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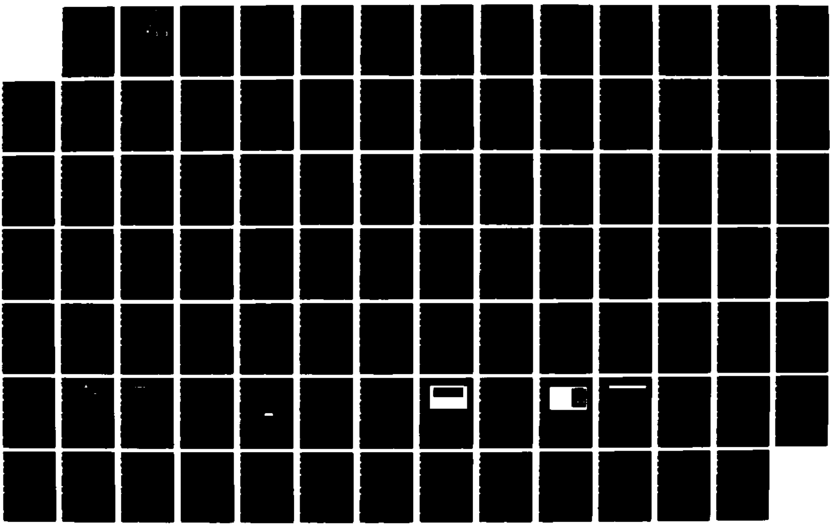

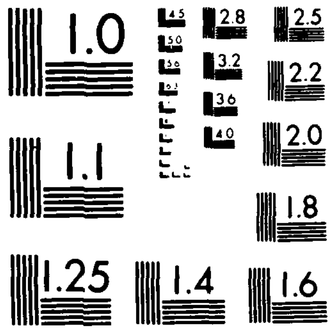

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THE APPLICATION OF CURRENT USER INTERFACE TECHNOLOGY TO INTERACTIVE WARGAMING SYSTEMS

by

Nora Gaye Stevens

September 1987

Thesis Advisor: Tung.X. Bui

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This thesis pursues the specific application of the "visual" interface and

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The Application of Current User Interface Technology to Interactive Wargaming Systems

by

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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

A major problem in the military wargaming arena is the difficulty in understanding and utilizing currently available user interfaces. Users span a broad range in terms of rank, background, technical skill, perspective, and computer literacy. Military workloads and complexity of computer and wargaming systems preclude familiarity with system interfaces. New users are inundated with a variety of obstacles, including unfamiliar hardware and cryptic command structures, as well as widely varying wargaming software systems. In most cases, in-depth training is required before a wargaming session can commence, thus consuming valuable time, resources, and money.

This thesis pursues the specific application of the "visual" interface and windowing to the user interface of wargaming systems for the purpose of improving the utility and usability of these systems to their users and sponsors.

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I. INTRODUCTION

A. PURPOSE OF THESIS

The purpose of this thesis is to examine the most effective utilization of currently available technology for the enhancement of user interfaces for wargaming systems, in particular the Joint Theatre Level Simulation (JTLS) and the Battle Group Tactical Trainer (BGTT). The JTLS is a theatre-level computer-assisted wargaming system which models two-sided air, ground, and naval combat. The JTLS was produced for joint military usage. The BGTT is a computer-based large-scale simulation of the naval warfare environment and was produced for use by the United States Navy. Both systems have far reaching utilization by numerous commands and individuals.

The author, having spent three years as a systems analyst at the United States Readiness Command during the development of JTLS, recognizes the need for improvements in the ease of use of the JTLS system as well as similar large-scale wargaming systems. A level of player training of one to two weeks in duration is common before they are competent to properly control the execution of a JTLS wargame exercise. In other systems, it is common for trained dedicated operators to act as assistants to the players and provide the player-machine interface. Even though the investment of time and money in those operators is considerable, it seems that the expenditures are justified due to a high usage rate of the gaming system.

Since the design and implementation of the JTLS and BGTT systems, the technology available for implementation of more effective user interfaces has been successfully implemented and proven in general-purpose systems as well as other special-purpose systems. This available technology has not been applied in these two actual wargaming systems even though it shows promise. Through the use of such systems and well-developed user interfaces, the casual user can rapidly be imbued with a level of skill such that he can effectively perform within a greatly abbreviated time span.

One available technology is that of the visual interface. A well-known implementation of a visual interface is in the Macintosh microcomputer system. The Macintosh system uses icons and a pointing device as a means of communication between the computer and the user. A large part of the system's success can be attributed to the "Desktop" metaphor, which allows the user's familiarity with common desktop items to be transferred to the control of the computer system itself. The extent of visual expression in the Macintosh system is very strong.

Another vital aspect of technology which has developed since the design of JTLS and BGTT is that of hardware efficiency. Lowering hardware costs coupled with increased capabilities has brought forth a new affordable level of graphics utilization in computer systems.

A number of current systems developers are exploring the use of windowing and window management which, to be implemented effectively, need these graphics capabilities. Because hardware is more reasonably priced and software has reached high levels of sophistication, widespread use of windowing and graphics is now feasible. Since windowing technology itself shows a great deal of merit and room for application in general, this thesis will look at windowing and its possible applications in wargaming.

B. METHODOLOGY

1. User Interface Research

The beginning of this study took a very broad perspective of the user interface and improvement thereof. It was a preliminary assumption that the user interfaces of large-scale wargaming systems have a strong need for improvement. Beyond that was the question, "How should those improvements be made?"

A review of user interface literature was undertaken to search for answers to this question. As a result of that investigation, it was the author's opinion that much of the literature was inconclusive in defining an operating environment where a user's performance can be optimized with a minimum of training. The information available was very general and totally void of functional models for practical application.

There exist a number of user interface guideline "checklists" which enumerate the many criteria of a "good" user interface. The most prominent of these is titled Guidelines for Designing User Interface Software, by Sydney L. Smith and Jane N. Mosier. Additionally, Ben Schneiderman, an expert in the design of user interfaces, has authored several books on the subject.

Unfortunately, systems developers must measure many task-specific needs within their application against these checklists only to produce a vague and confusing mental model of what they need to produce. After this process, there is no guarantee that the interface will be effective. It may merely consist of a spaghetti of favored attributes. Therefore, such guidelines may be helpful in making specific user interface decisions, but a ground-up, full-scale system approach presents many perplexing questions. In this respect, the literature search proved to be lacking in fully developed models for proven and accepted user interfaces.

The literature did, however, reflect a favorable direction in user interface technology which is now gaining wide acceptance. This technology could represent a general model for the development of user friendly interfaces. It is the graphic-based visual interface technology. Basically, the visual interface is the use of "visual expressions," a combination of text and graphics used for communication under a system of interpretation. The Macintosh is the currently accepted "standard" of the visual type of interface.

2. Projects, Theses, and Implementations

In parallel with the user interface research, several masters level projects and theses were reviewed. One Naval Postgraduate School student, Rob Irving, developed a program where the Macintosh acted as a command input terminal to the Naval Warfare Interactive Simulation System (NWISS, predecessor to BGTT). His objective was to "take advantage of the Macintosh windowing and mouse features and incorporate the NWISS command syntax in the software to produce a method of rapidly entering error-free commands." The project successfully demonstrated that the concepts of the Macintosh system user interface allow "rapid and easy command input for NWISS" without prior knowledge of the NWISS command syntax (Irving, 1986).

A thesis produced by Mark J. Sweeney and Kenneth J. Bitar (1986) did further research on the question of implementation of user friendly input devices to the NWISS. This study favored the use of continuous voice input over that of a Macintosh interface "if subject training time is not a significant restriction." Standard keyboard entry and continuous voice input were favored for trained participants. The results reflect that users of the Macintosh interface had only thirty-five minutes training each to practice, as opposed to six hours training on the voice system and high "lifetime exposure to keyboard technology." Additionally, the Macintosh input terminal had the lowest error rate under certain conditions. They concluded that, with a minimum of introduction to a speech or Macintosh system, near-equal performance can be attained to that of an experienced typist.

Recently, in another Naval Postgraduate School thesis, a masters student studied the design and development of a prototype for a visual interface to the Joint Theatre Level Simulation (JTLS). He concluded that "a graphical application of the game is a very efficient and desirable method to effect player inputs." (Lower, 1987)

Investigation of other research in the area of the user interface, and particularly the visual interface, led to the Naval Ocean Systems Center, San Diego, where the development of a knowledge based graphical interface is underway. This system is proposed to be the "command center of the future." It takes advantage of components of the visual interface as well as voice input/output technology and shows great promise for allowing the user to interact in a more natural and efficient workstation.

3. Wargame Research

A portion of research has been directed at the two applications, JTLS and BGTT. Research has been conducted through direct interaction with the systems, study of the available documentation, observation of game playing by organized teams, and interviews with sponsors as well as users. The user interfaces have been compared and contrasted. The primary criteria for selection of these two systems in this study are: 1) they are both major systems, widely used and recognized, and 2) they directly contrast in the primary input methodology. The JTLS is basically a menu-driven system while BGTT is primarily a direct syntactical command entry system.

During the development process, sponsors and users are often forced to conceptualize "what they want" long before they have any idea of what they really need. To further complicate problems, the user interface issues may not be addressed due to the overwhelming motivation to successfully model realistic simulation of war. It is common for interface considerations to take a "back seat" to everything else with the assumption that they hold less importance and will eventually fall into place anyway.

Common problems observed in the large-scale wargaming systems include, but are not limited to:

1) Navigation problems. Users find themselves lost, not knowing where they are within the command structure and not knowing what action to take next.

2) Syntax errors and complex command structure problems. Users make repeated errors and need lists of commands with the appropriate syntax at their side during play.

3) Speed problems. The complexity of the systems coupled with the simulation speed provide a compounded problem for the player who is trying to stay abreast of simulation events.

4) Developer support. Due to game complexity, developer support is often required for long periods of time after delivery for imparting understanding of the system and user training.

5) User interface representation. The systems are very difficult to learn and use, and very easy to forget. There is no standardization in the interface. Even with all the variations in existing user interfaces none are notably "user friendly."

6) Output overload. Users find themselves searching through numerous status reports and other output in attempts to find the information they need to continue effective game play.

C. SCOPE AND DIRECTION

As discussed earlier, preliminary research shows strong promise in development of visual user interfaces in wargaming. While the wargaming environment is complex, an enhancement to the user interface may provide enhanced usability and thus improved ease and frequency of utilization, which will provide increased information capabilities and decreased costs. Increased information capabilities will be a direct result of increased usage, which will be possible due to lower overhead in both time and money. Cost decreases in terms of dollars should be derived from lower training and personnel support costs.

From this point, this thesis will present a survey of wargaming, including general descriptions of the JTLS and BGTT systems and their respective user interfaces. Research will further encompass an in-depth analysis of the attributes of a visual interface. The Macintosh system will provide a case study of a successful visual interface implementation methodology. Then the formulation of a general wargame visual interface model will be introduced with specific recommendations for the JTLS and BGTT systems.

II. MILITARY WARGAMING

A. THE HISTORY OF WARGAMING

Wargaming today takes on many forms and functions, but the history of wargaming shows that the development of wargames has brought the games through various states of favor as well as disfavor by assorted groups of users. Before discussing the history of wargaming, a definition of wargaming is in order. "A wargame is a simulation, by whatever means, of military operations involving two or more opposing forces, conducted using rules, data, and procedures designed to depict an actual or assumed real life situation." (DON, 1985, p. 2-1)

Early war games, during the seventeenth century, were military chess or war chess games which had two sides of equal strength, each with known dispositions but unknown intentions. These games were further developed with the concepts of aggregation and terrain features. One of these games—the King's Game (developed in 1644 by Christopher Weikhmann)—was used extensively as a practical aid to military training. Another game, called War Chess, was played on a board of 1,666 squares and was used to train military officers of Germany, France, Austria, and Italy (Fox, p. 8).

In 1811, the von Reisswitz game was developed. It was the first game to break away from the chessboard environment. Terrain was modeled in sand at first. Colored paper attached to blocks was used to represent troops. The king of Prussia sponsored this game, which became operational in an improved version with porcelain game pieces and plaster terrain (DON, p. 3-1). Czar Nicolas played this game in Russia (Fox, p. 9).

