COVER SHEET

Collaboration Tool Suites Developed to Support Joint Command and Control Planning and Decisionmaking

Susan G. Hutchins[1]
William G. Kemple[1]
Ron Adamo[2]
Dan Boger[1]
Brian W. Nelson[3]
Heather L. Penta[1]

[1]Graduate School of Operations and Information Sciences
Naval Postgraduate School,
589 Dyer Road
Monterey, CA 93943-5130
(831) 656-3768 Fax: (831) 656-3679
kemple@nps.navy.mil; shutchins@nps.navy.mil;
boger@nps.navy.mil; penta@nps.navy.mil

[2]Jaycor, Defense Systems Group
(757) 836-3911 (JFCOM) (757) 222-4817 (w)
e-mail: radamo@jaycor.com

[3]Naval Surface Warfare Center, Crane Division, Code 4028
300 Highway 361, Crane, IN 47522
(DSN 482-5587) Fax 812-854-6348
Nelson_Brian@crane.navy.mil

May 1, 2002

This paper is submitted for consideration for the 2002 CCRTS track on C2 Experimentation.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
JUN 2002		**00-00-2002 to 00-00-2002**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Collaboration Tool Suites Developed to Support Joint Command and Control Planning and Decisionmaking	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Postgraduate School,589 Dyer Road,Monterey,CA,93943-5130**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**		**15**	

Collaboration Tool Suites Developed to Support Joint Command and Control Planning and Decisionmaking*

Susan G. Hutchins,[1] William G. Kemple,[1] Ron Adamo,[2] Dan Boger,[1] Brian W. Nelson[3] and Heather L. Penta[1]

[1]Graduate School of Operations and Information Sciences
Naval Postgraduate School
589 Dyer Road, Monterey, CA 93943-5130
(831) 656-3768 Fax: (831) 656-3679
shutchins@nps.navy.mil; kemple@nps.navy.mil;
boger@nps.navy.mil; penta@nps.navy.mil

[2]Jaycor, Defense Systems Group
(757) 836-3911 (JFCOM) (757) 222-4817 (w) e-mail:
radamo@jaycor.com

[3]Naval Surface Warfare Center, Crane Division, Code 4028
300 Highway 361, Crane, IN 47522
(DSN 482-5587) Fax 812-854-6348
Nelson_Brian@crane.navy.mil

Abstract

Military forces, operating as a networked force, can plan, decide, and act collaboratively and concurrently to accomplish many tasks simultaneously. Operating in a collaborative information environment will enable the joint force to transition from the use of a hierarchical, serial planning process to the use of a parallel, collaborative planning process to produce reduced decision times and an increased tempo of operations. Collaboration tool suites were introduced during two recent events to support operational planning and decisionmaking processes by providing an alternative means to communicate, collaborate, and share information among warfighters that extends what is available in today's current operational environments. One goal for these events was to develop an understanding of the implications and effects of distributed planing. A second goal was to obtain feedback on the effectiveness of these new tools for supporting future military operations in a distributed, network-centric joint force and to identify user-defined enhancements that would better meet future joint operational requirements. New information technology tools, to be used as part of a networked, web-based collaborative system were also introduced. This paper discusses the strengths and weaknesses of the tool suites and describes additional capabilities needed for future collaborative information environments.

1. Introduction

Military forces are beginning to operate as a networked force, which allows them to plan, decide, and act collaboratively and concurrently to accomplish many tasks simultaneously. These collaborative capabil-

* The research reported here was sponsored by the U.S. Joint Forces Command, J9, Joint Experimentation Center, Suffolk, VA.

ities are expected to contribute to reducing the time required to accomplish military objectives. Rapid access to current, accurate, and relevant information, and the ability to engage in real-time collaboration with other decisionmakers who are geographically distributed, have become indispensable elements of the joint command and control (C2) planning and decisionmaking process. While information access has always been critical to success in war, the concepts embodied in network-centric warfare (NCW) and rapid decisive operations (RDO) place an even greater emphasis on having rapid access to relevant and accurate information. NCW is an approach to warfare that derives its power from the effective linking or networking of the warfighting enterprise.[1] It is characterized by the ability of geographically dispersed forces to create a high level of shared awareness that can be exploited to achieve rapid decisive operations.

While the U.S. has an unmatched ability to gather information on the environment, the adversary, and ourselves, we currently lack the collaborative planing capabilities (both mature systems and practiced operators) and C2 systems to use this information to enable decision superiority.[2] RDO is an operational concept for future operations predicated on the idea that the U.S. can no longer plan on having months or even weeks to deploy massive theater forces into a region.[ibid] The ability to quickly create and leverage superior knowledge are critical aspects of RDO. This rapid formulation of knowledge and understanding of the battlespace should enable decision superiority, reduce operational risk, and increase the pace, coherence, and effectiveness of operations.

