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THESIS

HYPERCARD DATABASE TECHNOLOGY
AS APPLIED TO A
THREAT EVALUATOR REFERENCE TOOL

by

Frank E. Sutton
March 1991

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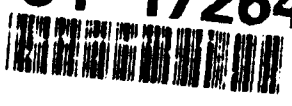

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Hypercard Database Technology
As Applied To A
Threat Evaluator Reference Tool

by

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ABSTRACT

The paperless ship concept proposed by VADM Metcalf has been advocated at the highest levels in the Navy. ARGOS is a prototype multi-media database system under development at the Naval Postgraduate School in support of this superior concept. This thesis has implemented a tactical evaluation and assistance tool called Threat Evaluator that can be used as an additional module to the ARGOS system or as a stand alone application. Threat Evaluator automates many of the evaluation and information keeping duties that a Tactical Action Officer is required to perform during normal watchstanding evolutions. It demonstrates the advanced capabilities attainable in a system implemented with economical, off-the-shelf technology.

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I. INTRODUCTION

In the United States Navy there are several watch stations that require a substantial investment in both time and energy to not only develop the skills and knowledge base, but also to earn the confidence and trust of the Commanding Officer (CO). One of the most critical positions is that of Tactical Action Officer (TAO). The TAO has the authority to engage the enemy and release weapons in the absence of the CO. The Navy organization manual [Ref.1] states the following duties of the TAO:

> a. Basic Function. When assigned, the Tactical Action Officer is the commanding officer's representative concerning the tactical employment and the defense of the unit.
>
> b. Duties, Responsibilities, and Authority. The TAO is responsible for the safe and effective operation of the combat systems and for any other duties prescribed by the commanding officer. Circumstances permitting, the TAO shall carry out promptly and precisely special orders and shall report deviations to the commanding officer.

Currently, much of the data required by a TAO is contained in publications that must be manually assimilated. This can take an inordinate amount of time to find critical information. Manual data retrieval methods typically increase the probability of selecting incorrect data which, in turn, results in an erroneous evaluation. Other information required by a TAO is contained on turnover sheets and written on status boards. Many times this information is not kept current or may be forgotten altogether. This can result in critical and/or perishable information being lost during the normal watch to watch turnover.

These problems can be solved with development of an application that would greatly assist TAO's in their duties by automating the myriad functions that a TAO must accomplish in his or her normal watch duties. These would include the searching of data to match an emitter with a platform or having available the current status of all ships' weapons and engineering systems. This application, Threat Evaluator, would be developed in accordance with the Argos architecture [Ref. 2]. This architecture specifies a multi-media interface that provides access to a real time database. This application interface would support text, graphics and audio to achieve the most desirable interface possible.

The environment in which Threat Evaluator was developed is Hypercard™, whose scripting language is Hypertalk™. Information on this environment can be found in Apple's Hypercard User's Guide [Ref 3]. This environment proved to be quite efficient in the production of the prototype application. The Threat Evaluator and Hypercard operate on Apple Macintosh™[1] computers. An important point is that Threat Evaluator can be converted for use on any Microsoft disk operating system (MSDOS) platforms which would facilitate its implementation throughout the fleet.

The purpose of this thesis is to demonstrate the feasibility of a tactical evaluation tool that will aide in the identification of platforms that may pose a possible threat to U.S. forces. The tool will also give the TAO relevant own ship's information so that tactical decisions can be made knowing all required information.

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[1]Hypercard™ and Hypertalk™ are trademarks of Apple Computer Incorporated.

II. PROBLEM STATEMENT

One of the most important qualifications and subsequent duties of a Surface Warfare Officer is that of TAO. It is the pinnacle qualification that a junior officer can achieve resulting from training, acquired knowledge and trust . It is also quite an identifiable achievement a CO can bestow; proclaiming that a junior officer is capable of fighting the ship in battle. The CO that conducts the qualifying process puts great trust in each of the officers that he or she qualifies. Stringent qualification requirements and thorough knowledge of own ship and other potentially hostile ship's characteristics and capabilities are essential to proficiency and success as a TAO.

Although the TAO position is quite important and essential, after the qualification process has been completed there is little continuous training conducted to maintain this high degree of readiness. Continued training is usually left to each TAO with little or no guidance. Normal means of keeping proficient is rote memorization. This process may be helpful in the short term, but must be continually refreshed in order to keep the knowledge base readily available and current in memory. It is difficult for the TAO to keep current all hostile, or potentially hostile, ships memorized and easily accessible at a moments notice. The will to train is often hampered by the sheer mass of data that must be memorized. The unappealing volumes that contain the data must also be learned to use. Methods that will give the data more appeal and even an exciting means of learning required knowledge would pique interest while being functional and informative.

Another problem encountered in the normal watch duties of the TAO is the time consuming evaluation of each emitter signal detected. The usual flow of

information starts with the detection of an emitter by the Electronic Warfare (EW) suite aboard. After the initial detection, search algorithms on the detection equipment attempt to make a match with the signal detected. This search usually takes longer than desired and may result in an incorrect evaluation. The search algorithm itself may not be optimal resulting in a slow search and retrieval process. The search is also conducted manually by EW personnel using printed reference volumes. This is done in order to reduce the number of erroneous matches that result from software searches alone. The whole process is time consuming and prone to errors.

Current tools available to U.S. Navy Combat Information Center (CIC) watchstanders, all of whom work for the TAO, for threat evaluation and recognition training are limited. Naval Warfare Publications (NWP), are used to search for data that is of primary concern. Of note, there is no quick reference available for correlation of essential initial identification information while in a tactical environment. By its very nature, this limits the flow of critical information that the TAO must have to support the decision making process. Loss of time conducting manual searches for information contained in hard copy volumes adversely affects the defensive posture of a single ship as well as the overall combat readiness on an entire battlegroup.

The effective transfer of information during watch turnover is crucial to watch continuity. Word of mouth, status boards, notes scribbled on paper and even seemingly organized notebooks have been the historical means of transferring current tactical as well as material status. Although this may prove effective in an isolated number of cases, for the most part essential information is left out or altered slightly by the typical watch to watch turnover. If notebooks are used for turnover information, the notebooks or status boards may not be updated in a timely matter, or may even be totally neglected. Additional clutter

is the result of paper turnovers and it leaves the oncoming watchstander sorting the remaining pile for useful bits of information. Visual means of exchanging data on electronic media is the most efficient choice available. Off the shelf technology can provide significantly more efficient data retrieval and a graphical interface that will aid this entire process.

A review of current procedures and first hand experience have revealed a number of items that should be improved for greater efficiency. These are:

- Resources are currently manual in nature, often leading to slow, inefficient information retrieval. Unwieldy publications and microfiche are the primary mechanisms for data storage and the only vehicle for training watchstanders.
- After qualification, TAO's typically have no formal training in threat evaluation as a means of maintaining/improving proficiency.
- Reference and training tools are not centralized, often requiring users to visit various locations to collate/coordinate the tools and information and to have access to the proper equipment.
- The lack of user friendly aids to threat evaluation is often frustrating to many TAO's.

Automation of many of the manual functions, such as searching databases and recording critical watch information to relieving watchstanders, would greatly improve the efficiency of the evaluation process. There are, however, factors that would be of primary concern in determining the implementation of such an application. These factors are reliability of the hardware system and the ease of use of the application.

The reliability of the system includes many items. Preferably, it should be more reliable than systems currently in use. Methods of protecting data and

applications from viruses as well as disk, system and application crashes should be carefully considered. A variety of media exists for data backup. Floppy disks, tapes, optical disks, hard disks and removable hard disks are all readily available and accessible.

Data updates are of primary concern to the user. The importance of having accurate, time sensitive information is critical. Efficient and easy methods of updating existing information would be important in saving time and effort as well as money. Determining the best possible method of delivering updated information is also a crucial problem.

The emphasis on ease of use cannot be over stressed. The goal is to make the application intuitive, thereby allowing novice users easy access to its capabilities. If the application requires enormous manuals and cryptic documentation be read and filtered prior to use, then ultimately the product will not be used. Determining which environment will best suit this requirement is an important undertaking.

III. SOLUTION

The recommended solution and the focus of this thesis research is the automation of numerous manual tasks that are conducted by the TAO and other watchstanders. Automation of procedures would simplify and streamline the warfighting capability of any warship. The speed at which many of the procedures can be accomplished through automation will significantly increase productivity of a TAO and his/her watch team. This solution is composed of both hardware and software. Both are crucial to ensure successful operation and integration of a total system into the fleet.