Further modifications of the von Reisswitz game were made by his son in 1824, including using a map instead of a sandtable and writing a set of improved rules for playing the game. Forces were represented by properly proportioned metal pieces and rules were based on realistic troop movement rates as well as delays in communications. Opposing forces were designated red and blue, which is a convention still used in most wargames. A designated umpire used dice with varying numbers of sides along with number tables to determine outcomes and assess battle losses. This game was called the "Kriegsspiel" and gained wide acceptance (Fox, p. 9).

Kaiser Wilhelm II ordered that the Kriegsspiel be adopted by the German Army. In time, the improved Kriegsspiel spread to virtually every country with a standing military. Professional groups formed to play the Kreigsspiel and clubs sprang up to promote interest in the game. Also during this period, Alfred Graf Schlieffen, Chief of the German General Staff from 1892 to 1906, used the game extensively for experimentation to develop a series of "Schlieffen Plans" for the invasion of Belgium and France in World War I (Fox, p. 10).

After World War I, interest shifted from rigid play to free play of the game. This method was characterized by disposal of the strict rules in exchange for dependence upon the judgement of the game director for game decisions. This was a forerunner for the type of political/military game now played by policy makers worldwide.

Germany continued extensive use of the wargame during the first half of the twentieth century. Wargaming flourished under Hitler and was credited for the smoothness of at least the initial operations of the German invasion of France and Belgium (Fox, p. 11). Unit commander knowledge was in large part derived from wargame experience, since after 1918 the wargame became an important part of the German officer's training.

Japan used wargames as educational tools in their war college because the successes during the Russo-Japanese War of 1904 were directly attributed to wargaming (DON, p. 3-3). The Japanese used wargaming extensively prior to World War II. Pearl Harbor and the occupation plan for the Pacific were gamed in a session of far-reaching scope conducted by Admiral Yamamoto, the Japanese combined fleet commander in chief (Fox, p. 12).

American involvement in wargaming was minor during this period. In the early stages, the United States adapted German games which were introduced in the army in 1867. The first American work on wargaming was entitled "The American Kriegsspiel" and was published by Major W. R. Livermore in 1879 (DON, p. 3-3).

Captain Alfred T. Mahan, president of the Naval War College, expressed strong interest in a series of lectures on wargaming presented by William McCarty Little in 1887. This provided the foundation on which continued wargaming activity has long been based at the Naval War College (DON, p. 3-4). Prior to World War II, wargaming was generally confined to the service schools for the purpose of training, though the United States Navy is credited with "considerable foresight'" because of the wargaming activity during World War II (Fox, p. 12).

Since World War II, the introduction of the digital computer has dramatically changed the face of wargaming. The capability of high-speed computation and simulation techniques have given even greater flexibility to the gamers for educational as well as analytical utilization of the now numerous available wargames.

Today, wargaming is used for many applications. Force planning, research, development of operation plans, and education and training are the primary uses. Education and training is by far the most extensive use. The service war colleges as well as other military education commands have well-developed and extensively used wargaming capabilities. Other world-wide commands, many of which are operational, use wargames for strategic and operational planning, training, and exercise support.

B. CURRENT SYSTEMS

As mentioned above, there are numerous wargames available to users today. Although manually played wargames are still in use, this thesis will address only wargames implemented on digital computers. Specifically, the systems to be addressed are two current major wargame systems in popular use throughout the Department of Defense today, the Joint Theatre Level Simulation (JTLS) and the Battle Group Tactical Trainer (BGTT).

1. The JTLS System

The Joint Theatre Level Simulation (JTLS) is a computer-assisted wargaming system which models two-sided air, ground, and naval combat. It can be used for warfare training, joint operational planning, and doctrinal analysis. The model is theatre independent (CPS, p. 2-1).

JTLS was developed by the Jet Propulsion Laboratory for a consortium originally consisting of the United States Readiness Command, the United States Army War College, and the United States Army Concepts Analysis Agency. This JTLS system was formed as an effort to develop a model general enough to address each agency's fundamental questions and yet rich enough to be useful throughout the joint Department of Defense community. The design of JTLS is based on a very extensive, detailed user requirements study and the use of computer simulation capabilities.

The JTLS software is designed to operate on the Digital Equipment Corporation VAX 11 series minicomputer. Associated with the VAX system are various storage media and input/output devices. The minimum input/output hardware configuration consists of four video terminals and one on-line printer. In the minimum configuration, the technical coordinator and controller each have one terminal, and each force commander has one terminal. The number of players is flexible to meet various gaming and personnel requirements. It is desirable to have a graphics display and input pad for each commander and the controller. The "standard" game configuration consists of ten video terminals, three graphics displays, and three printers.

2. The BGTT System

The Battle Group Tactical Trainer (BGTT) is implemented as a real-time interactive, discrete event, time step computer simulation of the naval warfare environment. The BGTT supports two-sided play and an umpire-like control function which handles neutral forces and can monitor or participate in scenarios (NOSC, p.1-1).

The BGTT was developed for use by the United States Navy to address the tactical aspects of naval warfare. The BGTT can be used for evaluation of new tactics and doctrines, support of major at-sea exercise planning and reconstruction, analysis of proposed or postulated fleet requirements, and validation of command control requirements (NOSC, p.1-4).

The BGTT software is partitioned into five major functions and is designed to operate on the Digital Equipment Corporation VAX 11 series minicomputers in conjunction with MEGATEK Corporation graphics display systems and various interface devices configured in up to a maximum of eight command centers.

C. THE JTLS AND BGTT SYSTEMS USER INTERFACES

1. Defining a User Interface

Stating the definition of a user interface is at the same time defining other older, but commonly used terms such as "man-machine interface" or "human-computer interface." Specifically, the user interface is the site of interaction between the user and the computer. The user generates inputs and the computer generates outputs.

In conventional systems, the primary method of user input is by keyboard while the primary method of output is from a video screen. Other systems have brought forth a wide variety of input and output devices. The inclusion of hardware devices alone in the definition of the user interface, though important, is somewhat incomplete.

A distinguishing factor in any user interface is the driving software of the application involved, which controls the manner and methods of interaction. This software decides what control actions will be effected and what representations will be displayed to the user.

In effect, this portion of the user interface governs the interaction at hand.

The user interface is becoming recognized as a significantly more important part of any computer system application because of the strong effect of the interface on the effective and efficient utilization of the application. The tremendous expenditure of money and resources is of little value if the users lack operating skills, alertness, or motivation.

2. The JTLS User Interface

The JTLS user interface is provided by one of four fundamental programs called the Model Interface Program (MIP). This software provides a continuous interaction between the warfare simulation model and the players. The Model Interface Program provides the following capabilities:

1) Entering orders.
2) Processing orders.
3) Communication between players and controller.
4) Communication between players and the warfare simulation.
5) Accessing and using support information.
6) Saving orders in Order History Files.

The Model Interface Program is a purely menu-driven interface with structured command entry and template fill-in (CPS, p. 3-8).

Separate graphics software provides graphic representations in the user interface on a dedicated graphics display screen. Current tactical situations can be displayed in color with graphics which have zoom capabilities (to change map scale) as well as iconic and textual unit information. Graphic representations are in the form of Defense Mapping Agency maps overlaid with text and standard military unit symbology.

User interface hardware in a JTLS workstation consists of a Digital Equipment Corporation VT-100 video terminal or a VT-100 compatible terminal, and a graphics display system comprised of a large-screen Sony monitor and a GTCO graphics pad.

The VT-100 terminal provides command input via a menu driven system with templates. Commands may be "stacked" or syntactically listed instead of following the structured menu interface. The terminal screen is divided into three portions. The divisions provide a game status line at the top, an output area in the center of the screen, and an input area at the bottom.

The status line provides game security classification, player terminal function, game speed, number of messages waiting to be read, and game time expressed in date-time group format. The center portion of the screen provides game output in the form of messages and various game reports. This space is also used to display templates which are currently being used to complete command input. The lower portion is for game input. Keystrokes are displayed to this area and echoed to the appropriate template area. See Figures 1 and 2 for typical JTLS command entry screens (CPS, p. 5-3 and 5-14).

The graphics pad and monitor allow graphic status of the game to be represented to the player on a frequently updated basis. Information regarding unit status such as unit strength is depicted continuously, while more specific information such as actual latitude/longitude may be chosen by selection using the graphics device.

Since JTLS graphics were produced later in the development cycle, the addition was an extremely welcome one. Before JTLS graphics became available, primary information for game play was most often derived from game reports and status displays on the VT-100. Depending on the type of information required, this may still be the case.

3. The BGTT User Interface

The Wargame mode of BGTT provides the user interface. It provides a set of orders which allow the users to control game action and progress. Specifically, information display orders and force control orders are the commands available to a player during the game. These orders are syntactic commands of the following general format:

key(system output)<data entry>.

```
UNCLASSIFIED  BLUE COMMAND        0.000      MSG:   0  100007JAN84 (000.00.00)
_______COMMANDER DIRECTIVES                    14  MISSILE                  MS
  1  TACTICAL.THRESHOLD        TT              15  RADAR                    RD
  2  MOVE                      MV              16  NAVAL.MOVE               NM
  3  ATTACK                    AT              17  SEA.ROUTE                SRTE
  4  DEFEND                    DF
  5  DELAY                     DL              _______ AIR DIRECTIVES _______
  6  WITHDRAW                  WD              18  AWACS                    AW
  7  FIRE                      FI              19  AIREF                    REF
  8  CANCEL.FIRE               CF              20  COMBAT.AIR.PATROL        CAP
  9  MINE                      MN              21  ORA.DCA                  OD
 10  CLEAR.MINES               CM              22  ORA.OAS                  OO
 11  REPAIR.TARGET             RT              23  CLOSE.AIR.SUPPORT        CAS
 12  GROUND.ROUTE              GRTE            24  ESCORT                   ESC
 13  SEALIFT                   SL              25  RECCE                    RC
                                                           MORE...

MIP
>CR ?
HIT RETURN TO CONTINUE OR Q TO QUIT:
```

Figure 1

JTLS COMMAND SELECTION MENU

```
UNCLASSIFIED  BLUE COMMAND          0.000        MSG:   0   1000ZJAN84 (000,00,00)
------------------------------------------------------------------------------------
ATTACK (AT) DIRECTIVE:

 1. REFERENCE:          ::::::::::            8. MOVEMENT:            ::::::::::

 2. GROUP:              (::::::::::)          9. ROUTE:               (::::::::::)
                                             (Null entry indicates a desire to
 3. UNIT:               ::::::::::             enter the points of a route.)

 4. START TIME:         ddhhmmZMMMYY

 5. ATTACK WITH:        (n.nn)
 6. PROTECT WITH:       (n.nn)
 7. SCREEN WITH:        (n.nn)

------------------------------------------------------------------------------------
MIP
>CR AT
REFERENCE: 82ATK01 1 82A
```

Figure 2

JTLS Template

"Key" is equal to the key words of the order. System output refers to the parenthetical expressions output by the system to explain or prompt for the next item of data to be supplied by the user. Data entry refers to expressions appearing within the <> symbols denoting the required user entered data. For example, an order in BGTT may appear as follows:

DEFINE CHAFF (life of) <minutes> (width) <nautical miles> (depth) <feet>.

Use of keyboard entry allows order key words to be entered in abbreviated form if a unique portion of the command is entered.

An alternate method of command entry is available to BGTT players. A menu display is available to help the user sequence the fields within the order and also sequence the various orders through the use of color on the display. The orders are displayed on the geotactical color display console. As an aid to the user, the orders are displayed in a menu format, showing the correct syntax and allowable options with system-generated prompting to assure proper order entry. This function is provided through combined use of the graphics display and tablet with a puck selecting device or optional joystick.

The user interface hardware in BGTT consists of a number of possible items, but a standard command center configuration will have one operator input/output terminal with a keyboard, a color graphic geographical and tactical display, several black and white monitors to display automatic status boards (usually four are used), a graphics tablet, and an intercom for communication. Other options include a joystick, a large screen display, a printer/plotter, and a voice synthesizer. See Figures 3 and 4 (NOSC, p. I-1-3) .

The BGTT interface is elaborate in the provision of multiple frequently updated terminal screens. Four text-based automatic status board screens as well as one graphics screen are continuously available for player reference. The overall effect of this interface along with the integrated voice communication system is the achievement of relatively lifelike command center environment.

4. User Interface Problems

In spite of concerted efforts by developers and sponsors to provide clear, reasonably easy-to-use interfaces, wargames today are lacking in the necessary components for meeting the needs of a fast-moving modern military environment. A major source of cost in the military wargaming arena is training users to a level of proficiency where the systems can be utilized efficiently. There is often considerable difficulty in understanding and utilizing currently available user interfaces.

