

AFLOAT TRAINING, EXERCISE AND MANAGEMENT SYSTEM (ATEAMS) HAND-HELD DEVICE (HHD)

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ABSTRACT

The Shipboard Mobile Aid for Training Evaluation (ShipMATE) effort to pair advanced performance measurement methods with state-of-the-art hand-held PC technology supporting training in a scenario-based environment has produced numerous lessons learned. It is time to review findings and prepare for transition of methods, tools, related strategies, and technologies to the user community. One ready target for transition is the Afloat Training, Exercise And Management System (ATEAMS). ATEAMS seeks to provide an automated process to manage Objective-Based Training (OBT). As originally envisioned, ATEAMS required use of cumbersome and error-prone paper-based data collection tools. Once data was collected, it had to be reduced and stored in a format and medium that would support useful reporting functions and allow future training evolutions to be informed by historical performance trends. These factors represent formidable obstacles to using behaviorally anchored performance measurement methods to enhance performance. While ShipMATE-like technology provides a potential solution to this challenge, hand-held PCs (HPC) are prohibitively expensive. The advent of increasingly capable, less expensive hand-held devices (HHDs) provides a technology-based solution that enables a digital data collection, reduction, and storage process. The HHD affords the developer the ability to transform a static measurement tool into an interactive performance measurement tool that can be tailored to an individual's level of expertise, check input, prompt for actions, and generally increase the consistency with which a methodology is administered. This paper details research into the use of emerging hand-held computers and associated software development environments to assist trainers in the measurement of performance, specifically, in support of the development of a prototype HHD for ATEAMS. Integration of the HHD with ATEAMS will significantly increase the usability of this software, and hence, increase the training potential of ATEAMS and BFTT.

ABOUT THE AUTHORS

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INTRODUCTION

Research and development (R&D) efforts to investigate and develop theoretically-based, empirically validated methods and tools for complex team training environments have existed for many years (Cannon-Bowers, Salas, and Grossman, 1991) and continues to drive much of Naval Air Warfare Center, Training System Division's (NAWC/TSD's) team training research. With several related R&D efforts sponsored by NAWC/TSD as lessons learned, it is time to review findings and prepare for transition of methods, tools, related strategies, and technologies to the user community. Examples of this work include performance measurement efforts in the Team Effectiveness Assessment Methodology (TEAM), Shipboard Instructor Training and Support (SITS), Advanced Embedded Training/Advanced Technology Demonstration (AET/ATD), Force Air Defense Warfare Commander (FADWC), Anti-Air Team Performance Index (ATPI) programs.

In these programs two interrelated goals have emerged: 1) a desire to transition R&D concepts, and 2) a need for validation of R&D concepts. One of these important efforts covered by this paper is research into the use of hand-held computers and associated software development environments to assist trainers in the measurement of performance.

BACKGROUND

A primary focus within training R&D is human performance measurement. One of the guiding principles in developing human performance measurement methods and tools is to be as precise as possible. This means systematic and consistent measurement. Several methodologies have been developed at NAWC/TSD that follow this guideline.

While fundamentally sound in concept, in practice, these measurement methodologies can be difficult to use because they are paper-based and require users to do a good deal of extra work in order to accurately record, reduce, and analyze data. Similarly, Navy Objective-Based Training (OBT) efforts, although fundamentally sound, have also shown that a paper-based approach to complex performance measurement problems can prove cumbersome and unusable.

With the advent of lightweight hand-held computers, there was the potential to address these use issues with

the application of technology. Moreover, it was felt that these performance methodologies could be extended by taking advantage of the capabilities of hand-held devices. While the HHD has general appeal as a mobile computing technology, it supports two concepts that are critical to providing good training: (1) facilitates systematic performance measurement, and (2) facilitates a structured training process.

To facilitate performance improvement of individuals working with complex systems, it is first necessary to be able to reliably quantify that performance. Given the complex nature of the systems and tasks in these environments, describing task performance requires detailed observation. While there may be system-generated information from which human performance can be inferred, methods have not advanced to the point of supporting fully automated human performance measurement for all training requirements.

Traditionally, the task of human performance measurement fell to observers using paper-based methods. However, these methods can be cumbersome, subject to error, and to inconsistent implementation. Moreover, once collected, this data must be reduced and stored in a format and medium that will support useful reporting functions and allow future training evolutions to be informed by historical performance trends. These factors represent formidable obstacles to using behaviorally anchored performance measurement methods to enhance performance.

The development of hand-held devices provides a technology-based solution to the issues outlined above. As a stand-alone tool, or as an integrated element of existing operational or training systems, the HHD supports an infinite variation of existing methodologies and enables a digital data collection, reduction, and storage process.

