

# Designing and Implementing Technologies to Facilitate the Sharing of Knowledge in a Web-Centric Environment

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## Abstract

The Navy's *Command 21* project, currently being conducted at SPAWAR Systems Center, San Diego, is directed at supporting the needs of senior decision makers and support staff in military command centers. As part of that effort, the concept of using Web-based technologies to share operationally relevant information and knowledge has become a focus. This concept – referred to as a *Knowledge Web* – is intended to facilitate group interaction and augment the decision-making capabilities of senior staff. To support the concept of a Knowledge Web, available data and information must be processed, formatted, and stored in such a way that it represents *meaningful knowledge* to the consumer. Further, since different users may have different levels of experience or training – and almost certainly have different information requirements – the Knowledge Web must be both extremely easy to use, and be flexible enough to adapt to varying needs. A number of prototype tools have been developed to facilitate the formatting, dissemination, and Web-based presentation of information so that it is easily shared and understood. How these tools were designed, developed, and used to support the concept of a Knowledge Web will be discussed. Several of the tools will be demonstrated to highlight their capabilities.

## Introduction to the Knowledge Web Concept

Vast amounts of data and information can easily be exchanged in today's high-tech, digital world, but sharing *knowledge* – the familiarity, awareness, or full understanding of a fact that can only be gained through experience or study – is not so easily accomplished. Command-level decision-making requires that the decision maker understand all aspects of a problem and be fully aware of the implications of every decision made. How can data and information be presented in such a way that it facilitates true understanding of a problem? What tools are required to help command-level support staff share their information and knowledge with each other and their commander? The Space and Naval Warfare System Center, San Diego (SSC-SD) is currently working to address these questions with the *Command 21* project, an ONR-sponsored effort directed at supporting the needs of senior decision makers and their support staff in military command centers.

A primary focus of the Command 21 effort is the development of a concept referred to as a *Knowledge Web*. The Knowledge Web concept takes advantage of Web-based technologies to share operationally relevant information and knowledge. In a Knowledge Web, available data and information is processed, formatted, and stored in such a way that it represents *meaningful knowledge* to the consumer. A number of prototype tools have been developed to facilitate the formatting, dissemination, and Web-based presentation of information so that it is easily shared and understood. This paper will discuss how these tools were designed, developed, and used to support the concept of a Knowledge Web.

### **User Requirements as a Start Point**

As part of the Command 21 project, a cognitive task analysis (CTA) was conducted to determine the specific tools and features that military command center personnel require (Smallman, Oonk & Moore, 2000). The findings of this CTA were supported and augmented by the results of several recent studies and analyses conducted in team- and command-level decision-making environments (Bolstad & Endsley, 1999; Klein, Schmitt, McCloskey, Heaton, Klinger, & Wolf,., 1996; Miller & Klein, 1998; Moore & Averett, 1999; Proctor, St. John, Callan & Holste, 1998). These analyses revealed a consistent general requirement for tools to support improved situation awareness / assessment, dynamic synchronous and asynchronous collaboration, and adaptive, real-time resource and action management and planning support. Further, a core set of information requirements was identified to support command-level decision-making. These information requirements include:

- Tactical data (preferably multiple views)
  - When possible, presented in map-based and highly graphical views / context
- Mission Summaries and Commander's Intent
  - To provide necessary context and set "boundaries" for the mission
- Real-time information (or close to it)
- Alerts / Advisories / Recommendations
  - Specifically, presented in terms of:
    - What isn't working according to plan?
    - What do we do to fix it?
- Impacts & Indications
  - Presented as in "X" happened; how does it affect everything else?
- Plans (and alternate Courses Of Action)
  - Tools to support Response & Timeline Management
- Effects Summaries
- Asset / Resource Management
- Collaboration Tools

These identified requirements were used as a starting point in the development of information and knowledge development tools.

### **Designing and Implementing Prototype Knowledge Web Tools**

Each of the tools that make up the Command 21 Knowledge Web Tool Suite is described here. In each case, the tool was developed using an iterative design process. First, the core information requirements identified above were considered. Next, basic design requirements were developed and imposed, and human-computer interface designers developed primitive storyboard concepts. Representative subject matter experts and selected fleet representatives then reviewed these storyboards to determine how well they met identified needs. As necessary, storyboards were reworked and reevaluated. Once a storyboard concept met with basic approval with regard to function and features, it was turned over to rapid prototypers for development.

#### ***Basic Design and Implementation Requirements***

Three basic design and implementation requirements were settled on to facilitate the development and use of the Knowledge Web tool suite.

