confronted with a blur of different user interface styles on DOS-based trainers. Now they are much more able to learn from the testing material, since they can access it with a familiar graphical user interface that includes Microsoft-standard buttons, menus, and list boxes.

As on any platform, software for the AMEWT must be developed within the constraints of its hardware and operating system configuration. In addition, the developer must consider standardized policy decisions regarding operating procedures. For example, security concerns dictate that AMEWT users may not write data to the Bernoulli cartridge. Therefore, the AVST is designed so that the administrator-level function mentioned earlier, which prints out parameters from the training database, writes only to the floppy disk drive. The update function, which downloads the automated testing database and uploads Fleet-wide operator and signal statistics, involves the copying of files from a floppy disk to the cartridge. This process is controlled directly by the AVST software to prevent users from writing to the cartridge on their own.

To a large degree, the success of the AMEWT-based AVST in meeting sponsor requirements in a timely manner is attributable to the use of Borland's Delphi, a visual development tool that allows rapid prototyping and interface development. Unlike most other visual development tools, it is also a compiler that turns source code into stand-alone executable code. The original Sun-based AVST is coded in Precision Visuals PV-Wave, an interactive data analysis/interface development tool. Borland's Delphi was chosen over direct translation of PV-Wave code from the Sun to the PC for two main reasons: (1) PV-Wave requires a licensing fee for each target platform that is significant relative to the cost of the PC, and (2) run-time interpreters such as PV-Wave require more work for the computer, a performance burden that is largely unnoticed on the Sun but not on a midrange PC.

Typically, the downside to developing a stand-alone executable code is the increased development time involved with using a compiler. This added turnaround time is a particular problem for a small, relatively informal software project like the AVST, where the spon-



sor and users may be expected to make numerous requests for changes in functionality or performance over the course of the development cycle. The immediate response to a customer's needs has a lot to do with the popularity of the AVST and sponsor willingness to fund future development work at APL.

The ability to make rapid changes to the AVST software interface is a direct result of using "visual" development tools. Such development environments (e.g., Visual BASIC, PowerBuilder, Delphi) allow the developer to think first and foremost in terms of the user's interface. Much attention has been given to the concept of "object-oriented" software design and languages (C++, Ada, and Smalltalk, for example), and with good reason. The holy grail of code reuse appears within reach of the object-oriented paradigm. Too often, however, the promise of massive productivity gains from object-oriented design methods has been difficult to fulfill. Part of the problem may be that, although code may be organized in intuitive, object-oriented blocks, it is still code, and as such must still too often be read and understood by anyone wanting to effectively use or reuse it.

The new visual tools advance the object-oriented paradigm by focusing the programmer's attention on the visual results of the code as it appears in the finished product. Applications are component oriented and are built from large multiobject components (themselves objects) that already contain significant functionality on their own. Most important, these components are connected to the application with a minimum of code. The programmer can literally "drag and drop" a component object from a palette of options onto his or her application window. The code required immediately follows it, with no further action needed except to add responses to component events. Finding the code that activates when a virtual button on the screen is clicked is as simple as clicking on the button in the design form and selecting `OnButtonDown` from the menu of events relating to that button component.

What might seem like a mere coding convenience has, in fact, resulted in massive gains in development speed and programmer productivity. Thanks to this marriage of object-oriented component technology and a visual perspective to software development, APL has been able to develop a better trainer for the Fleet that is more usable, maintainable, and modifiable than they had previously thought possible.

## PATROL AVIATION EER TRAINING

Each of the 15 patrol aviation (VP) squadrons in the Navy continually form and reform flight crews as personnel receive orders into and out of a squadron. The squadron always attempts to maintain 12 combat-ready flight crews. Each squadron conducts extensive ongoing personnel training to keep combat readiness

