Decision Support Displays for Military Command Centers

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ABSTRACT

This paper summarizes work on interface design requirements for decision support tools and for command centers at the Commander, Joint Task Force (CJTF) level. These tools include a "knowledge wall" for decision-makers and multi-modal workstations for the liaison officers who maintain the summary situation displays for each functional area, enabling a new concept of operations based on enhanced situation awareness throughout the command team.

INTRODUCTION

For over 10 years, SSC San Diego, with sponsorship from the Office of Naval Research (ONR), has been striving to develop improved displays based on decision support technology for military decision-making. At the center of this effort has been the Tactical Decision-Making Under Stress (TADMUS) project and its successors. The TADMUS project was spawned by the 1988 USS *Vincennes* (CG 49) incident, in which an Aegis cruiser, engaged in a littoral peacekeeping mission, shot down an Iranian Airbus after mistaking it to be a tactical threat. Investigations following the incident suggested that stress may have affected decision-making and that the effects of stress were not well understood. The TADMUS project was established to address these concerns and to develop improved decision support tools for use by command decision-makers.

TADMUS developed a series of prototype decision support tools that came to be embodied as the integrated Decision Support System (DSS), (Figure 1). The DSS research showed that when tactical decision-makers had the prototype DSS available, significantly fewer communications were needed to clarify the tactical situation, significantly more critical contacts were identified earlier, and a significantly greater number of defensive actions were taken against imminent threats. Furthermore, false alarms were reduced by 44%, and correct detection of threat tracks

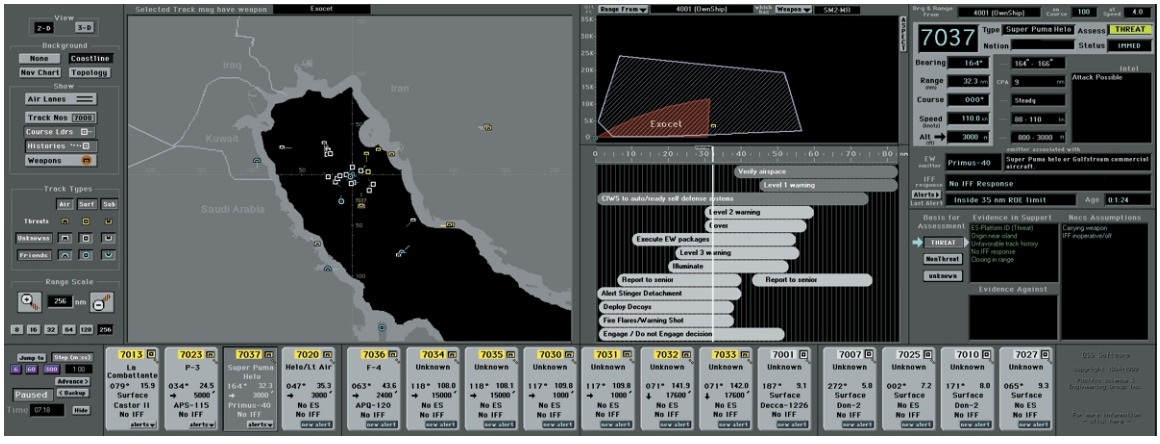

FIGURE 1. The TADMUS Decision Support System.

increased by 22%. These findings suggest that the prototype DSS enhanced the commanders' awareness of the tactical situation, which in turn contributed to greater confidence, lower workload, reduced errors in adherence to rules of engagement, and more effective performance.

The Chief of Naval Operation's Strategic Studies Group XVI report "Command 21—Speed of Command" recognized the significance of the TADMUS work and stated that its results were more broadly applicable. The Group concluded that

- Fleet decision-makers are faced with too much data and not enough information.
- Fleet information systems are often not designed to support the decision-makers.
- Reduced manning requirements and complex mission requirements will further exacerbate the problem.

One of the key recommendations to come out of the Command 21 report was that decision support technology developed in the TADMUS project should be extended from single ship combatants to higher echelons of command. The Command 21—Decision Support for Operational Command Centers (Command 21) project is addressing this recommendation by conducting research into the unique requirements of decision-making within military operational command centers.

The initial Command 21 work with Second and Third Fleet command ships has suggested that (1) collaboration is problematic in these command centers, and (2) commercial off-the-shelf (COTS) collaboration tools often are not as useful as might be expected. Military decision-makers were found to engage in "asynchronous collaboration," where each was working on different parts of a common problem in their own space and their own time, and as a result, each having their own decision cycle. This situation is different from traditional "synchronous" collaboration, such as the "brainstorming" or group problem solving found in the business world. Staff-wide synchronization is largely achieved when briefings are given to the assembled staff at watch-turnover. A central premise for Command 21 is that "Speed of Command" can only be achieved when it is not necessary to stop and brief command decision-makers so that they can be fully informed as a basis for deciding what actions to take. The Command 21 project has developed a concept of operations for sharing information that incorporates unique, Web-enabled collaboration "push" tools to provide all decision-makers ready access to the best available data at all times.

