THAAD User Interface Design

Relying on Adherence to Standards, Soldier Involvement

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Developing a user interface for any system presents challenges; most notably, an interface must be usable by soldiers across a broad spectrum of experience levels and performance differences. These challenges can be addressed by adhering to the Department of Defense (DoD)-mandated Human-Computer Interface(HCI) standards and involving the user frequently during the interface design process.

The Operator System Interface (OSI) Integrated Product Team (IPT) is one of several IPTs on the Theater High Altitude Area Defense (THAAD) Project. This team has been developing a User Interface that maximizes functional capability while ensuring soldier performance and accuracy by using a tried and true screen design process. Although much work remains to be done, the process is sound and results to date have been extraordinary. A key aspect of the THAAD process is the involvement of soldiers in the design. This article provides a brief overview as well as benefits to the THAAD program from using this process.

THAAD Background

On June 23, 2000, Dr. Jacques Gansler, former Under Secretary of Defense for Acquisition, Technology and Logistics, formally approved THAAD's entry into the Engineering, Manufacturing, and Development (EMD) phase. The THAAD mission is to protect multiple, widely dispersed assets from short-to-medium-range Tactical Ballistic Missiles. The THAAD system consists of five segments: Battle Management Command, Control and Communications (BM/C3I); Launcher; Radar; Missile Round; and Peculiar Support Equipment. The BM/C3I Segment acts as the integrator to coordinate the segments into a weapon system.

BM/C3I software development occurs within six functional areas: Operations Management, Battle Management, Communications Management, System Support, Embedded Training, and OSI. The OSI acts as the conduit between the command and control operator and the BM/C3I system.

User Interface Design Guidance

Scientifically validated guidance acts as the first input into the design process. This guidance comes in the form of performance and usability-based standards such as MIL-STD-1472, Institute of Electrical & Electronics Engineers Standards on Graphic User Interface Design, Open Software Foundation Motif Style Guides, and Apple/Microsoft standards.

Principal documents governing user interface design include:

- *Department of Defense Joint Technical Architecture* (April 2001)
- *Joint Technical Architecture – Army* (May, 2000)
- *Department of Defense Technical Architecture Framework for Information Management* (TAFIM), Volume 8, "DoD Human-Computer Interface (HCI) Style Guide" (June 1994)
- *Defense Information Infrastructure (DII) Common Operating Environment User Interface Specifications* (October 1999)

Active Duty Artillery soldiers participate in the February 2001 User Screen Design Experiment to validate design of the BM/C3I software system, Fort Bliss, Texas.

Photos courtesy THAAD Program Office

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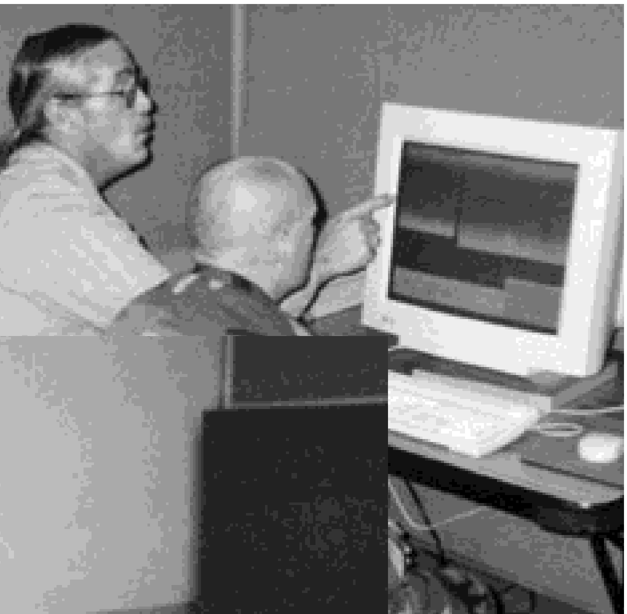
U.S. Army Weapon Systems Human-Computer Interface (WSHCI) Style Guide (December 1999).