With respect to structuring the training process, the HHD affords the developer the ability to transform a static measurement tool into an interactive performance measurement tool. An interactive tool is one that can be tailored to an individual's level of expertise, check input, prompt for actions, and generally increase the consistency with which a methodology is administered.

HHD Software Prior Efforts

Several research efforts led to the ability to study HHD performance measurement within this program. These efforts are outlined below.

The Shipboard Mobile Aid for Training Evaluation (ShipMATE) ShipMATE was a Shipboard Instructor Training and Support (SITS) program R&D effort that was expanded into the Advanced Embedded Training (AET) Advanced Technology Demonstration (ATD). ShipMATE extended the behaviorally anchored measurement approach advocated by the NAWC/TSD Team Training Laboratory effort through software based performance measurement tools running on Hand held PCs (HPCs). The ShipMATE interface was developed around a scenario-based training model so that a given performance measurement tools could be integrated once it was developed. Each supports the following elements integral to scenario-based team training:

1. Manipulation and presentation of pre-brief materials
2. Time-stamped data collection supported by access to pre-brief materials
3. Data reduction and debrief preparation
4. Debrief presentation
5. Enhanced situation awareness of instructors (with wireless LAN enabled)

ShipMATE Team Dimensional Training (TDT) TDT was the first of these measurement methodologies taken from its paper-based format and implemented on ShipMATE. It was initially developed using a rapid prototyping language ToolBook™. Subsequent ShipMATE performance measurement tools (including TDT) have been developed in Visual Basic™ (VB).

TRACTs Another tool to extend the state of performance measurement was the **Tactically Relevant Assessment of Combat Teams (TRACTs)** tool. The TRACTs tool was developed for use in a simulation-based Army artillery environment. Because it is based on the checklists generated from existing standard operating procedures (SOP), it is expected to have utility in other environments in which SOP is well documented (e.g., engineering environments or training environments where course objectives are documented).

ShipMATE FADWC Tool In early 1997, an effort to develop a prototype instructor support tool for the Aegis Training and Readiness Center (ATRC) was initiated. The basic objectives of this effort were to develop a prototype instructor support device for the Aegis Force Air Defense Warfare Commander (FADWC) course, which supported the following objectives:

1. Improved briefing capability
2. On-line data collection
3. Objective-based debriefing capability
4. Demonstration of leadership training methodology

Technology enhanced performance measurement systems such as the FADWC tool offer considerable promise for extending the vision and capability for instructors and trainers at ATRC. The FADWC effort demonstrated the applicability of a hand-held performance measurement tool for instructors at ATRC and was the first step in developing a capability for similar training environments that are experiencing a significant decrease in instructor resources.

ShipMATE ATPI Tool Significant progress was made in developing and refining performance measurement methods and tools through further development of the Anti-air warfare Team Performance Index (ATPI). Under the auspices of NAWC/TSD's Manning and Affordability Initiative, a functional version of the ATPI was developed and successfully fielded. Using a graphical user interface based on a scenario timeline, ATPI raters are able to select any track in a given scenario for rating against the detect-to-engage sequence. This tool is integral to the ongoing analysis of team performance with and without the multi-modal workstation.

ATEAMS and Training Management Background

In addition to performance measurement research, multiple investigations into scenario and event-based training methodologies were occurring. There was a logical need to formalize the linkage between training requirements, stimulus events, performance measurement capabilities, and subsequent feedback.

The first investigation, an outgrowth of the Tactical Decision-Making Under Stress (TADMUS) program, was the NAWC/TSD and ONR Shipboard Instructor Training and Support (SITS) program proposed in 1993 and begun in FY95. This program focused on shipboard instructor skill requirements and on training management and performance measurement technologies in an effort to apply new technology to the completion of the learning cycle. In particular, the **Training Management Module (TMM)** was developed to enable systematic scenario generation.

The second effort was a fleet sponsored movement, initiated by the Afloat Training Group, Pacific (ATGPAC) that defined a formal process to facilitate shipboard watchstander and team training. This "train by objective" concept was a result of work by various afloat training organizations, and by personnel in the TADMUS, Battle Force Tactical Trainer (BFTT), and Joint Exercise Mission Planning (JEMP) programs.

Training objectives were constructed utilizing a standard curriculum development model of terminal and enabling objectives supported by measures of performance/effectiveness. The “Objective Based Training (OBT) Process” was implemented in part to support the Navy’s movement to scenario-based training, and in particular to support fleet implementation of the BFTT learning model. The initial set of Basic Phase Training Objectives resulted from a collaborative effort between ATGPAC and the Afloat Training Group Atlantic (ATGLANT). The initial implementation tools included an MS Access™-based application to help the ATGs manage the Navy’s first afloat training objectives database.