Users span a broad range in terms of rank, background, technical skill, perspective, and computer literacy. Military workloads and

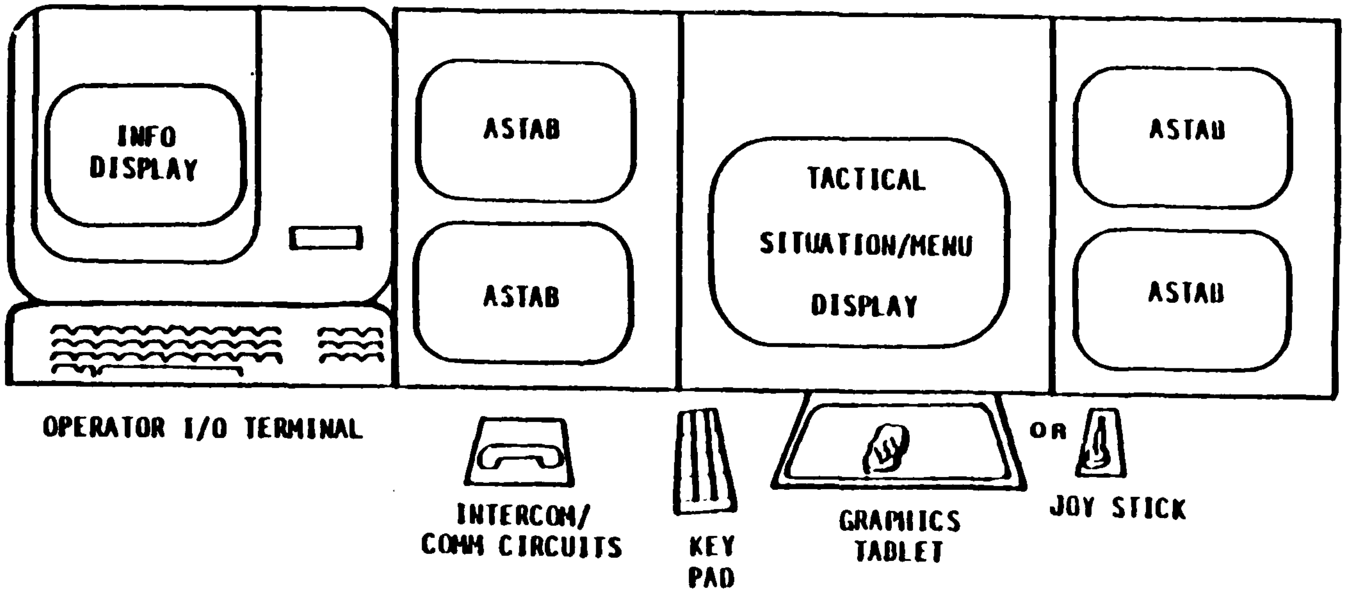

Figure 3

Typical BGTT Command Center

```
View: aaaa9      ACTIVE AIR TRACK STATUS BOARD - Page 99      Game Time: 999999
PLATFORM   TRK      BEARING  RANGE   TIME     LAT      LONG       CLASS
 -----     -----      ---    ---UNKNOWN---  ------   -------      -----
 aaaaa     aa999      999     999    9999   99-99a   999-99a      aaaaa
          (aaaaa)    (999)                 (99-99a   999-99a)
 aaaaa     aa999      999     999    9999   99-99a   999-99a      aaaaa
          (aaaaa)    (999)                 (99-99a   999-99a)
 -----     -----      ---    ---ENEMY----   ------   -------      -----
 aaaaa     aa999      999     999    9999   99-99a   999-99a      aaaaa
          (aaaaa)    (999)                 (99-99a   999-99a)
 aaaaa     aa999      999     999    9999   99-99a   999-99a      aaaaa
          (aaaaa)    (999)                 (99-99a   999-99a)
 -----     -----      ---    --NEUTRAL---   ------   -------      -----
 aaaaa     aa999      999     999    9999   99-99a   999-99a      aaaaa
          (aaaaa)    (999)                 (99-99a   999-99a)
 aaaaa     aa999      999     999    9999   99-99a   999-99a      aaaaa
          (aaaaa)    (999)                 (99-99a   999-99a)
 -----     -----      ---    -FRIENDLY---   ------   -------      -----
 aaaaa     aa999      999     999    9999   99-99a   999-99a      aaaaa
          (aaaaa)    (999)                 (99-99a   999-99a)
 aaaaa     aa999      999     999    9999   99-99a   999-99a      aaaaa
          (aaaaa)    (999)                 (99-99a   999-99a)
```

Figure 4

Typical BGTT ASTAB Display

complexity of computer and wargaming systems preclude familiarity with system interfaces. New users are inundated with a variety of obstacles including unfamiliar hardware and cryptic command structures, as well as widely varying wargaming software systems. In most cases, in-depth training is required before a wargaming session can commence, thus consuming valuable time, resources, and money.

The primary goal in a wargame used for the purpose of training and education is to develop and refine warfare skills. Unfortunately, the above-mentioned complexities of the systems and the widely varied skill levels of the users create difficult circumstances which must be overcome before reaping intended benefits. A large portion of available training time is often spent teaching the user to interface with the system.

In other cases, where the wargame is used for planning or analysis, players are subject to extended hours of play as well as repeated play. Typing input in syntactically correct phrases, which is in itself difficult enough, becomes increasingly difficult with fatigue. Although the players involved may play a particular game on a regular basis and may become very familiar with the interface, if interest is lost and fatigue causes errors, the resulting analyses may be invalid. Additionally, familiarity with one or two interfaces does not guarantee any transfer of understanding since there is very little consistency or standardization in the available interfaces.

In addition, the military personnel system creates frequent personnel turnovers, which in turn dictates that experienced personnel are frequently replaced by inexperienced personnel. It is not uncommon for thorough training of an inexperienced user on a complex wargaming system to take months or in some cases years before required job proficiency is attained.

General problems of cryptic command structures, inconsistent interfaces, computer system hardware and software complexities, as well as the intricacies of the wargames themselves create a myriad of problems for training commands and sponsor commands.

Specific problems are numerous. It has been observed that players cannot learn commands and therefore cannot play without notes and manuals at their sides. Even with these memory aids, players still find their input commands have syntax errors and their input parameters are often far from reality and/or the sponsor's intentions.

Another problem is information overload. As players participate in the game, automatic reports are generated on screen and on paper, inundating the user with a lot of unusable information due to the fact that he cannot find what he needs. The user has little or no control over the information and the presentation of that information.

This brings us to the problem of control. The wargame player is controlled by the system in a sort of maze-like race. The player is continually trying to keep up with the game action while trying to figure out how to use the system and interface, not to mention his efforts to grasp the relevant portions of the database he is supposed to be using, all at the same time.

Even structured menu and template input causes trouble because users become "lost" in the command structure or menu tree. Navigation problems are a major difficulty in these systems for the unfamiliar user. Additionally, there is often no escape from inadvertent choices or mistakes. It is not uncommon for a player to find himself in the lower level of a menu tree to realize that he is not where he wants to be. He then may request help, follow the advice, if available and clear, then try to figure out how to accomplish what he originally intended to do.

Such problems are compounded by lack of experience with hardware, computers, and/or wargame simulation models in general. Often users do not know how to perform simple tasks on the computer and keyboard such as the use of function keys or interpretation of user messages on the screen. Often, users require not only wargame training, but fundamental computer skill training.

The purpose of this thesis is to take wargame system interface problems and examine an alternative method of user interface. No efforts in the area of standardization have been approached in the currently available wargame user interfaces. In the following chapter, this thesis will examine the Macintosh interface standard produced by

Apple Computer, Inc. with the following research question, "Can this technology be effectively applied to the solution of problems in the user interfaces of systems such as JTLS and BGTT?"

III. CURRENT USER INTERFACE TECHNOLOGY

A. A USER-FRIENDLY INTERFACE

1. The Macintosh-like User Interface

The Macintosh microcomputer system represents a new standard in the microcomputer industry. As described later, the Macintosh has a number of characteristics which differentiate it from other systems. There are many reports of very positive reactions regarding the use of this system. Some of these reactions include feelings of:

1. Control of the system.
2. Competence in task performance.
3. Intuitive ease in learning the system.
4. Ease in assimilating advanced features.
5. Confidence in retention of skills.
6. Enjoyment in using the system (Schneiderman, p.180).

Based on research done by Xerox corporation, the Macintosh user interface is very different from traditional approaches. It is the result of several years of intensive research on how people interact with computers and how the interface should be designed to be both highly productive and painless for its users. (Simpson, 1986, p. 2)

The vision was to bring the power and versatility of computers to ordinary people (Apple Computer, 1986, foreword p. ix). Although the concepts created by Apple were initially introduced in the Lisa microcomputer system, the Macintosh represents the most mature and successful implementation of those efforts. An interesting result of the Macintosh has been that it allows both computer experts and novices to share and appreciate the technology.

The Apple Macintosh user interface was designed to enhance the effectiveness of the people using the system. This approach is generally called *user friendly*, although Apple calls it *user centered*. And while the interface is often called *simple*, Apple maintains that the terms *direct* and *effective* make more sense (Apple Computer, 1986, p. 2).

The Macintosh user interface is called the Apple Desktop Interface or, to the indoctrinated Macintosh user, the *Desktop*. The principle on which the Desktop is based is that of a metaphor for an actual working space on one's desk. It is a concrete metaphor with which we are all familiar in our daily lives. This metaphorical foundation, and the way it is represented to and manipulated by the user, accounts for the tremendous success of this system. It is presented in common terms, which makes it more easily understandable, and it is comfortable.

a. Hardware Elements of the Macintosh User Interface

The Macintosh system uses a mouse and keyboard for input, and a printer and a high-resolution, bit-mapped screen for output. The high resolution graphics screen is a key feature of the Macintosh. The black and white screen consists of 175,104 (512 horizontal x 342 vertical) pixels. This allows applications to be presented to users in effective combinations of text and graphics. The use of graphic objects for commands, parameters, and features is promoted strongly in the Macintosh user interface. The high resolution capability of the video screen supports this goal.

The Macintosh has a highly visual interface which requires not only the standard use of a keyboard for entry but also a mouse. A mouse is a pointing device which allows users to select desired actions by pointing to an object on the screen and clicking a button on top of the mouse.

The mouse, keyboard, high-resolution monitor, and printer are common elements in microcomputing today. What makes the Macintosh unique is its software. The software, including ROM routines, is the basis for the special user-computer dialog.

A user-computer dialog is a two-way conversation between the user and the computer. The user is presented with possible choices on the video screen and, instead of making the traditional direct command entry or menu selection by keyboard, the Macintosh user will most likely point to a graphically depicted object and click the mouse to select it. A large percentage of operations completed by the user will generally involve such selection of graphic representations with the mouse.

b. Software Elements of the Macintosh User Interface

The Macintosh operating system and Finder software are universal across Macintosh applications. They provide the basis for interaction and control. The operating system provides essential functions such as interrupt handling, memory management, and input/output to keep the Macintosh functioning (Apple Computer, 1983, p. 3). With the Finder software, the user can manipulate files and start up applications. In normal operation, it is automatically the first program to be run when the Macintosh is turned on (Chernicoff, 1985, p. 591).

There are a number of visual components in the Macintosh interface which are used for such tasks as file manipulation and program interaction. These visual components, as mentioned above, are icons, windows, dialog and alert boxes, pull-down menus, and other symbolic control devices. These representations are implemented in software application programs by calls to the ROM, which provides them as standardized functions. Most of these functions are graphic in nature.

As one may note, the Macintosh system is composed of a complex foundation of interface software. This interface software may be accessed through the Macintosh 128-kilobyte ROM and is called the User Interface Toolbox. Application programmers may therefore call from their programs the standard routines which provide the broad range of facilities and features of the Macintosh interface.

The system, while somewhat difficult to learn to program, can present a very friendly interface to its user. The most important, and possibly the most difficult, part of programming the Macintosh, however, is to put the Macintosh design philosophy into effect. It is quite possible to develop an application which integrates the excellent features of the Macintosh User Interface Toolbox, yet very poorly presents an effective user interface. Therefore, great care must be taken in using such a system. There is no panacea, but there are helpful guidelines available to the developer.