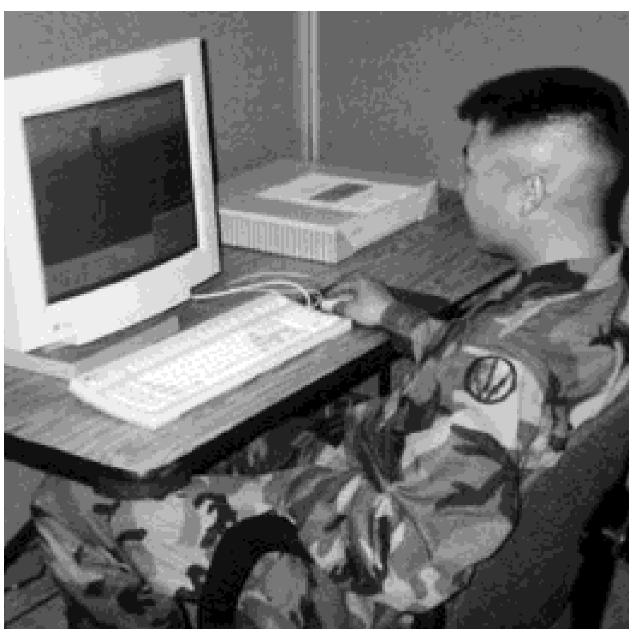
The *TAFIM* guides the lowest levels of interaction; it provides guidance for color usage, font sizes, and principles of organizing information within the user interface. The *DII User Interface Specification* provides guidance for ensuring consistent use of screen "widgets" such as push buttons, pulldown menus, and text fields. Finally, the *WSHCI Style Guide* provides guidance for developing the interface for real-time situations such as the battlefield. It includes recommendations on what types of information to display at all times or how to ensure the soldier has access to information at critical points in a battle.



Human-Centered Design

A unique aspect and possibly the most important input into the design process for BM/C3I OSI development has been the focus on human-centered design. Early involvement of the soldier in the development effort has proved to be a quick and effective way to incorporate direct feedback into the design. Figure 1 outlines the typical design process of new screens or modification of existing screens.

Step 1 involves identification of problem areas in the OSI by representatives from the THAAD Program Office, the soldiers, or the contractors. Problems may exist with prior screens, or there may be concerns about how a particular future function will be displayed to the user. Issues can often be resolved without experimentation by incorporating human factors design, previous experimental results, and screen templates. If issues cannot be resolved or more than one solution is offered, then screen experimentation is necessary.



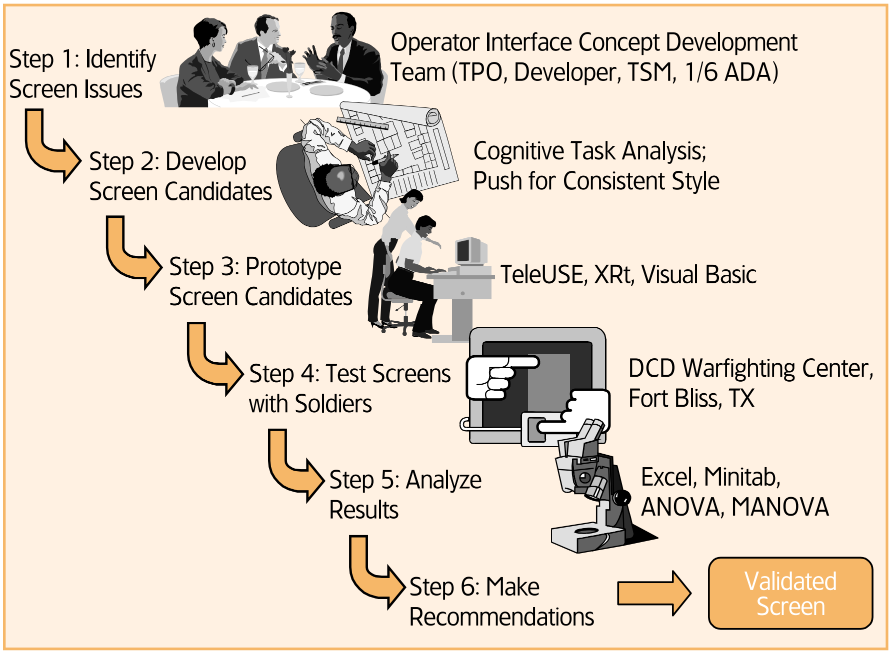
Step 2 involves design of candidate screens to resolve the screen issues identified in Step 1. First, the designer should conduct a task analysis of the screen. Identifying the purpose of the human interacting with the particular screen or set of screens is important to the task analysis effort. Cognitive task analysis tools such as Goals, Operators, Methods, and Selection Rules are useful for breaking the overall purpose of each task into sub-tasks and screen interaction methods that can support those subtasks. Once the tasks and sub-tasks are defined, screen interaction methods are proposed. Designs are constrained, however, to keeping candidate screens consistent with the rest of interface. Simply designing each window with good human factors' input without designing for consistency will defeat the benefit intended by the human factors' design.

