TECHNICAL REPORT 1912
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Knowledge Engineering for Command and Control Transformation at United States European Command (USEUCOM)

Joanne Pester-DeWan
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ADMINISTRATIVE INFORMATION

The work described in this report was performed in the Simulation and Human Systems Technology Division (Code 244) of the Command and Control Department (Code 240) of Space and Naval Warfare Systems Center, San Diego (SSC San Diego) with Pacific Science and Engineering Group, Inc., under contract number N66001-99-D-0050. Funding was provided by European Command (EUCOM) to incorporate web technology capability in the EUCOM Theater C4ISR Coordination Center (TCCC).

Released by
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EXECUTIVE SUMMARY

OBJECTIVE

This report describes the results of knowledge engineering conducted during the period 20–31 October 2003 at the request of the United States European Command (USEUCOM), commonly referred to as "EUCOM." The work is intended to identify baseline technology utilization and operational practices, which might then be used to assess the impact of changes brought about as they transform the command in accordance with guidance issued by the Office of the Secretary of Defense (OSD). The transformation can be characterized as a desire to move from a command organization focusing on the oversight and facilitation of communication and coordination among subordinate operational units to a concept of operations known as Standing Joint Force Headquarters (SJFHQ), which will involve network-centric, command and control (C^2) capabilities, with increased speed of command, greater flexibility in addressing command operations, as well as more efficient use of limited staff manpower. The issues identified in this report are not intended as criticisms but as opportunities for change that would facilitate EUCOM in meeting its stated transformation objectives. The issues highlighted in this report are being provided to assist EUCOM in identifying opportunities for improvement and making strategic decisions in determining where limited resources might be most effectively applied. As part of this transformation, EUCOM has already implemented significant changes to their command facilities, introduced a number of state-of-the-art supporting technologies, and has begun the process of redesigning their organizational structure and developing new internal processes to support the SJFHQ concept of operations.

A fundamental aspect of C^2 and the SJFHQ concept is the efficient and effective use, management, and exchange of information and knowledge. Therefore, EUCOM senior commanders and staff are interested in better understanding how current and emerging information and knowledge management concepts, practices, and technologies might be adapted to meet their specific efforts. The objective of the effort reported here was to identify issues relevant to information and knowledge management at EUCOM and, where appropriate, to recommend changes to information and knowledge management policies, practices, procedures, and supporting technologies.

Additionally, since EUCOM is currently in the midst of the transforming to a SJFHQ concept of operations, the interviews conducted for this project are intended to serve as an early, informal baseline of attitudes, opinions, and perceptions of the EUCOM staff across a number of topic areas—a baseline that can be referred to as the SJFHQ concept evolves.

METHOD AND RESULTS

A multi-disciplinary knowledge management team led by Dr. Jeffrey Morrison of the Space and Naval Warfare Systems Center, San Diego (SSC San Diego) conducted semi-structured interviews with personnel assigned to, or directly in support of, the EUCOM Plans and Operations Center (EPOC). The EPOC is a central part of the transformation to a SJFHQ concept of operations and serves as the main command center at EUCOM. The EPOC brings together representatives from all of the traditional directorates, or "J Codes," to facilitate improved communication and coordination during the planning and execution of operations.

Interviews were conducted with 20 personnel from a variety of services, backgrounds, and organizational affiliations across several echelons of command. The interviewers encouraged discussion of a wide range of topics, including job roles and responsibilities; common tasks; standard operating procedures; technologies used (and a subjective assessment regarding the utility and usability of each); and general organizational, information, and knowledge management issues. Interviewees shared their insights and experiences, lessons learned, opinions regarding various

organizational issues, and their views on the strengths and weaknesses of current information and knowledge management practices at EUCOM. Twelve themes were identified across organizational groups and command echelons that are relevant to EUCOM's SJFHQ transformation process:

1. Lack of formal assessments/metrics for current and evolving tools/procedures
2. Inadequate training
3. Inadequate data and information management procedures
4. Lack of business rules/standard operating procedures
5. Difficult-to-use or unreliable tools/technologies
6. Unclear or conflicting tasking
7. Organizational/personnel strengths
8. Organizational/personnel issues
9. Briefings and other information products
10. Reliability and accuracy of some data/information
11. General attitudes and morale
12. Situation awareness (both mission/tactical and organizational)

It should be noted that this initial effort to identify knowledge and information management issues related to the SJFHQ transformation was limited in scope and therefore represents a relatively narrow view into the command's information and knowledge management environment (e.g., a small number of participants, relatively short, semi-focused/structured interviews, all participants were from a new organizational construct (i.e., the EPOC), interviews took place over the course of just a few days, etc.). Still, given the number and wide variety of personnel participating in the interviews, it is likely that these results are highly representative of the larger information and knowledge management environment at EUCOM.

RECOMMENDATIONS

Based on lessons learned from research and development supporting similar command centers, and established best practices in the fields of organizational psychology, human factors, and information and knowledge management, it is possible to develop and implement specific recommendations to address the 12 themes identified by the interviews. This report provides such recommendations along with supporting information to facilitate improved information and knowledge management at EUCOM. It is recommended that this report be seen only as an initial step toward achieving the transformation implied by the SJFHQ concept of operations. As specific interventions are identified for implementation during the transformation process, it is recommended that additional knowledge engineering be conducted to better understand the issues impacted by that intervention. Successful implementation will address technologies as well as the processes and business rules that make them work. Best practices for these interventions must be developed, captured, and formalized into a living document that becomes the basis for standard operation procedures. Lessons learned by individual staff members in instituting change should be captured and shared so as to maximize the value in lessons learned from across the command as well as from future staff members. Specific metrics for change should be developed as an integral part of the transformation process that assesses the impact the changes have on organizational effectiveness. Metrics such as personnel-hours required to complete specific critical tasks, rate and extensiveness of information dissemination, staff redundancy and conflicts, etc., would prove most useful and pervasive in assessing progress among

many of these issues. Finally, we recommend that change be facilitated using the best systems engineering principles, with a multi-disciplinary team of engineers and subject-matter experts.

RECOMMENDATION SUMMARY

Issue: Lack of formal assessments/metrics for current and evolving tools/procedures	**Recommended Solution:** Conduct detailed cognitive task analyses to develop specific, relevant metrics essential for measuring whether transformation to the SJFHQ concept of operations is a success[1]. Development of performance-based metrics can also be used for evaluating, measuring, and influencing the staff's attributes, behaviors, and outcomes.
Issue: Inadequate training	**Recommended Solution**: Develop and provide "EUCOM Basics" and "Core Competency" training courses and mentoring programs that can be provided onsite as quick-study courses compatible with watch schedules. The Core Competency course should address general policy and guidance associated with EUCOM's mission as a Joint command. The EUCOM basics course would review standard operating procedures, protocol issues in working with outside commands, etc., points of contact, and general policies and practices for working within the EUCOM command. Recommend this course make extensive use of online materials, accessible from anywhere in the command, and that resources be dedicated to treating these materials as evolving, "living documents." Supplement with appropriate, regularly scheduled classes.
Issue: Inadequate data and information management procedures	**Recommended Solution:** Adopt a network-centric information management system that supports a new and more effective way to rapidly collect, manage, display, and use information. Look at developing best practices guides, frequently asked questions (FAQs) archives, online communities of interest collaboration systems, etc.
Issue: Lack of business rules/standard operating procedures	**Recommended Solution:** Develop business rules and establish best practices that provide personnel with direction and guidance for using technology and accomplishing work activities. Maintain as a living library. Identify "expert" staff to serve as resources and mentors to reservists and detailees.
Issue: Difficult-to-use or unreliable tools/technologies	**Recommended Solution:** Develop a template-based order management system, a database/document management system, and a status tracking system. Additionally, develop a prototyping capability for new systems and track, identify impacts, and offer solutions for software changes to old systems. Establish a formal usability assessment process to assess and document changes from the perspective of those users who will be impacted by system changes.