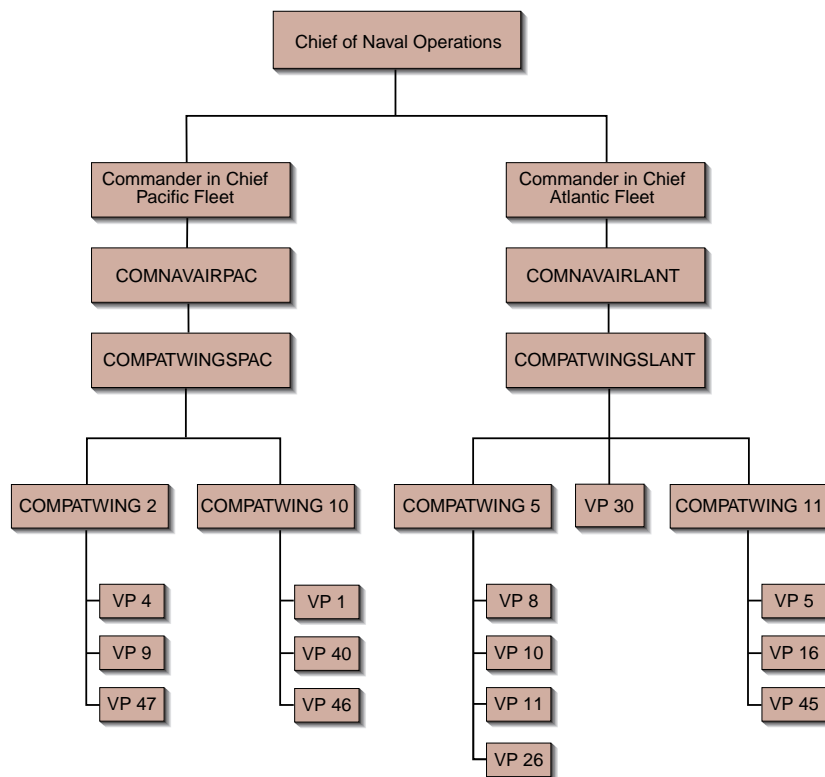
as high as possible. Figure 8 illustrates the administrative organization of the VP community. Active-duty VP squadrons are organized into four patrol wings: two in the Atlantic Fleet (Wing 5 and Wing 11) and two in the Pacific Fleet (Wing 2 and Wing 10).

At the squadron level, specific flight crew training requirements of all types of naval aircraft are promulgated in a set of aircraft type-specific training "matrices." The P-3C training matrix is jointly created by the commanders of the naval air forces of both the Pacific and Atlantic Fleets. From the P-3C training matrix, a VP qualification exercise manual is jointly generated by the commanders of the Pacific and Atlantic Patrol Wings. The purpose of the manual is to provide each squadron with the description, requirements, procedures, and evaluation responsibilities for each training event specified in the P-3C training matrix. The latest revision of the VP qualification manual includes training events for flight crews to become qualified and maintain currency in the use of the EER system. As part of the EER training requirements, acoustic sensor operators must complete 12 hours of aural and visual training using the AVST. Because of its portability and relatively low cost, every active-duty patrol squadron has an AMEWT capable of running the AVST application.

## Fleet Replacement Squadron

Figure 8 shows that VP-30 is not in the administrative chain of command of any particular patrol wing but, rather, is under the direction of the commander of the Atlantic Patrol Wings. (Although not indicated, the commander of the Pacific Patrol Wings provides some direction to VP-30 as well.) The squadron is located at Naval Air Station, Jacksonville, Florida, and is the Fleet Replacement Squadron (FRS) for the entire VP community. The FRS provides initial training to officers and enlisted personnel and develops a training syllabus to prepare personnel for the aircrew training requirements they must complete when they get to their squadrons. The FRS maintains liaison with the training divisions of the patrol wings to recommend revisions to the aircrew training syllabus and to obtain feedback from operational squadrons should FRS training fail to meet their requirements. It is the responsibility of the operational squadrons to continue the training that personnel received from the FRS to maximize their operational readiness.