A. HARDWARE SOLUTION

Hardware is vitally important in an enclosed shipboard environment because space is scarce. The smaller a system is, the better it will support limited space of fleet units. A micro computer is an excellent choice. The cost of micro computers has dropped dramatically in recent years and they have become quite affordable. Micro computers with speeds in the 16MHZ-25MHZ can be purchased for under $3000. Most micro computers contain a number of additional features such as sound, expansion slots and network capabilities which ensure a system could be expanded to meet future requirements.

The ability of the micro computer to support sound is an important factor. For example, sound can be a critical feature in the evaluation of EW parameters. Sound capability could assist the users in identifying various platforms by matching emitter parameters contained on those platforms. Other implementations of sound, such as acoustic signatures, could be used to further enhance the solution. Speakers and associated sound supporting equipment

should come included in the micro computer rather than having to buy an additional equipment in order to add this feature. This will provide two benefits: first, is the elimination of requirements to have the expertise and tools available to install sound equipment; second, the cost of buying required sound equipment would be avoided. The micro computer that includes sound capabilities may be slightly more expensive in the initial purchase, but when the cost of the installation tools, the installation of the sound equipment, and the sound equipment itself are added to the price of the micro computer that did not have it previously installed, the result is an overall lower cost for the one having the capability built into the micro computer.

The ability of a micro computer to be expandable is also crucial in the selection of a micro computer. Many micro computers have expansion capabilities available through expansion slots. Expansion slots provide the means of installing additional cards that add useful features. These capabilities include 24 bit color, file compression and networking. It is important that future requirements be considered when selecting a micro computer for implementation.

The ability of a micro computer to support networking is fast becoming an essential part of any computer solution. The ability to share data and resources between multiple user computers, as well as different types of computers, is a significant attribute. A multi-user environment is necessary for complete implementation of a solution. Users typically use only a portion of data from the solution application. Examples of multiple users that would use a solution application may be the CO, Executive Officer, Department Heads, TAO's, and on-watch personnel such as those in the CIC, EW and ASW modules. A networking capability must be available in the micro computer selected.

An important part of a hardware solution, in addition to the micro computer, is a monitor. A monitor is essential for displaying data that is generated from the micro computer and solution application. Over the last few years, monitors have become quite inexpensive. High resolution color monitors can be purchased for approximately $500. The resolution of the monitor is important because the graphics that will be displayed in the application must be clear. A thirteen inch monitor having a 640 by 480 pixel display with 72 dots per inch (dpi) resolution should be sufficiently high in resolution to show the required graphics.

B. SOFTWARE SOLUTION

When considering a specific software environment to be used in the generation of a solution application, there are a number of criteria that should be evaluated in order to choose the most desirable option. These criteria can best be described as features that the environment will support. These features for a development environment include reusable code, modularity and rapid prototyping capabilities. Features of the solution application include: a multimedia interface, rapid search, display of windows, graphics, sound, tailored menu capabilities and machine independence.

1. Development Environment

The software development environment chosen should support two main features. The first is modular design and the second is reusable code. This is by no means an exhaustive list of requirements, but these two are certainly essential to the solution of this specific problem.

The development environment must support a modular program design. This design will make the expansion of the solution application much easier to

implement. Whitten, Bentley, and Barlow [Ref 4] say the following about dividing a program into modules:

> Given these programs, we want to break them into manageable modules around which program specifications will be written. Programmers can then build and test each module independently. Then modules can be integrated according to the structure chart and tested as a whole program.

This approach to program design would enhance the solution application since the program data would lend itself to a modular design. For example, some of the required data would be divided into countries. Each of the country modules would contain the information on the equipment and platforms owned by that country.

Reusable code has become a buzzword in the software development community. Reusable code promotes efficiency in the development of new applications or new modules that will be add-ons to existing applications. Reusable code still requires some modification, however the savings that such code generates makes the cost of such changes insignificant when taken in aggregate. Powers, Cheney, and Crow [Ref 5] state the following:

> Systems designers have long been interested in the concept of reusable code. The idea is to write general purpose modules that can be used in many programs, thereby reducing the overall programming and testing effort during development and simplifying the on-going maintenance effort. The large majority of program code involves routine processes such as data entry and verification, file maintenance, and report writing. It should be possible to create a standard set of modules supporting these operations that could constitute 70 to 80 percent or more of the code for a new system.

These two factors, modularity and reusable code, contribute to a rapid prototyping environment that would support quick delivery of a product to the fleet. Prototyping is an excellent way to determine additional requirements and solutions before the final product is distributed to end users.

2. Application Solution

This solution application includes a multimedia interface for real time databases that supports text, graphics and audio. This capability would be required to provide the needed data that a TAO would use in the course of his/her duties. These capabilities are also essential in displaying that data in a timely, easy to assimilate manner.

This application must have a rapid search capability. From a users' perspective this feature is quite important. In a tactical environment, a rapid search could mean the difference between the success or failure of a mission. Vast amounts of data must be searched increasing the need for a search to be fast and accurate.

The manner in which information is displayed is very important. The user should be able to easily distinguish different parts or categories of information from one another. An ideal way to do this is to display the information in windows that appear as specific queries are selected by the user. This provides a quick means of assimilating data. The solution application should support this method of data display. From a human factors point of view, this is a better interface.

Graphics are an essential part of this solution application. They are used to enhance recognition of platforms for training and tactical situations and also to make the interface user friendly. The power of a user friendly interface cannot be underestimated. The easier it is to understand and use the application,

the greater value it will provide end users as a tool for accomplishing their missions. Graphical user interfaces provide clear, concise object relationships that a user with only modest experience can easily associate. Pictures of familiar objects on the screen guide a user to operate the application. A user sees an icon in the shape of a missile, he or she should expect information about missiles to come from using that icon. The interface is intuitive which adds to the desirability of the application. Considerable thought and study must be incorporated in the design of an interface. Graphical capability is a means to achieving this desired result.

Sound is another method of providing information to the user. For example, sound could be used to distinguish one level of a program from another or to provide an audible alarm that will alert the user if needed. There are many other options that could also employ sound to assist the user.

In order for an application to be adapted to a specific use, menus of the program should be tailored to support needed functions and information. Tailored menus allow the user to quickly identify his or her options for retrieving desired data. Menus support the proper setup and flow of information to the user.

It is crucial that the application be machine independent and transportable to other hardware. This would then allow the application to be available on most hardware in use in the fleet. True machine independence provides an application with an enormous platform base upon which to operate. Access by all fleet users increases the ability to develop and capitalize on large user groups.

IV. IMPLEMENTATION

A. OVERVIEW

The Threat Evaluator was developed in a Hypercard environment on a Macintosh II computer. Hypercard comes free as system software with all Macintosh computers. The assumption in this chapter is that readers are familiar with Hypercard. In Threat Evaluator, all algorithms and modules have been thoroughly considered throughout the development process. Threat Evaluator can be implemented as an additional module to the Argos System or as a stand alone application. For the purpose of the prototype, the Threat Evaluator is made up of five modules and is modelled after a FFG-7 class ship There is the Threat Evaluator module, the U.S. Aircraft data file, the U.S. Surface Ship data file, the U.S. Submarine data file and the Threat Evaluator Help data file. The modular design was considered the best option for future expansion of this application because every country that has military equipment would be modelled in a data file. For example, Germany would have its own data file containing information on its' platforms. This modular approach also conforms to the design of the Argos system. The Threat Evaluator is the most tailored tool to date that gives a TAO continuous personal training as well as evaluation of platforms that may pose a possible threat to the safety of the ship.

Hypercard has met all the criteria for the software environment solution. It supports both modularity and reuseable code. Reuseable code features of Hypercard support a high percentage of the code needed for development of all the modules.

B. STARTUP SCREEN AND MAIN MENU CARDS

The startup screen displays high resolution graphics and plays digitized soundt to show the many capabilities of Hypercard and a Macintosh as soon as possible. A picture of a U.S Aegis cruiser was placed over a background that has a marble like appearance. This was done to give the user the feeling of viewing a warship in a background of space giving a futuristic appearance. The sound was used to welcome the user to the Threat Evaluator as well as demonstrate digitized sound. The command to play the sound is contained in the card script. Digitized sounds for the stacks were installed using the MacRecorder® by Farallcn™[2]. These sounds were then placed into the main Threat Evaluator stack as resources. These resources could then be called and played as required.