As OBT and the SITS research programs matured, results were extremely encouraging. This new approach allowed trainers to formally quantify readiness and performance in a manner previously unavailable. However, it was painfully apparent that these processes were administratively burdensome and required technological solutions.

Meanwhile, the Fleet noted predictable problems inherent in the implementation of a non-automated OBT process, and fleet funding was provided to construct a standalone OBT management system, with the ultimate goal being full integration with M&S based systems, such as BFTT. This new system, the Afloat Training And Exercise Management System (ATEAMS) was first designed as a standalone, interim solution until ATEAMS functionality could be integrated into the BFTT architecture. These parallel and mutually supportive efforts allowed PMS 430 to capitalize on the fleet implementation of a new approach to training while leveraging research and emerging technologies.

ATEAMS Integrated System Overview

This paper details the effort developing a prototype HHD to be fielded for ATEAMS data collection. As described by a companion paper (Stretton, this session), ATEAMS has two fundamental configurations; ATEAMS Core, a standalone configuration applicable to ships without the Battle Force Tactical Training System (BFTT), and ATEAMS Integrated, an integrated configuration for ships with BFTT. ATEAMS Core is currently under development. However, this effort was approached with a focus on the ATEAMS Integrated configuration because the HHD requirement for the BFTT System has already been established.

For ATEAMS Integrated, several components participate in enabling the learning cycle for the training audience. Figure 1 depicts the interaction between ATEAMS and the ATEAMS HHD.

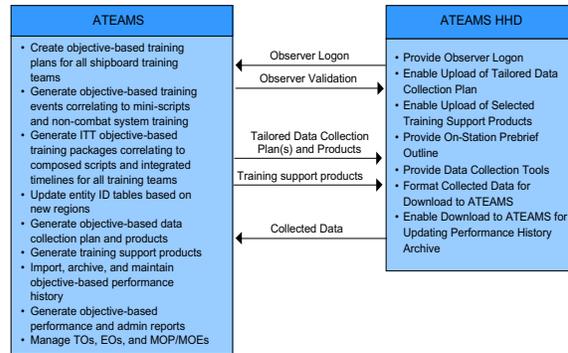


Figure 1: ATEAMS & ATEAMS HHD system interaction.

Shipboard OBT presents the challenge of collecting data that accurately reflects the completion of desired training objectives in a meaningful and traceable manner. Currently, only in Combat Information System embedded trainers do any provisions for automated data gathering exist. This creates the need for intensive human-based efforts that ATEAMS helps to standardize. ATEAMS currently provides the means by which to streamline the processes of scenario generation and paper-based data collection product creation, however, it does not streamline the data collection process itself. There are currently over 7000 Measures of Performance (MOPs) that must be managed within the scenario based training realm. Integration with BFTT will provide a powerful tool to automatically collect data, however, analysis shows that very few of the current MOPs can be evaluated by solely relying on embedded automated data collection systems. There is a need for a portable, long-lasting device that will provide a structured presentation of scenario events and the related training objectives and MOPs and that incorporates a variety of data gathering techniques.

Since automatically collected data is limited to some elements of the Combat System, an approach that captures more than just time referenced positional information and operator console interactions must be deployed if improvements in data collection are to be realized in all mission areas. There are a number of means by which performance assessment data can be recorded that are not being captured using automated systems, such as:

- Ink Notes
- Non-Circuited Voice Communications
- Internal Communications
- Console Screen Captures
- Non-console Graphics Captures
- Team Process Measurement (e.g., TDT)

- Digital Data Capture not covered by Embedded Trainers
- Scenario Support Information

DERIVED REQUIREMENTS

Beginning with BFTT 4.0, ATEAMS has a requirement to implement a handheld computer-based data collection system to move away from manpower intensive paper-based collection of training scenario performance data. The implementation of this requirement presents a ripe opportunity to improve a training observer's ability to collect a wide variety of data using a portable computing tool that will fully address performance measures that cannot be assessed by automated means.

ATEAMS/BFTT is intended to provide a full spectrum of training from a single ship to the battle group. The implementation of the tools presented in this paper are predicated on the integration of ATEAMS with BFTT 4.0. However, recognizing that non-BFTT ships will also receive standalone ATEAMS installations, the discussion of technologies that will support a handheld, computer based data collection system should be equally applicable to these non-BFTT ships.

The present effort focuses exclusively on a "Prototype" HHD for ATEAMS. Time and resources did not permit extensive end-user involvement. A more detailed requirements analysis involving users will necessarily be part of the acquisition process.