Step 3 involves the development of the candidate screen prototypes proposed in Step 2 (Figure 2). Rapid prototyping tools aid in quick development of functional prototypes for experimental testing. Many times, a baseline screen already exists. This screen serves as the baseline for testing along with one or two alternative screens.

Step 4 involves the experimental testing of the screens prototyped in Step 3. Experimental testing is superior to feedback-based assessments in that the performance of the operator is used as a factor in making decisions about the best real-time interface rather than relying strictly upon preferences and opinions of the operators. Usually, a full factorial experimental methodology is used for experimental purposes, i.e., all the soldiers being tested perform all the tasks on all the screens to be tested.

In some circumstances, depending upon the time it takes to test or the amount of preparation required to switch between test requirements (e.g., Mission Oriented

FIGURE 1. **Human-Centered Screen Design Process**



Protective Posture [MOPP] 0 vs. MOPP 4), soldiers will test using blocked procedures, i.e., half the soldiers test using alternative 1, then alternative 2; and the other half test using alternative 2, then alternative 1. Typically, 16-20 soldiers are required to collect sufficient data for statistical power purposes (i.e., ensuring that collected data are representative of the larger THAAD user population). Data are typically collected over a two-day period (8-10 soldiers per day).

Step 5 involves analysis of the time and accuracy data collected during the experimental testing. Data are reduced to soldier number, performance time (in seconds) for each particular trial, and number of errors committed during that trial.

Step 6 involves making recommendations based on the results of statistical analysis. The following situations can occur:

- If an alternative prototype screen has been statistically proven (95 percent confidence) to be superior to the baseline screen, then a recommendation will be made to replace the baseline screen with the alternative prototype.
- If the baseline screen has been statistically proven to be superior to the alternative prototype(s), then a recommendation will be made to keep the baseline screen.
- If no prototype has been statistically proven superior when compared to the other prototypes, then a recommendation will be made to keep the baseline screen. If this occurs, however, it may prove valuable not only to incorporate the best features of the alternative prototypes into improving the baseline, but also to incorporate any valid suggestions from the soldiers.

Benefits of the Process

THAAD has capitalized on human-centered design, particularly by incorporating experimental testing, resulting in several benefits. First, human-centered design is an effective method for incorporating the soldier voice (qualitative and quantitative) in the screen design