1.1 A Shared Information Environment

A shared information environment, and the tools that enable collaboration, are essential to conduct the effects-based planning and assessment process envisioned in the RDO Concept. This is due, in part, to the way the Joint Force Headquarters will be organized in the future, that is, into Boards and Centers, each of which will include members from the subordinate components and members from other agencies. These other members will be in geographically distributed locations. Examples of boards and centers that are part of the new joint force headquarters organization include the Joint Planning Center, the Joint Operations Center and the Joint Coordination Board. It is not be feasible to collocate members of the boards and centers, since it will be necessary for the same person to participate in different boards and centers at different times – some scheduled, and some as required.

This shared information environment is also essential to conduct the effects-based planning and assessment process. (For a description of the effects-based planning and assessment process, see Hutchins, Kemple, Adamo, & Boger, this proceedings.) In order to achieve rapid and decisive outcomes, activities such as developing the course of action must be conducted as a parallel collaborative process. This parallel collaborative process includes the subordinate commands and other agencies. Parallel collaborative planning contrasts with today's serial planning process, where planning and coordination is conducted with external agencies at one level before passing the plan to the next lower level for the next level of planning and coordination. In addition, the activities undertaken by the tactical forces need to be accomplished synergistically to achieve the higher-level effects desired at the operational and strategic levels. Moreover, the activities undertaken at all levels to perform assessment, and the actions taken as a result of the assessment, must continue this tightly orchestrated actions-to-effects linkage. The entire effects-based planning and assessment process can only be accomplished by using collaborative planning and execution.

Collaboration tool suites were introduced to facilitate the information-intensive interactions involved in effects-based planning and decisionmaking during two recent events. These events were Global

Wargame 2001, held at the Naval War College, in Newport, RI, 16-27 July 2001, and an experiment conducted at U.S. Joint Forces Command, Suffolk, VA, 3-14 December 2001. These tools were developed to support operational planning and decisionmaking processes by providing an alternative means to communicate, collaborate, and share information among warfighters that extends what is available in today's operational environments. A key objective for both events was to obtain feedback on the effectiveness of these new tools for supporting future military operations in a distributed, network-centric joint force and to identify user defined enhancements that would better meet future joint operational requirements. The Joint Task Force conducted effects-based planning and assessment using two collaboration tool suites that provided decisionmakers with the ability to share information and produce the recurring and non-recurring products that were required.

The ability to have extensive collaboration and coordination across functional areas and service components within the organization was recognized as one key to the success of both events. It is anticipated that a collaborative information environment, enabled by high-speed bandwidth connectivity and electronic collaboration tools, will facilitate the exchange of information among members of the Joint Force and those organizations supporting, or being supported by, the joint force. Concepts such as information and knowledge superiority, knowledge management, and effects-based operations, are important components of effective NCW and RDO. The need to rapidly achieve desired effects, with coordinated actions, points to the demand for powerful, reliable, and capable IT tools to support military planners and decisionmakers. These tools are expected to be critical elements of success for the warfighter who will be operating in a constrained battle space, working toward achieving shared situational awareness, information and decision superiority, unity of effort, and the ability to respond rapidly and autonomously. The long-term goal for operating in a collaborative environment is to reduce planning time-lines while increasing organizational effectiveness. This paper will discuss the strengths and weaknesses of the tool suites and describe additional capabilities needed for future collaborative information environments.

1.2 Collaborative Information Environment

Operation in a collaborative information environment (CIE) will enable the joint force to transition from the use of a hierarchical, serial planning process to the use of a parallel, collaborative planning process to reduce decision times and increase the tempo of operations. Figure 1[(from 5)] depicts a CIE were the Joint Task Force Headquarters interacts with a variety of geographically distributed, subordinate and external agencies to develop and share information, provide information products, collaboratively develop plans, and monitor the effects of executing these plans. A practiced interagency collaboration process that allows all partners to inform, and be informed by, the others, is the foundation of this blueprint for the future. The CIE, in which the joint force operates, will provide the information to form the foundation for participants to develop enhanced knowledge. Enhanced knowledge is the key to decision superiority. Processed and fused data become information; decisionmakers, enabled by study, judgment, and experience, convert information into knowledge and situational understanding. These two elements are the key to *decision superiority*—the ability to make better decisions faster than the adversary.