[1] It is important to note the iterative nature involved in measuring organizational transformations.

Issue: Unclear or conflicting tasking	**Recommended Solution:** Develop a Web-based tasking management system that allows personnel to easily access, manage, and monitor task responsibilities, status, timelines, interdependencies, and implications. Make explicit areas of responsibility and procedures for resolving ambiguities in authority/responsibility before they become a problem. Empower working-level staff to detect and deconflict tasking to eliminate redundancy/inefficiencies.
Issue: Organizational/ personnel strengths	**Recommended Solution**: Considering personnel are motivated and open to change initiatives, solicit input with regard to development of business rules, policies, and training area needs from subject-matter experts. If corporate knowledge holders are leveraged, personnel will take pride and ownership in the change process and increase its chances for success. Create a climate that encourages and rewards change/transformation efforts, and is reasonably tolerant to failure. Establish formal procedures and entry/exit criteria for change/transformation. Consider mechanisms by which new tools and procedures can be prototyped in parallel to existing tools/procedures so as to create fail-safes until new tools and procedures are sufficiently mature for wide-scale adoption.
Issue: Organizational/ personnel issues	**Recommended Solution:** Avoid unnecessary movement of personnel trained in specific elements of the command for administrative reasons. Do not assign people based purely on clearance status. Ensure personnel have the needed training (e.g., "EUCOM Basics and Core Competency" courses), clearances, and computer skills prior to fulfilling their billets. Capitalize on Military Occupational Specialty, if possible. Attempt to identify "shortcuts," e.g., training, innovative administrative procedures, etc., to get the appropriate people the necessary qualifications prior to their arrival at EUCOM. Make a point of considering the opportunities for staff that will enhance their careers as well as meet immediate EUCOM needs. Such efforts should dramatically impact morale, quality of life, and ultimately command effectiveness.
Issue: Briefings and other information products	**Recommended Solution:** Revise briefing culture to a less formal Web-based approach to maintaining status information. Disseminate Commander's intent, priorities, information requirements, as well as senior staff feedback through Web tools. Such an approach will allow more rapid speed of command because current knowledge products will no longer be tied to the briefing cycle, and will allow increased efficiency because critical information will be available to a wider audience when they need and/or are better equipped to assimilate it, rather than forcing all work to stop among a majority of the staff during the daily briefing. Denote critical information with uniform change as well as criticality indicators.

Issue: Reliability and accuracy of some data/information	**Recommended Solution:** Develop and enforce policies to ensure information is accurate, time-stamped, timely, updated, and complete. Additionally, provide templates and examples to guide information providers when developing and producing information content and structure.
Issue: General attitudes and morale	**Recommended Solution:** Sufficient training, guidance, and business rules should allow for more evenly distributed workloads. Develop and implement onsite, condensed training options to fulfill career development requirements. Enforce policies for timely award completion. Identify those staff positions where there is a linear relationship between tasking and time required, and focus on those positions first in seeking improved efficiencies. Note: These positions also appear to be the limiting factors in the overall speed of command.
Issue: Situation Awareness (both mission/tactical and organizational)	**Recommended Solution:** Acquire or build a tactical tool that permits information producers to create interactive tactical pictures that provide value-added information and hyperlinks to other documents. Additionally, identify staff positions where numerous information products must be used concurrently. Consider the adoption of multi-display workstations, and/or build Web pages and business rules around a situation report page and a watch turnover pages for these staff positions first.