The startup screen dissolves into the main menu screen. This visual effect was included to demonstrate one of the many screen change features of Hypercard. The dividing line in the center of the main menu screen is used to distinguish training areas from actual tactical applications. The training portion of the screen, above the separation line, has three card layer buttons. The three areas modeled were aircraft, surface ships, and submarines. Each of these card buttons has an associated icon that correlates the name displayed to the button. For example, the aircraft button has an icon in the shape of a jet. This was done to give an additional visual confirmation to the user of what is being selected when he or she clicks on that button. Each of the buttons calls an external command (XCMD) that generates a popup menu. The countries contained in the popup menus for each of the aircraft, surface ships and submarines buttons are

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[2] MacRecorder® is copyrighted by Farallon Computing Incorporated.

categorized in accordance with the International Institute for Strategic Studies' (IISS) yearly publication [Ref. 6]. This publication provides a well organized categorization of various countries. The country and department modeled on the aircraft and surface ships card buttons is the United States and the U.S. Navy (USN). The United States is modeled on the submarines card button. The scripts for the aircraft, surface ships, and submarine menus are contained in Appendix A. The categories provided by the IISS were determined to be a reasonable manner in which to categorize the data within the Threat Evaluator.

Selection of items on the popup menus contained in the aircraft, surface ships and submarine card buttons take the user to a second level menu screen. The specific country or department chosen from that first menu is broken down into the various agencies on the second menu screen. These agencies have control of the equipment (aircraft, surface ships, submarines) selected from the first menu screen. For example, after selection of "USN" under the aircraft card button on the first menu screen, the screen changes to display the types of squadrons associated naval aircraft. The user then has access to the individual aircraft type within each squadron designation. These squadron designations are in accordance with Ball [Ref 7]. Representative scripts for the second menu screen card buttons are contained in Appendix A. The second menu screen has a horizontal dividing line to differentiate fixed wing aircraft from helicopters. This provides another visual confirmation to the user. Squadrons and ship classes are not all inclusive but were chosen to represent different communities.

C. INFORMATION CARDS

After a specific aircraft, surface ship or submarine is chosen from the second main menu screen the user is then shown the card with that specific platform. On the card there are features that will be of assistance to the user in

categorizing the possible threat to his own ship. Capabilities of the platforms are divided into the four warfare areas modeled. The warfare areas chosen were anti-air warfare (AAW), anti-surface warfare (ASUW), anti-submarine warfare (ASW), and electronic warfare (EW). Not all warfare areas were modeled due to time constraints. Labels for the card button associated with the warfare areas were placed into the background because these labels would be used on all platforms within the stack. The actual buttons were placed in the card layer because the popup menu would have to be tailored for each platform. These card buttons can be copied and used in new cards and easily modified for other platforms since the script is copied along with the card button. Repetition of equipment that appears under these warfare menus is purposely done to show the possibilities of using a certain system in more than one mode or warfare area. For example, a surface to air missile may also be used in a surface to surface mode. This repetition would assist the TAO in remembering the capabilities of various weapons. Scripts for the warfare area buttons are contained in Appendix A. Equipment and systems listed in the menus for the F/A-18 Hornet [Ref 8], the Oliver Hazard Perry class frigate [Ref 9], and the Los Angeles class submarine [Ref 10] were taken from Jane's Fighting Ships and Jane's All The World's Aircraft.

After a weapon or electronic system is selected from the menu of a warfare area, a window appears containing specific data and characteristics that a TAO may require for proper tactical evaluation. The windows are actually card fields being displayed upon the selection of a menu item. The use of card fields was determined to be ideal in separating system data in a logical systematic manner and providing a visual consolidation of information for the user. Card fields containing data have been locked to prevent inadvertent alteration of the data. This gives an added measure of security as well as ensuring that data remains

intact. There are many card fields containing information on each card. Each is given a specific name and that name is placed in the script of the applicable warfare area button. Once the field is displayed, it can be hidden again by clicking the cursor within the field. This format of displaying data will be useful in training prospective TAO's. The method of data display is also useful for training prospective TAO's since on-line quizzing can be accomplished within each warfare area.

D. SEARCH AND IDENTIFY FUNCTION

One of the most crucial and useful functions available to the TAO in the Threat Evaluator application is the Search and Identify option. This option is located on the main menu screen for easy access by the user and is vital for quick identification of an incoming threat associated with a particular emitter or weapon system. The search and identify screen contains three card fields, one of which is hidden. The name of the hidden card field is "stacks to search". Scripts [Ref 11] for the visible fields are found in Appendix A. The first field receives the search string that will be compared to all the data card fields of the information stacks. The search algorithm will search each stack that is listed in the hidden field. Additional stacks that are created would merely need to be added to this field. Upon a match of the search string and the name of a data field, the name of the card and the name of the stack in which a match was found is returned and displayed in the second visible field.

The second field displays the name of the platform and the name of the stack on which the platform is located. These are separated by a comma and the number of matches displayed is unlimited. If a TAO desires further information on a particular platform, he or she merely uses the mouse to click on the desired platform's name and the information card for that platform is displayed instantly

by pushing the search card. This is done so that the user can return to the search card and evaluate further matches. The card field displaying the results of the search is locked to permit the routine to work. This routine was considered an essential function of the search card. The TAO had to have the capability to quickly evaluate the results of the search without having to navigate back through menus. This routine allows the TAO to evaluate in detail the capabilities of each of the platforms found by the search.

E. TAO STATUS BOARD

The TAO status board was created to give a TAO a place to record information that was critical for the proper conduct of the watch. He or she also needed a place to record any information that would be pertinent for following watch sections. The TAO status board is an ideal tool for easy access to all required ships' information. The TAO status board is comprised of two cards that display critical ships information. The combination of these two cards assures that the TAO has available all data essential to fighting the ship. Two cards were determined appropriate to hold all the information that would be of importance while not requiring an excessive amount of searching by the TAO through many cards. The first card was chosen to hold general data that would be easy to assimilate at a glance. The second card was constructed to hold more detailed data regarding the casualties of various engineering and combat systems.

The first card of the TAO status board displays tactical weapons systems' information. Weapons status and condition of readiness are displayed at the top of the screen. The position of this was important because a TAO must first be aware of the weapons status ordered. The screen is essentially divided into three main segments in order to logically collate data. The segment on the left of the screen contains ASW related information including associated weapon's systems.

Information such as the mode of the sonar, water conditions for the day and torpedo loading data are essential for ASW operations. Radio buttons (which are small round buttons) and text fields were used to accept and display information. The torpedo tube graphic serves to give the user a visual reference of which tubes are currently loaded. The segment on the right of the screen contains information on the installed gun systems. This information would be required in any AAW or ASUW engagement. Information is also displayed through the use of text fields and buttons. The segment on the lower center of the screen shows the remaining missiles and their respective locations in the magazine. This display gives the TAO a visual perspective as to the remaining missiles and their locations after a firing. Each of the cells contain four buttons, each symbolizing the three types of rounds (SM-1, blue bird, harpoon) plus an empty cell symbol that would be generated once a missile from that cell was fired. The symbols chosen were representative of the actual rounds and an empty cell was given an "x" symbol.

The second screen of the TAO status board is divided into two main sections. The left side of the screen is the combat systems status and the right side of the screen is the engineering status. This information is very important to the TAO because the material condition of either of these two areas directly affects the combat readiness and the survivability of a ship in combat. If there is any degradation in the equipment, then the TAO must be aware of what is not working and what effect its' failure has on the combat readiness of the ship. Card text fields were considered necessary to hold information on what equipment has a casualty, what effect the casualty has overall and what, if any, scheduled maintenance.

F. TACTICAL ALGORITHMS

This module has not been developed. A stub was placed here indicating future possibilities. Ideally, it should be capable of using tactical algorithms that would calculate the probability of kill (P_K) against a particular target with a selected ship's weapon. This would then give the TAO the optimum weapon release point against that target and the number of weapons to use in any given engagement. The TAO would then have a solid recommendation on which to base his final decision.

G. INTER-STACK BACKGROUND BUTTONS

There are a number of references which a TAO must read and be familiar with. These written orders should be easily accessible to the TAO. Throughout each of the modules of Threat Evaluator, the TAO has access to a number of background buttons. The background buttons of note are Battle Orders, Rules of Engagement (ROE), Night Orders, Pass Down Log (PDL), INCSEA signals and Allied Tactical Publication (ATP) signals.

Battle orders, ROE, night orders and PDL cards were constructed in the same format. A scrolling field was chosen to hold the data. This field can expand as the amount of data grows. The field will hold a total of 30,000 characters [Ref 12]. A button prints the time and date into the field when required by the user. The time/date stamp was considered necessary so that the user could identify any new entries since the last time he/she read the file.