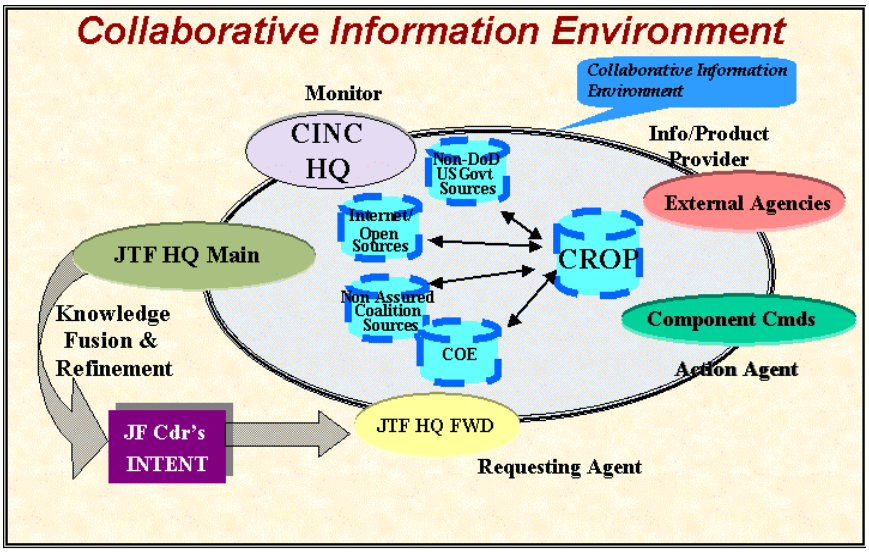

Figure 1. Collaborative Information Environment

1.3 Collaborative Planning

Collaborative planning supports the transition from the traditional hierarchical, serial planning and execution process to a parallel, concurrent process, as depicted in Figure 2.[from 5] Distributive collaborative tools are currently supporting staffs, separated by geography, time, and organizational boundaries, to interact and to coordinate concurrently in the development of plans and operations. This virtual collaboration capability means that fewer personnel will need to be forward deployed to the area of operations. Virtual collaboration allows the simultaneous involvement of CINC headquarters, components, and other organizations to participate in planning activities. It is anticipated that an extensive collaboration capability will result in faster and improved understanding of the commander's intent and better unity of effort.

Networked forces allow the military to compress and change the nature of the sequential, hierarchical way planning and operations are currently conducted. A networked force can leverage shared situational knowledge among a geographically dispersed force, which will increase the speed and precision in planning and the application of power. New missions will require that constantly updated mission information be provided to the core planning team and extended partners in other commands. Information systems will "push" planing information electronically to higher, lower, adjacent, and supporting organizations so that the corresponding plans update automatically. This should facilitate a common shared awareness among all elements of the joint force and supporting organizations.

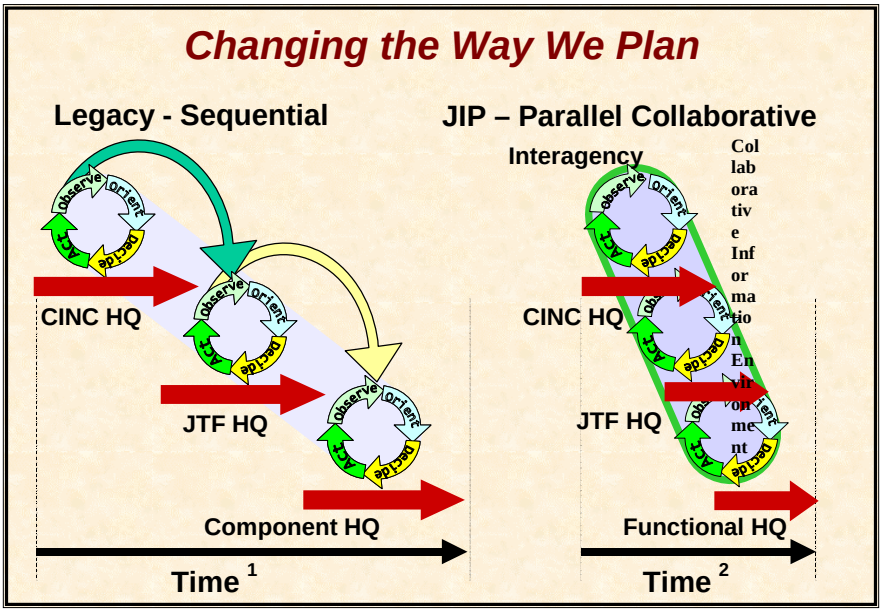

Figure 2. Collaborative Planning

2. Experiments on Effects-Based Planning in a Collaborative Environment

The Effects Tasking Order-to-Actions Limited Objective Experiment (ETO-to-Actions LOE) was conducted at the U.S. JFCOM, Joint Experimentation Center, to examine aspects of Effects-Based Operations and to specifically assess and refine the effects-based planning and assessment processes. This experiment was designed and conducted by a partnership of the Naval Postgraduate School, JFCOM J9, and the Navy Warfare Development Command. The collaboration process that enables effects-based planning was one area of focus for the experiment. A suite of tools — a collaborative information environment — was developed to facilitate collaborative planning. For additional details on the experiment see the companion papers on knowledge management and collaboration in an effects-based operations environment (Hutchins, Kemple, Adamo, & Boger, this proceedings) and an empirical evaluation of the effects-based planing process (Kemple, Hutchins, Adamo, Boger, & Crowson, this proceedings).

The Global Wargame is the U.S. Navy's Title 10 Wargame series conducted annually at the U.S. Naval War College (NWC), Newport, Rhode Island. Global Wargames provide an opportunity for naval, joint, and coalition forces to investigate advanced warfighting concepts and issues in a complex, distributed environment representing future military operating conditions. The objective of Global 2001 was to explore NCO by conducting joint/coalition contingency operations with uncertain warning using rapidly deployable forces. Two specific concepts were used as implementing vehicles: Rapid Decisive Operations (RDO) and the Joint Mission Force (JMF). In the Global 2001 wargame, exploration of the concept of Network Centric Operations (NCO) and its associated pillars of Knowledge and Information Advantage, Effects Based Operations (EBO), Assured Access, and Forward Sea Based Forces continued the investigations conducted in previous games of the series.