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1. INTRODUCTION

The Department of Defense is seeking to transform the way it executes its mission to better take advantage of the possibilities presented by modern technologies and the best business practices currently being used in industry. The United States European Command (EUCOM) is taking a leadership role in this transformation. At the core of the transformation effort has been the adoption of the Standing Joint Force Headquarters (SJFHQ) concept of operations. The most salient aspect of the SJFHQ concept of operations is changing the function of a joint headquarters from a traditional "communication and coordination center" to a theater-level agent responsible for command and control (C^2). EUCOM's SJFHQ concept of operations focuses on enhanced theater and mission analysis and planning, and emphasizes mission monitoring and execution as the means to address multiple, simultaneous, dissimilar joint operations more quickly, effectively, and efficiently. EUCOM's European Plans and Operations Center (EPOC)—a physical instantiation of the SJFHQ concept of operations—is designed to provide a core, cross-functional staff to organize, plan, and execute both short- and long-term C^2 of assigned forces and military operations in the EUCOM area of responsibility. The expectation is that this transformation will improve the effectiveness of both the fighting forces under their command and improved efficiencies and effectiveness within EUCOM itself. Implicit in the SJFHQ concept is the ability of EUCOM to do more with less, specifically in terms of the number of senior staff required to manage complex operations; the ability to make major command decisions quickly; and improved information management within EUCOM and across its subordinate command. However, the transition—in some ways a very radical transition—brings with it the potential to carry forward old ineffective business practices or introduce new ones. Additionally, with the new emphasis on C^2 (vice communication and coordination), tried and true methods of using, managing, and exchanging information and knowledge may no longer be efficient or effective. Fortunately, transitioning from old to new also provides many opportunities for incorporating new or improved policies, practices, and procedures, as well as the technologies that support them.

Senior leaders at EUCOM recognize that a successful transition depends on effective and efficient information and knowledge management. A key aspect of this transition is understanding current organizational, technological, and procedural strengths and weaknesses and then carefully leveraging these in ways that facilitates efficient and effective information and knowledge management to support the new SJFHQ concept of operations. Accordingly, the EUCOM leadership is devoting considerable effort toward optimizing information and knowledge management at EUCOM with the establishment of a Theater Chief Information Officer, and an Information Superiority and Knowledge Management group, as well as directing an independent, unbiased evaluation by three Knowledge Engineers/subject-matter experts, well versed in C^2 environments. This document reports the efforts and results from the knowledge engineering evaluation, based on semi-structured interviews with staff from various organizational codes and echelons at EUCOM, and relies on tools and techniques defined below.

Knowledge Management (KM): KM—broadly defined—is a "discipline for identifying, capturing, retrieving, sharing and evaluating an organization's information assets" (p. 1; Bair, 2000). At EUCOM, there are many kinds of information assets, including implicit and explicit expertise and experience resident in staff members, tools/systems that pull or push information, information products, lessons learned, business rules, practices, and procedures.

Knowledge Engineering: Knowledge engineering is a specialized field of engineering and analysis involving a variety of techniques and practices to develop effective and efficient tools, technologies, policies, practices, and procedures supporting improved task performance and

enhanced decision support. In other words, "knowledge engineering" is a high-level, umbrella term that actually encompasses a variety of purposes, methods, and goals. For example, knowledge engineering often includes efforts such as:

- Conducting focused interviews and cognitive task analyses to:
  - Identify information requirements for specific tasks as well as user preferences related to the use of that information in performing those tasks
  - Identify and document factors that affect cognitive task performance and decision making for various decision-making tasks
  - Develop recommendations for hardware, software, training, and business rules and practices
- Applying specialized knowledge of:
  - Relevant literature and efforts
  - Accepted "best practices"
  - Relevant standards, specifications, and guidelines
  - Relevant Systems Engineering and technical issues
- Developing storyboards/rapid prototyping to iteratively develop, test, and validate solutions to user needs
  - Develop storyboards/conceptual interface designs/drawings
  - Create semi- or fully functional concept demonstrations/software
  - Develop and implement experiment/data collection stimuli
- Conducting assessment/validation/verification/analysis
  - Conduct data collection and reduction
  - Perform detailed analysis and reporting
  - Develop change recommendations
- Providing documentation
  - Establish and document functional requirements
  - Create hardware/software specifications
  - Recommend business rules
  - Develop/publish training materials