2. Lessons Learned From This System

Due to the recognition that even the best tools if not properly used are of little or no value, Apple Computer has developed two very helpful sets of principles for the developer of Macintosh applications. These principles are based on extensive research which should prove useful in programming most any visual interface. The first set of principles relates to general design principles. The second set relates to the principles of graphic communication.

a. General Design Principles

1) Metaphors from the real world. "Use concrete metaphors and make them plain, so that users have a set of expectations to

apply to computer environments." (Apple Computer, 1986, p. 3) Audio and visual effects that support the metaphor should be used whenever possible. This is based on the fact that most users are not experts but people do have direct experience in their immediate world. Therefore, using familiar concepts makes users feel comfortable.

2) Direct manipulation. This should be used to give the user a sense of control over the activities of the computer. Direct manipulation is based on the fact that people expect physical actions to result in some sort of physical feedback. Therefore, moving the mouse results in a corresponding move of the pointer or cursor, and clicking the close box of a document causes it to shrink into an icon representing the document.

3) See-and-point. Users should be allowed to select actions from alternatives presented on the screen. This allows users to see-and-point (as opposed to remember-and-type). Recognition, not recall, is important here; the user should not have to remember anything the computer already knows. It is simple for most programmers and expert users to work with a command-line interface that requires memorization and Boolean logic. This is not a simple task for the average user. Through the use of a visual and spatial environment, people are able to work effectively while using the computer in a sensible human environment.

   This removes the burden of learning and remembering cryptic or complex command structures, thus allowing the user's focus to be on the actual task. Recognition rather than recall is all that is needed for successful operation.

4) Consistency. "Effective applications are both consistent within themselves and consistent with one another." (Apple Computer, 1986, p. 6) The very important reason for this point is that of skill transfer. If a user is accustomed to the interface of one application and that application is consistent with others in operational concepts and elements, then the skills used may be transferred to other applications.

5) WYSIWYG (what you see is what you get). "There should be no secrets from the user, no abstract commands that only promise future results. There should be no significant difference between what the user sees on the screen and what eventually

gets printed." (Apple Computer, 1986, p. 7) This concept means that user actions result in feedback which corresponds with actions taken. An action to copy a file to another disk displays the copy in both places, the original and the new, thus assuring the user that the action resulted in the desired effect. Also, a document will be printed as displayed on the screen. The user does not have to guess or perform uncomfortable manipulations to achieve the desired output. This is in direct support of the direct manipulation concept.

6) User-initiated actions. All man-machine interaction should be driven by the user, not the system. The user is no longer in a reactive state to a machine. A user may receive warnings if he is about to take a risk, but the user still maintains control and is allowed to make his choice of action, not the computer's.

7) Forgiveness. Even the most proficient user makes mistakes. The system should be forgiving when mistakes occur. Since provided documentation is often avoided by users and since this avoidance takes on a form of exploration, users should be allowed to learn by doing. In support of this, naive or inattentive users should be warned before making unrecoverable mistakes.

8) Feedback and dialog. The user should be kept informed. Feedback should be immediate and clear. "User activities should be simple at any moment, though they may be complex taken together." (Apple Computer, 1986, p. 8) The user must remain informed to maintain his state of control over the environment. Also, the user needs to be aware of the progress of operations and be presented with brief, direct explanations if operations cannot be completed.

9) Perceived stability. "Users feel comfortable in a computer environment that remains understandable and familiar rather than changes randomly." (Apple Computer, 1986, p. 9) The interface provides a two-dimensional visual stability and a conceptual sense of stability with a clear finite set of objects and actions within the fast and versatile computer environment.

10) Aesthetic integrity. "Visually confusing or unattractive displays detract from the effectiveness of human-computer interactions. Different 'things' look different on the screen. Users should be able to control the superficial appearance of their computer workplaces—to display their own style and individuality." (Apple

Computer, 1986, p.10) The visual appearance of the screen and its components is essential to the Macintosh interface. Apple states that "Consistent visual communication is very powerful in delivering complex messages and opportunities simply, subtly, and directly." (Apple Computer, 1986, p.10)

b. Principles of Graphic Communication

Apple Computer has further guidelines which address the graphic aspects of the interface. "Graphics are not merely cosmetic. When they are clear and consistent, they contribute greatly to ease of learning, communication, and understanding. The success of graphic design is measured in terms of the user's satisfaction and success in understanding the interface." (Apple Computer, 1986, p. 11)

Further, Apple has three primary measures for effective graphic presentation: visual consistency, simplicity, and clarity. These support the concept of conveying real world metaphors in a context which will be most appropriate to the application and comfortable for the user (Apple Computer, 1986, pp. 11-12).

B. THE VISUAL INTERFACE

1. Using Visual Concepts

The Macintosh system is certainly not the only system which has taken advantage of a visual interface. The Macintosh's direct predecessor was the Lisa microcomputer system by Apple Computer. The Lisa system heavily influenced a number of products, including "Microsoft Windows," "GEM" by Digital Research, and IBM's "TopView."

The Lisa system began to take shape after the Apple senior staff visited Xerox's Palo Alto Research Center in 1980 to see a demonstration of Smalltalk. At the end of a three-year development period, the Lisa was introduced as the first multitasking windowing system for a personal computer. The Lisa did not prove to be successful in sales, but much of the technology was passed to the higher-performance, lower-cost Macintosh. Many of the user interface concepts used in the Macintosh were in fact developed for use in the Lisa (Tesler, 1985, pp. 17-22).

The Xerox Star system is a widely known system which is credited as a forerunner in the implementation of a visual interface. Announced in 1981, Star's use of icons, pointing devices, and an office metaphor predate the Lisa and Macintosh. The system had strong limitations in that the system addressed the visual interface only at a very simple level. To perform in an application environment, Star was used in a command mode much like other types of systems (Shu, 1986, p. 21).

The significance of the aggregate work discussed above is that it brought forth a new standard of user interface which can be called the visual interface. A visual interface uses visual objects as the basis of communication. "A visual communication object is some combination of text and graphics used for communication under a system of interpretation, or visual language." The benefit of visual communication is

"When humans are faced with cognitive complexity, they often need graphics as well as text to help them deal with that complexity." (Lakin, 1986, p. 36)

If appropriately applied, the visual interface is capable of bringing positive benefits in dealing with complex problems such as military wargaming. The benefits are even more noticeable when the visual interface is contrasted with the user interfaces of the past.

The typically used menu and command structure interfaces are plagued with problems in the areas of syntax, modes, and navigation. The visual interface easily overcomes these problems in an environment centered on the user's control of the system. Learning time for new users is greatly reduced because the visual interface is based on familiar and intuitive processes and actions.

Given the particular needs and goals of a given application, prototypes of the visual interface can be easily implemented and tested for maximum effectiveness.

2. The Design of a Visual Interface

Ben Shneiderman (1986), developed a model called "direct manipulation." This model addresses the visual interface and consists of three parts:

1. "Continuous representation of the objects and actions of interest."
2. "Physical actions or labeled button presses instead of complex syntax."

3. "Rapid incremental reversible operations whose impact on the object of interest is immediately visible."

While the Macintosh system provides an example of a visual system, no specific design models have been formulated for guidance in development of other specific applications of visual systems. Most research supports the principles which Apple developed as user interface guidelines, but some recommendations should be emphasized before undertaking the development of a visual interface.

It is clear that a visual interface in and of itself does not merit reward. It is the careful and planned design and implementation of the visual interface through which its many rewards may be reaped. Application goals must be carefully integrated with the user needs and the principles of good visual interface design. This is a primary requirement and it is recommended that strong consideration be given to the ideals of this approach before development begins.

As mentioned earlier, the visual interface can be easily prototyped and tested for effectiveness within the context of any application. This aspect requires considerable graphic creativity and expertise. Poorly designed graphic tools can produce only poor results within the application. Careful, application-specific design considerations must be created to communicate with the user clearly and concisely.

Icon, window, menu, and dialog design must be integrated into more than a "package" that works together. It should represent a metaphor of reality which will effectively bring the abstract actions of the computer into concrete, realistic terms for the user.

After the initial graphic-based design takes form, a considerable task still remains. Follow-on prototyping and thorough testing of the design are critical to success. Prototyping tools exist which allow relatively simple implementation of screen, window, dialog, and icon design. User interactions and reactions may be prototyped and tested through these tools as well.

The prototyping and testing phase is the most important aspect of the user interface design process. The best plans can fail when presented to the user who can not or will not effectively use the interface. The prototyping methodology is highly efficient in development of the visual interface because it allows low cost and high speed at the same time. This is necessary and most productive in this type of situation.

The visual interface design presents special problems of its own. Since screen space is limited, the effective use of window management is necessary. The following section presents some important considerations in windowing methodology.

C. WINDOWING

There are associated concepts which are of importance in the design and implementation of windows.

1. Window Management Design

Windows provide views for the user into applications. As previously discussed, windows may occur in various sizes, shapes,and forms. Windows are actually complex graphic representations which require highly efficient software structures for their display and control. The mechanism which usually provides this service is a Window Management System.

The Workshop on Window Management defines the following: "A Window Management System (WMS) is a system service that provides for the creation, deletion, and modification of windows. The WMS allocates scarce resources (represented by on-screen real estate, entries in a colour map, use of mouse and keyboard input devices) among contending applications." (Hopgood, et al, 1986, p. 145-147) Functions of a WMS as defined by the same research group include:

1) creating and destroying windows;
2) redrawing images in windows;
3) providing titles for windows;
4) requesting the allocation of color table entries;
5) requesting sampling input from the mouse, keyboard, or other entry device.

Window design is concerned with a number of aspects, from technical to functional, to aesthetic. Assuming that technical capabilities exist to perform the desired operations at acceptable speeds, attention turns to the user oriented issues of function and aesthetics.

The Application Interface Task Group of the Workshop on Window Management defined eight principles to be considered in window manager design:

1) Symmetry—application and window manager should be able to do the same functions.

2) Synchrony—single thread of control should exist.

3) Hints—impossible tasks initiated by applications should be allowed graceful exit by the WMS.

4) Redraw requests—requests should be hidden and redraw mechanism should be simple.

5) Procedural interface—interfaces should be procedural as opposed to exposed data structures.

6) High level libraries—applications should talk through a window manager toolkit.

7) Strategy specification—it should be possible to specify strategies such as font or color matching.

8) Generality—this principle is difficult to achieve. The research group expects compromise in this area (Hopgood, et al, 1986, pp. 213-214).

Window management design addresses a large number of control issues regarding the participation level of the WMS. The consensus among the Workshop on Window Management is that most of these specific issues should be dealt with at the application level in consideration of the application goals. The group also addressed a number of important general issues which should be resolved in the future to establish accurate conclusions regarding future development decisions (Hopgood, 1986, p. 172).

2. Window Management Implementation

Implementation of a Window Management System requires the observed workings of the system by the user. Creativity could result in innumerable variations across a range of applications, but guidelines can be helpful in the general development process. Warren Teitelman created a set of guidelines for development of an environment where the user is expected to be in control of the system. He suggests that the interface should:

1) Be intuitive—use images suggestive of operations being performed.

2) Accommodate novices and experts—to enhance growth and flexibility from ease of use to power.

3) Allow customization—allow macro mechanisms for expert customization.

4) Provide extensibility—use of macros to extend functionality.

5) Use lots of feedback—inform, but avoid intrusive interaction by appropriate use of feedback.

6) Be predictable—use a consistent, uniform, easily remembered set of basic actions.

7) Be deterministic—predictable methods are preferred.

8) Avoid modes—avoid states that persist.

9) Don't preempt the user—do not force the user to respond (Hopgood, et al, 1986, pp. 187-188).

The working group agreed that, in the context of the end user, a WMS should consider the user's model to define standards for interfaces. Additionally, the group agreed that present methods of representation are unsatisfactory, and that there is presently no obvious means of standardization of the user interface. Again, further research is suggested. In this case, the group suggested study of existing window manager models and better ways of representing user models (Hopgood, et al, 1986, pp. 189-190).

Valuable suggestions were offered by the group on window implementation. The window functions should be provided by a toolkit approach. This is consistent with the Apple approach to window implementation through the Toolbox and Window Manager software. The window manager should provide generic functions which can be interpreted by applications. This again is consistent with the Apple implementation, which provides generic cut-and-paste functions as well as others. A final recommendation is that "User Interface Management Systems should be developed which enable the rapid tailoring of window managers to application requirements." These systems are used to generate window managers. (Hopgood, et al, 1986, p. 190-191)

Since windowing is a critical aspect of the visual interface, strong consideration and support should be given to WMS development in the context of specific applications by sponsors and developers. The success or failure of a visual interface implementation may be rooted in the WMS and adequate resources should therefore be allocated.