The INCSEA background button displays a card that defines the future use of this module. The module would contain all the signals from the INCSEA agreement. These signals would be displayed either in a list or a specific signal could be encoded/decoded as required. The signal would be input by the TAO,

resulting in the encoded/decoded signal displayed on the screen. Construction of this module is a follow-on to this thesis.

The ATP-1(C) background button displays a card that defines the planned future use of this module. This module will contain all the signals from the ATP-1(C) volume I and II. These signals would be displayed either in a list or a specific signal could be encoded/decoded as required. The signal would be input by the TAO, resulting in the encoded/decoded signal displayed on the screen. This module is also a follow-on effort to this thesis.

V. LESSONS LEARNED

There are several lessons learned from the development of the Threat Evaluator application tool. Programming and interface standardization is especially crucial with future modules that supplement the Threat Evaluator application since it is an iterative and continuous development process. This standardization would assist the developers in the construction of new modules or data files. Important lessons learned include the use of sound and graphics to achieve unique methods of data representation. These lessons will provide valuable information for future module development.

The first lesson learned was in the use of graphics. The careful utilization of graphics was determined to be a benefit and not a distraction to the user. This determination came from demonstrating the application to interested individuals. Graphical representation of familiar objects creates a more acceptable environment to new users of the application. Objects that appear in the users' normal work routine and duties are taken and represented graphically in the application. Implementing this graphic representation into the application results in the user bringing previous knowledge to the application. This gives the application an intuitive interface. This intuitiveness is highly sought after in an application such as Threat Evaluator.

The second lesson involved unique benefits of using sound as another means of transmitting information to the user. Sound provided the user with a variety of data. Digitized sound was used to repeat what main menu function he or she was choosing. This supplied the user with an audio confirmation of his or her actions. Computer generated sound was used after the first main menu screen. The differentiation of digitized sound and computer generated sound gives the

user the positive reinforcement that he or she is in a different part of the application. The demonstration of both types of sound lends credibility of the sound capabilities and their further expansion into other areas of this application.

The third lesson learned was the proper method of program and data design in constructing the Threat Evaluator. Initially, Threat Evaluator began as a single stack. However, this became cumbersome and changes to the stack were often difficult to incorporate. A modular concept of data was determined as the most convenient and cost effective method. For future additions to the Threat Evaluator, modularization would facilitate the replacement of old data files with new ones. This modular concept allows a specific program area or data file to be worked and updated as necessary, then easily reintroduced into the main application. This method will reduce the code necessary for implementation in fleet as opposed to a system that was not of a modular composition.

The fourth lesson learned was to include proper documentation for the application's operation. Appendix B contains a user's manual that describes the operation of Threat Evaluator. This documentation assists the user in the proper operation of the functions and features of Threat Evaluator.

VI. CONCLUSIONS

The development of the Threat Evaluator tool has shown the feasibility of an automated reference and evaluation tool. The modular design of the application as well as the quick prototyping aspects of the Hypertalk language show that the Hypercard environment can be both economical and technically sound for future development of projects of this sort. Many provisions greatly needed by TAO's have been incorporated into the Threat Evaluator. These features can be fine tuned and tailored as further iterations of the application are developed.

The storage media most likely to be of greatest benefit for the Threat Evaluator is compact disk read only memory optical storage (CD ROM). This would be best for a number of reasons. First, the CD ROM disks will hold about 550 megabytes of data. This large volume is necessary to hold all of the data that is required for a fully implemented Threat Evaluator application and data files. Once Threat Evaluator has been completely implemented, every country that has military equipment would be represented by a module that contained information on that equipment. Today the only true alternative for this amount of data is CD ROM. Second, distribution of CD ROMs would be easy. Cognizant agencies would merely send new CD ROMs to fleet units as updates to the data files are required. Users would then be able to return the old CD ROM for proper destruction or sanitization of data. Third, distribution disks would be read only memory. Fleet personnel would not be able to alter the information contained on the CD ROM. This ensures that all units will have the same data files. Finally, optical disks are quite sturdy and are not easily damaged by normal day to day use. This will provide protection of the data as it is in transit to the user facility.

Future areas of study directly relating to the Threat Evaluator application include:

- Development of a module that incorporates probability of kill algorithms to generate a recommendation to the TAO.
- Development of a module that incorporates the signals and data in volumes one and two of ATP 1(C).
- Development of a module that incorporates the INCSEA signals.
- Determination of which storage media is truly best for this application to include CD ROM, tape drives and removable hard disks.

The development of the Threat Evaluator supports the Argos environment and the concept of a paperless ship. It provides the TAO with an exceptional tool for analysis of tactical operations. It also provides the user with a method of clear and concise information transfer between watch sections.

APPENDIX A

SCRIPTS FOR THREAT EVALUATOR

A. CODE FOR THE MAIN MENU SCREEN POPUP MENUS.

1. Aircraft button

```
on mouseDown
  play aircraft

  put "United States,USN,USAF,USA,USMC,USCG,NOAA" into aircraft

  put return & "Soviet Union" after aircraft

  put return & "NATO,Belgium,Canada,Denmark,France,Germany,Greece,"¬
  &"Iceland,Italy,Luxembourg,Netherlands,Norway,Portugal,Spain,Turkey,"¬
  &"United Kingdom" after aircraft

  put return & "Warsaw Pact,Bulgaria,Czechoslovakia,Hungary,Poland,"¬
  &"Romania" after aircraft

  put return & "Mideast & North Africa,Algeria,Bahrain,Djibouti,Egypt,"¬
  &"Iran,Iraq,Israel,Jordan,Kuwait,Lebanon,Libya,Mauritania,Morroco,"¬
  &"Oman,Qatar,Saudi Arabia,Somali Republic,Sudan,Syria,Tunisia,"¬
  &"United Arab Emirates,North Yemen,South Yemen" after aircraft

  put return & "Sub-Saharan Africa,Angola,Benin,Botswana,Burkina Faso,"¬
```

```
&"Burundi,Cameroon,Cape Verde,Central African Republic,Chad,Congo,"¬
&"Ivory Coast,Equatorial Guinea,Ethiopia,Gabon,Ghana,Guinea,"¬
&"Guinea-Bissau,Kenya,Liberia,Madagascar,Mali,Mozambique,Nigeria,"¬
&"Senegal,Seychelles,Sierra Leone,South Africa,Tanzania,Togo,Uganda,"¬
&"Zaire,Zambia,Zimbabwe" after aircraft

put return & "Asia & Australasia,Afghanistan,Australia,Bangladesh,"¬
&"Brunei,Burma,Cambodia,China,India,Indonesia,Japan,North Korea,"¬
&"South Korea,Laos,Malaysia,Mongolia,Nepal,Pakistan,Papua New Guinea,"¬
&"Phillipines,Singapore,Sri Lanka,Taiwan,Thailand,Vietnam,New Zealand"¬
after aircraft

put return & "Carribean & Latin America,Argentina,The Bahamas,Belize,"¬
&"Bolivia,Brazil,Chile,Colombia,Costa Rica,Cuba,Dominican Republic,"¬
&"Ecuador,El Salvador,Guatemala,Guyana,Haiti,Honduras,Jamaica,Mexico,"¬
&"Nicaragua,Panama,Paraguay,Peru,Suriname,Uraguay,Venezuela"¬
after aircraft

get HPopupMenu(aircraft,0,The mouseV,The mouseH)
if it <> 0 then
  put item 1 of it into row
  put item 2 of it into column
  if (row = 1) and (column =2) then
    go to card "usn"
  end if
 end if
end mouseDown
```

