

**The Design, Implementation and Use of Web-Technologies  
to Facilitate Knowledge Sharing:  
A 'Real-World' Application**

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## **Abstract**

Space and Naval Warfare Systems Center, San Diego’s (SSC-SD) Command 21 project, sponsored by ONR, is addressing how information technology can be designed to best facilitate information production, consumption, and management. For the past several years, the focus of the Command 21 effort has been the development of Knowledge Web (K-Web), which utilizes Web technologies to share operationally relevant information. In K-Web, data is processed and stored by ‘producers’ in a way that represents meaningful knowledge to ‘consumers’. Use and utility of K-Web at the Global 2000 war game, were reported at last year’s CCRTS. K-Web was implemented on USS Carl Vinson in May 2001, for use during deployment. Upon the ship’s return, interviews of users were conducted, focusing on use and utility of K-Web tools, products, business rules and training materials. The interview data indicate K-Web as invaluable for asynchronous, distributed dissemination of operational information. Additionally, automatically collected data were analyzed for patterns of use. Quantitative and qualitative data enabled assessment of how the current K-Web concept and technologies support users’ requirements within operational environments. These analyses were also compared to analyses from the war game environment.

## **Introduction**

As technology increases the speed and ease of information exchange, the problems associated with information production, consumption, and management also increase. Effective command-level decision-making requires a high level of situation awareness (SA) (Endsley, 1995). To support improved SA, information must be made available in a format that is meaningful and useful for application to real-world problems; in other words, information must be transformed into knowledge. Space and Naval Warfare Systems Center, San Diego’s (SSC-SD) Command 21 project, sponsored by ONR, is addressing how information technology can be designed to best facilitate information production, consumption, and management in support of the needs of senior decision makers and their staff in military command centers.

For the past several years, the focus of the Command 21 effort has been the development of a concept referred to as Knowledge Web (K-Web). The K-Web concept utilizes Web-based technologies to share operationally relevant information. In K-Web, available data is processed, formatted, and stored by ‘information producers’ in a way that represents meaningful knowledge to the ‘information consumers’. A number of tools have been developed to facilitate the formatting, dissemination and Web-based presentation of information that is easily shared and understood. The tools and products were designed to meet 14 user requirements determined through a cognitive task analysis (Smallman, Oonk & Moore, 2001). The initial design and implementation of these tools was in an operational exercise environment at the Global 2000 war game. Analyses of the usage and utility of the K-Web in this environment were reported at last year’s CCRTS (Moore & Averett, 2001; Oonk, Smallman and Moore, 2001). Several changes were made to the K-Web tools and products based on those analyses and follow-up laboratory experiments (Oonk, Smallman, Obermayer, Pester-Dewan & Rogers, 2001)

The first operational implementation of the K-Web occurred following the Global 2000 war game onboard the USS Carl Vinson in May 2001, for use during their WESTPAC deployment (see Table 1). COMCARGRU THREE (CCG3) and DESRON9 were embarked aboard the USS Carl Vinson and used K-Web during the deployment. The USS Carl Vinson Battle Group arrived in the North Arabian Gulf on September 11, 2001. Subsequently, CCG3 became the Composite Warfare Commander (CWC) for military activities supporting Operation Enduring Freedom. CCG3 and his staff used a functional area based concept of operations for Command and Control, which was supported by K-Web. This combination of organizational structure and information technology made CCG3 uniquely qualified to take on the CWC role. Having K-Web aboard allowed the Battle Group to innovate and explore the implications of Web-enabled Speed of Command.

May 2001	K-Web / K-Desk installation onboard USS Carl Vinson
Jul 2001	USS Carl Vinson / CCG3 deploys
Sep 2001	Terrorist attack on World Trade Center / Operation Enduring Freedom begins
Jan 2002	USS Carl Vinson / CCG3 returns from deployment
March 2002	Automated Data Retrieved / Observational Data Collected

Table 1. Timeline of K-Web on USS Carl Vinson WESTPAC deployment.

Following the ship’s deployment, interviews of K-Web users were conducted (March, 2002). The focus of these interviews was the use and utility of the K-Web tools, products, business rules and training materials. In addition, data collected automatically by the K-Web software were analyzed in order to determine patterns of use over the course of the deployment. Quantitative and qualitative data analyses enabled the assessment of how current K-Web concept and technologies support users’ requirements within critical operational environments.