Any or all of these efforts—and many others not listed—can be considered within the domain of knowledge engineering. As appropriate to the situation, scientists and technologists must apply these techniques to ensure that a system or process has been engineered to facilitate the acquisition, use, and sharing of knowledge for the benefit of the system's users. The application of knowledge engineering is based on the premise that system users must be considered as the center of the person–machine system– not as a component of the system, but rather *the reason that the system exists at all*. When system design, development, and acquisition efforts fail to take system users into consideration, the resulting system is often difficult or impossible to use, and technology tends to be much less effective. Technology is often not the limiting factor in modern systems. People are. Knowledge engineering, therefore, views human performance as an integral element to achieving total system performance that satisfies personnel's work task, and mission requirements.

Cognitive task analysis (CTA) applies cognitive science[2] principles to understand complex information processes as they relate to personnel performance when carrying out their job related tasks and responsibilities. To do so, CTA observes cognitive systems from the point of view of the

[2] Cognitive science: Study of the mental processes involved in perceiving, remembering, understanding, thinking (Neisser, 1967), attention, and awareness.

user/staff member, and identifies aspects of his thought process that place heavy demands on his ability to perceive and process information.

CTA is a useful technique for identifying the cognitive, perceptual, and physical factors that contribute to task performance. The purpose of CTA is to identify the actions, knowledge[3], and thought processes that expert users engage in when performing a task (Jonassen, Tessmer, & Hannum, 1999). The results of a CTA can be used to guide the development of performance-based measures for jobs that require complex cognitive processes. "All forms of cognitive task analysis rely on the premise that human action can be decomposed, and that the decomposition can be used to …" determine what people need to know in order to complete a task (Barnard & May, 2000, p. 154). CTA has been used to specify subject-matter experts' requirements in a wide range of settings, with different purposes, including expert systems for decision-support, policy-making, training, benchmarking performance for strategic improvements, and instructional design (Schraagen et al., 2000).

A typical CTA focuses on the cognitive aspects of work, such as the goals and objectives of users, how they create and manipulate information, and the workplace parameters in which they operate. As such, it focuses on the underlying knowledge, skills, and structures of task performance. In addition to knowledge, a CTA must also include the essential features of the environment, a description of how the task is conducted, and what makes problems cognitively complex (Jonassen et. al., 1999). Therefore, a CTA consists of not only a description of the actions (behaviors and decisions) that users perform, but also knowledge, skills, and abilities that are necessary to perform those actions. Thus, the focus is placed on:

- User Goals:
  - What is the purpose of the task?
  - What are the products, end points, or decision points?
- Information:
  - Type: What information is actually used?
  - Integration: How are the data being integrated and used?
- Processes:
  - Task: How is the task conducted?
  - Communication: How is information received, sent, and shared (among collaborators)?

Key to the successful conduct of knowledge engineering is the employment of a multi-disciplinary knowledge engineering team experienced in CTAs and similar knowledge management issues as well as possessing the requisite domain expertise. Our experience has shown that domains of expertise required for knowledge engineering should include human factors; cognition, decision support; knowledge management, e.g., business rules and procedures; subject-matter expertise related to information technologies that can support C^2 environments; cognitive task analyses; system support research to support rapid situation assessment; organizational studies; and performance-based metrics. The team responsible for this report has conducted numerous research, development, and assessment efforts associated with information and knowledge management. The efforts most relevant to EUCOM's recent transition to the SJFHQ concept of operations involve analyses focused on decision-makers in ship- and shore-based command centers, specifically Battle Watch Captains and other personnel in Joint Operations Centers (JOCs). These analyses described the existing JOC practices, policies, and procedures with regard to information and knowledge management, and revealed a critical need for improved display and information management systems.