Products must feature basic HTML / Web-based format. Computer and Web technologies are becoming commonplace features of the warfighter environment. To take advantage of these tools and the IT-21 computer / Internet / Web infrastructure already in place, the Command 21 Project settled upon basic HTML as the format for the knowledge-based products that populate the Knowledge Web. To reduce potential Internet security concerns and facilitate widespread compatibility across operating systems and software versions, advanced Web technologies such as Dynamic HTML (DHTML), Active Server Pages (ASP), JavaScript, and ActiveX are not to be used.

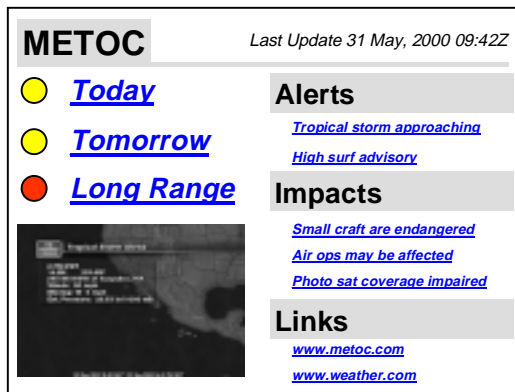
This HTML approach allows the information to be created / produced / disseminated using widely accepted standards and accessed using widely used Internet browsers. Furthermore, because the standard point-and-click Web interface associated with basic HTML-formatted content is becoming almost universally understood, this dramatically reduces the amount of training necessary to understand and operate the interface.

Tools must provide a simple, easy-to-use interface. The tools used to create and view content within the Knowledge Web must feature an easy-to-learn, and easy-to-use interface that facilitates rapid production, dissemination, and access of information- and knowledge-based products. Therefore, point-and-click and drag-and-drop functionality is used wherever possible, and unnecessary features and functions are suppressed or removed.

Information- / Knowledge-based products must be easily readable. Many of the information- and knowledge-based products developed using the Knowledge Web tool suite will be viewed under less than optimum circumstances, e.g., from a distance, in

poor lighting conditions, or on small or poor quality displays. Therefore, the text and images represented on these products must be easily viewable and understandable. To accommodate this requirement, text shall be presented using high-contrast colors (dark text on white background) using large, easily readable fonts whenever possible.

The picture below represents a conceptual storyboard of an information product that meets all of the basic design requirements, i.e., HTML format, point-and-click interface, and large, high-contrast text.

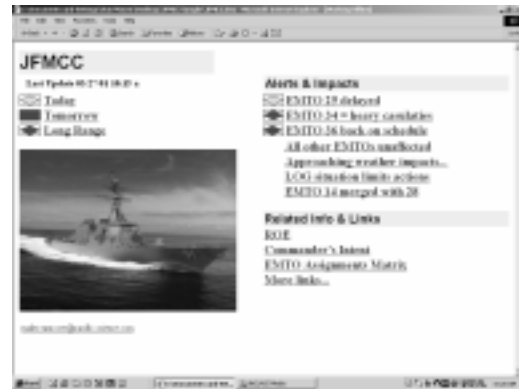


### ***Summary Maker Tool (also referred to as SumMaker)***

One of the general requirements called out in the CTAs was the need for tools to support improved situation awareness (SA). One way to improve SA among decision makers is to make mission-relevant information easily and rapidly available, and provide it in the appropriate context. Summary Maker (SumMaker) (Moore & Averett, 2000) is designed as a basic web page creation tool to facilitate the rapid production and dissemination of standardized summary information for inclusion in a Knowledge Web. The published product of Summary Maker – a basic HTML Summary Page – is used by Information Consumers to acquire and maintain SA.

Information Producers need not know anything about publishing HTML to create Web content using Summary Maker. A flexible template approach is used whereby Information Producers create summaries of mission- or situation-relevant information. These summaries serve two important purposes. First, once published they convey concise, key information and knowledge to the Information Consumer; second, they serve as hyperlinks to more detailed information available within the Knowledge Web. Most of the fields in the template support drag-and-drop editing. Once published, the HTML-based summaries are made available on the Web using standard Web-hosting software. Because of Summary Maker's inherent flexibility to display or link to virtually any kind of information product, Summary Maker affords the user the ability to provide information associated with each of the core information requirements identified previously.

The picture on the left represents the template view of the Summary Maker tool (version 2.1.1) prior to publishing a product; the picture on the right represents the published, HTML product of Summary Maker.



### ***Knowledge Wall Tool (also referred to as Knowledge Web Viewer)***

Core information requirements identified by the CTAs and related studies included access to multiple views of tactical data, mission summaries, alerts / advisories / recommendations, Plans and COAs, asset / resource management, and collaboration tools. The Knowledge Wall tool (Knowledge Web Viewer) is a designed as a multi-screen web browser and multi-window controller that facilitates the navigation and display of information and knowledge residing in a Knowledge Web. It also affords display of non-Web content.