2. Surface Ships Button

```
on mouseDown
 play "surface ships"

 put "United States,USN,USA,USCG" into ships

 put return & "Soviet Union" after ships

 put return & "NATO,Belgium,Canada,Denmark,France,Germany,Greece,"¬
 &"Iceland,Italy,Netherlands,Norway,Portugal,Spain,Turkey,"¬
 &"United Kingdom" after ships

 put return & "Warsaw Pact,Bulgaria,Czechoslovakia,Hungary,Poland,"¬
 &"Romania" after ships

 put return & "Mideast & North Africa,Algeria,Djibouti,Egypt,Iran,"¬
 &"Iraq,Israel,Jordan,Kuwait,Lebanon,Libya,Mauritania,Morroco,Oman,"¬
 &"Qatar,Saudi Arabia,Somali Republic,Sudan,Syria,Tunisia,"¬
 &"United Arab Emirates,North Yemen,South Yemen"after ships

 put return & "Sub-Saharan Africa,Angola,Benin,Cameroon,Cape Verde,"¬
 &"Ivory Coast,Ethiopia,Gabon,Ghana,Kenya,Liberia,Madagascar,Nigeria,"¬
 &"Senegal,Sierra Leone,South Africa,Tanzania" after ships

 put return & "Asia & Australasia,Australia,Bangladesh,Brunei,Burma,"¬
 &"Cambodia,China,Fiji,India,Indonesia,Japan,North Korea,South Korea,"¬
 &"Malaysia,Pakistan,Papua New Guinea,Phillipines,Singapore,Sri Lanka,"¬
```

```
 &"Taiwan,Thailand,Vietnam,New Zealand" after ships

 put return & "Carribean & Latin America,Argentina,Bolivia,Brazil,"¬
 &"Chile,Colombia,Cuba,Ecuador,Mexico,Nicaragua,Paraguay,Peru,Uraguay,"¬
 &"Venezuela" after ships

 get HPopupMenu(ships,0,The mouseV,The mouseH)
 if it <> 0 then
   put item 1 of it into row
   put item 2 of it into column
   if (row = 1) and (column =2) then
     go to card "usn1"
   end if
 end if
end mouseDown
```

3. Submarines Button

```
on mouseDown
 play "submarines"

 put "United States" into submarines

 put return & "Soviet Union" after submarines

 put return & "NATO,Belgium,Canada,Denmark,France,Germany,Greece,"¬
 &"Iceland,Italy,Netherlands,Norway,Portugal,Spain,Turkey,"¬
 &"United Kingdom" after submarines
```

```
  put return & "Warsaw Pact,Bulgaria,Poland,Romania" after submarines

  put return & "Mideast & North Africa,Algeria,Egypt,Israel,Libya,"¬
  &"Syria" after submarines

  put return & "Sub-Saharan Africa,South Africa" after submarines

  put return & "Asia & Australasia,Australia,China,India,Indonesia,"¬
  &"Japan,North Korea,South Korea,Pakistan,Taiwan" after submarines

  put return & "Carribean & Latin America,Argentina,Brazil,Chile,"¬
  &"Colombia,Cuba,Ecuador,Peru,Venezuela" after submarines

  get HPopupMenu(submarines,0,The mouseV,The mouseH)
  if it <> 0 then
    put item 1 of it into row
    put item 2 of it into column
    if (row = 1) and (column =1) then
      go to card "subs"
    end if
  end if
end mouseDown
```

B. CODE FOR THE DEPARTMENT/SQUADRON/SHIP TYPE MENUS

1. Aircraft

```
on mouseDown
```

```
 put "FA-18" into va

 get HPopupMenu(va,0,The mouseV,The mouseH)

 if it <> 0 then
  put item 1 of it into row
  put item 2 of it into column
  if (row = 1) and (column =1) then
   push card
   go to stack "u.s. aircraft"
  end if
 end if
end mouseDown
```

2. Surface Ships

```
on mouseDown
 put "CG,Belknap,Leahy,Ticonderoga" into crudes

 put return & "CGN,Bainbridge,California,Long Beach,Truxton,"¬
 &"Virginia" after crudes

 put return & "DD,Spruance" after crudes

 put return & "DDG,Adams,Arleigh Burke,Coontz,Kidd" after crudes

 put return & "FF,Bronstein,Glover,Knox" after crudes

 put return & "FFG,Oliver Hazard Perry" after crudes
```

```
 get HPopupMenu(crudes,0,The mouseV,The mouseH)

 if it <> 0 then
  put item 1 of it into row
  put item 2 of it into column
  if (row = 6) and (column =2) then
   push card
   go to stack "u.s. surface ships"
  end if
 end if
end mouseDown
```

3. Submarines

```
on mouseDown
 put "Ethan Allen" into ssn

 put return & "Glenard P. Lipscomb" after ssn

 put return & "Los Angeles" after ssn

 put return & "Narwhal" after ssn

 put return & "Permit" after ssn

 put return & "Seawolf" after ssn

 put return & "Skipjack" after ssn
```

```
 put return & "Sturgeon" after ssn

 get HPopupMenu(ssn,0,The mouseV,The mouseH)

 if it <> 0 then
   put item 1 of it into row
   put item 2 of it into column
   if (row = 3) and (column =1) then
     push card
     go to stack "u.s. submarines"
   end if
  end if
end mouseDown
```

C. CODE FOR THE PLATFORM CARDS

1. F/A-18 (Hornet)

```
on mouseDown
 put "Guns,20mm Machine Gun" into aaw

 put return & "Missiles,Sidewinder,Sparrow" after aaw

 get HPopupMenu(aaw,0,The mouseV,The mouseH)

 if it <> 0 then
   put item 1 of it into row
   put item 2 of it into column
```

```
  if (row = 1) and (column = 2) then
    show card field "20mm"
  else if (row = 2) and (column = 2) then
    show card field "sidewinder"
  else show card field "sparrow"
 end if
end mouseDown
```

2. Oliver Hazard Perry (FFG-7)

```
on mouseDown
 put "Missiles, Standard Missile" into aaw

 put return & "Guns,76mm,20mm CIWS" after aaw

 get HPopupMenu(aaw,0,The mouseV,The mouseH)

 if it <> 0 then
  put item 1 of it into row
  put item 2 of it into column
  if (row = 1) and (column = 2) then
    show card field "standard missile"
  else if (row = 2) and (column = 2) then
    show card field "76mm"
  else show card field "20mm CIWS"
 end if
end mouseDown
```

3. Los Angeles (SSN 688)

```
on mouseDown
```

```
 put "Missiles,Harpoon,Tomahawk" into asuw

 put return & "Torpedos,Mk-48" after asuw

 get HPopupMenu(asuw,0,The mouseV,The mouseH)

 if it <> 0 then
  put item 1 of it into row
  put item 2 of it into column
  if (row = 1) and (column = 2) then
   show card field "harpoon"
  else if (row = 1) and (column = 3) then
   show card field "tomahawk"
  else show card field "mk-48"
 end if
end mouseDown
```

D. SEARCH ALGORITHM CODE

1. Search script

```
on returninField
 put empty into card field "Found Card List"
 set the lockMessages to true
 set the lockRecent to true
 set the lockScreen to true
 put card field "search criteria" into wordToFind
 put card field "stacks to search" into stacksList
 push this card
```

```
 repeat with x = 1 to the number of lines in stacksList
  go stack (line x of stacksList)
  unmark all cards
  mark cards by finding wordToFind
  repeat with y = 1 to the number of marked cards
   put (the short name of marked card y) & "," & ¬
   the short name of this stack & return after foundCardList
  end repeat
 end repeat

 delete last char of foundCardList
 pop card
 put foundCardList into card field "Found Card List"
 set the lockMessages to false
 set the lockRecent to false
 set the lockScreen to false
end returninField
```

2. Clickline

```
on mouseDown
 get the value of the clickLine
 push card
 go card (item 1 of it) of stack (item 2 of it)
end mouseDown
```

3. Stacks to Search

Card field "Stacks to Search" contains the following names:

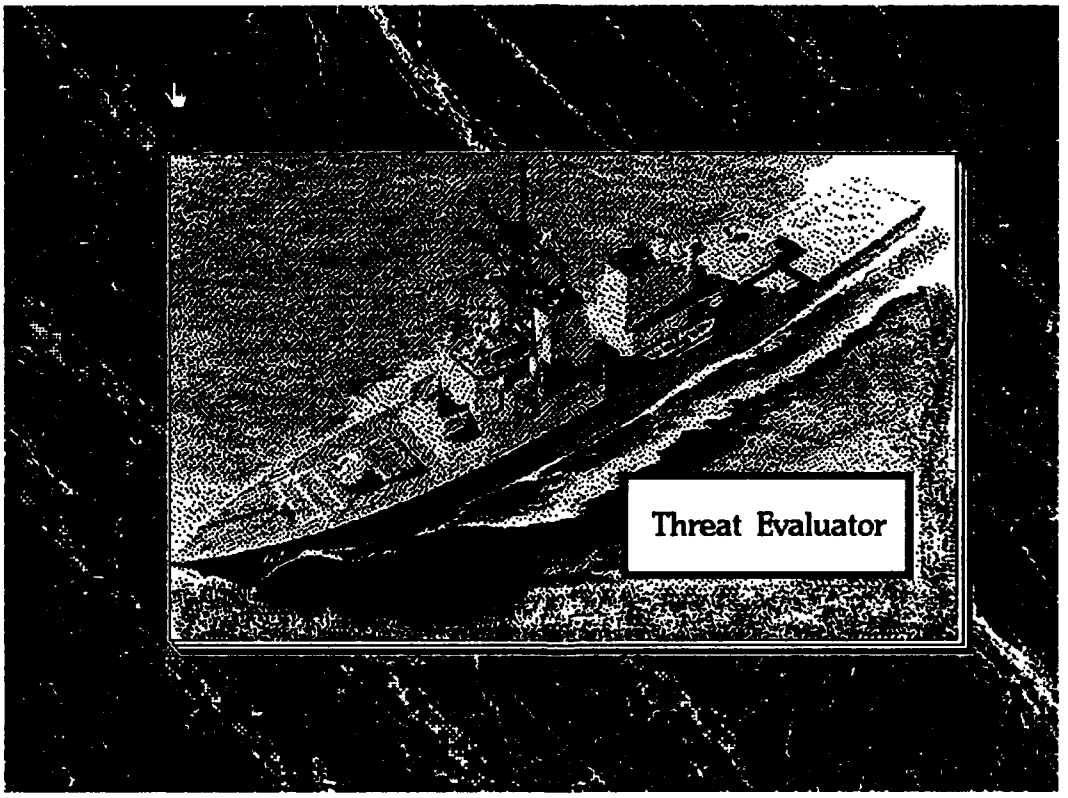
u.s. aircraft

u.s. surface ships

u.s. submarines

APPENDIX B

THREAT EVALUATOR USER'S MANUAL



A. INTRODUCTION

The Threat Evaluator is an application that automates many of the functions that are required during the normal watchstanding routine of a Tactical Action Officer (TAO). Threat Evaluator can be implemented as an additional module to the Argos System or as a stand alone application. It is the most tailored tool to date that a TAO has available for continuous personal training as well as evaluation of platforms that may pose a possible threat to the safety of the ship.

To start the Threat Evaluator application, double click on the icon shown in Figure 1.

Figure 1 Threat Evaluator Icon

B. MAIN MENU SYSTEM

After startup, the user is taken to the main menu screen of the Threat Evaluator as shown in Figure 2. From this screen the user has many options available The horizontal dividing line in the center of the screen distinguishes

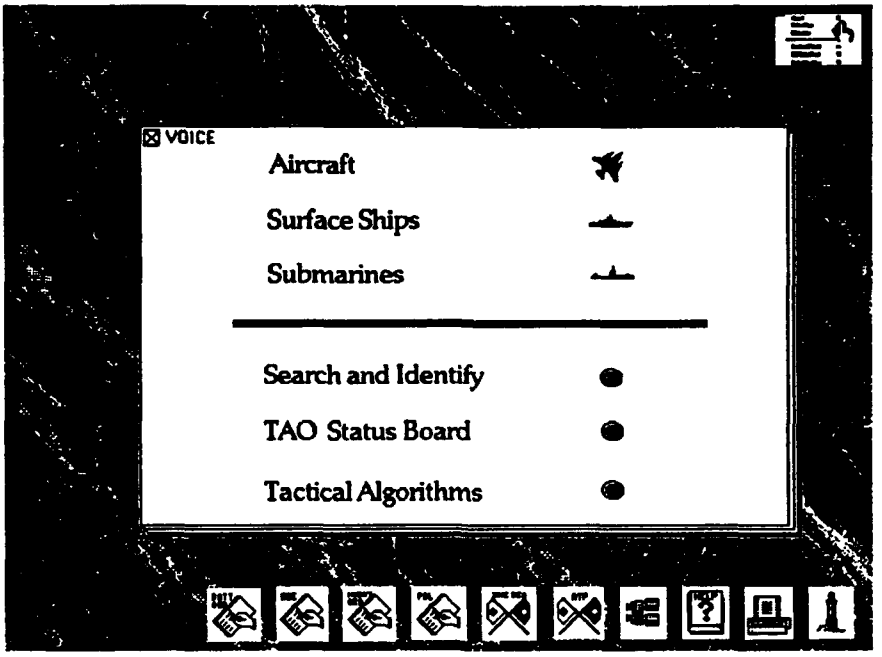


Figure 2 Main Menu Screen

the training portion of the Threat Evaluator application from the tactical portions. The upper half of the main menu screen contains the aircraft, surface ships and submarines menus which make up the training portion of the application or proceed to specific tactical operations such as Search and Identify, TAO Status Board or Tactical Algorithms. Menus on the upper portion of the screen are accessed by clicking on the area desired, such as Aircraft, and holding the mouse button down (see Figure 3). This will then show a popup menu where

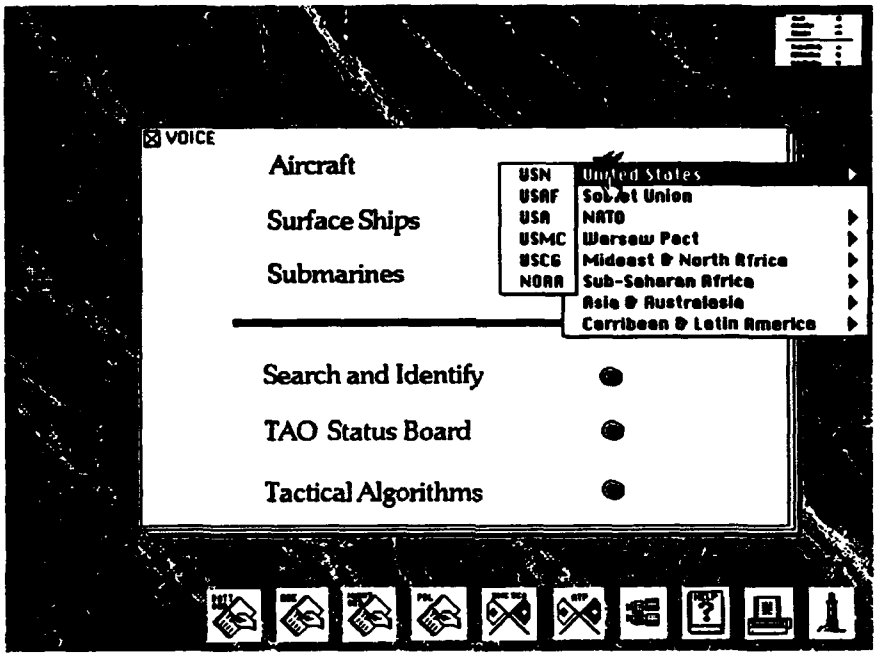


Figure 3 Popup Menus

selection of a particular country within a geographic region can be made. In the popup menus for each of the aircraft, surface ships and submarines icons, countries are divided into geographic regions. After the selection of a country, the user is taken to another menu where selection of an agency, within the country selected, that has control of the original type platforms selected (i.e. aircraft) can be made. As shown in Figure 4, after the selection of the particular agency, i.e. "USN" under the Aircraft main menu icon, the screen changes to display the departments, or squadrons, within the agency. The user then has access to the individual aircraft type within the department or squadron designation.

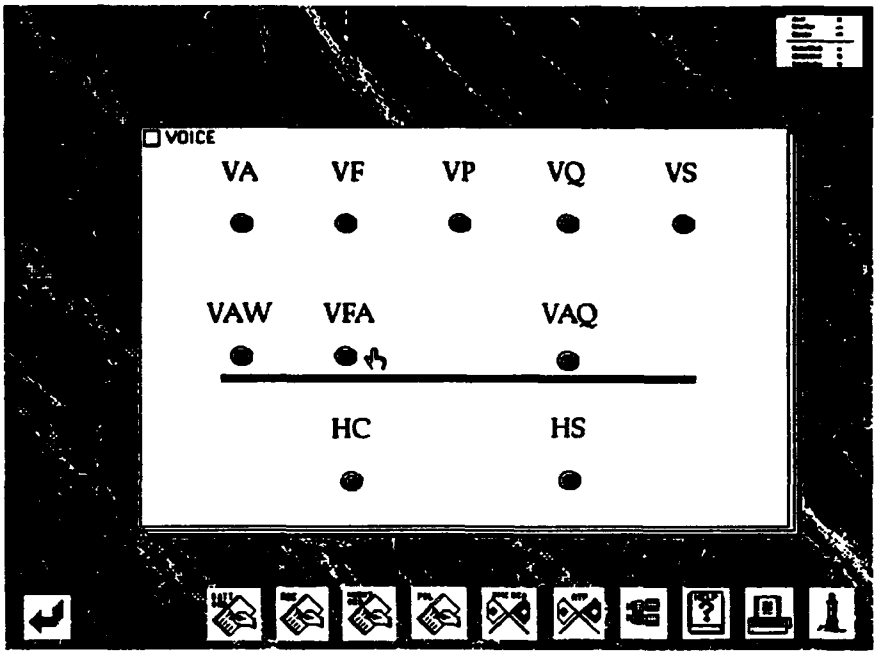


Figure 4 Department/Agency Screen

C. AIRCRAFT, SURFACE SHIPS AND SUBMARINES CARDS

After a specific aircraft, surface ship or submarine is chosen the user is then shown the card with that specific platform. An example of an aircraft card is shown in Figure 5.