3. Collaborative Tool Suites

A web-based tool, called the Wargaming Information Grid System (WIGS), and a collaborative planning and operational environment, the Information WorkSpace (IWS), provided the core for both

collaboration tool suites. WIGS was designed to be the central authoritative data source for game information and shared awareness during scenario play. For Global Wargame 2001, an interactive homepage was developed to provide players with a means of planning, communicating, and promulgating orders. Promulgation of this information via the website was intended to facilitate changes to the participants' common operational picture and also provide a means to review players' decisions, strategy, and direction both during game play and afterwards. The objectives for this website were to: (1) provide a location to post information for all players and facilitate the exchange of documents, (2) provide access to analytic tools and to an underlying database of reference and briefing materials, and (3) provide links to additional websites, hosted within the Wargaming Center, at the Naval War College, in order to provide additional information related to game play.

IWS is a collaborative planning and operational environment designed to be used within and among the functional and service components. IWS was designed to facilitate collaboration where planning was required among distributed participants to produce the recurring and non-recurring products produced in response to the game play. Capabilities afforded by IWS were expected to be tailored by the users to their specific requirements. Some functions provided by IWS include real-time text chat and voice chat, both conducted over the Internet. Text chat provides a form of interactive communication where more than one person can join the chat session to collaborate. All occupants within a virtual "room" (within the IWS tool) can view and respond interactively to an initiator's message. Voice chat is also a tool within the IWS where a person can talk with everyone who is in the same "room."

3.1 Information Technology Tools at Global Wargame 2001

WIGS and IWS provided the core for both collaborative information environments. Additional IT tools that were provided for each event are briefly described here. At Global Wargame, where the goal was to use innovative technologies to enhance all aspects of the operational decisionmaking process, the following tools were provided to participants in addition to WIGS and IWS: Battlespace NT, Text Documents, the Knowledge Wall, Email, and Video Teleconferencing. Battlespace NT was a software application used to present the picture of the unfolding battle. The Knowledge Wall (KW) was designed to provide senior decisionmakers with a common view of game information and to support a novel model of collaboration (that is, asynchronous collaboration) for the senior staff of the Commander, Joint Task Force (CJTF) staff. In addition, by virtue of it being installed for both the CJTF and the Commander in Chief (CINC), the Knowledge Wall provided a means of collaborating for the CJTF and CINC echelons, as a secondary function. The Knowledge Wall comprises ten 21-inch CRTs, and two large-screen displays. The displays operate as a single, integrated digital desktop. Conceptually, the KW may be viewed as a dynamic status board. The small, peripheral displays were intended to provide summary information for each of 13 functional areas that were identified through knowledge engineering (these functional areas correspond to the 13 areas that were played at Global.) Each summary display is formatted consistently with a variety of tools dedicated to different operational requirements. Email was also provided via a standard commercial-off-the-shelf email system. Text documents were a collection of documents located within the web-based gaming architecture. These documents included material such as the Battle Plan, Commander's Intent, Rules of Engagement, and many others.

3.2 Information Technology Tools at Effects Tasking Order-to-Action Limited Objective Experiment

At U.S. Joint Forces Command, where one goal for the experiment was to develop an understanding of the implications and effects of distributed planning, the following tools were provided to participants in

addition to WIGS and IWS: ADOCS, ONA Tool, and JDIM. Figure 3 [From 5] depicts the collaborative information environment tools used during the Effects Tasking Order-to-Actions limited objective experiment. The automated deep operations coordination system (ADOCS) is a joint service mission management software application that presented the visual display of the battlespace. ADOCS provides a suite of tools and interfaces for horizontal and vertical integration across battlespace functional areas. The operational net assessment (ONA) tool was accessed through WIGS and provided a planning assessment of the effects of proposed actions from multiple points of view. (For a description of the ONA process see Hutchins, et. al, 2002.) These other views include information and analysis from other branches of the U.S. Government and many others as well as non-governmental organizations' needs and requirements. The Joint Distributed ISR Management Tool (JDIM), accessed through WIGS, enabled the user to find what intelligence, surveillance, and reconnaissance information existed at particular nodes.