One Command 21 tool is the "knowledge wall," shown in Figure 2. The wall features a series of windows incorporating decision support tools tailored to the Commander Joint Task Force (CJTF), as well as windows with "summary status" information being "pushed" from the anchor desks used by liaison officers (LNOs) representing the various

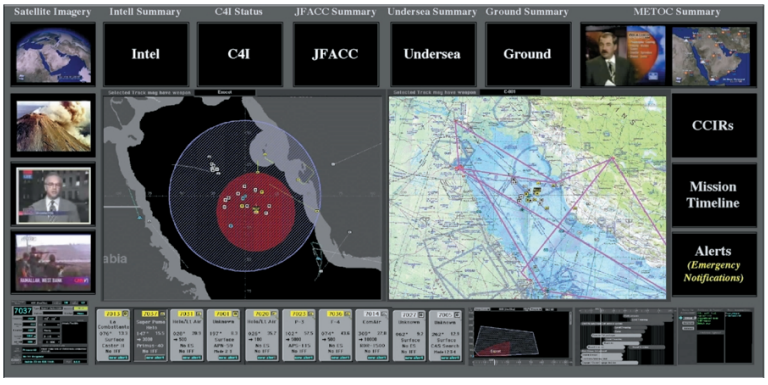

FIGURE 2. Command 21 knowledge-wall vision.

CJTF departments. The battle watch captain in charge of the command center can choose which aspects of the situation to focus on by moving relevant content to the center of the wall and drilling down into deeper levels or related information.

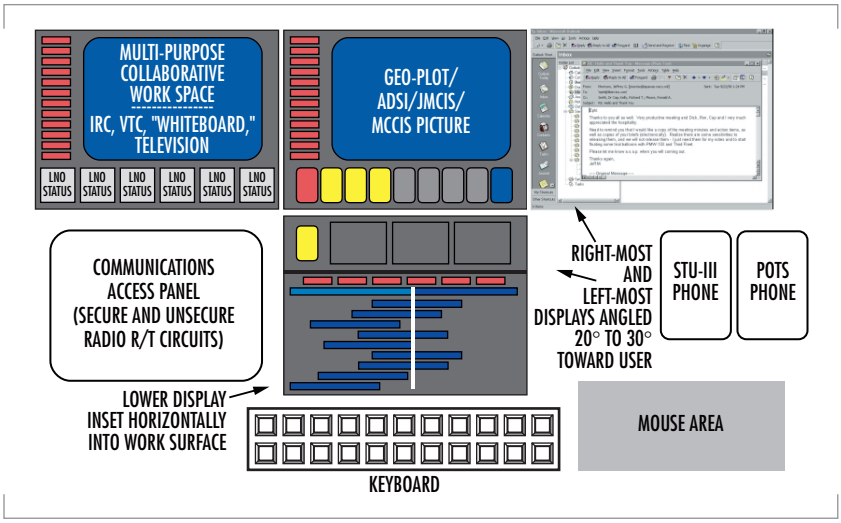

FIGURE 3. Knowledge-desk concept.

A watchstation being developed for the DD 21 (21st Century Destroyer) as part of the ONR Manning Affordability Advanced Technology Demonstration could be adapted as a "knowledge desk" to allow LNO collaboration. The knowledge desk uses software tools (COTS and information-push Web applications) together with computer display hardware to enable the operator to create and publish value-added information to the Web. Figure 3 shows a conceptual version of the knowledge-desk operator console. It consists of an integrated "desktop" spread across four different display surfaces. The top-right display is dedicated to routine office tasks such as preparing briefs, processing e-mail, writing memos, etc. The top-center display is dedicated to providing the tactical situation "big picture" tailored to the user's decision-making needs. The bottom-center display is a dedicated place for monitoring the execution of an operational plan. The top-left display is a tool explicitly designed to facilitate sharing information. The concept uses templates to "push" information from the operator to a Web site viewable by the rest of the command staff. The information "pushed" consists of worksheets, forms, and prompts to others on the command staff that would facilitate their understanding information relevant to their decision-making tasks. The software tools cause the information pushed to be formatted in a manner that others would recognize and understand, and published to a shared database in the Web environment.

The development of the knowledge wall was greatly accelerated through its use as part of the Global 2000 wargame. The objective of this game was to explore how the elimination of "stove pipe" command and control systems (i.e., "network-centric warfare") might change the way we perform military missions. The wall was designed using COTS hardware and software capabilities that exist today so as to minimize development costs, and therefore differs from the original Command 21 knowledge-wall vision. Figure 4 shows the knowledge wall as installed in the Joint Command Center at the Naval War College.