The visual interface of today is dependent on windowing, although future implementations may explore utilization of spatial information, where information is nested in spatial images. These images may be thought of as something like projections of information allowing a user to "zoom in and out" of an image to obtain more or less information regarding that item. This concept is used by the Dataland system developed at the Massachusetts Institute of Technology (Bolt, 1984, p. 24). Research in this area is very young but may show even greater promise than the visual interface we commonly know today.

The visual interface is effective in its current state but, as just noted above, there may be any number of improvements and refinements which may be developed in the future. On the other hand, improvement may take the form of an integration of currently available technology.

IV. A FRAMEWORK FOR USER INTERFACE DESIGN

A. A GENERIC ARCHITECTURE

The Decision Support System literature proposes a generic architecture to construct a user interface (Bui, 1987). This architecture consists of three independent, inter-related modules: 1) the dialog unit, 2) the control unit, and 3) the inter-module linkage unit. Various user interface representations may be developed within this generic model.

The purpose of the dialog unit is to provide the input/output links or physical interface between the user and the system. The software portion of the dialog unit contains routines which monitor the hardware. The hardware portion of the dialog unit may include a CRT, keyboard, mouse, touchscreen, printer, or other varieties of input/output devices.

The control unit guarantees smooth, error-free interaction between the user and the system. The checking of syntax and logic as well as provision of a help facility is the responsibility of this module. Correct and relevant representation to the user is the primary goal of this very important unit.

The inter-module linkage unit provides a liaison of the model with the data components or other elements of the system.

The overall goal of this framework is to provide an effective and efficient user interface design strategy focused on learning, creativity, and interaction delivered in a friendly, helpful fashion.

B. A SURVEY OF USER INTERFACE REQUIREMENTS

A group of forty graduate students from the Information Science Department at the Naval Postgraduate School participated in a survey regarding the design of a wargaming user interface. Students were asked to address each of the three aspects of the above model with a description of what they considered important components of an effective wargaming interface. All of the requirements they developed were with respect to the above framework.

Students participating in the study were professional military officers, familiar with warfare in general but unfamiliar, in most cases, with wargaming systems. This data, therefore, provides information based on a relatively strong understanding of the user interface, with limited exposure to the direct application of wargaming. It should be noted, however, that, as professional military officers, the survey participants' training and job experience lend an understanding to the strong importance of the content and purpose of wargaming within the military.

The surveys were reviewed and analyzed by compiling a list of features recommended by the survey participants for each of the three components within the user interface framework discussed in the previous section. Corresponding recommendations were then tallied and ranked in descending order of frequency.

The *dialog unit* brought forth the most varied and interesting conclusions in the survey. Survey participants, in their independent designs of a dialog component for a wargaming user interface, considered several items to be very important. Eighty-three percent of the participants recommended a high-resolution graphics monitor as the primary output device in the system. Most participants felt that a menu-based system was preferable to a command-driven system, and in many cases, the participants felt that a menu system should be supplemented with some other methodology such as windowing (thirty-eight percent), voice input/output (thirty-eight percent), icons (twenty percent), and/or graphic manipulation (thirteen percent).

Sixty-three percent felt that a mouse input device was preferred to other input devices such as touchscreens, joysticks, or light-pens. Sixty percent of the participants recommended a standard keyboard, in conjunction with the mouse or alone, although only a very small number (five percent) of the participants considered using the keyboard alone.

While twenty percent of the participants included high-speed workstations in their description, seventy percent neglected to mention color as an important characteristic of the high-resolution graphics monitor/workstation concept. The criteria most often mentioned as important to the user were response speed and ease of use.

The *control unit* portion of the survey found that the participants most highly valued an on-line help facility. In fact, this item, with a seventy-percent frequency, had the strongest support of all items considered in the survey. Very close to the on-line help feature was a rigid input/output error-checking/verification system (ranking sixty-three percent), which the participants felt was necessary in any application supporting a wide variety of users.

Items mentioned with respect to the control unit were all software related except for one item. This was a separate or front-end processor to provide high-speed and responsiveness to the user. Thirty percent of the participants considered this necessary to provide adequate control.

The remaining recommendations for the control unit were to provide simple and clear prompts and messages (twenty-eight percent), timely and informative feedback (twenty percent), forgiveness in error recovery (fifteen percent), and an on-line tutorial (fifteen percent).

In the *inter-module linkage unit*, the most desirable characteristic was modular implementation (thirty-eight percent) for the purposes of flexibility and maintenance. Ranking second in this category, with twenty-eight percent each, were rapid access via a local central processing unit or high-speed memory and ease of data access and availability.

The participants had a variety of responses but, in general, the above provides a condensed overview of the most desirable characteristics as seen by prospective users of wargaming systems. The developer of a wargaming user interface could consider these characteristics as a basis for a simplified, generic, user requirements definition on which refinements and further recommendations could be based.

C. A FEASIBILITY ANALYSIS OF DESIRABLE WARGAMING CHARACTERISTICS

In the previous section, different characteristics were recommended by the potential users surveyed. As is typical in most user surveys, there is a broad base from which developers and sponsors must make limited selections. The determination of good, productive, cost-effective characteristics must remain in the final analysis of any successful project. Many, although not all, of these decisions are based on a union of user and application requirements. Other factors influencing such decisions may be based on time, hardware, financial, or political constraints.

This portion will address a general set of requirements drawn from the broad set of user requirements listed above. Additionally, it should be noted that the items mentioned here are discussed in a generic wargaming context as an attempt to provide a general feasibility framework and foundation for application-specific issues.

1. The Dialog Unit

Within the dialog unit, one must assume varying degrees of computer literacy. Use of a wargaming system should primarily provide for the development of warfare skills as opposed to computer skills. This implies that a high level of sophistication must exist in the user interface to remove the user from the problems associated with conventional computer interfaces. As recommended by the survey participants, a highly graphic-based system can help provide the level of sophistication desired.

Objects familiar to a military officer may be graphically depicted so that a *minimum of* textual information must be read and interpreted. This is in support of the time constraints faced during the play of a real-time or accelerated wargame. It would be ideal to provide the fastest interface possible. High resolution in the graphics screen allows detailed and clear representation and hence interpretation. This is why a number of survey participants recommended this option. It is not only desirable but rather a necessity within the realm of current technology.

To effectively use this graphic technology, the user input hardware technology should be at least as sophisticated as the output device to remove the user from interfacing with conventional input/output devices such as keyboards. This hardware should consist of some type of pointing/picking device. As suggested in the survey, user familiarity with and acceptance of the mouse is fairly broad today. This lends the mouse a bit of an advantage, although other technologies have certain merits.

In particular, touchscreens require no peripheral device, no tracking area on the desktop, and are readily available to the player. In the same context, though, touch screens and other devices may pose problems of their own. The touchscreen is at times difficult to implement and "fine tune" for detailed work such as pixel manipulation because of finger sizes and screen divisions. No single device is perfect, but the mouse is a strong candidate if it can be effectively integrated into the needs of the specific application.

Thirty-eight percent of the participants suggested that voice input/output is the ideal medium for use in wargaming. This may be the fastest method available if implemented under "ideal" circumstances of very high levels of sophistication. This technology is still young and will continue developing into more reliable and promising implementations. Voice technology shows much promise and should be considered for further research within the wargaming application.

With the recommendation of high-resolution graphics capabilities and improved hardware, software implementations should address the utilization of detailed screen graphic manipulation. The possibilities include, as suggested by the survey, windows, menus, and icons within an environment of graphic manipulation where the user can perform tasks by operations on, or with, the graphic objects.

These elements, coupled with the processing capability to provide the power and speed demanded by such graphic manipulation, provide a foundation environment on which to build application specific implementations of the dialog unit within a wargaming system.

2. **The Control Unit**

Since the control unit must provide for error-free operation, the hardware and software must be proven robust enough to handle all potential error situations and provide on-line help, automatic feedback, and forgiving continuation of the wargame process. Extensive testing and evaluation of any control unit is a necessity, but in a wargaming system, with numerous data elements and parameters which need to be verified throughout the game, a dedicated processor is recommended to reduce the processing burden on the other system components.

Survey participants felt that the on-line help facility was the most important part of the control unit. While it is terribly important, at least as much effort should be spent in making the control unit informative to the player by providing unsolicited guidance during game play. All players make mistakes, even the experts. It is usually the novice who may not know how to recover. The system should allow flexibility here to give the expert an alert of a problem without the drudgery of details, but also give the novice the option of specific guidance out of the problem area.

3. The Inter-Module Linkage Unit

Since this module provides the interface between the user's input from the dialog unit and the model and data components, it is imperative that the hardware and software be fast, reliable, and easily maintained. Thus the survey participants were accurate in predicting the need for modular implementation of this unit. It must be easily maintained and modified as data elements and model components change.

The link performed by this unit is very time-critical to game play. Player requests for data access should be easily and rapidly served by this unit. This can be enhanced by a dedicated processor capable of handling the interactive model as well as data.

Each of the three units of the user interface framework is critical in the provision of a complete environment which wargaming systems developers must address individually. The components work together as a whole to establish a framework for wargame-specific decisions. The generic framework established here is only the foundation of that task on which much elaboration takes place in actual development.

V. APPLICATION OF AVAILABLE TECHNOLOGY

The concepts discussed to this point have indicated several proven effective, available modes of technology which the author believes, if properly applied, may bring positive results to the military wargaming arena.

As has been stated a number of times in this thesis, each application must be evaluated independently for specific implementations of a visual or other effective user interface. However, guided direction tempered with good solid research, and strong prototyping and testing will undoubtedly prove effective in producing improvements. It is therefore highly recommended that efforts in this area be actively pursued in military wargaming. The following model may provide a beginning framework.

A. AN INTEGRATED FRAMEWORK

Human beings gather information in many ways. Since human information gathering is sensory in nature, it would seem logical to support the sensory system as fully as possible. With a visual interface alone, even though highly effective, only one channel is open for communication. With the integration of a voice input/output system, another channel is opened. Together, the auditory and the visual aspects could be more complete and meaningful.

This combination also supports the human cognitive processes through integrated visual and auditory stimulation. Long-term memory requirements are minimized. Visual and auditory information can be processed much more rapidly than textual information if the representations are meaningful. Anxiety levels will be low because of familiar graphic object representations and the intuitive operations to be performed on those objects. Strong feedback and ease of recovery from errors will promote user acceptance. Most important, the user's attention is now directed at the wargame instead of trying to figure out what to do to effect commands or interpret cryptic output.

Consider a wargaming system using this integrated technology. If a player were to approach a wargaming system which is implemented with a relevant, well-developed metaphor for wargaming, recognition and interest would immediately develop. If operations were intuitive rather than obscure, a player would feel more comfortable in learning and using the system. The concepts would allow more recognition than memorization, thus lending additional simplicity for all concerned.

The visual aspects alone in an application such as wargaming have tremendous potential. Military maps and symbology are largely standardized within service branches. The "grabbing" and "dragging" of icons and symbols in the Macintosh system are certainly useful concepts in effecting unit movements and route selection. If extended to voice input/output operations such as those in the Dataland system (Bolt, 1984), a player could simply point and say "move that there." There is no need for fill-in templates or complex commands containing long sequences of numbers.

A workstation with enhanced capabilities and high performance is necessary for fast, high quality graphics and data processing. This may be accomplished with a sophisticated system such as the SUN or the APOLLO, but a less expensive alternative might be use of a low-cost microcomputer such as the Macintosh.

Regardless of the system chosen, it is suggested that, rather than support numerous screens per station, use one high-capability screen/terminal. With windowing and complex graphic capabilities, one screen can provide one central information control unit.

1. Implementing the Elements of a Visual Wargame Interface

The variations of visual wargaming interface elements have numerous possibilities within the contexts of actual wargaming systems. It is important to define in general terms how the visual elements of a wargaming interface may be characterized. It is also important to note that if properly developed, these elements may be further developed into a "standard" group of wargame interface tools, such as the elements and functions of the Macintosh Toolbox. The fundamental elements to be addressed here are icons, windows, dialog boxes, alert boxes and controls, as well as the menu bar and pull down menus.

a. Icons

Icons are graphic, symbolic representations of files, applications, or program functions. They may be moved, activated, deactivated, or otherwise manipulated in standard ways. Icons are useful because they contribute greatly to the clarity and attractiveness of an application.

When used as a part of the Apple Desktop, icons generally have associated titles listed in text just below the icon. When used in an application, titles may or may not be used depending on the purpose of the icon and the intuitiveness of that purpose.