## **Implementation of K-Web on the USS Carl Vinson**

The following information is intended to provide a brief overview of the K-Web concept and tools, as they were implemented aboard the USS Carl Vinson, as well as at the Global 2001 war game.<sup>1</sup>

In K-Web, multiple, distributed “information producers” create Web pages, by inputting available information, tactical pictures and other resources into a standardized Web page template called SumMaker (Figure 1). SumMaker products are referred to as “Summary Pages” (Figure 1). Each functional area within a command produces a Summary Page that contains operationally relevant information pertaining to their area. These Summary Pages are all linked through a common “Overview Page” (Figure 1), which serves as both an integrated status tool for quick-look SA and as a navigational tool. The “information consumer” is then able to view the Overview Page and linked Summary Pages from either a single-monitor PC, a multiple-monitor PC (Knowledge Desk) or a large three-screen display (Knowledge Wall). Figure 2 represents the information flow within a K-Web. Table 2 shows which user requirement(s) each feature/tool was designed to meet.

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<sup>1</sup> For more detailed information on this topic see Moore & Averett (2001).

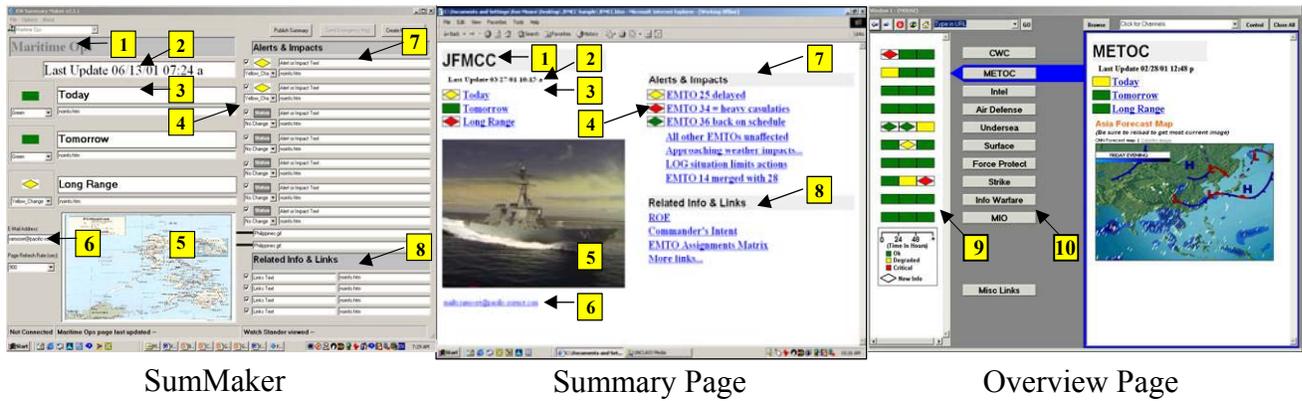


Figure 1. SumMaker (left) has a “drag-and-drop” and pull-down menu interface. “Producers” fill in fields with headlines then link to qualifying information. Summary Pages (center) are SumMaker products. Users drill down for information via links. Overview Page (right) gives integrated status information and serves as a navigation tool for accessing Summary Pages. See Table 2 re: numbers.

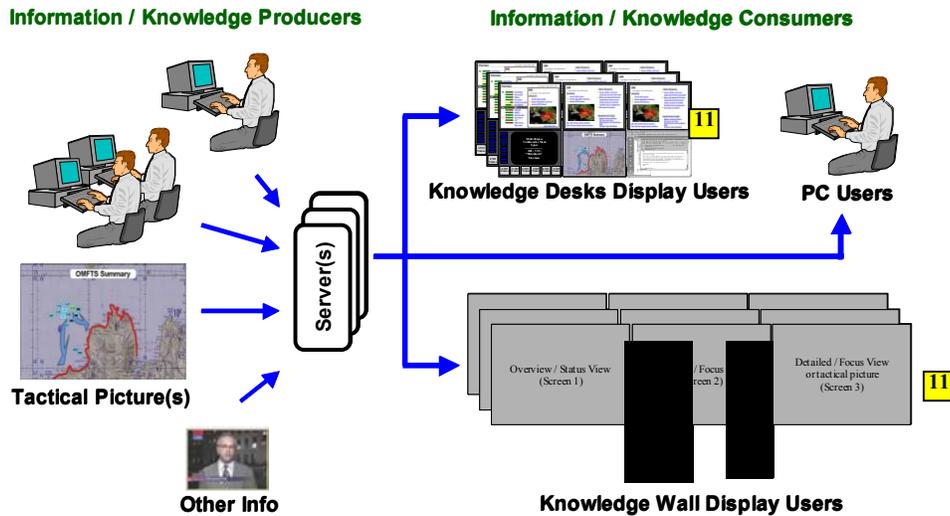


Figure 2. K-Web information flow. Information producers (left) create Web pages that are accessible to information consumers (right) from multiple display types. See Table 2 re: numbers

#	Feature	User Requirements	#	Feature	User Requirements
1	Functional Area Title	*Consistency *Situation awareness	7	Alerts and Impacts	*Consistency *Supplemental information *Cognitive support *Drill down
2	Date / Time Stamp	*Information age / reliability	8	Related Links	*Consistency *Supplemental information *Drill down
3	Status Titles	*Consistency	9	Status Bar	*Integrated Information *Quick-look SA
4	Diamonds / Colors	*Integrated information *Cognitive support	10	Summary Page Links	*Integrated Information
5	Graphic Area	*Intuitive graphical interface	11	K-Desk / K-Wall	*Shared SA *Integrated Information *Connectivity/Collaboration *Flexible Configuration
6	Producer Email	*Information age / reliability			

Table 2. K-Web features and tools were designed to meet specific user requirements.