Hardware Requirements

The initial hardware requirements for the hand-held data collection tool are described in this section. These requirements served as a guide for the research effort. HHDs from different vendors, using two different operating systems, were tested and compared. The candidate hardware complied with the following minimum requirements:

1. Surface ships have onboard training teams to support self-training. Based on the typical shipboard training team structure outlined in the Surface Force Training Manual (COMNAVSURFLANT/PAC INST 3502.2 series), our estimate is that an average size ship will minimally require 30 HHDs to support ship-wide training.
2. The size and weight are to allow for comfortable, continuous use over a two-hour period.
3. Require a mobile power source (e.g. battery) to provide for 5 hours of daily use.
4. Display must be readable in direct sunlight, low light, or no light conditions.

5. Must support a cradle-based desktop computer interface.
6. Must have sufficient memory to store the application and robust training plans.
7. Must support pen-based data entry.

Hardware Assessment Hardware evaluation focused on a group of COTS HHDs that included Handspring Visor Deluxe, Palm Vx, Symbol 1740, and Compaq iPAQ. Each assessed hardware platform meets the above mentioned hardware requirements and variations that affect relative desirability are discussed in this section.

The **Handspring Visor Deluxe** (Palm OS, ~\$290) is a high quality, very usable and inexpensive handheld platform. It provides 8MB of memory, dynamically shared between the storage and RAM in Palm OS fashion, and a Motorola Dragonball processor that operates at 16MHz. The display screen gives a 160 x 160 pixel display area, which is capable of showing up to 4 shades of gray. The low resolution and lack of color presentation are drawbacks that tend to detract from the ease of use. Potentially one of the most flexible and scalable characteristics of the Visor Deluxe is the expansion port, called the Springboard™ module slot, which allows addition of memory, a digital camera, a modem, or a digital voice recorder. The Visor Deluxe is the most readable of the Palm OS based HHDs in any lighting condition and can run for extended periods on the AAA batteries that are required (shipboard hazardous waste reduction efforts make disposable batteries a less attractive option).

The **Palm Vx** (Palm OS, ~\$400) provides performance to most of the same specifications as the Visor Deluxe, except that it is somewhat smaller, lighter and does not have an expansion port. The Vx is somewhat pricier but is constructed more ruggedly than the plastic-encased Visor Deluxe (the Vx's casing is made from anodized aluminum). At \$400, it is a capable platform that can be used in the field where more ruggedness is required.

The **Symbol 1740** (Palm OS, ~\$925) was chosen for assessment to investigate the wireless RF network connection capability. The Symbol 1740 is a seriously ruggedized and capable Palm handheld device - its main features being survival of a 4-foot drop onto concrete, a built-in barcode scanner, and a high-contrast anti-reflective LCD display. The base unit has only 2MB of memory, but can be configured to have up to 8MB along with 4MB of flash memory. The unit provides wireless RF capability, special serial cables, multiple unit cradles and a long list of other additions to the basic HHD functionality. While the list of capabilities is impressive, the base unit (with 2MB of memory) cost is \$925. With accessories and add-ons, this platform can cost over \$2000. Wireless RF

capabilities have recently gained attention, however the technology still requires development and resolution of security issues before it is a viable option for fielding in the fleet. The Symbol 1740 is a capable platform that incorporates desirable technologies, but is priced at level that does not justify the capability gained from a rapidly developing technology such as wireless RF connectivity.

The **Compaq iPAQ H3650** (Microsoft PocketPC OS, ~\$500) handheld computer was the most impressive HHD with its practical functionality. This unit provides a color display and at 240 x 360 resolution, it can show up to 4096 colors (12 bit). It is powered by the Intel StrongARM 206MHz processor, has 32MB of RAM, and includes 16MB of ROM that holds the OS and base applications, leaving more RAM for training package storage and expansion port add-ons. It includes the additional functionality of an internal stereo soundboard, headphone output jack, small built-in speaker, and 5-way joy pad. There is a built-in microphone and a shortcut button for instantly recording memos and notes.

Hardware Assessment: Conclusions No other HHD tested provided the same capability as the PocketPC. There is no special area reserved for writing with the stylus as on Palm handhelds. The PocketPC OS allows one to selectively turn a virtual keyboard on and off. A transcriber program is provided that allows writing directly on the screen, the text of which can either be saved or translated into a digital format by the included handwriting recognition software. Palm handhelds require the user to learn a special way to write letters and numbers called Graffiti that can be tedious when trying to write lengthy notes. The iPaq allows a user to write in freehand and can automatically convert the input. The PocketPC uses an ambient light sensor that automatically adjusts backlight intensity for the surrounding lighting conditions. In addition to providing the most readable display in any lighting condition, the light adjustment feature effectively conserves power optimizing battery life. The internal lithium polymer battery will give approximately 12 hours of usage before requiring a recharge. The iPaq is slightly larger than the Handspring and Palm candidates, but remains small enough to handle with one hand or place in a pocket.