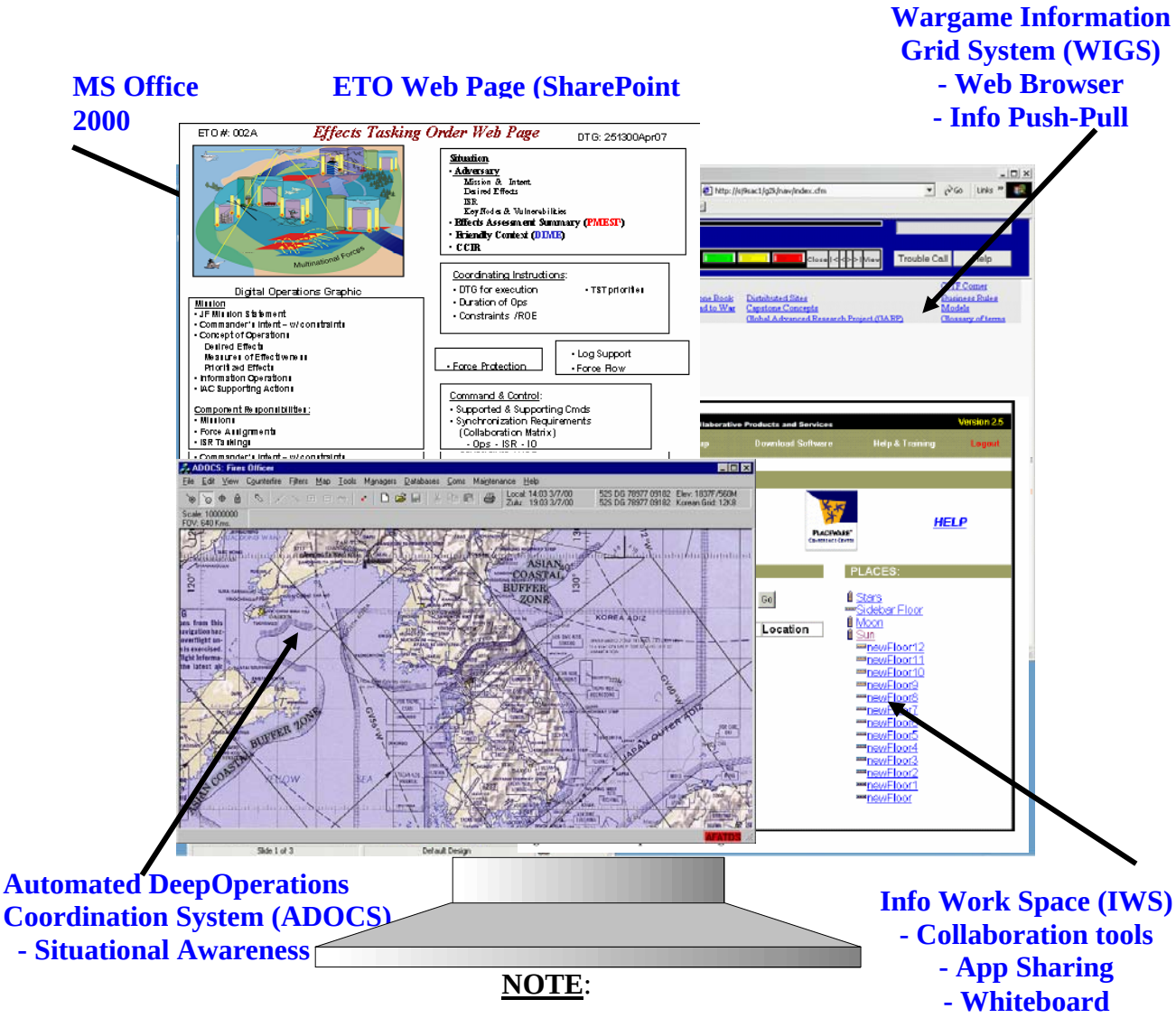

Figure 3. Collaborative Information Environment used during the Effects Tasking Order-to-Actions Limited Objective Experiment

4. Collaboration Tool Functionality Survey

In order to collect the data with which to assess user perceptions of the utility of the collaborative tool suites, a Collaboration Tool Functionality Survey was developed and administered during both events. This paper will present a brief summary of the results of analysis of data from the combined 196 respondents' who completed the survey during one of the two events. The survey was designed to assess the utility of the collaboration tool suites in supporting the users in conducting collaborative planning sessions, accessing and sharing information, enhancing decisionmaking, as well as how the tools might be improved in future versions. This section will discuss the results of analysis of the participants' responses to the following topics: (1) which tools were most helpful and how they were helpful; (2) how the tools impacted decisionmaking; (3) limitations of the tools; and (4) features desired in the design of a future collaborative system.

5. Results

The general consensus was that all the capabilities offered by the collaborative tool suite are needed, yet each tool has room for improvement. (It is important to bear in mind that most of the tools provided were prototypes and are still under development.) Many useful recommendations were made that will enhance the usefulness of collaboration tools. This section will summarize the strengths and limitations of the tools and describe features desired in a future collaborative information environment.

5.1 Operating within a Collaborative Environment

IWS was considered to be a useful tool for conducting the effects-based planning and assessment process by a majority of players (73% percent agreed or strongly agreed that IWS was useful). The majority (71 percent) indicated the established meeting rooms in the IWS structure were sufficient to cover their effects-based planning needs. IWS facilitated the rapid identification of meeting locations and the composition of participants, allowed monitoring of multiple meeting rooms, and supported sharing planning products. The meeting room structure provided an effective framework and organizational methodology for collaboration. However, one player thought that if players are not adept at group dynamics, using a collaboration process may result in increased time for decisionmaking because the decisionmakers may spend more time considering other opinions in order to develop a consensus. Limitations of IWS included that IWS was not convenient for ad hoc collaboration and IWS did not offer private chat. Others indicated the use of business rules are needed to improve the collaborative planning process, i.e., to add "discipline" and make the meetings go more smoothly.