Each icon or type of icon has a distinctive appearance for rapid recognition by the user. Apple recommends that, wherever an explanation or label is needed in an application, one should consider using an icon (Apple Computer, 1986, p. 38).

As previously stated, icons are graphic representations of files, applications, or program functions. Wargaming is an ideal area in which to use icons because, in many cases, well-developed military symbology already exists. Although not usually standardized across military branches, the accepted and understood symbologies are readily adaptable to the visual interface.

The JTLS wargame already utilizes standard Army ground combat symbology to display unit position on the geographic display. BGTT uses the Navy standard NTDS symbology for the same purpose. This is an obvious use of the available symbology, but the use of icons in wargames should be extended far beyond this traditional method.

The potential for icon utilization begins with a very simple but effective foundation. For example, in JTLS, the player of the command terminal has an initial choice of several fundamental types of orders. These orders are categorized into operational groups of ground combat, air combat, intelligence, logistics, and so on. Rather than issuing a complex typed command stating that the player wants a certain amount of fuel transported to a certain unit, then having to go through sequential menus and entry of parameters in the necessary templates, the visual solution might offer a far superior alternative.

The visual implementation should allow the player to "click" the logistics symbol (in this case, maybe a transport truck) to designate that function. That function should respond by offering the further selections of fuel, men, food, equipment, or ammunitions. These items also lend themselves to easily recognizable graphic representation as icons. Also note though that each icon can be labelled if so desired or necessary. This provides quick, clear, and precise recognition of the choices.

If the player were to follow the order through to send fuel to a unit, he would select the fuel icon, at which time a dialog box would prompt him for the amount of fuel and the desired delivery time. The fuel load could be represented on a bar scale with a sliding indicator and the time could be designated with a clock whose hands could also be moved by a mouse action. After the selection, the player could "drag" the fuel load icon produced by his actions to the unit or units of his choice on the geographic display in a nearby window.

The possibilities for implementation of icons in wargames are almost endless. But more importantly, they can be implemented very effectively. The symbols should be easily recognizable objects, with labels if desired or necessary. They should be items which are common and clear to the user of the system. The user should be able to relate to the meaning and intent of the well designed icon. See Figure 5.

b. Windows

A window is the "frame" through which a user views and accesses a document. Depending on the type and size of a document, all or part of it may be viewed in the window at any given time. A number of windows may be on the screen, displaying the document in use as well as other open documents and any associated information. Since a particular window represents a document, it is recommended that actual document contents not be spread to multiple windows. To prevent such ambiguity, split or partitioned windows are used.

The standard document window contains certain characteristics used for control or informational purposes. These characteristics include a close box, a title bar, a zoom window box, and a scroll bar which includes a scroll arrow and a scroll box.

The functions of these items are fairly intuitive in that a zoom box allows one to zoom in and out on the window contents. The close box allows the option of closing a document by clicking the mouse while the cursor is within the designated area.

The scroll box allows a document to be scanned in a chosen direction, whether it be vertical or horizontal. The scroll box acts much like an elevator in a shaft. The relative position of the box within the shaft shows the user his relative position within the document.

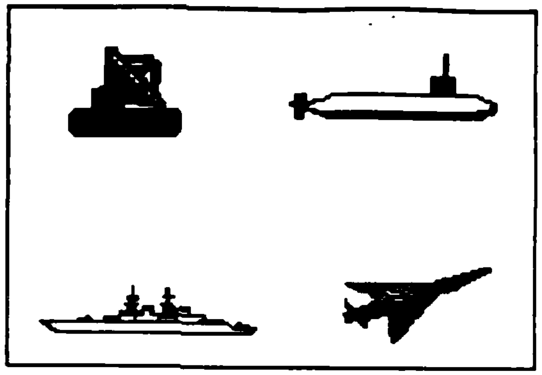

Figure 5

Icons

Windows may exist on different planes. This allows applications to have more than one window open at once. Windows may overlap each other. One window is "active" while the others remain inactive. The "active" window refers to the window currently being used. To bring a window to active status so that its contents may be manipulated, the user must select it by merely clicking anywhere within the window itself. This brings the selected window to the front of the others and places it in plain view. The user is therefore capable of moving around between windows just as he would with sheets of paper.

Windows have additional versatility. They can be resized, and moved to satisfy the user's changing needs. Windows are capable of displaying text, graphics, or a combination of the two. See Figure 6.

As mentioned above, the user may need to move icons within or between windows. Windows provide the user with relevant information within logical "frames" of reference. Windows may be effectively utilized in a wargame environment to provide the player

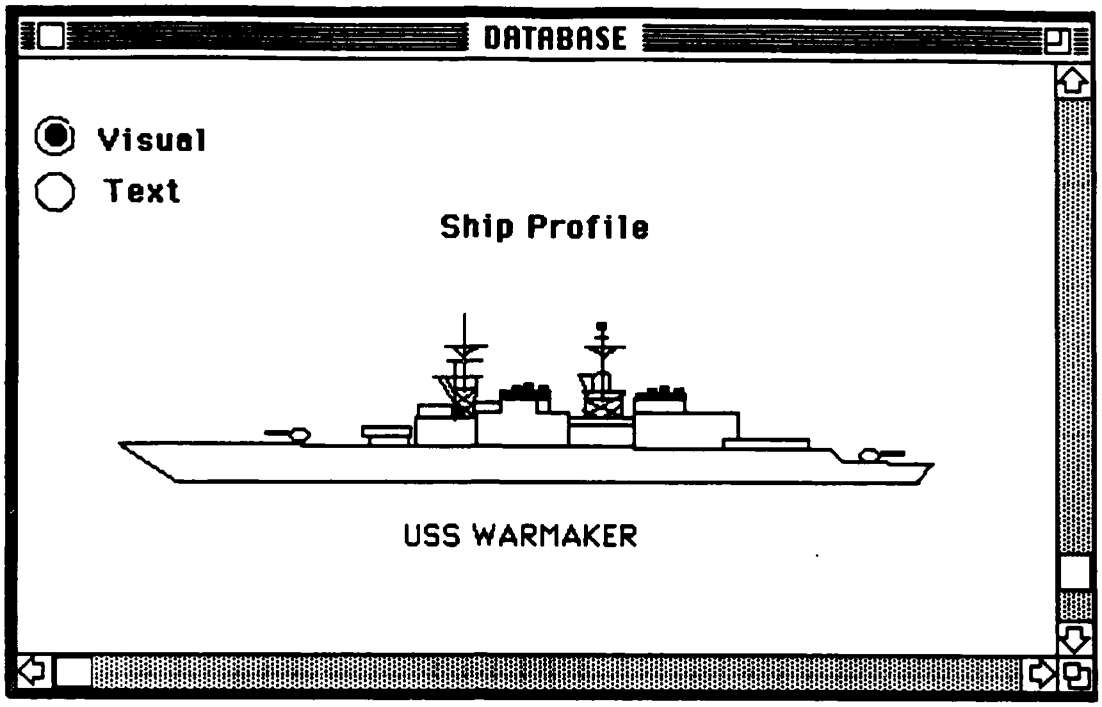

Figure 6

Wargame Database Window With Attributes

with the necessary information as well as a means of manipulation of that information.

The geographic display, which is of primary importance in a wargame interface of any type, is an ideal candidate for display in a window. The geographic display must be capable of displaying concise, current information about unit status, action, and interaction.

The geographic display in current implementations has a tendency to become cluttered and difficult to interpret because of the requirement for a high level of detail. For that reason, wargames such as JTLS and BGTT are capable of decluttering the separate graphics screen by selection of specific items to be displayed and by changing the scale of the display.

The geographic display should occupy a window on the user's primary screen. The window should be capable of movement, opening and closing, resizing, and handling different levels of planes, just as in any good window implementation. The distinction between the traditional implementation and the visual implementation though should lie in the degree of user control over the window. See Figure 7.

The geographic window should be available to the user at the "click" of a mouse or any other similarly quick device. The user should not only be able to observe the results of his typed commands as in other systems, but rather the user should be able to directly manipulate objects on the display. Design should allow effective movement of objects within and in between windows providing the user with more intuitive tools. This is a means to increased speed and understanding for the user. For instance, to call a unit in to the arena, just "drag" the appropriate symbol from one window to the active geographic display.

With a drop-down menu bar selection, any requested status information, database query, or geographical display can be immediately available. See Figure 8. Windowing will allow simultaneous viewing and manipulation of several vital screens. The geographic display window should allow immediate unit information retrieval for items such as current activity, pending orders, strength, losses, communication paths, resources available, and so on.

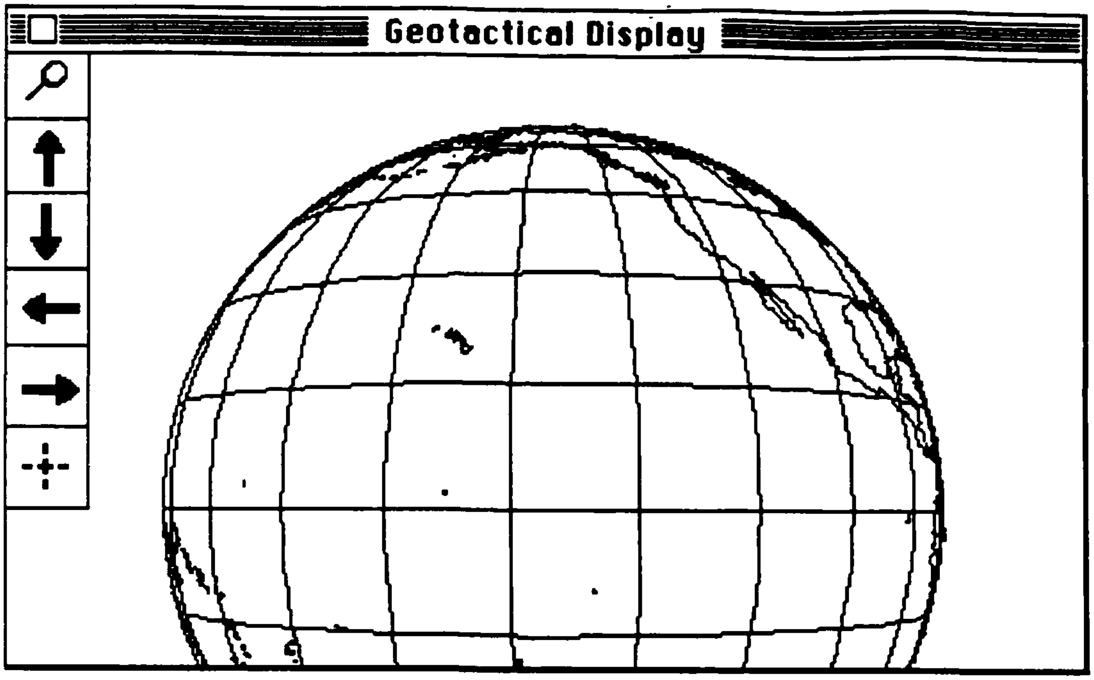

Figure 7

Geographic Display Window With Control Icons

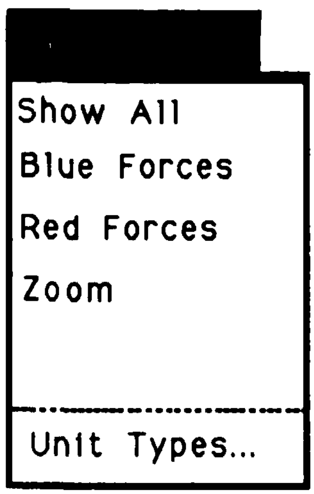

Figure 8

Typical Pull-Down Menu

Windows in a wargame should be flexible but with enough structure to avoid ambiguity. The user should be able to call upon and graphically manipulate as much information as possible without frequent switches between the keyboard and the graphics input device. This is not entirely avoidable, but in other systems it is not uncommon to control the graphic display with cumbersome typing of commands. In the visual interface, for instance, to zoom in or out of the geographic window, a click in the appropriate "zoom box" will effortlessly step the user to the next level of detail.

Another possible use of windows in the wargame is to provide "information planes" whereby the user may select different levels of windows through icons, or whatever means, to provide differing resolutions of information for the player. For instance, if the player is accessing the game data or a player report, a "double click" on the window should provide the information in greater detail. A "single click" on the window should provide an abbreviated, more general view of the information.

c. Dialog Boxes, Alert Boxes, and Controls

In addition to standard windows, there are other kinds of windows. These are dialog boxes, alert boxes, and controls. These are not windows in the strict sense but rather auxiliary types of windows which provide specific functions.