Software Requirements

Based on ATEAMS specifications, two software applications were identified as necessary to support interface with ATEAMS; a desktop database conversion application to format ATEAMS data to a state usable by a HHD and the HHD software application. While the ATEAMS software will eventually provide the capabilities specified below, this

requirement was not in place at the time of the evaluation effort.

The desktop database conversion application needs to interface with Microsoft Access™-® and must be capable of providing the user interface and structure to provide the following support:

1. A database with sufficient detail and structure to emulate the Data Collection Plan (DCP) that will be generated by ATEAMS. The database will hold training session data for a minimum of two observers, each assigned two watch stations for observation.
2. Export of scheduled watch station-based terminal objectives, enabling objectives and Measures of Performance (MOPs) to the HHDs, unique to the training observer. The desktop application “pushes” or exports the data to a cradled HHD.
3. Export of static training support and briefing information to the HHDs. This information includes general ship-wide information as well as training team specific information.
4. Import of collected performance data from a cradled HHD and stores that information in the appropriate database tables/fields.
5. Synchronization with the Palm HHD through the cradle device.

The HHD software requirements are as follows:

1. Display of the observer rank/rate and name.
2. Display of the training plan title.
3. Display of the scenario clock.
4. Display of training plan support and briefing information. This information includes: Scenario summary, ITT timeline data (event time and title), training team timeline data (event time and title), terminal objectives, enabling objectives and measures of performance linked to unique trainees, and lessons learned.
5. Display of the data collection interface that aids in the manual collection of MOPs.
6. Selection of observable trainees.
7. Display of scenario clock, controls and display.
8. Display of trainee rank/rate, name and watch station.
9. Display of the applicable training event.
10. Display of the status of the training event (will occur, is occurring, has occurred)
11. Display of current terminal and enabling objectives.
12. Display of the MOP.
13. Collection and storage of performance values and modifiers. (Completed or Not Completed)

with the following Cause Codes: Material, Personnel, Documentation, Training Team, Safety, Other)

14. Linking of comments to ITT timeline and to the training team timeline.
15. Display training plan support and debriefing information.
16. Support synchronization with the desktop application through the cradle device or wireless IR connection.

Application Software Environment

HHD Application Software Development: Palm OS

For the Palm OS, there are numerous choices for embedded development on the PC under standard Windows 98 or NT. Here, they are listed in order of increasing usefulness with estimated pricing (including licensing fees):

1. Java 2 Micro Edition (J2ME) (Unknown, product not available yet)
2. Pendragon Forms (~\$300, \$995 for Developer's Toolkit)
3. Satellite Forms (\$1899)
4. Codewarrior for Palm OS (\$369)
5. AppForge toolkit for MS Visual Basic 6 (~\$300)

Java 2 Micro Edition (J2ME) though not available for review during this effort, may provide a useful development environment for future efforts and warrants additional investigation. The basic premise of this software is similar to that of using Java for a desktop application; complete portability across similar platforms. Java is based upon having a Virtual Machine (VM) runtime library for various operating systems and computers that translates a universal code into functionality for each. J2ME is aimed at embedded devices, but at the time of evaluation only supported certain mobile phones, alphanumeric pagers, and a small portion of Palm capabilities.

Pendragon Forms offers a quick, easy way to design a custom data collection application. It allows for quick and easy generation of basic data collection forms. The logic interface has no provisions for anything other than moving linearly through the data collection forms (field by field), which makes navigating the form cumbersome. To hierarchically relate data in the handheld application several forms must be created and called during the running of the application so that appropriate data is available. The need to call additional forms makes the program unacceptably for the ATEAMS HHD, especially with large databases. The program will import and export data from/to Access™, however it provides no means to insure hierarchical integrity of the data. A Developer Toolkit

has been developed to allow royalty-free standalone applications to be built with Pendragon Forms (\$995).

Satellite Forms proved more versatile than Pendragon Forms and deals with tables and data in a fashion that is more useful, but its logic was also too primitive to fill the needs of ATEAMS HHD. Satellite Forms is an improvement over Pendragon Forms, as the program was structured to be similar to Microsoft Visual Basic (VB). It is a standalone application that has provisions for working with databases and tables, and for creating custom forms with predefined controls (such as text fields, buttons, list boxes, etc) with a programmer friendly interface. The scripting, however, did not allow for extensive custom control over the application. There also is no direct way to work with an Access™-database at runtime unless it is imported during application development. This issue is a limitation in that the HHD will not recognize new or modified training packages unless the user conducts a synchronization to distribute the full HHD application as well as the new training package for each training evolution.