## Method

Assessment of how the K-Web concept and technologies support users' requirements within critical operational environments is possible using both quantitative and qualitative data produced by the use of K-Web during Operation Enduring Freedom. These data were collected using multiple methods: automated, interview and survey. Two groups of users aboard the USS Carl Vinson were targeted, CCG3 and DESRON9. These two groups had both common and unique user requirements. For example, although each group used K-Web for information dissemination, the purpose of information sharing and the target audiences varied significantly across the two groups<sup>2</sup>. This fact facilitated the capture of different perspectives and use of K-Web.

K-Web software applications automatically captured and stored several types of quantitative data, resulting in a historical record of 1) publish rates; 2) use of specific software features; and 3) structure and content of top-layer Web pages. These data were collected from each of eight functional areas (FAs): Air Defense, C3, CWC, Force Protect, Maritime Ops, MetOc, ROE-JAG and Schedules<sup>3</sup> (henceforth referred to as FA1-FA8, though not respectively).

Upon returning from WESTPAC deployment, qualitative data were collected by interviewing 19 users on an individual basis (four users were interviewed in pairs). All users were both producers and consumers of K-Web content, representing seven functional areas: CWC, Intel, JAG, Logistics, Maritime Ops, MetOc and TLAM.<sup>4</sup> Interview questions focused on the use and utility of the K-Web tools, products, business rules and training materials. Additional qualitative data were collected via an anonymous on-line survey addressing these same topics, using both multiple choice and open-ended questions. The seven respondents represent two functional areas: Maritimes Ops and Air Defense (some survey respondents were also interview respondents).

The same versions of the K-Web products and tools had previously been evaluated with regard to use and utility during the Global 2001 war game (July, 2001). Results of automated and observational data collected from the Global 2001 war game provide additional perspectives and suggestions for the status and development of the K-Web concept and tools.

## Results and Discussion

*“Having multiple people who are not on watch and not at the same place, all having access to the same information is invaluable. It [K-Web] is a fantastic tool that didn't become clear until Operation Enduring Freedom broke out... This was an operator's dream,”*  
(Commodore, Maritime Operations, DESRON9).

### 1. K-Web use and access

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<sup>2</sup> CCG3 staff created information primarily for own use and for use by other large ships and commands with high bandwidth. DESRON9 staff typically created information products for use by smaller ships with lower bandwidth.

<sup>3</sup> Command, Control and Communications (C3); Composite Warfare Commander (CWC); Maritime Operations (Maritime Ops); Meteorology and Oceanography (MetOc); and, Rules of Engagement –Judge Advocate General (ROE-JAG).

<sup>4</sup> Intelligence (Intel) and Tomahawk Land Attack Missile (TLAM).

Although the intended audience of K-Web's content resided aboard USS Carl Vinson, others throughout the Battle Group, other commands and entities, such as the Pentagon, were accessing the USS Carl Vinson K-Web. The automated data show that during the time period of September 29, 2001, to December 29, 2001, K-Web was accessed by an average of 482 visitors per day (range = 340 to 676).<sup>5</sup> Output from automated data capture shows a clear pattern of high and low usage point throughout the day, with 5 a.m. - 8 a.m. and 3 p.m. - 6 p.m. being the peak hours of use. All survey respondents indicated that they used K-Web seven days a week during deployment, with use ranging from 1-14 hours per day. The CCG3 group never used PowerPoint to brief, in the traditional sense, during deployment. During interviews, users described how K-Web was used to conduct briefings to senior officers instead of using lengthy PowerPoint<sup>6</sup> slide presentations. Through K-Web, commanders had access to *current information at all times*; as a result, briefing sessions were used for directly discussing the issues and problem solving, while using K-Web as a backdrop. Users agreed that K-Web was useful as a complement to other tactical/real-time tools.

When asked whether or not it was difficult to implement K-Web into their organization, CCG3 felt that it was an "easy", "natural" transition. DESRON9 had a somewhat difficult transition, due to the lack of training and technical problems (unrelated to K-Web). Both groups responded that direction and support from the commanders were the critical factors that made transition to K-Web possible and successful.