5.2 Impact of Tools on Decisionmaking

Many positive comments were made regarding the impact of the tools on decisionmaking. The tools provided a stable environment for collaboration, decisionmaking, and execution. ADOCS, when combined with IWS, allowed real-time collaboration, which enhanced decision-making. IWS facilitated having all the planners in one central collaboration area which gave the participants the ability to share information, produce planning documents, and obtain required information immediately, which in turn, enabled the participants to know what was happening at headquarters. A player stated that the combination of IWS, the ONA tool, and WIGS enabled decisionmakers to increase the tempo and effectiveness of planning and execution cycles. The tools facilitated the flow of information, which lead to quick information gathering, and thus quick decisions. The tools helped accelerate key information flow and decisions between Washington and the CINC's staff. down." Therefore "collaboration may impede…decision-making because it becomes consensus building."

5.3 Effectiveness of IWS collaborative tool for planning

When asked about the manageability of participating in more than one collaborative session the majority of the participants thought they could only effectively participate in one meeting at a time, especially if the participant was key to that meeting. Many participants thought it was difficult to have “two thinking caps on at once,” and that it was hard to monitor more than one window or more than one conversation. Although many participants suggested that the focus should be limited to only one meeting, some participants indicted that two simultaneous sessions are workable. The majority (76 percent) of the participants thought the numbers of participants in the collaborative sessions were manageable. IWS was perceived as a time saver due to its integration with other information sources. Technical difficulties associated with participating in more than one meeting are that dialogues from the meeting can become intermingled, making it difficult to keep track of other participants and having multiple sessions opened cause audio lags.

While IWS provided access to much useful information, users found it difficult to keep track of tasked assets and this detracted from their ability to make efficient use of available units. It was also difficult for some users to find tasking by specific context, thus, players felt this tool needed better organization to support the warfighter's needs. The suggestion was made to organize WIGS by warfare commander's areas rather than administrative categories. Additional suggestions for improvement include the recommendation to add the following features: better linking between IWS and electronic documents, the ability to easily obtain information on tracks, weapons coverage, sensor coverage, mission plans, and task orders; keyword searching; an automatic refresh capability; and an improved organization for the overall IWS structure.

5.4 Text Chat

Text chat was the primary method used to quickly communicate and conduct a "distributed discussion." The primary advantage afforded by text chat was that is provided real-time communication that was useful for collaborative planning. Additional advantages offered by text chat were that is was considered to be better than traditional radio-telephone, since text chat has the added feature of an audit trail, and it provides a good back-up form of communication if/when other forms of communication fail. Text chat also offered very good real-time communication and participants felt a record of text chat should be retained as an official logbook. Negative aspects were that it was time-consuming to participate in the text chat sessions, and difficult to monitor these sessions when performing other ongoing tasks. Some users found it difficult to keep up with discussions while performing their functional task responsi-bilities. Others thought it was difficult to identify who the "speakers" were.

Suggestions for improving text chat include adding the following features: an integral assurance of receipt capability, date-time group tags, alerts to help users know when the status has changed, e.g., a pop-up feature, an automatic save capability, a history feature that allows a person joining the session after the session started to see what has transpired up to that point in time, and an address book that lists users names and identities. A suggestion was also made to include the capability to view briefing slides and then use text chat as a backup to the slides. Text chat also needs a retention capability if a user logs off or the system goes down, enhanced voice communications for all attendees, and business rules for operating in a collaborative environment, e.g., including an agenda and background slides to support the discussion topic.

5.5 Knowledge Wall

The Knowledge Wall is not covered in this paper due to space limitations. Information on the usage, utility, and usability design solutions can be found in two recent reports (Smallman, Oonk, Moore, and Morrison, 2001; Oonk, Smallman, Moore, and Morrison, 2001).[6, 7]

5.6 Email

Email was used primarily to send messages and attachments. Advantages offered by Email include its familiarity and that there is a permanent record of the communication. Email was seen as a good vehicle for tasking and for responding to a chat session. Negative aspects were that Email could become dated before it was read, and there could be too much to read. [Note, these are not inherent limitations of Email, per se, rather, they are a statement about the amount of information people are required to process in these environments.] Suggestions for improvement included adding the following features: a confirmation of receipt feature, a prioritization feature (flash, priority, routine), and an address book.

5.7 Battlespace NT

In general, this tool was not considered to be as useful as other applications used to depict the unfolding battle, because the display was seen as too cluttered and it lacked many of the features that participants expect to see in a tool that is used to display the unfolding battle. For example, other displays have included an easy-to-use filtering system and the ability to obtain specific mission information, such as the history of a track, order of battle, and weapons status. Participants indicated this tool lacked fidelity and the presentation was inadequate. For instance, this tool did not provide flexibility to users in terms of the presentation of the maritime picture, users found if difficult to find and identify specific tracks, it was slow to update, and it allowed only limited operator input. Suggestions for improvement included adding the following features: many more user options for tailoring the display, e.g., an ability to group and ungroup objects (e.g., ARG or CVBG), better filters and overlays, and the ability to insert "bookmarks."