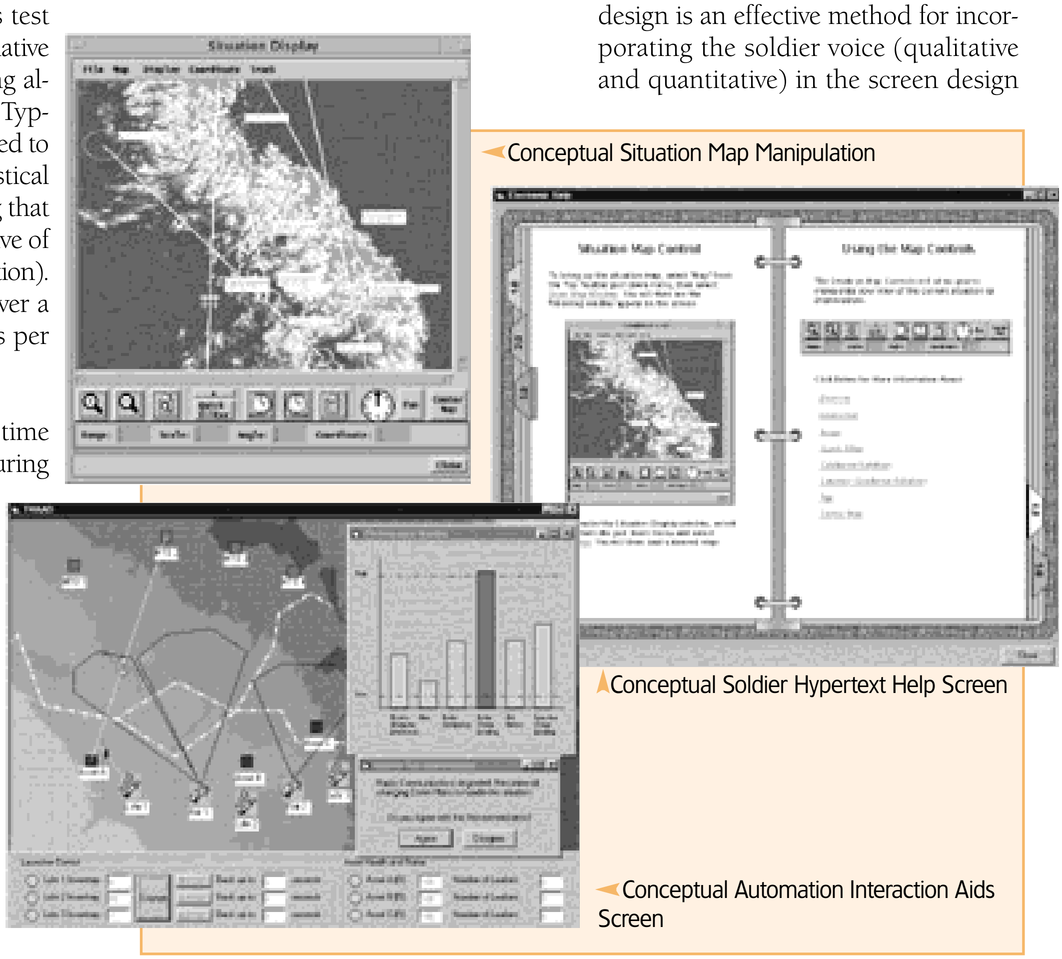


FIGURE 2. **Screen Captures Typical of the BM/C3I Software**

process. Second, it reduces the need for expensive design changes due to poor usability of the product by taking the human user into account in a timely manner during the design cycle. Third, it removes guesswork in defining the best screen for a particular real-time function by analyzing the soldier's performance in terms of decision time, action time, and accuracy for candidate screens. Finally, it increases the probability that THAAD soldiers will positively accept THAAD interface because their concerns, desires, and preferences are being taken into consideration from Day 1 of development. In particular, the usability testing that takes place in Step 4 has proven to be a valuable input into the BM/C3I design. Some results of this testing follow:

- Usability testing with THAAD soldiers allowed the number of separate windows in the Demonstration/Validation phase of the OSI to be reduced 75 percent for the EMD phase by incorporating tabs in screens. The soldiers' interaction performance was increased significantly, and they reported being more able to follow through a complex battle planning and evaluation process by using this interaction method.
- Usability testing with THAAD soldiers uncovered methods for effectively allowing them to monitor automated processes and make decisions regarding the nominal behavior of the THAAD system.
- Usability testing with THAAD soldiers showed that the complex process of battle plan decision making could be more easily performed by allowing the soldier to use plan filters and situational map interaction.

Getting It Right the First Time

Designing a user interface for any system remains a challenge. Adhering to published guidelines while involving the user early and often in development greatly increases the chances of getting it right the first time. The current THAAD screen design process is a way to maximize functional capability while ensuring soldier performance and accuracy.

Editor's Note: Wiley welcomes questions or comments on this article. Contact him at *wileyd@thaad.army.mil*.

From the Defense Procurement Director

Deidre Lee

Contractor Personnel in the Procurement of Information Technology Services

The Department of Defense, General Services Administration, and National Aeronautics and Space Administration have agreed to an interim rule amending the Federal Acquisition Regulation (FAR) to implement Section 813 of the Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001 (Pub. L. 106-398). The Act requires that the FAR be revised to address the use, in the procurement of information technology services, of requirements regarding the experience and education of contractor personnel.

This interim rule adds FAR 39.104 to prohibit the use of minimum experience or education requirements for contractor personnel in solicitations for the acquisition of information technology services, unless –

1. The contracting officer first determines that the needs of the agency cannot be met without such requirement; or
2. The needs of the agency require the use of a type of contract other than a performance-based contract.

Preference for Performance-Based Service Contracting

An interim change to the FAR explicitly states that performance-based contracting is the preferred method for acquiring services. This change is one of a series of acquisition reform measures for adopting the best commercial practices to achieve greater savings and efficiencies. The Department of Defense is increasingly relying on the acquisition of services to meet its mission needs. As this trend is expected to continue, DoD needs to ensure that services are acquired with the most efficient practices and processes, and performance-based contracting fulfills this need.

Performance-based contracting is a method for acquiring services by defining a requirement in terms of performance objectives and placing the responsibility for how it is accomplished on the contractor. Section 821(a) of the Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001 required the government to establish the following order of precedence when acquiring services:

- A firm-fixed-price performance-based contract or task order.
- A performance-based contract or task order that is not firm-fixed price.
- A contract or task order that is not performance-based.

Editor's Note: The changes outlined in this notice are posted to the General Services Administration Web site at *http://www.arnet.gov/far/*.