Codewarrior is an IDE for creating custom Palm applications and can meet many of the requirements the ATEAMS HHD presents. Its logic is driven by a C++ based Palm programming language. While C++ affords the ability to program at the hardware level, there is a substantial downside to this IDE. Even the most basic application dealing with forms and control arrays requires intensive programming effort. Most standard ANSI C/C++ functions such as strcmp (compare two strings) have been rewritten and even have new names (StrCompare is strcmp in Codewarrior). This slows the development process as the programmer must learn the new set of C/C++ functions to work with the Palm hardware. Codewarrior also does not provide controls equivalent to TabStrip or TreeView controls, that are important to displaying and maintaining the hierarchical relationship of the data being collected. Such controls can be custom programmed utilizing Codewarrior's 'Widget' control (an embedded control development environment), but developing a custom control frequently can take more effort than developing the overall program shell itself. Codewarrior also does not have any way to work directly with Access™-databases. Databases are converted to Palm-format data tables before use and during runtime, and once again complete code would have to be researched and written to work with the data once placed on the Palm.

AppForge is an add-on toolkit for Microsoft Visual Basic (VB) 6 that enables the user to take advantage of Visual Basic's programming interface in creating Palm applications. AppForge was initially released in December 2000 and certain features of VB are currently

unavailable to the user in the current version. Among these features are the TabStrip and TreeView controls, which allow Microsoft-style 'tabs' and object 'tree' lists to be used in the application (these controls are under development). AppForge can provide the same functionality for a Palm OS device that Codewarrior can – at a lower cost and can be used more quickly and easily due to the VB-based functions and programming environment. The lack of TabStrip and TreeView controls required the development of custom controls. AppForge also has utilities and methods for direct conversion of Access™- databases into a format that can be used on the Palm. This feature enables AppForge to maintain correct data organization better than all other evaluated development environments.

HHD Application Software Development: PocketPC

For the PocketPC line of handheld computers, Microsoft has available a special edition of Visual Basic called Embedded Visual Basic (eVB). This IDE for Windows PocketPC-based handhelds has the necessary capabilities to develop the ATEAMS HHD. Application development requires much less programming effort within a VB environment than when developed using a C++ based IDE such as Codewarrior for the Palm OS. The ability to work directly with Access™- databases via ADOCE (Access Data Objects CE) is one of the biggest advantages over all other development tools, beyond the level of programming effort required. This interface to databases provides basic SQL (Structured Query Language) functionality, which is widely recognized for its database handling and navigating capabilities. Distributing an application designed with eVB requires no licensing fees.

Software Assessment: Conclusions AppForge for the Palm OS is the most capable IDE to date for Palm OS-based handheld devices while Microsoft's eVB is the development environment of choice for the PocketPC.

TRAINING OPERATING CONCEPT

The following section describes how a user would employ the prototype HHD in an integrated shipboard training environment.

Data Transfer from Desktop to HHD

The ATEAMS HHD desktop component provides a front end to the data collection software that the operator uses to interface with ATEAMS. The desktop application retrieves the appropriate training package from the ATEAMS database, for the identified scenario and user, and converts the data to an Access™-database that will be exported to the HHD. The desktop application maintains the hierarchical integrity of the ATEAMS database while exporting only the data collection information that a particular trainer will

require for a training session. This function is expected to be handled by the ATEAMS program when the HHD is integrated, but for the purposes of this effort, the intermediary software is required.

After the ATEAMS Training Package Session development work has been completed, the Prototype HHD desktop application user identifies a trainer of interest (see Figure 2). The trainer can be selected from the drop down menu accessed through the down arrow to the right of the text box.

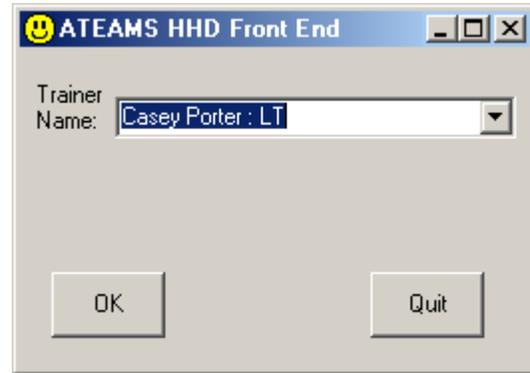


Figure 2: HHD Front end--trainer selection.

A form that allows the user to select the desired training session (see Figure 3) appears. The selected trainer of interest is shown on this form as well as training sessions that have this trainer assigned as an evaluator. A list of sessions is accessed through the down arrow to the right of the Training Session Name text box. When a session is selected, a description of that session is displayed as shown below.