5.8 Web-based system (WIGS)

WIGS was considered very useful as the main source for locating text information. WIGS provided a good hierarchy of the information and an intuitive format for searching, however, some players indicated the task order system was difficult to navigate. Suggestions for improvement include adding the following features: a better linking capability to integrate related data and other information; an automatic refresh capability; a true "one-stop shop" threat library; the ability to subscribe to reports through email; and make it less "pull" intensive by providing more “push” technology capabilities, and a search capability. Additional desired features were that WIGS needs to have a less labor-intensive posting process, and an index, or sorting capability, for task orders.

5.8 Suggested changes for the collaborative tools

Many suggestions were made for improving the collaboration tool suite. The tools included in the collaborative information environment were considered helpful, however, they all need to be made less complex and more intuitive to use. The ONA tool needs to have better graphics and a user-friendly interface. Many participants felt the ADOCS tool was “inflexible.” Other suggestions included adding a split screen, or two monitors, to enable the users to better see more of the activity. All the tools need to be better integrated and have easier “links” between them. If the user-interface is improved,

participants expect there will be a decrease in the amount of time spent on information searches and an increase in productivity.

5.8.1 Graphic Representations to Reduce Cognitive Processing Demands

Graphics-based tools are needed to support — and help implement — the new *processes* that the Joint Task Force will use as it transitions to employing the new warfighting concepts that are currently under development. For example, the effects-based planning and assessment process entails a much more comprehensive approach to planning. This comprehensive planning process, which will be accomplished in a collaborative environment, among participants separated by time, geography, and organization, will need to be supported by tailored tools that are designed specifically to assist this complex process. Participants stated that a tool that can display and track the workflow required for all the various planning documents that will be developed through a collaborative process would offer a great benefit. This tool should present a graphic depiction of the overall process, and the sub-steps (e.g., the various planning documents), to help planners who are geographically distributed, and working on different parts of the overall plan, to visualize where they are in the planning process in relation to others. For example, the status of various effects directives, mission plans, and tasking orders that are collaboratively produced and iterated by planners who are separated by organization, geography, and time. Icons with a "drill down" feature would allow the user to get amplifying information and speed up information access times.

5.8.2 Information Sharing and Linking

Links are needed between specific types of information and the associated tasked forces, their status, the assets to be used, assets available, situation summaries, and so on. Providing links to presentations and a shared picture library, to share diagrams, would reduce the load on the network. Planners and operators need improved decision support tools to help them visualize where they are in the planning process, the status of various tasks, what other groups are doing, which tasking orders have been approved, the status of corresponding mission plans, effects directives, and so on. Decision support tools are particularly important to bring about the synergistic effects that are crucial to success in an effects-based operations environment. Asset deconfliction related to information operations is one example of an area that would significantly benefit from a capability to graphically depict, for example, the ten current tasks that are currently being executed to prevent over-tasking assets and to ensure no efforts are conducted at cross purposes. Regarding support for the planning process, a graphic with links to indicate the status of each plan, with color coding to indicate the status, would inform the user regarding which tasks have been completed, and which tasks were unsuccessful, and need to be re-executed.

5.8.3 Agile tools that provide flexibility

Flexibility in tool use is essential, as different users have varying needs depending on their functional area and their position within the organization. As an example, specific intelligence information needs vary considerably across individual users. An agile system should allow each user to access needed information by task responsibility. For example, a prompt could appear when a critical new piece of information is known, along with associated decision boxes, tailored for the specific users. For instance, when a submarine is detected, an automated decision aid could present appropriate choices to the decisionmaker, e.g., "assign P-3," "assign SSGN-xxx," etc. For operators involved in categorizing and filtering tracks and nodes, "hot buttons" that provide one-button selection of information, and pre-

formatted choices for actions to be taken in response to new information received, would reduce the time required to conduct collaborative planning tasks.

5.8.4 Push information to the user

Technology offers great potential to help decrease the time to accomplish the various required tasks. If more information can be "pushed" to the user of that information, the time to perform the task will be reduced. Incorporating “push” technology in the tools will facilitate coordination among distributed planners.

5.8.5 Planning Aid

Ways to depict the sequence of all actions related to a given mission plan are needed. This feature should include a way to visually depict tracks are they are being developed, plotting targets, etc. Planning tools could also include pre-planned templates to decrease time spent on developing planning documents.

5.8.6 Business Rules

Clear delineation is needed regarding what form of communication is to be used for what purposes, when there are so many tools from which to choose. For example, what constitutes tasking? Participants indicated they needed more familiarity with the different aspects of each of the tools in order to make the most effective use of the tools, both individually, and collectively, as an integrated collaborative tool suite. Business rules are needed to articulate who uses which tools, and when, for the various steps entailed in the planning and executing process.

5.8.7 Need Additional Training

Many participants found it very difficult to coordinate their use of so many new tools and stated that additional training was needed to allow them to use the tools to their advantage.