[3] Knowledge: The structure or the organization of information (Hawkins, Levy, & Montgomery, 1988).

Our experience has shown how the implementation of even basic Web technologies can, when deployed with appropriate business rules and the adoption of standardized business practices for sharing information, achieve dramatic results. We believe many of the issues described in this report with EUCOM are readily amenable to similar solutions. As an example, one solution developed to meet information sharing requirements for the JOC was a Web-based system to quickly and easily develop and exchange high-level status information as a Web-based, dynamic "status board." The status board was an interconnected series of Web sites that were consistently formatted and used across various organizational elements. The Web status board served to rapidly disseminate high-level information such as commander's intent, as well as keep all interested parties aware of the status of executing mission plans. Information elements shared through this mechanism included course of action recommendations, graphical representations of the situation being discussed, and important alerts and projected impacts of events. The system also allowed for "drill-down" to more detailed or supporting information as required. With this solution, available data and information are processed, formatted, and stored by information "producers" in a way that represents meaningful, useful knowledge to "consumers." The system was designed specifically to support human cognitive processes such as data integration, pattern recognition, event memory, and distributed cognition. Additionally, it provides users with a shared operational picture to promote rapid acquisition and dissemination of situation awareness (Oonk, Smallman, & Moore, 2001; Schermerhorn, Oonk & Moore, 2002).

> **Situation Awareness (SA):** There are several definitions of SA (Jeannot, 2000; Royal Aeronautical Society, n.d.; Uhlarik & Comerford, 2002). According to Zhang and Hill (2000), SA encompasses information about relevant objects, their features and relationships, actions for supporting understanding the situation, and potential responses to events. Smith and Hancock (1995, cited in Uhlarik & Comerford, 2002, p. 5) define SA as "… the ability to produce competent performance by appropriately directing consciousness in a dynamic task environment." According to Dominguez (1994, cited in Jeannot, 2000), definitions of SA should include the concepts of extracting and integrating information, continuing direction of perception, and anticipation of future events. For purposes of this paper, we define SA as the completeness and accuracy of an object's (e.g., individual, team, senior-level staff) mental model of the situation. A complete mental model will include the object's perception of current and prior status of individual elements of the situation, comprehension of the relative importance or interrelationships between these elements, and projection of future events or conditions.

It should be noted that this initial effort to identify knowledge and information management issues related to the SJFHQ transformation at EUCOM was limited in scope and therefore represents a relatively narrow view into the command's information and knowledge management environment (e.g., a small number of participants were interviewed, interviews were relatively short semi-focused/structured, all participants were from a new organizational construct (i.e., the EPOC), interviews took place over the course of just a few days, etc.). Still, given the number and wide variety of personnel participating in the interviews, it is likely that these results are highly representative of the larger information and knowledge management environment at EUCOM.

2. METHOD AND APPROACH

2.1 DATA COLLECTION TEAM

The data collection team consisted of three experienced knowledge engineers who were responsible for conducting knowledge engineering interviews, focusing on issues relevant to information and knowledge management[4] at EUCOM; and where appropriate, to recommend changes to information and knowledge management policies, practices, procedures, and supporting technologies. All of the interviews took place 23–30 October 2003.

Members of the data collection team were situated within the Information Superiority and Knowledge Management (IS/KM) group's workspace at EUCOM, where all interviewees voluntarily attended knowledge engineering sessions.

2.2 PARTICIPANTS

The data collection team interviewed a total of 20 individuals. Eligible participants were solicited from personnel assigned to, or directly in support of, the EPOC. All eligible personnel voluntarily participated in separate knowledge engineering sessions lasting 1–2 hours, with the exception of one session in which two participants attended. Participants were from a variety of services, backgrounds, and organizational affiliations across several echelons of command, as listed in Table 1. Additionally, the majority of participants were Joint Staff officers and NCOs (Non-Commissioned Officers), as listed in Table 2.

Table 1. Number of participants by command type.