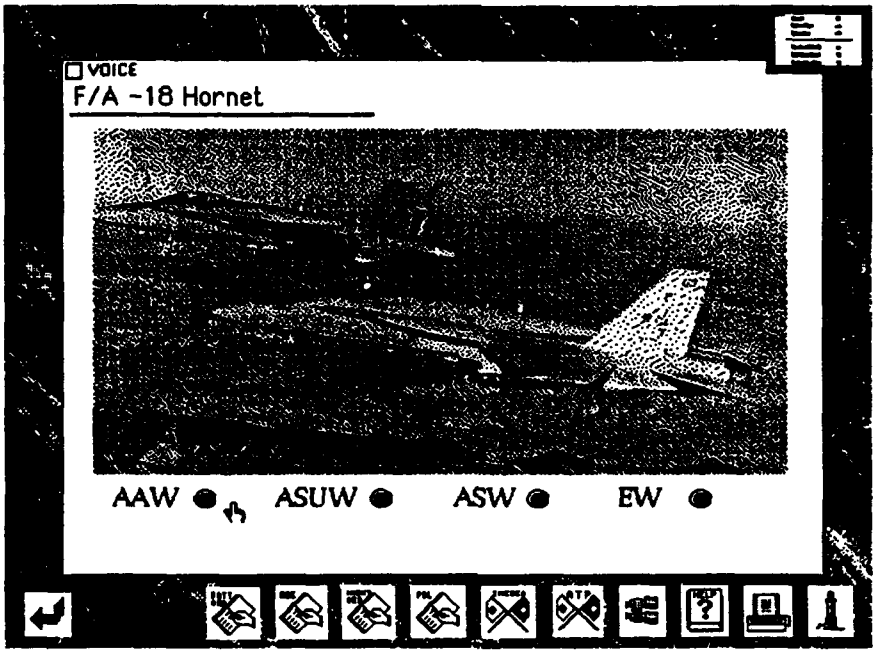


Figure 5 Aircraft Data Card

On the card, features that will be of assistance to the user are divided into four warfare areas. These areas are anti-air warfare (AAW), anti-surface warfare (ASUW), anti-submarine warfare (ASW), and electronic warfare (EW). There are many other warfare areas, however, since this is a prototype application, only four were chosen to demonstrate the concept. Repetition of the equipment that appear under these menus is purposely done to show the possibilities of using a certain system across warfare areas. An example of this is a surface to air missile that may also be used in a surface to surface mode. After a system is selected from the menu of a warfare area, a window appears (Figure 6) that contains specific data and characteristics that a TAO may require for tactical evaluation. To close the window, simply click on the window with the cursor.

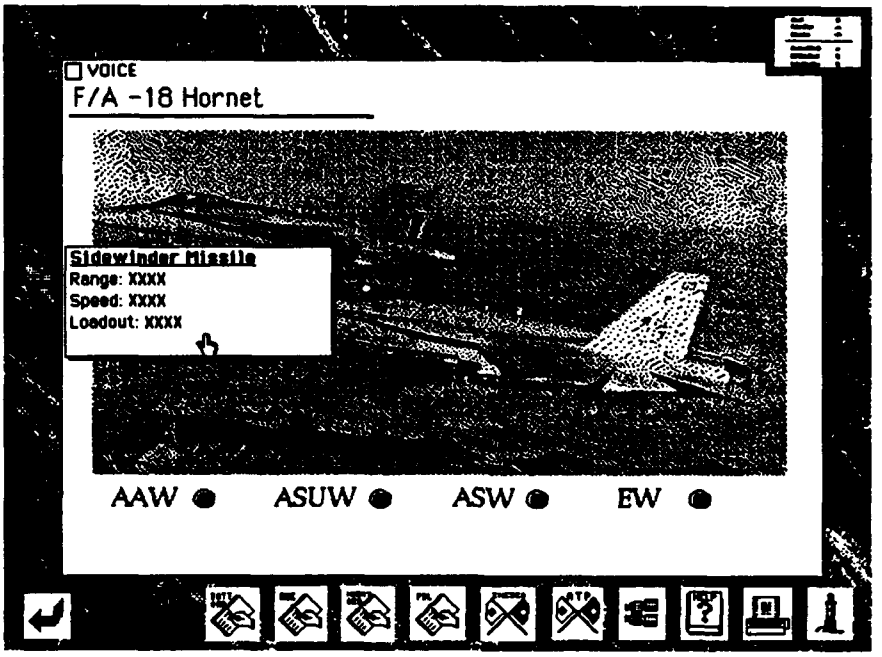


Figure 6 Information Window

D. SEARCH AND IDENTIFY FUNCTION

One of the most useful functions that is available to a TAO in the Threat Evaluator application is the Search and Identify option. This option is vital for the quick identification of possible threats associated with a particular emitter or weapons systems. The screen for the Search and Identify screen is shown in Figure 7.

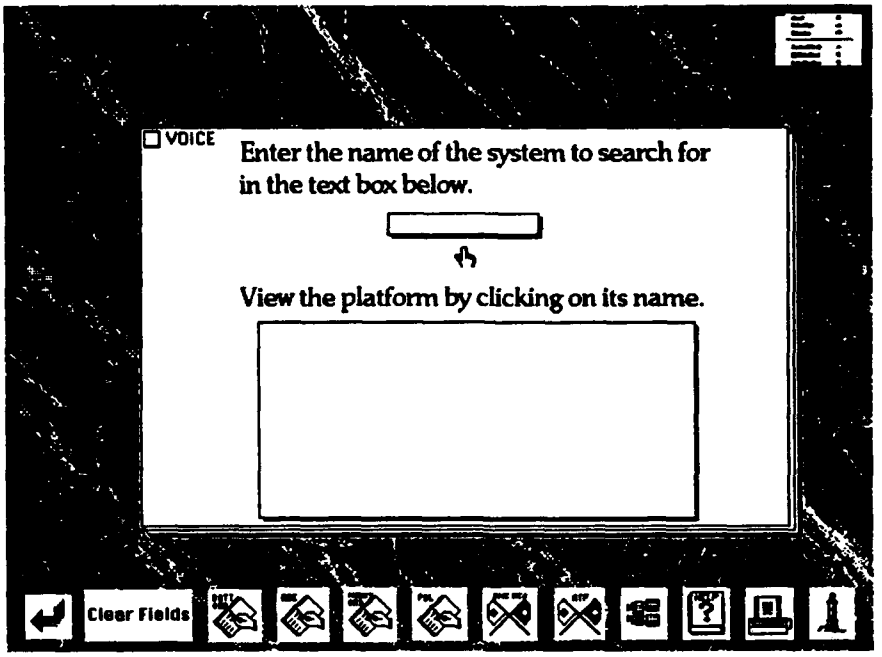


Figure 7 Search and Identify Screen

The search function is designed to accept as input the name of a radar or weapon system that has been identified. With this information the search algorithm will search each platform card for a match to the system entered by the user. Upon a match, the names of platforms which have that emitter or weapon system will be displayed in a window for the TAO to view. If the TAO desires further information on a particular platform that has been identified in the list, he or she merely uses the mouse to click on the desired platform's name and the information card of that platform will be displayed. The TAO can then evaluate in detail the capabilities of the platform by selecting the appropriate warfare area as described earlier in the Aircraft, Surface Ships and Submarines Card section.

E. TAO STATUS BOARD

The TAO status board is accessed through the main menu screen and is an exceptional tool available to the TAO. It is ideal for easy access to all required perishable own ships' information. This portion of the Threat Evaluator provides routinely needed data to the TAO and provides continuity in watch to watch turnovers. The TAO status board is comprised of two cards that display critical ships information. The combination of these two cards ensures that the TAO has available at his fingertips all essential data for fighting the ship.