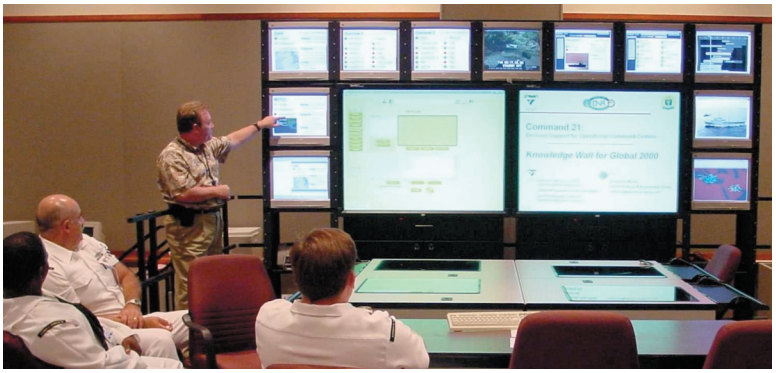

FIGURE 4. Global 2000 wargame knowledge wall.

The knowledge-wall hardware consists of a dual-processor Information Technology for the 21st Century (IT-21)-compliant workstation using three 4-port Appian Jeronimo Pro COTS video boards. The knowledge-wall display is made up of ten 21-inch CRTs and two SmartBoard rear-projection large-screen displays with internal liquid-crystal display (LCD) projectors. The displays operate as a single, integrated digital desktop, where each physical display has a resolution of 1024 by 768 pixels. This creates a digital desktop of 6144 by 1536 pixels. An additional CRT is dedicated to video and video teleconferencing requirements.

The peripheral displays are intended to provide summary information for each of 14 functional areas of the CJTF command identified through knowledge engineering with the staffs of the U.S. Navy Third Fleet, Carrier Group One, and Carrier Group Three. Each summary display is formatted consistently by using a template-authoring tool that facilitates the creation of, and linking to, a variety of Web content without the operator responsible for producing content having to know hypertext mark-up language (HTML). Additional authoring tools were provided to facilitate the creation and publishing of map-based tactical data. All pages are implemented as HTML pages on a common server, with numerous links to more detailed pages for supplemental information.

Figure 5 shows how the information might look in a representative summary display. The title line indicates the functional area described by the display. The "stop lights" in the top-left quadrant are intended to be viewable from 15 to 20 feet away, and indicate the status of activities in various time frames. Light colors indicate the severity of the alerts in terms of their deviation from the plan. The bottom-left quadrant provides space for a summary graphic or multimedia object. The right side of the screen provides space for amplifying links/headlines. The "Alerts" section describes specific problems within this domain/functional area that might be of interest to others. The "Impacts" links describe the impacts of alerts in terms of effects on other functional areas. The "Links" area allows access to reference and supplemental material. Any text or graphic in the page may be linked to a more detailed Web page.

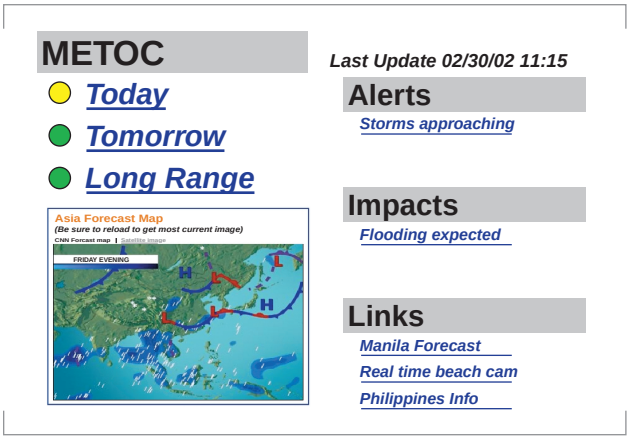

FIGURE 5. Representative summary display.

The Global 2000 wargame substantially validated the case for the use of Web-enabled decision support and collaboration tools as a means to "Speed of Command" and network-centric warfare. At the start of the game, it was argued that speed of command meant not having to stop to have a situation briefing to figure out what was known across the staff. By using the knowledge wall and a number of information technology collaboration tools, not one staff briefing was required through 8 days of game play. The wall was used extensively, with 30 to 70 unique summary pages being accessed each hour.

Both the TADMUS and Command 21 projects have empirically demonstrated how the application of decision support technology and effective human factors can improve military decision-making by turning data into meaningful information presented where, when, and the way it is

needed. The Global 2000 wargame showed how network-centric warfare, in combination with decision support and a Web-enabled command and control architecture can move tomorrow's military to "knowledge-centric warfare."

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Current Research: Decision support technology; knowledge engineering/management; collaboration.