Dialogs allow the system to prompt the user for additional information before a command is executed. Dialog boxes are either modal or modeless. A modal dialog box requires that the user dismiss the box by performing a specific action or acknowledgement before doing anything else. A modeless dialog box allows the user to perform other operations without dismissing the box.

Dialog boxes in the wargame interface will provide a clear method of communication with the user. For instance, if the system is in need of parameters or information which the user for some reason has not specified, the dialog box will appear to inform and prompt the user for the appropriate items. An example of this may be in the logistics example used previously. The user indicated that fuel was required, but the wargame needs to know the quantity and delivery time. A dialog box could tell the user that the information is needed, specify the parameter range, and wait for the response.

It is important in dialog boxes that the user maintain control of the system such that the user is not forced to input the parameters. The dialog box usually will allow a "cancel" function along with appropriate warnings and statements of consequence to allow the user some degree of flexibility.

Alerts notify the user in the event of an unusual situation, such as an error condition. Since users are error prone, alert boxes allow the system to inform them that a mistake has occurred. The significance of the mistake and guidance for recovery are usually included in the text. See Figure 9.

Alerts in a wargame can be used to warn the players of threats within the game itself as well as to warn the players of unusual situations and system error conditions. Guidance should be provided

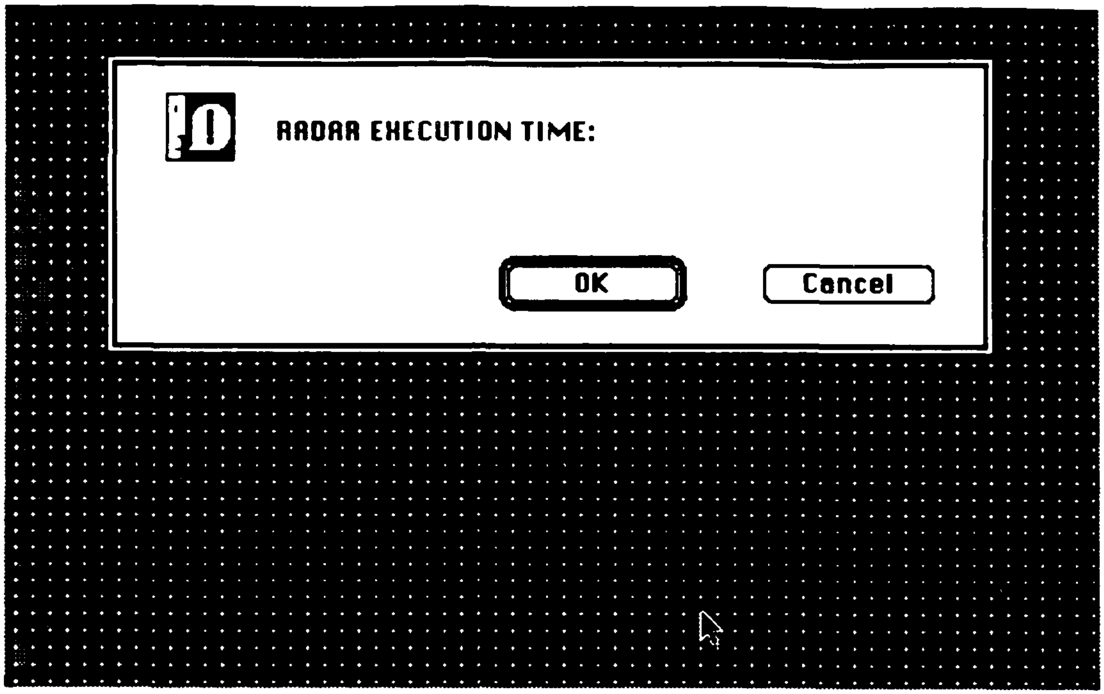

Figure 9

Typical Alert Box

to inform the user of appropriate actions and/or recovery procedures so that wargame play can be continued with as little difficulty as possible.

Controls are graphic objects which can be manipulated with the mouse to perform instant actions, either visually or audibly. Controls can have four basic varieties: buttons, check boxes, radio buttons, and dials.

Buttons are small objects, found usually within a window, labeled with text or an icon. A button performs an instantaneous or continuous action described by associated text. Check boxes act like toggle switches to turn functions on or off. Radio buttons occur in groups in which only one radio button can be active at the time. Dials display a value or magnitude which is alterable by the user (Apple Computer, 1983, pp. 32- 33).

Controls are graphic objects which can be used to increase and enhance the manipulation characteristics of the wargame. Familiar objects may be graphically depicted to guide the user to the choices available. For instance, to turn on radar, a player may "click" on a graphically depicted toggle switch or button, or to increase the sensitivity of some equipment the player may turn a dial. There are numerous possibilities for implementation of control elements in wargame systems. See Figure 10.

d. Menu Bar and Pull-Down Menus

The menu bar is displayed at the top of the screen. It contains logically grouped titles of the pull-down menus which are available to the user for expressing commands. Pull-down menus may consist of text or graphic entries. Each application usually has its own menu bar to make program-specific selections available. These selections remain constant throughout the application, though all commands may not be available or operative at all times. Users are always able to peruse the available commands while maintaining the information being worked on in the current document on the screen.

The menu bar and pull-down menus are ideal for implementation in wargaming systems. The menu bar provides for categories of commands to be actively displayed for selection during game

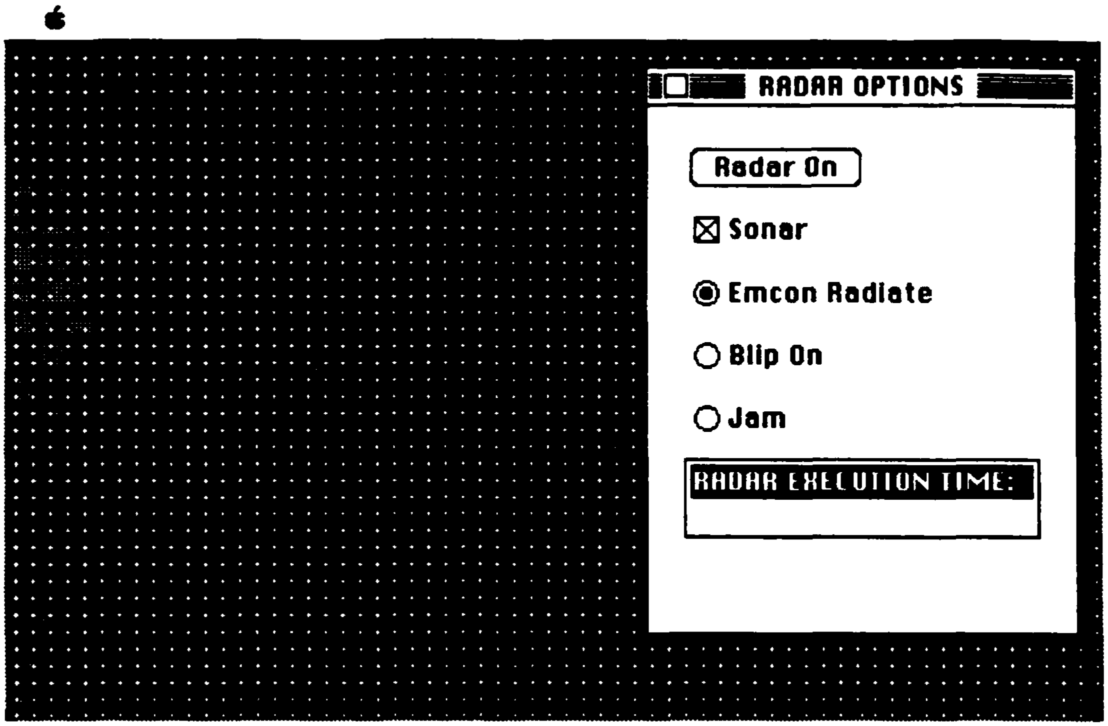

Figure 10

Different Types of Controls in a Window

play. The pull-down menus allow the user to select specific commands from those categories. The benefits in a wargaming system are that the user has only to recognize a command to use it. Cryptic command structures do not have to be memorized or frequently referenced. See Figure 11.

The menu bar should contain standard commands and functions for all players, but depending on the command needs of the player station, the menus and menu bars will vary accordingly. A point of caution should be noted here. With the large number of commands usually necessary in wargaming systems, care should be taken to avoid

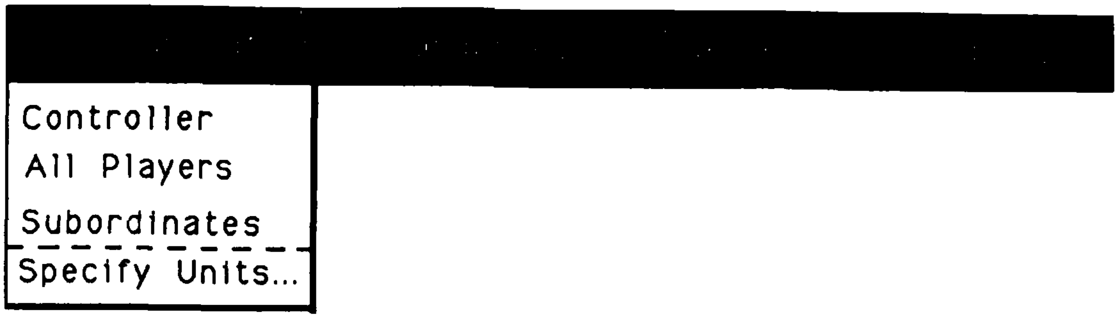

Figure 11

Menu Bar With a Pull-Down Menu

confusing and numerous menus. Careful design and integration will avoid associated problems.

B. HARDWARE/SOFTWARE REQUIREMENTS

The hardware is composed of a number of high-speed workstations, each consisting of a large-surface, high-quality, high-resolution graphics monitor and a pointing device or touch screen with a keyboard for manual input. The workstation ideally has extensive local graphic processing and database storage capabilities.

Hardware and software requirements will vary widely depending on the extent and method of implementation. Workstations are becoming more and more popular due to their strength and flexibility. They are also providing more value per dollar as hardware prices decline. As mentioned above, the SUN and APOLLO are examples of such systems, but advanced microcomputers such as the Macintosh might easily serve as low-cost alternatives, especially in the development stages.

C. IMPLEMENTATION: A SESSION IN JTLS

This portion of the thesis will address two scenarios: 1) a JTLS wargamer stepping through a task in the current interface, and 2) a JTLS player stepping through the same task in a hypothetical visual interface. Figure 12 illustrates a comparison of the man-machine interactions for the two scenarios.

1. The Current JTLS Interface Scenario

The current JTLS interface, as described previously, is menu-based. A player involved in a JTLS wargame is faced with sending numerous commands under tight time constraints. The scenario to be addressed here is for the ground terminal player to create an attack mission. This involves a common operation for the ground player and resembles tasks which other players must perform on a regular basis.

At this point in the game, the player has already been playing actively, building and sending directives to perform various actions. It is common in the current version of JTLS for the player to reuse directives created previously by modifying them to reflect newly desired parameters as the game progresses. This is done because modification of previously built orders, while still tedious, takes considerably less time than developing new ones. However, in this case, the player is creating a new attack directive.

Assuming that this player is new to JTLS, he will first attempt to refresh his memory with a menu option which might allow him to inform himself how to perform this task. His first action will be to type "?" in an attempt to display the top-level directives (assuming he

	Current Interface		Visual Interface	
Task	Hardware	Software	Hardware	Software
'CREATE' Directive	keyboard, CRT	hierarchical menu command	mouse	pull-down menu
'ATTACK' Command	keyboard, CRT	menu command, template fill-in	mouse/ keyboard	pull-down menu dialog box with controls
Communication Function	keyboard, CRT	menu command, template fill-in	mouse/ keyboard	icon, dialog box
Help Function	keyboard, CRT	menu command	mouse	icon, dialog box
Clock Function	keyboard, CRT	menu command, template fill-in	mouse	icon, controls

Figure 12

Comparison of typical Man-Machine Interactions For the Two JTLS Scenarios

is currently at the top level of the menu structure). If the player is at the top level, he will see a screen display of menu options, three of which will allow the player to move into a manipulation level. He finds the command desired at this time, the "Create" directive.