6. Discussion

Future effects-based planning processes will be more complex as effects-based planning uses a much more comprehensive approach which means planners will need to consider and process a much wider range of information. Tools are needed to facilitate the processes entailed in writing and reviewing task orders, reviewing draft rules of engagement, and commander's intent in a dynamic, fast-paced environment. For example, determining which maritime task orders have been assigned, which require action, and who has the lead responsibility for execution are critical steps that would tremendously benefit from tools designed to support this type of tracking. The ability to display an ISR plan before it is implemented and to manage its execution, is a related task that is critical and could also greatly benefit from this type of support. Similarly, being able to easily track changes to the rules of engagement is essential. Once the effects-based planning and assessment process is firmly established, a well-thought out, comprehensive approach to aiding this process can be developed.

Some participants found it difficult to collaborate (using chat or voice) while conducting their functional tasks. This ability to engage in multiple chat sessions at the same time may be a skill that can developed over time, especially when the timeline is not artificially compressed as it was during the experiment. Collaboration needs to be a long-term, ongoing element of participants' daily jobs in order to facilitate their developing trust and confidence in both the process and the products. The artificial setting of an

experiment may have contributed to this difficulty. In the actual situation, players will have established relationships, which should facilitate the ability to maintain

7. Conclusions

A significantly more complex and time-compressed future planning and operating environment is envisioned for the future. Operators expressed a strong need for tools that will support their collaborative planning in these rapid decisive operations environments. It is cognitive behavior, the problem solving, decisionmaking, planning and the analytical aspects of the warfighter's actions, more than ever, that will be critical determinants of how the battle evolves. Command staff and C2 system operators rely on their own understanding of the battlespace to make critical decisions, and they must share this understanding with other decisionmakers. Staffs must collaborate to make decisions based on a shared understanding. C2 decisionmaking is a team process requiring a high level of interaction and a shared understanding of events in the mission space. Mission complexity, high operational tempo, and the nature of collaborative decisionmaking, combine to create a problem of high cognitive load among commanders and staff. This underscores the need for well-designed tools to truly support the planners and decisionmakers and to mitigate the effects of a C2 environment that is characterized by information overload and stress.

Some basic heuristics for tool design are listed below (from Shneiderman, Nielsen, Olson, and Krueger, 1994) with examples of things participants found lacking in the tools as they currently exist.

Visibility of system status. The system should always keep the users informed about what is going on, through appropriate feedback within reasonable time. Participants had difficulty determining which maritime task orders were assigned, which required action, who had the lead on which ones, which assets were assigned, etc. When reviewing rules of engagement, it was difficult for participants to know what had changed, and where the most current version was. A cognitive task analysis of the jobs to be performed should be used to develop tools that will provide the appropriate and necessary types of support.

Match between system and the real world. The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order. Users did have a clear understanding of how the new process and the tools were to work. Decision aids and tools should be designed to decrease the cognitive load for the planner. Provide ways to alert the user regarding maritime task orders, effects achieved, changes to mission, etc., to show the current status.

Consistency and standards. Users should not have to wonder whether different words, situations, or actions mean the same thing. Users wanted to have a framework to help them compare the traditional planning process with the new process to better understand which parts were similar and which were novel.

8. References

1. Alberts, D. S., Garstka, J. J., & Stein, F. P. (1999). *Network Centric Warfare: Developing and Leveraging Information Superiority*. Washington, DC. CCRP Publications.

2. U.S. Joint Forces Command. A Concept for Rapid Decisive Operations. RDO Whitepaper Version 2.0, J9 Joint Futures Lab, 22 August 2001, Suffolk, VA.

3. Hutchins, Susan G., Kemple, William G., Adamo, Ron and Boger, Dan (2002*). Knowledge Management and Collaboration in an Effects-Based Operations Environment*. Proceedings of the 2002 Command and Control Research & Technology Symposium, Naval Postgraduate School, 11-13 June 2002, Monterey, CA.

4. Kemple, William G., Hutchins, Susan G., Adamo, Ron, Boger, Dan, and Crowson, Jeffrey J. (2002). *Effects-Based Planning: An Empirical Examination of the Process.* Proceedings of the 2002 Command and Control Research & Technology Symposium, Naval Postgraduate School, 11-13 June 2002, Monterey, CA.

5. *A Concept for Rapid Decisive Operations*, RDO Whitepaper Version 2.0. (2001). U. S. Joint Forces Command, J9 Futures Lab, Suffolk, VA.

6. Smallman, H. S., Oonk, H. M., Moore, R. A., and Morrison, J. G. (2001). The Knowledge Wall for the Global 2000 War Game: Design solutions to Match JOC User Requirements. SPAWAR Systems Center, San Diego, Technical Report 1860, August 2001

7. Oonk, H. M., Smallman, H. S., Moore, R. A., and Morrison, J. G. (2001). Usage, Utility, and Usability of the Knowledge Wall for the Global 2000 War Game. SPAWAR Systems Center, San Diego, Technical Report 1861, August 2001

8. Shneiderman, Ben, Nielsen, Jakob, Olson, Judy, and Krueger, Myron. (1994). User-Interface Strategies, A Live Satellite TV Broadcast, University of Maryland at College Park, Instructional Television System, December 14, 1994.