For enlisted personnel designated as aviation warfare systems operators (AWs) who are heading to the Fleet for the first time (designated as Category I individuals), VP-30 provides a 9-month syllabus to qualify them as observers in the aircraft. These junior AWs are introduced to the "single advanced signal processor" and related equipment used by the P-3C for EER. VP-30 also provides training to smaller groups of AW personnel who



**Figure 8.** Administrative command structure of the patrol aviation (VP) community. Squadron training requirements are generated by COMPATWINGSPAC/LANT but promulgated by joint instruction from COMNAVAIRPAC/LANT.

are either returning to a patrol squadron for their second sea tour (Category 2) or are qualified to fly only in older versions of P-3 aircraft (Category 3). For both of these categories of AWs, VP-30 provides a more abbreviated period of customized training to prepare them for the Fleet. In all cases, an AW must complete the required personnel qualifications standards syllabus in a squadron to become a qualified acoustic sensor operator in the aircraft. All pilots, naval flight officers, and AW students receive an introductory schoolhouse lecture on EER. Currently, only the more experienced Category 2 naval flight officers and AW students receive EER ground school training consisting of more extensive classroom lectures and weapon systems trainer periods.

### Tactical Support Centers

All of the commands shown in Fig. 2 are administrative as well as operational. As a result, many of the personnel in these commands have dual roles. Supporting the assigned missions of the VP squadrons is an organization of tactical support centers (TSCs). For all operationally tasked antisubmarine warfare missions, a TSC provides the flight crew with an extensive preflight brief. This preflight brief covers most aspects of the mission, including, for example, ocean and atmospheric environmental predictions, intelligence

on the target of intent, and acoustic search tactics. After a mission the TSC debriefs the aircrew, and all logs and data tapes are collected and reviewed. The relevant intelligence and tactical data collected from the flight are then entered into the TSC's database and dispersed to other agencies with a need to know.

Besides being a repository of information collected by all flight crews, the TSC also helps train flight crews. This is done in two ways. First, for most operational missions, TSC personnel perform an evaluation of the flight crew based on analysis of the returned flight data. Second, the TSC provides training aids. Under direction from the Naval Command, Control, and Ocean Surveillance Center In-Service Engineering East Coast Detachment, APL is integrating AVST software into all TSC mission support systems. Specifically, all TSCs carry Sun systems as part of their acoustic processing configuration, referred to as a fast-

time analysis system, that can host the AVST. (Modifications to the Sun-based AVST are being made to include automated testing.) Once integrated, the AVST will be installed at TSCs worldwide.

### The 14B53A Part-Task Trainer

The 14B53A is a part-task trainer designed to provide EER training. It is referred to as a part-task trainer since it is dedicated to training only part of the aircrew: the acoustic sensor operators and the tactical coordinator (TACCO). The 14B53A plays a valuable role in training coordination between the sensor operators and the TACCO. In addition, its realistic display consoles and switches provide a favorable environment for crews to learn EER controls. There are only three 14B53As in the Navy. Besides the limited availability of this trainer, the 14B53A has other drawbacks as a trainer for the EER system. When used in a stand-alone mode, the 14B53A produces synthetic, rather than actual, recorded data and does not present the operators with any false contacts, which occur frequently during actual EER missions. In addition, the oceanographic model in the 14B53A assumes a flat-bottom topography and homogeneous water mass.

To overcome the drawbacks of using synthetic data, the Navy contracted for a single EER basic training

exercise, emphasizing EER processing functionality, in a deployable acoustic readiness trainer system (DARTS) format. The DARTS EER lesson uses a roll-on/roll-off tape drive unit that provides acoustic training on a parked aircraft or in the 14B53A trainer. The DARTS uses recorded EER data samples that are input to the acoustic processing gear. The DARTS EER lesson has been lauded as the best source for basic EER theory and operations. Unfortunately, the DARTS program is currently unfunded, and, without further EER lessons, the training value of this single lesson is greatly diminished after an operator's first or second exposure.

## SUMMARY AND FUTURE WORK

The AVST is a success for three reasons: it is simple, challenging, and fun. Navy operators are often overwhelmed by computer systems. The easy-to-use AVST interface shortens the operator's learning curve and lets him or her focus immediately on training. As a skill-based trainer, the AVST requires little coursework or prior knowledge to use. The design breeds healthy competition against the machine and among operators, which adds to the challenge and enjoyment of the system by a generation of users immersed in an era of video games.

Future work at APL will extend the scope of the AVST to include more of the sensor operator's

processor functions beyond that of aural and visual classification. This will allow limited 14B53A or in-flight training sessions to be more productive. In addition, APL is leveraging the software to develop desktop trainers for follow-on air antisubmarine warfare systems.

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