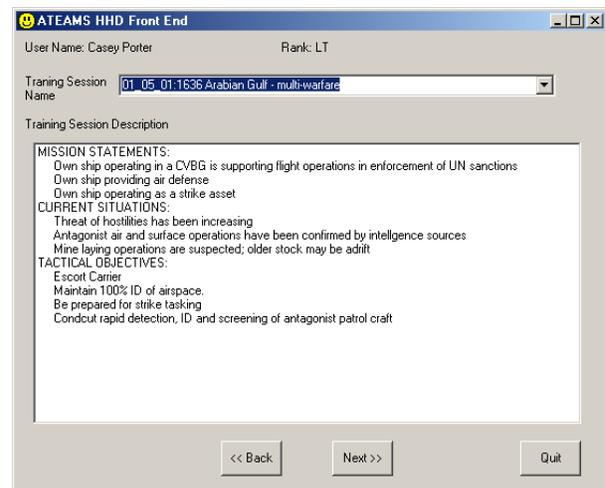


Figure 3: HHD Front end – training session selection.

Advancing to the database conversion form (see Figure 4), draws the necessary information from the ATEAMS database for the watchstations, events, and objectives

that are associated with the identified trainer. Displayed on this form is information regarding training teams, timelines, MOPs, ROE, Lessons Learned and Safety should the user want to double check this before the database is converted to the appropriate HHD database format.



Figure 4: HHD front end – database conversion.

When the HHD is placed in its cradle, a new directory becomes available in Windows. The HHD database is transferred from the PC to the PocketPC HHD by simply clicking and dragging the database file to the HHD directory. The user must ensure the communication path is not interrupted during the data transfer process. The user cannot interact with the HHD during this process and must wait until the transfer is complete.

When the data transfer is complete, the ATEAMS application on the HHD can be started. Once the application has been launched, the user is ready for the pre-training briefings and collection of data to begin.

HHD Data Collection

The first form the trainer will see when using the HHD will be the Prebrief form (see Figure 5). This page allows a trainer to refer to much of the data that will be covered during the Training Team and Trainee pre-exercise briefings. This form also provides the user a ready reference to some of the guiding elements for the scenario during training and can be referred to by navigating back to the form as desired during runtime. The navigation buttons are arranged intuitively and simplify moving through the HHD pages.



Figure 5: Pocket PC training pre-brief form .

Just above the navigation buttons are the tab controls that allow the trainer to access various elements of the pre-brief. When the pre-brief sessions have been completed, the user is ready to advance to the Collect Data Form.

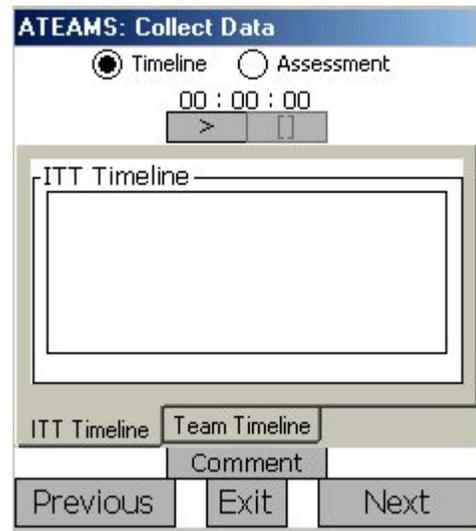


Figure 6: PocketPC collect data form – timeline.

The Collect Data form (see Figure 6) has two navigation radio buttons at the top to allow the user to select either the Timeline or Assessment page. The Timeline window displays a list of events from the scenario. When choosing the Timeline option, a choice between ITT Timeline or specific Training Team Timeline pages is available and can be made by selecting one of the tabs below the text window. The clock timer included at the top of this screen is can easily be initiated, stopped, reset, or set to a specific time using the stylus to click the appropriate button. Stylus entered amplifying comments may be provided

using the Comment button found at the bottom center of the screen. Data is written to the HHD database as the user navigates the forms.

Figure 7: PocketPC collect data form – assessment.