## **2. SumMaker Software (information producer perspective)**

### **a. Ease of use**

Information producers used SumMaker software to create and update Summary Pages. All CCG3 users stated that they did not have previous Web publishing experience, yet found SumMaker easy to learn and use. The features of the software met most of their needs, however almost every functional area expressed the need for more flexibility in the SumMaker template. For example, many areas did not follow the Today/Tomorrow/Long-Range headline titles<sup>7</sup>, and desired the flexibility to change the number of fields available for headlines. One functional area expressed the need for several different SumMaker templates, each with a different focus: graphic, statistical, or text. Survey responses reflect similar information, with users rating the Alerts & Impacts fields as needing improvement.

Due to limited access to the software and computer systems, most DESRON9 users did not use SumMaker. One person who did use SumMaker indicated that it was easy to use.

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<sup>5</sup> A single IP address might represent an individual person or it might represent a router or firewall behind which many individuals might be "hidden." Therefore, it is possible that the actual number of persons visiting using the K-Web is *significantly higher*. Determining the number of actual "visitors per day" is extremely difficult and is based on an elaborate formula taking into account unique IP addresses, domains, and discernibly separate visits or sessions. Due to a number of technical considerations, these numbers may not be entirely accurate. They do, however, give a general sense of the number of people who visited the K-Web.

<sup>6</sup> PowerPoint®, Word®, Chat and Excel® are registered trademark of the Microsoft corporation.

<sup>7</sup> These titles were included in the design based on results of cognitive task analyses.

All survey respondents that used SumMaker indicated that the tool “usually” or “always” met their needs as information producers.

**b. Color and Diamond Use**

Colored status indicators were used on Summary Pages to indicate the severity of impact information had on the mission plan (red indicating most severe, yellow indicating less severe and green indicating no impact). Analysis of the data collected automatically by SumMaker shows that most (82%) published status indicators were green (Figure 3). The dominant use of green reflects adherence to business rules: colors were being used to indicate the impact on mission plan, not the severity of the situation at large. Change in status was not indicated often: 3% of status indicators reflected degraded status (e.g. green to yellow) and 2% reflected improved status (e.g. red to yellow), relative to previous published status (Figure 4).

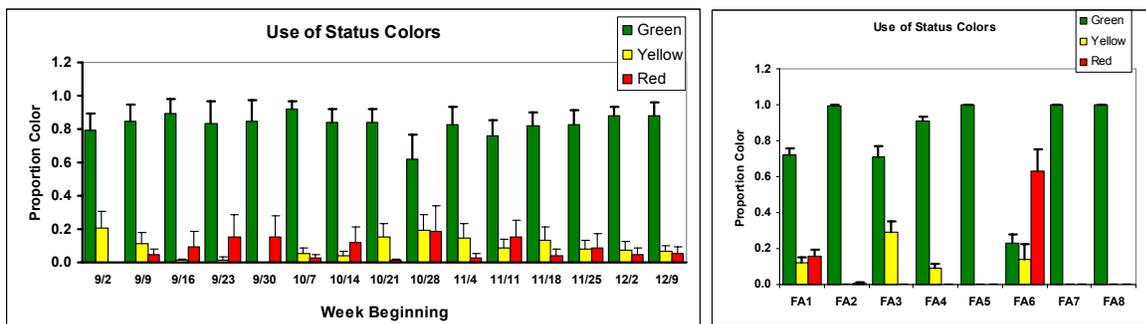


Figure 3. The use of status colors on Summary Pages over the fifteen-week period (left) and for the eight functional areas assessed.

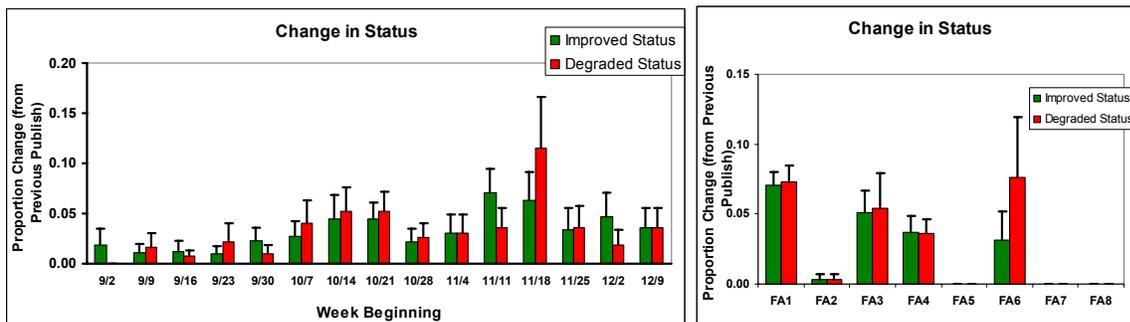


Figure 4. Changes in status reflected on Summary Pages.