The first card of the TAO status board displays tactical weapons systems' information. This card is shown in Figure 8. Weapons status and the condition

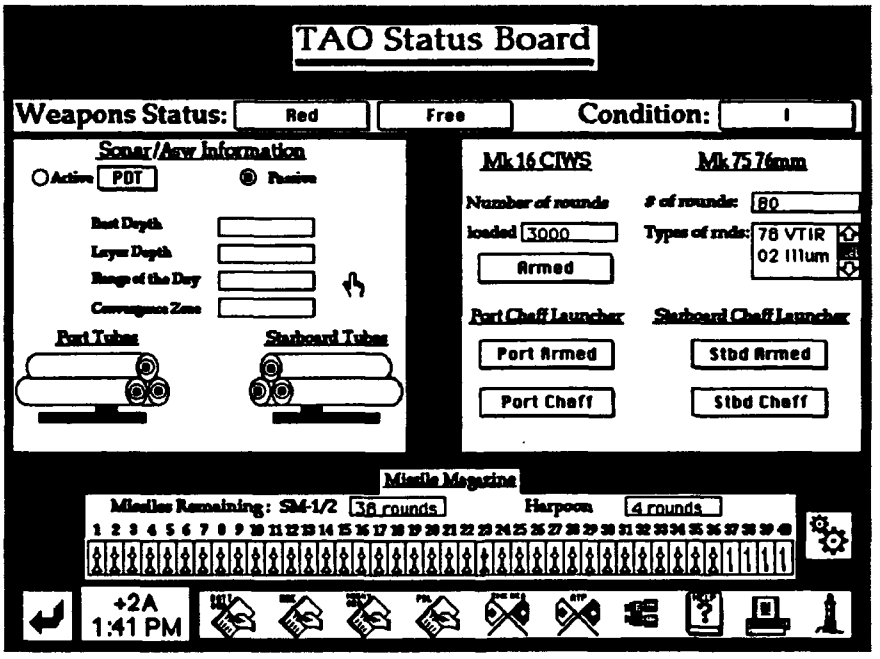


Figure 8 TAO Status Board Screen

of readiness that the ship is in are displayed at the top of the screen. Changes to these are accomplished by clicking the cursor on the desired button. The rest of the screen is divided into three main segments.

The segment on the left of the screen contains ASW data and information on the specific ASW weapons systems of the ship. Information such as the search mode of the sonar, water conditions for the day and torpedo loading data are input by typing the information in the spaces provided or by clicking on the appropriate buttons.

The segment on the right of the screen contains information on the gun systems aboard the ship. The information such as number of rounds and the status of the chaff can be changed by typing the information into the spaces available or by clicking on the desired buttons.

The segment on the lower center of the screen shows the remaining missiles and their locations in the magazine. This information is required to provide the TAO a current missile magazine inventory update. The button shown in Figure 9, will take the user to the second screen of the TAO status board.

Figure 9 Combat Systems/Engineering Icon

The second screen of the TAO status board is divided into two sections. The left section on the screen is the combat systems status and the section on the right of the screen is the engineering status. The material condition of these two areas can effect the combat readiness and therefore the survivability of a ship in combat. If there is any degradation in the equipment, then the TAO must be

aware of what is not working and what effect its' failure has on the combat readiness of the ship. Information such as this is input by typing the information into the appropriately labelled spaces available or by clicking on the desired buttons. The Combat Systems and Engineering status screen is shown in Figure 10.

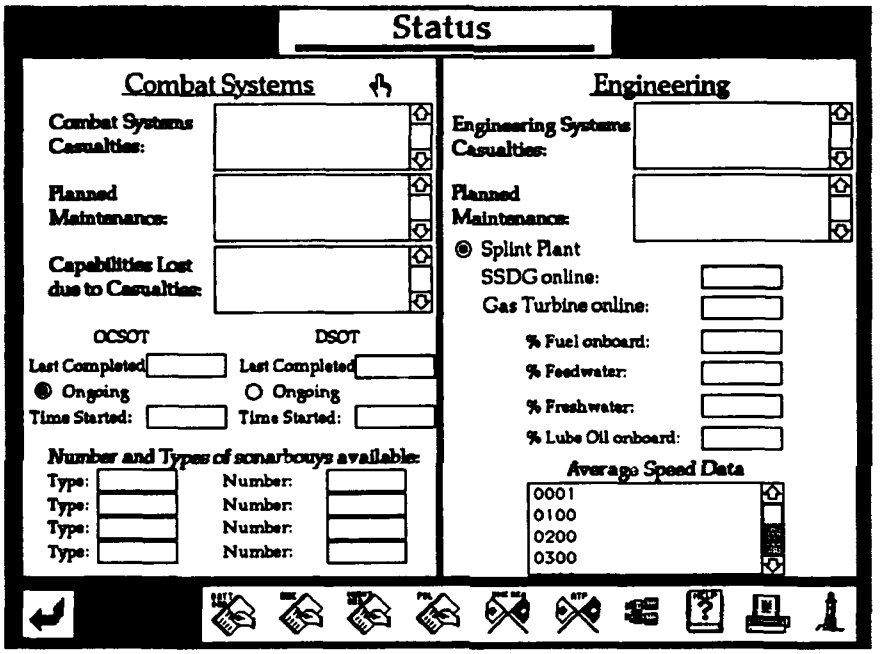


Figure 10 Combat Systems/Engineering Screen

F. TACTICAL ALGORITHMS

Tactical Algorithms are accessed through the main menu screen. This is a module that would greatly assist the TAO in weapons selection and employment. Tactical Algorithms would provide the user with a method of quickly calculating the probability of a kill against a particular target with a selected ship's weapon. This would then aid the TAO in determining the optimum weapon mix and release point against the target.

G. EASY ACCESS BUTTONS

Throughout the Threat Evaluator, the TAO has access to a number of buttons. These buttons provide access to certain modules and functions which include Battle Orders, Rules of Engagement, Night Orders, TAO Pass Down Log, INCSEA signals, Allied Tactical Publication signals, Find function, Help stack, Home stack access, Return, Print, and Return to Main Menu commands. These features are described in detail in the following sections.

1. Battle Orders

The Commanding Officer's battle orders are contained in this section. Access to them is achieved by clicking on the icon shown in Figure 11. Within the screen is an icon that will give a time and date stamp if required. This icon is shown in Figure 12.

Figure 11 Battle Orders Icon

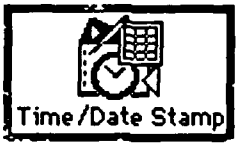


Figure 12 Time/Date Stamp Icon

2. Rules of Engagement (ROE)

The Rules of Engagement are contained in this section. Access to them is achieved by clicking on the icon shown in Figure 13. A time and date stamp function is also avaiable on this screen.

Figure 13 Rules of Engagement Icon

3. Night Orders

The Commanding Officer's night orders are contained in this section. Access to them is achieved by clicking on the icon shown in Figure 14. A time and date stamp function is also avaiable on this screen.

Figure 14 Night Orders Icon

4. TAO Pass Down Log (PDL)

The TAO Pass Down Log is contained in this section. Access to it is achieved by clicking on the icon shown in Figure 15. A time and date stamp function is also avaiable on this screen.

Figure 15 TAO Pass Down Log Icon

5. INCSEA

The INCSEA signals will be accessed through the icon shown in Figure 16. The module would contain all the signals from the agreement. These signals would be displayed either in a list or a specific signal could be decoded as desired. The signal would be input by the TAO, resulting in the decoded meaning being displayed on the screen. This would give the TAO quick access to required information. As envisioned, signals could also be encoded using this system tool.

Figure 16 INCSEA Incon

6. Allied Tactical Publication (ATP)

The ATP-1(C) signals will be accessed through the icon shown in Figure 17. The module would contain all the signals from the ATP-1(C) as well as the information describing general maneuvers.. These signals would be displayed either in a list or a specific signal could be decoded as desired. The signal would be input by the TAO, resulting in the decoded meaning being displayed on the screen. This would give the TAO quick access to required information. As envisioned, signals could also be encoded using this system tool.

Figure 19 Help Stack Icon

9. Home Stack

The Home stack will be accessed through the icon shown in Figure 20. This takes the user to the home card of the Hypercard environment.

Figure 20 Home Card Icon

10. Return

The Return command will be accessed through the icon shown in Figure 21. This button returns the user to the previous screen.

Figure 21 The Return Icon

11. Print

The Print command will be accessed through the icon shown in Figure 22. This allows the user to print items if required.

Figure 22 The Print Icon

12. Return to Main Menu Button

The Return to Main Menu button will be accessed through the icon shown in Figure 23. This allows the user to return to the main menu screen fron any location in the Threat Evaluator. This gives easy access to the main menu by a single click on the mouse.

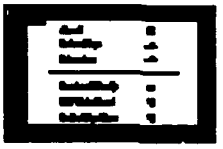


Figure 23 The Return to Main Menu Button

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