Selecting the Assessment button presents the user with the form used to assess training (see Figure 7). The Assessment form displays training objective information needed to assess the trainee’s performance. The form includes:

1. The current training event title.
2. An event status indicator that displays an icon to indicate one of three states: (1) not active (<) – awaiting activation in the timeline (prepare to observe), (2) active (.) – currently in operation in the timeline (observable), or (3) expired (!) – no longer in operation or active (observation period has passed).
3. The enabling objectives (EO) or terminal objectives (TO) associated with the event currently being displayed. These are displayed in the same window to conserve form space and can readily be toggled between by the trainer.
4. The objective select button (displaying “TO” in Fig. 3-5) that can be used to toggle between EO and TO as the user desires.
5. MOP statement to be evaluated. These MOPs contain any performance standards and conditions necessary to evaluate performance.
6. Event time.
7. Performance Assessment buttons. Under the MOP window, buttons are provided to assign one of two fundamental assessment values, Complete or Incomplete. When the trainee has met an MOP’s standard, the user selects the checkbox labeled Complete. Conversely,

Incomplete indicates the trainee did not complete the MOP to the standard. If the MOP is evaluated as incomplete, a form appears that allows the user to assign cause codes (Personnel (p), Training Team (t), Documentation (d), Material (m), Safety (s), and Other (o), see Figure 8).

Figure 8: PocketPC cause codes form.

Figure 9: PocketPC debriefing form.

The last task of the data collection phase is the post-training briefing, commonly called Debrief (see Figure 9). When data collection is complete, the user moves to the Debriefing form, in which post-training debrief material is displayed in a hierarchical format, relating the objectives and training events in a tree format. Users can click to expand and collapse the tree controls to display the desired level of detail. Subordinate to the training events and objectives are the performance measures. To the left of the measures are the

assessment/cause code values: C – Complete, M – Material, P – Personnel, D – Document, T – Training Team, S – Safety, and O – Other.

Data Transfer from HHD to Desktop

The final phase in the overall data collection process involves exporting gathered data to the PC. Before beginning the export process, the Pocket PC must be connected to a PC host running ATEAMS. When the HHD is placed in its cradle, the HHD directory (My Mobile Device is the default) again becomes available in Windows on the desktop PC. Simply clicking and dragging the HHD database file to the ATEAMS and prototype desktop application directory will place the file on the desktop PC for further processing. The user must ensure the communication path is not interrupted during the data transfer process. The user cannot interact with the HHD during this process and must wait until the transfer is complete.

USABILITY EVALUATION

In order to determine the extent to which the APDA software is user friendly, an independent heuristic evaluation and user test were conducted by Dr. Robert Allen of NAWC/TSD (Allen and Daskarolis-Kring, 2001). Three users that had taken part in the ATEAMS software evaluation were asked to perform specific tasks using the APDA software. Information from the previous evaluation such as training team members being evaluated, Training Events (TEs) and associated Measures of Performance (MOPs), were downloaded onto the iPAQ™ via the APDA software. The tasks in the current study required users to confirm the identification of the trainee and scenario information (created previously during the ATEAMS evaluation) as well as review the Training Objectives (TOs) of the scenario. Users were then instructed to score several MOPs in a pre-specified manner and then review and comment on the debriefing material provided by APDA.

User testing revealed several limitations that, if corrected, should lead to increased usability of the system. Overall, 35 violations were identified during the heuristic evaluation and user testing sessions, with the majority of the violations occurring under the consistency heuristic. User's also wanted the capability to access their comments during the debriefing phase and they felt that the method used to scroll through some of the displayed information was too tedious. Finally, presentation and readability of displayed text were areas of concern, both to the users and evaluators.

SUMMARY

With a long history in R&D, semi-automated performance measurement methods and tools are ready for use in the operational environment. In this paper, using an ATEAMS-driven requirement, we described the process for deriving requirements, an evaluation of hardware and software, and a use case depicting software development efforts. This work affirms our claim that this technology is ready for real-world application.

There are, however, important issues yet to be resolved before an ATEAMS HHD can be fully developed and delivered to the Fleet. Usability, as highlighted by the evaluation performed by Allen and Daskarolis-Kring, needs to be improved upon. Moreover, though the current effort focused on low-cost HHDs, detailed requirements analysis is likely to reveal a need for a mix of HHDs of differing capabilities.

In the current effort, the candidate mobile device was connected to a desktop PC via a cradle. While this was useful during our research and development, it does not optimally support the envisioned shipboard or client/server environment. In fact, the envisioned use is a many (HHDs) to one (ATEAMS server), distributed environment. To enable the mobile device connection to a database or application server over a LAN, a synchronization server is needed.

Another critical issue that will need to be addressed is security. The very mobility that makes the HHD so attractive as a performance measurement technology poses security challenges as users move from secure to non-secure areas—this issue must be addressed prior to implementation.

For the past seven years, much research has been carried out to develop tools that can pair advanced performance measurement methods with state-of-the-art hand-held PC technology. Effective tools that dramatically improve automation in the collection of performance measurement metrics during training in a scenario-based environment have been developed and are in position for transition to fleet use. The prototype hand-held data collection tool developed for use in conjunction with ATEAMS enables digital data collection, reduction and storage that reduces manpower required to carry out training and facilitates systematic performance measurement.

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