Diamonds were included on summary pages to alert the consumer of “new” or “changed” information (squares indicated that information had not changed recently). On average, a Summary Page displayed 1.47 diamonds (Figure 5). Only 4% of pages published reflected that a diamond had either been added or removed (when compared to the previously published page) (Figure 6). When producing information, most users relied on colors and diamonds to alert others of new or important information, unless the information was particularly urgent, in which case they would use the colors and diamonds in addition to more traditional methods, like Chat.<sup>6</sup>

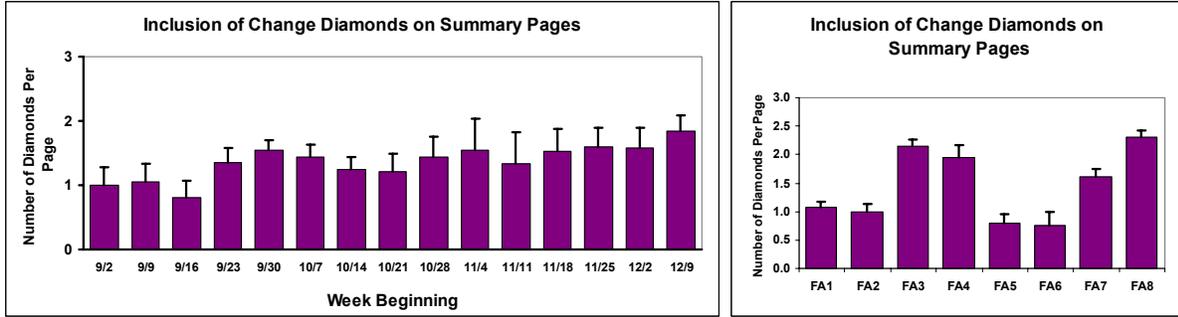


Figure 5. The use of diamonds on Summary Pages.

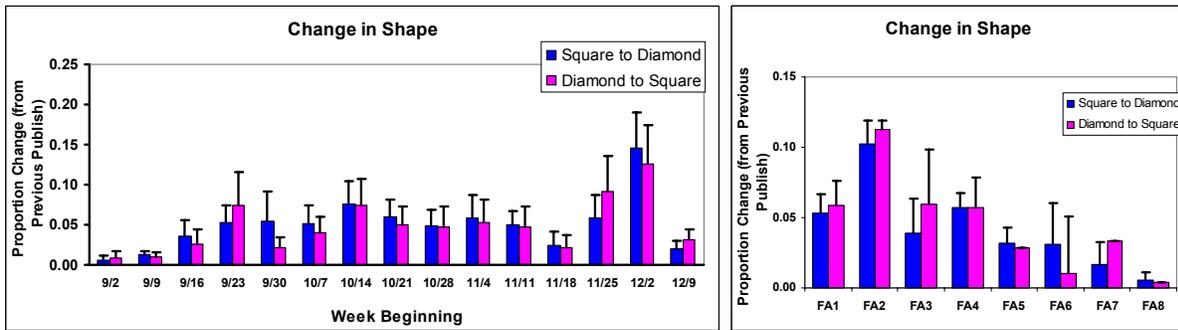


Figure 6. Changes in shape reflected on Summary Pages.

**c. Linking and Cross-linking**

Summary pages, on average, contained 13.61 links to other K-Web content. This number was consistent across most areas (Figure 7). Linked information varied in format with over 11 different formats being commonly used. The most commonly used formats across all areas being Web pages, graphics and PowerPoint (Table 3).

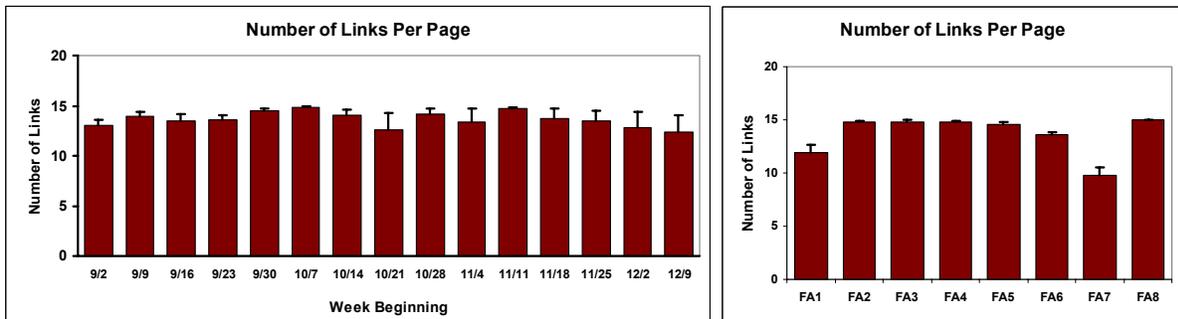


Figure 7. The number of links included on Summary Pages.