Again, as a novice, the player may have forgotten the next syntactical element to be entered, therefore, he will type "CR ?" to display his options at the manipulation level. "Attack" appears in the list as option number three out of seventeen available choices now on the screen. The player then recognizes the command and enters "CR AT," which is the abbreviated form of "CREATE ATTACK."

After this entry, a template for the attack directive appears on the screen. This particular template has nine parameters which must be completed. In addition, the completion of another entirely different directive sequence and template is necessary to provide the ground route for the attacking forces, the name of which is provided as the ninth parameter of this first template.

During template completion, feedback is minimal. The first parameter in the attack template is called "REFERENCE." This is actually a name by which the player may reference this particular directive after completion, e.g., for the directive to be sent to the game for execution. The player may insert any name which he considers appropriate here, but when the player attempts to enter the parameter for item number three, "UNIT," the player must be able to specify an accurate unit name which is active in the current game database. Otherwise, the game will respond with "There are no GROUND units whose name begins with 82A." Unfortunately, the player at this point must escape his current activity and review the database for an accurate name. This is time consuming and troublesome, especially for the novice, but it happens to all types of players at one time or another.

After the player finds an appropriate entry for the name parameter, he must reenter the template (if he knows how) and continue along the same path until the directive and the ground route are complete. The player then must return to the top level and, when ready, recall the directive for the "SEND" operation to actually enter this directive into game play.

This is an abbreviated hypothetical case used as an example only. A number of sample command sequences may be followed in the *JTLS Player Guide* (CPS, 1984)

2. A Visual JTLS Interface Scenario

In this scenario, the JTLS player sees a much different portrayal of the system. The player screen consists of a menu bar across the top of the screen. The menu bar always contains a pull-down menu for the currently available wargame "DIRECTIVES" as well as a "HELP" pull-down menu, a "GENERAL PURPOSE" or "UTILITY" pull-down menu, and a "WINDOWS" pull-down menu. The menu bar may vary in content or accessibility with the current game modes or player choices.

The "GENERAL PURPOSE" or "UTILITY" menu provides functions which are useful during any part of game play, such as "CANCEL" to quickly escape the current series of player actions. Upon selection, the cancel option presents a dialog box asking, "Will you resume this operation later? If so, it will be saved, if not it will be destroyed." At this point, the player may point and click to either the "SAVE" or "CANCEL" options according to his situation.

The "WINDOWS" pull-down menu allows the user access to various informational displays, such as the geographic display or the database query window, which is capable of displaying textual and graphic database information.

Additional items appearing on the screen may be a palette of icons used for common operations which are modal in nature, such as the designation of ground units, or weapon load creation, or message sending. For instance, a telephone icon is resident in the palette at all times, just as a communications device would be at the commander's disposal. The player uses his mouse to click on the telephone icon to activate communication. Immediately, a dialog box appears requesting the sendee's name or identification. The available choices within the current game appear in a scroll region to be readily accessible to the caller. The caller may scroll until he finds the correct entry, at which time he may double click to select that party, or if multiple parties are desired, he may press the shift key on the keyboard and click any number of parties, each of which is highlighted as he clicks on the entry. When finished he clicks on the text input region and types the message. He may at any time click either a "SEND" box or a "CANCEL" box as appropriate.

To accomplish game directives as in the current JTLS interface example above, the player initiates action by placing the cursor on the menu bar above the "DIRECTIVES" category. As the player presses the button on the mouse, a pull-down menu containing the currently available game directives is displayed. The player moves the cursor over the "CREATE" directive and releases the mouse button. Immediately the menu bar reflects a change by displaying a new menu bar selection, "ACTIONS." This indicates to the player that he now has the option of continuing his directive by accessing this pull-down menu as well.

Notice one thing. The user still may change his mind. If he returns to the "DIRECTIVE" pull-down menu, he may cancel the previous selection by making another selection. This interface is event-driven, not hierarchical as in the other JTLS interface. The user now decides where he wants to be. If he chooses not to cancel, and continues in his original path, he may select "ATTACK" from the "ACTIONS" pull-down menu.

A dialog box appears immediately. This dialog box provides a unique reference name which may be changed if desired. A scroll box containing candidate unit names appears to provide data for item number three. The user scrolls to the appropriate unit, then clicks on it. A digital clock icon appears to provide for the execution time input. The user clicks on up and down arrows to indicate the appropriate time, then clicks outside the clock icon to indicate approval. Scroll boxes are available for the "ATTACK WITH," "PROTECT WITH," and "SCREEN WITH" parameters. These may be ignored if no entry is desired.

The final parameter to be entered is the "ROUTE" which provides a path for the unit to take to a destination. The user clicks on "ROUTE" to indicate that he is ready to fill this parameter. The geotactical display window appears with the specified unit(s) appearing in their current positions on the map. The user then points to the unit(s), presses the mouse button, and moves the cursor along the desired route to the destination. Notice no coordinates were looked up, written down, or repeated by another person as usually happens in the game.

The user then selects "SAVE," "SEND," or "CANCEL" and the directive is accomplished with a minimum of effort. The support required for the player is self contained in one workstation. Several other people are not now needed to chart routes, research unit or target names, or provide game instructions.

This interface provides a continuously available help facility, and, at practically any point, will allow the user flexibility in the way he wants to enter commands and access data or reports. When contrasted to the current JTLS interface, it seems that much time and effort could be saved in this type of implementation. The most important aspect, though, is the usability of such an interface. The user will feel much more comfortable pointing to familiar objects than typing complex syntax. The user will be more comfortable with a system which he feels he controls and which is most forgiving of his mistakes.

VI. CONCLUSION: A NEW USER ENVIRONMENT IN WARGAMING

In a foreword to Richard Bolt's book, Nicholas Negroponte of MIT (1984) makes a very strong case for improvement of the human interface. This excerpt is included here because it strongly reiterates the ideals of this thesis. "The human interface with computers is the physical, sensory, and intellectual space that lies between computers and ourselves. Like any place this space can be unfamiliar, cold, and unwelcoming. But it can also be like some other places, those we know and love, those that are familiar, comfortable, warm, and, most importantly, personal." (Bolt, 1984, foreword)

User benefits have been emphasized throughout this thesis. It serves no practical purpose to list them all again, but it does serve a practical purpose to recognize the fact that the benefits from such modification of user interface software will be significant for all users. The novice and the expert will both experience large gains in productivity. The long-term development of the visual interface into an even stronger tool holds virtually unlimited potential. It is limited only by the imagination because eventually the technology will be there to support it.

The Department of Defense supports vast research and development in many important fields. The area of the user-computer interface affects all of us. The potential benefits of friendly, easily understood interfaces are innumerable.

Only through dedication to the ideal of making computers work for us will we ever have full command over the available resources. To ignore readily implementable systems which will establish a milestone foundation for the advancement of the military and society in general seems wasteful and unproductive. Implementation of such interfaces will open new avenues of communication and creativity which can lead to strong positive strategic growth potential.

The technology discussed in this thesis is readily available for application to the wargaming environment. Implementation costs may be high for full-scale implementation, but long-term benefits should be immense to the Department of Defense. If managed properly, with small-scale development and prototyping followed by thorough testing, costs can be cut drastically. It is very inexpensive and simple to develop a prototype on a Macintosh system which will simulate the workings of a full-scale implementation.

It is expected that certain elements of the visual interface will productively lend themselves to the improvement of the visual wargame interface. These elements include:

1) Extensive use of metaphors, icons, and familiar graphic symbology to promote rapid learning and transfer of knowledge and understanding.

2) Use of windowing for centralized attention to a single screen for the direct manipulation and control of the interface by the user.

3) Use of dialog and alert boxes, and controls for ease and clarity of communication between the user and the computer.

4) Command entry by menu bar and pull-down menus for availability and recognition versus memorization of commands.

Further research in the area of specific application is necessary. While the JTLS and BGTT system interfaces are good candidates for visual interface implementation, it will be necessary in follow-on work to develop prototypes which will effectively implement visual principles as well as model the wargame systems and users. Specific recommendations for the development and implementation of advanced interfaces include:

1) Thorough requirements analysis of the wargame user interface from a user's perspective.

2) Research of graphic workstation technology for capacity, capability, and interface evaluation.

3) Further research of available visual interface principles, including a development plan for application specific transfer of principles.

4) Design and prototyping of interfaces based on conclusions of research.

5) Testing and evaluation of prototypes, coupled with further refinement based on results.

6) Evaluation of results to determine common elements which may be applicable to the development of a "Toolbox" type of interface tool for use with different wargame systems.

It would be most interesting and productive to compare the results of such research for common factors. If commonality is found, further research may prove useful in the development of a generic toolbox system for implementation of these and other wargame systems. If this were possible, the costs could be spread across many applications, while benefits of standardization of a very good interface could multiply with use.

Wargaming is becoming an invaluable tool in strategic force planning and analysis. It only seems prudent to bring such a valuable tool to the user in a highly refined state. Based on the information available, the visual interface—and in the near future, voice technology—appear to be a most practical direction for substantial improvement in wargaming systems.

LIST OF REFERENCES

Apple Computer, Incorporated, *Human Interface Guidelines*, 1986.

Apple Computer, Incorporated, *Inside Macintosh*, Addison Wesley Publishing Company, 1984.

Bolt, R.A., *The Human Interface: Where People and Computers Meet*, Lifetime Learning Publications, 1984.

Bui, Tung X., *Designing the User Interface for DSS*, Naval Postgraduate School, 1987.

Chernicoff, S., *Macintosh Revealed,Volume Two: Programming with the Toolbox*, Hayden, 1985.

Contingency Planning Subtask (CPS), Joint Theatre Level Simulation, *Executive Overview*, Jet Propulsion Laboratory, Pasadena, California, 1986.

Contingency Planning Subtask (CPS), Joint Theatre Level Simulation, *Player Guide*, Jet Propulsion Laboratory, Pasadena, California, 1986.

Department of the Navy, Space and Naval Warfare Systems Command, *Enhanced Naval Warfare Gaming System, Instructor/Lesson Guides—Training Courses for Introduction to War Gaming Course*, Computer Sciences Corporation, September, 1985.

Ford, D., *What is the Defect? Pig tail., Circuits Manufacturing*, Volume 25, December 1985.

Fox, D.B., *A Conceptual Design for a Model to Meet the War-Gaming Needs of the United States Air Force*, Air University Press, July, 1985.

Hopgood, F.R.A., and others, *Methodology of Window Management*, Springer-Verlag, New York, 1986.

Hoskins, J.W., *Voice I/O in the Space Shuttle, Speech Technology*, Volume 2, August/September, 1984.

Irving, R., *MacNWISS: Using the Macintosh as a Command Input Terminal for NWISS*, project, Naval Postgraduate School, Monterey, California, 1986.

Lakin, F., *A Visual Programming Environment for Designing User Interfaces, in Visual Languages* edited by Chang, Ichikawa, and Ligomenides (eds.), Plenum Press, 1986.

Lower, S.L., *The Development of Visual Interface Enhancements for Player Input to the JTLS Wargame*, M.S. Thesis, Naval Postgraduate School, Monterey, California, March, 1987.

Naval Ocean Systems Center, *Interim Battle Group Tactical Trainer, Executive Summary*, 1983.

Naval Ocean Systems Center, *Interim Battle Group Tactical Trainer, Student User's Guide*, January 1983.

Newell, A.F., *Speech—the Natural Modality for Man-Machine Interaction?*, Human-Computer Interaction—INTERACT '84/B. Shackel (ed.), Elsevier Science Publishers B.V. (North-Holland), 1985.

Perla, P.B., *An Introduction to Wargaming and Its Uses*, Center for Naval Analyses, October, 1985.

Schneiderman, B., *Designing the User Interface*, Addison Wesley, 1986.

Shu, N.C., *Visual Programming Languages: A Perspective and a Dimensional Analysis*, in *Visual Languages* edited by Chang, Ichikawa, and Ligomenides (Eds.), Plenum Press, 1986.

Simpson, H., *Programming the Macintosh User Interface*, McGraw-Hill, 1986.

Sweeney, M.J., Bitar, K.J., *An Analysis of Friendly Input Devices for the Control of the Naval Warfare Interactive Simulation System (NWISS)*, M.S. Thesis, Naval Postgraduate School, Monterey, California, March 1986.

Tesler, L., "The Legacy of the Lisa," *Macworld*, September 1985.

Visick, D., Johnson, P., and Long, J., *The Use of Simple Speech Recognisers in Industrial Applications*, Human-Computer Interaction—INTERACT '84/B. Shackel (ed.), Elsevier Science Publishers B.V. (North-Holland), 1985.

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