The Knowledge Web Viewer (Moore & Averett, 2000) features a simplified set of Web browsing controls that allow easy and rapid access to Knowledge Web content. The software can be run on single-display computer systems but is optimized for multi-display use.

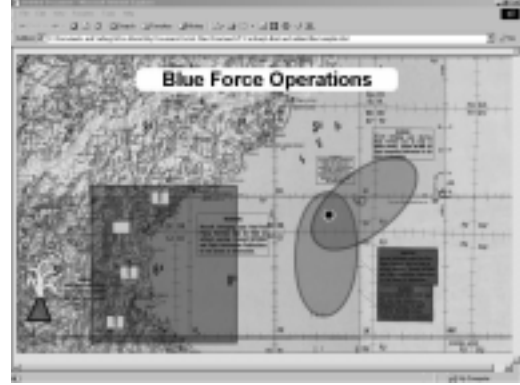
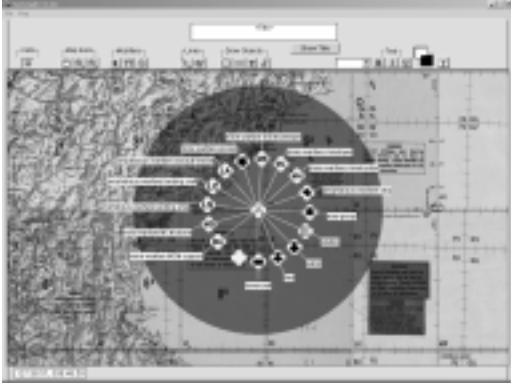
Knowledge Wall software is currently in use on very large, wall-sized displays at several locations, as well as smaller, desk-sized units. The picture below represents a prototype single-user "Knowledge Desk" running version 2.1.1 of the Knowledge Wall software.



### ***TacGraph Tool***

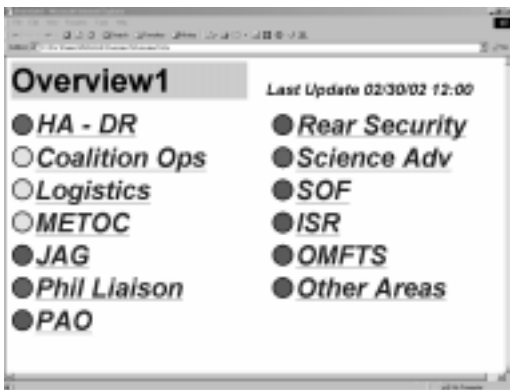
Map-based, highly graphical views of tactical data was one of the highest priority information requirements identified in the CTA conducted to establish user requirements. Other kinds of data are also often desired in graphical and map-referenced form. TacGraph is designed to address this need.

TacGraph (Bank & Moore, 2000) is designed as an easy-to-use graphical drawing tool customized for use by military personnel. It features Military Standard 2525B symbology (Military Standard 2525B, 1996). TacGraph is used to rapidly develop summarized tactically-relevant images and Web content. TacGraph features imbedded NIMA map data and a number of specialized drawing tools, and produces web-standard HTML and graphics files. Images and text within these files can be made interactive and linked to other Web content using Summary Maker. The picture on the left shows TacGraph's spoke-style symbol selection menu. This menu allows users unfamiliar with the 2525B symbol set to rapidly select from among thousands of possible symbol choices. The picture on the right shows a finished TacGraph product as viewed using Microsoft Internet Explorer. Each of the symbols on the map is an interactive link to information available in the Knowledge Web.



### Evolving the Tool Designs and Functionality

Based on the results of an in-depth usage, utility, and usability analysis conducted at the Global 2000 war game (Oonk, Smallman & Moore, 2001) and continuing feedback from fleet users and advocates, several minor evolutionary changes have been made to the Knowledge Wall tools. For example, one of the key features of earlier versions of the Knowledge Wall software was an overview page that allowed users to monitor the status of multiple information sources. Limitations in this early design led to a number of changes such as change awareness cues, enhanced status indicators, and improved user control of where and how information is placed on the various displays. The picture on the left represents the early overview design; the picture on the right indicates the redesigned page (circa April 2001).



### Summary

Using existing Web technologies and designing and developing customized tools to aid the user, the ONR sponsored Command 21 Project has made significant improvements in the development, management, dissemination, use, and *understanding* of mission-relevant information by command-level decision makers. SPAWAR Systems Center,

San Diego, has led project efforts to support the needs of senior decision makers and their support staff, and the Command 21 Knowledge Web concept represents an evolutionary step towards helping users turn raw data into meaningful information and knowledge – and sharing that knowledge with others.

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