	PowerPoint	Word	Excel	Graphic	Other Web Pages (html)	nsf	asp	other
FA1	0	0	0	7	92	0	0	1
FA2	15	11	0	8	66	0	0	0
FA3	1	0	7	38	41	0	0	14
FA4	11	3	3	2	66	10	4	0
FA5	4	0	0	9	87	0	0	0
FA6	10	4	1	7	77	0	0	0
FA7	5	27	13	11	43	0	0	0
FA8	0	0	10	7	79	0	0	5
Sample	7	3	2	8	75	3	1	1

Table 3. The format of links provided on Summary Pages by Functional Area (as percentage of total links).<sup>6</sup>

Several users found cross-linking (i.e. providing a link to a product created by another functional area) to other areas useful. Producers interpreted cross-links to their own page from other area pages as an indication that their content was useful. One significant problem that cross-linking presented was that there was no way for a producer to know if the information they cross-linked to had changed, other than by continuously monitoring that link's content, which was cumbersome. Another problem with cross-linking occurred when the author of the cross-linked material moved the material into a different folder, which broke the path to link. Despite these problems, all SumMaker users who responded to the survey rated cross-linking as “usually” or “always” helpful when creating K-Web content.

**d. Update Rates**

The average daily update rates for the summary pages derived from the automated data are shown in Figure 8. On average, each area published 1.58 summary pages a day; this rate varied considerably over time and across functional areas. In the interviews, each represented area indicated they updated at least once, and often several times a day. Updating was driven by many factors, including 1) the rate of information coming in, 2) the needs of consumers, 3) mission requirements and 4) consumer feedback. For example, several users reported that off-ship consumers notified them if information was not updated quickly enough, which helped set the pace. Survey respondents and interviewees agreed that information was updated in K-Web at a rate that met their needs. Often, underlying K-Web content was updated more frequently than summary page data.

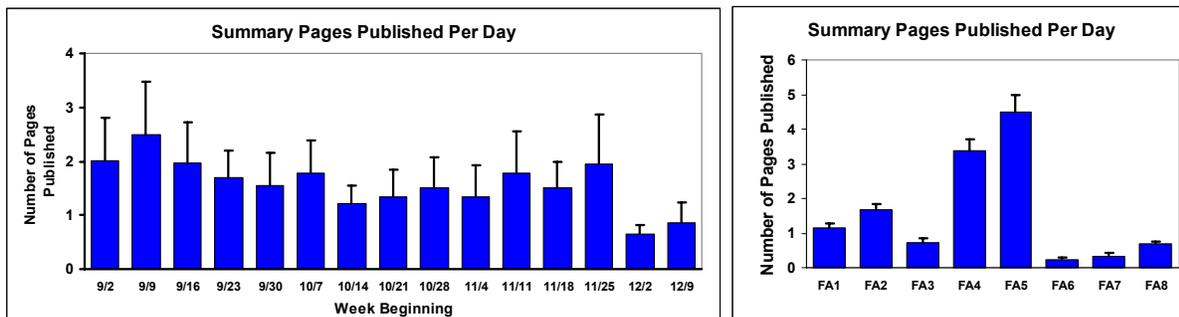


Figure 8. Average daily Summary Pages update rates.

One concern expressed by several users from one group was the time invested in keeping K-Web current. Time spent updating pages ranged from an hour to several hours a day. Although several stated that maintaining K-Web was time consuming from the production side, they felt it was more than made up for on the consumer side. Survey respondents and interviewees agreed that posting information to K-Web was less time consuming than previous methods used to update the Commander and others. (There is no baseline to compare time taken to disseminate similar kinds of data using traditional methods.) The general consensus was that K-Web content was nearly “real-time” and therefore could be used as an operational tool.

***e. Feedback About Content:***

When asked what drove page content, most responded that feedback from consumers was a primary consideration. Along with including content that fit the mission requirements based on their judgment and experience, content was a reflection of questions, requests and other communications from consumers. Survey respondents indicated that conversations, emails and Chat with watchstanders and other functional areas, along with direction from senior officers contributed to deciding what to include on a page. These interactions also contributed to an understanding of what content that was produced was actually useful. Some users noted a significant drop in the number of questions coming in on a particular topic once that topic was posted to their web site. Feedback also helped information producers to know what context to put their information in. Producing content for one’s own functional area use usually required less contextual or background information than producing content for users outside the group. This led to users outside the group sometimes asking for more clarification. Thus, questions about interpretation and consequences of the information presented on their Summary Page influenced content elaboration. The influence of feedback on page content resonated throughout all areas aboard USS Carl Vinson. When asked if it was important to know who had seen their page and when, the consistent answer across survey and interview respondents was that it was not important to know this information; it was assumed that the right people had seen it. Specifically, they would not want any kind of report or automated device alerting them of who had seen their page and when.

***f. Training and BRs***

Most CCG3 users participated in K-Web training in one or both training sessions conducted by Command 21 developers during Global 2000 or aboard ship during K-Web installation. These users found that both learning to use K-Web and training newcomers to use K-Web was quick and easy. Although users trained during the initial sessions were exposed to training materials and “quick reference guides”, interview respondents reported that these were not necessary to use when training newcomers.

CCG3 users explained that common business rules, based on tool functionalities and capabilities learned in training, were developed during initial work-ups of the deployment and were adhered to throughout deployment. These business rules designated that a diamond on a summary page indicated new information and that status colors pertained to the severity of impact information had on the mission plan. Business rules for use of diamonds and colors in their use on the high-level links of Summary Pages seemed consistent across areas. One functional area used diamonds differently at lower-level links. For example, colors corresponded with preset thresholds of supply availability. These indicators were intended for internal use, so that while

red diamond at a lower-level link was an alert within this area, it did not necessarily require the Admiral's attention. Therefore, red alerts at a lower-level link were not always reflected as red alerts in higher-level links. Another common business rule was that K-Web would be updated consistently and used as a briefing tool, in lieu of the traditional PowerPoint presentation (which was the previous standard). One business rule changed by the users pertained to the titles used in the left three links of the Summary Page. Originally designed to represent Today, Tomorrow and Long-Range status, functional areas each adopted their own status titles for these fields. Chronological organization, although useful to some, was not optimal for all areas.

Most DESRON9 users did not receive any training from Command 21 developers and were not aware of training materials available on-line. Lack of training resulted in many users not knowing what diamonds and colors meant. Because most users only produced and updated information products within lower-level links and did not work with SumMaker, they were able to ignore the colors and diamonds if they did not understand them. Approximately half-way into the deployment, most people used and understood these alerts in the same way that CCG3 did. In contrast to CCG3, DESRON9 users still produced PowerPoint briefs and simply attached them to their Web page. One business rule that was not established within this group was a maximum file size for pictures and attachments. DESRON9 was directing content to off-ship consumers with low bandwidth capacity. These consumers would often be unable to access content they needed due to large file sizes.

One issue that consistently challenged CCG3 or DESRON9 staffs was who to produce content for. In other words, should the content be directed to the Admiral, USS Carl Vinson only, the entire Battle Group or beyond? Each producer seemed to cater to a different audience depending on feedback they received, old habits or personal opinion about how the tool should be used. In response to the survey question of who content should be directed toward, users' answers varied from other battle group units to shore sites to coalition partners. Some survey and interview respondents thought content should be directed only at ownship. The combination of survey and interview results reveals an important issue with regard to content production.

### ***3. Summary Pages (information consumer perspective)***

#### ***a. Color and Diamond Use***

Users from CCG3 found diamonds and colors helpful for identifying important or changed information. Survey and interview respondents agreed that keeping track of new information in K-Web was usually easy. Both groups explained that although colors and diamonds would sometimes draw their attention and influence K-Web navigation, for the most part, users would consistently monitor the pages they were most interested in, regardless of colors and diamonds. Many users from DESRON9 did not find colors and diamonds useful during the first half of deployment because they were not aware of how to use them or what they meant. Even after establishing a business rule for diamond use and meaning, this group tended to rely more on established methods of alerting, such as phone, Chat or face-to-face. Colors and diamonds did lose meaning when an area repeatedly used the same color with a link. Both groups expressed the need for a timestamp linked to colors and diamonds for more precise information age.

#### ***b. Preference / Ease of Use***

In contrast to the stated need for more flexibility in the SumMaker template by information producers, several users indicated that having a standardized format was useful as a consumer for navigation purposes. In addition, the structured and limited space in the Summary Pages forced users to publish only relevant and needed content, which resulted in survey respondents and interviewees agreeing that they were usually quickly and easily able to locate the mission-related information they needed within K-Web. Survey respondents also reported that information was usually presented in formats that met their needs without further clarification.

#### **4. Knowledge Wall/Desks**

##### **a. Usage of K-Wall – briefing and SA**

Users from both groups recognized great added value gained by using Knowledge Desks (6-headed displays provided for information consumption). The multi-headed display helped them monitor K-Web pages, multiple Chat rooms and email, while also working on MS Office applications. Regardless of which applications were being viewed, several interview respondents determined that the value that K-Desk offered was the ability to monitor multiple tasks at once. The K-Wall, known to CCG3 users as the “Video Wall” in TFCC, and the SmartBoard in their briefing/war room, proved useful for different reasons. Again, regardless of the content being viewed, the K-Wall allowed several people to simultaneously view and discuss the same information. Several users stated that the combination of K-Web and K-Wall facilitated collaboration during traditional briefing times, as opposed to one-way presentations.

##### **b. Legibility**

Of the survey and interview respondents that had access to K-Wall or a K-Desk, all indicated having no problem viewing information from either display type.

#### **5. Overview Page**

##### **a. Integrated status**

Several users from both groups indicated that because each area used different headings for the Today/Tomorrow/Long-Range fields that the status bars on the Overview Page did not have consistent meaning. Despite this, the status bar was still used for quick-look status information; six out of seven survey respondents rated the status bar as either “acceptable”, “very good” or “excellent” with respect to their needs as information consumers.

##### **b. Navigation**

Survey and interview agreed that locating the information they needed was usually easy and that organization by functional areas worked well. Some users relied on the Overview Page as a table of contents to the different areas, while others set up shortcuts that linked directly to the pages they consistently accessed. Navigation within the areas was easy for most users because the same kind of information was generally stored and updated in the same place on the Summary Page. Some areas did store considerably more information than other areas under single headlines, which made it more difficult to navigate. When this problem arose, users would simply ask the producers of that page where to find needed information.

Users from DESRON9 suggested that a search or find function would be helpful, not only for finding a specific piece or type of information, but also for recognizing relationships between pieces of information. Navigation within their site seemed more difficult because they had

several functional areas under the heading Maritime Ops, resulting in a smaller K-Web within a larger K-Web's structure.

## **6. Training**

When asked what improvements would a) make K-Web easier to use, or b) enhance its functionality, DESRON9 users responded unanimously that training would be the single most important improvement. This group did not participate in any training sessions (with the exception of one individual), nor were they aware of the on-line training materials. Without training, users relied on learning from each other and through trial and error. This, along with limited access to SumMaker, a rapidly changing information environment, and some technical problems (unrelated to K-Web), caused frustration among users during the first few months of deployment. Once everyone was "up to speed" on how to use K-Web, the value was recognized, but training could have alleviated many problems up front. Specifically, DESRON9 users recommended help functionality embedded in the software tools. CCG3's experience with K-Web, however, did not lead to the same suggestions. In general, CCG3 users expressed that the training they received was good and that training newcomers took a matter of minutes (answers ranged from 5 – 30 minutes). This group, however, did participate in training at the Global 2000 war game and aboard ship, during K-Web installation. It may be that newcomers are so easily trained because they are starting in an established K-Web environment (Goldstein, 1993). Although exhaustive help functionality may be useful, or even required for a command that picks up K-Web without training, this not the recommended solution. Training the command *prior* to installation is more desirable, economical and effective. Once the majority of people are comfortable with using the basic K-Web concept and tools, newcomers and veterans may benefit from on-line help assistance (Koslowski & Salas, 1997). Clearly, releasing the software products, without either training or on-line support could be a costly waste of time and operational capabilities.

## **Conclusions and Recommendations**

The concept of Web-based information production and dissemination to facilitate speed of command was tested aboard the USS Carl Vinson during Operation Enduring Freedom. Overall, K-Web proved to be an extremely valuable tool for the production and dissemination of information in this critical operational environment.

The major lessons learned from the evaluation of the usage of K-Web aboard the USS Carl Vinson are listed below. A similar evaluation was conducted of the same K-Web tools and products when they were being used at the Global 2001 war game (see Oonk, Rogers & Moore, 2002 for more details). Whenever applicable, findings that emerged from that evaluation that augment or contrast with those from the "real-world" K-Web evaluation are also included.

Major lessons learned:

- Usage aboard the USS Carl Vinson suggests that training needs to occur prior to implementation of the K-Web concept and tools, and needs to be supplemented with help functionality;
  - Similarly, the Global 2001 evaluation suggested a need for integrated training to promote a better understanding of K-Web tool capabilities by information producers and consumers.

- Business rules regarding tool use and content audience need to be established prior to implementation;
  - Similarly, the need for mechanisms for improved dissemination of K-Web business rules to support optimal use of the K-Web by information providers and consumers emerged from Global 2001.
- Accessibility of K-Web content by external consumers is impacted by file sizes; and
- Different functional areas have different content organization needs, which implies the need for more flexibility in the templates.
  - Global 2001 also suggested a similar need for tools and content that are flexible and customizable to meet the needs of different users.

The keys to USS Carl Vinson's success using K-Web were:

- Easy to learn, easy to use tools;
  - This makes K-Web easy to learn and
  - keeps file sizes small.
- Functionalities, capabilities and designs that met users' needs;
  - this contrasts with the findings from Global 2001 which suggested a need for better cognitive tools to support cognitive functionality, such as attention management and change alerting.
- Combination of consumer and producer driven content;
  - this contrasts with the identified need for improved feedback mechanism to enhance content production that emerged strongly from the artificial war game environment.
- Establishment and adherence to business rules;
- Consistent formatting across functional areas;
- Self-determined update rates; and
- Leadership support.

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