Command Type	Number of Participants
J3 Operations	13
J2 Intelligence	3
J4 Logistics	1
J5 Strategic Planning and Policy	1
IS/KM	1
J6 Command, Control, Communications and Computer Systems	1

[4] Information management is defined as the process, methods, and technologies by which people perceive the status, attributes, and dynamics of relevant elements in the environment, and then fuse these disorganized elements into a combined operational picture that is easy to interpret, store, and retain. Conversely, knowledge management is *specifically* defined as the process, methods, and technologies by which senior decision makers acquire and use fused information to project and predict future courses of action.

Table 2. Number of participants by rank.

Rank	Number of Participants
General	1
Captains/Colonels	2/1
Commanders/Lieutenant Colonels	1/8
Majors	4
Staff Sergeants	2
Civilian	1

2.3 INTERVIEW STRUCTURE AND DATA COLLECTION TECHNIQUE

The same procedure was followed for all interviews. After a general description of the purpose of the interview, participants were informed of their rights to confidentiality and future outcomes of interview findings—a preliminary out brief conducted on 31 October 2003 and a technical report (this report) detailing interview findings, methods, and suggested solutions.

The interview process involved a semi-structured discussion, wherein participants provided comments to many or all of the following categories:

- Demographic Information
  - Primary billet and time in position
  - Military Occupational Specialty
  - Types of work related training
  - Work experience
  - Knowledge, skills, abilities
- Job/Role
  - Description of job roles and responsibilities in the form of a walk-through of the participant's typical day. Information identified from this open-ended item includes:
    - Coordinating agencies with which the participant's exchanges information
    - Task priorities
    - Types of information products for which the participant is responsible
    - How and when information is shared, retrieved, and/or evaluated
    - Identification of work-arounds resulting from ineffective or inefficient tools/systems, information and knowledge quality, acquisition, and integration, and/or business rules, policies, and procedures
    - Tasks performed and a brief description
- Standard Operating Procedures (SOPs)
  - Are there developed SOPs? If so, are they complete, accurate, and up-to-date? Do SOPs guide day-to-day operations? Do SOPs assist new personnel in learning their jobs and areas of responsibilities? Do SOPs identify workflow processes, points of contact, and content inclusion for product completion?
  - What barriers preclude personnel from accessing, developing, and maintaining SOPs?
- Tools/Systems
  - What systems/tools do you use daily/often?
  - What are each tool/system's strengths and weaknesses?

  - How could tool/system improvement be made? If improvements were performed, how would it impact you (e.g., save time, decrease frustration, deliver essential information to more coordinating agencies)?
  - What tool/systems are needed to make your job easier?
  - What systems have been developed to help personnel with their job tasks/roles?
- Data Acquisition/Data Quality
  - With regard to your general job or role being performed, do you receive questionable, compromised, or unreliable information? If so, what is the effect of obtaining such information?
  - How often and from whom do you receive information that is questionable, compromised, or unreliable?
- Data Fusion
  - What unprocessed/raw data is processed or "fused" by decision makers or support staff?
  - How is this unprocessed information fused?
  - Who is responsible for this fusion?
  - Once fused, is it deemed as having high utility or value-added?
- User-Identified Strengths or Problem Areas
  - Describe strengths and/or problem areas related to your stated job/role, the organization, and coordinating agencies?
- Critical Event Discussion
  - Recall a recent, non routine event to determine to determine cognitive processes required, decision points, processes used to develop products, and supportive processes, information, business rules, and/or agencies used to accomplish the mission goals.
- General Comments
  - Participants were provided the opportunity to explore previous KM related comments or new topic areas.

Data collectors individually compiled open-ended and general comments made during the interviews, which then underwent an independent and group-level content analysis. It is important to note that all data collectors specialize in specific KM areas; as a result, individual level analyses were conducted from three complementary, yet independent, KM perspectives. A group-level content analysis led to the identification of KM strengths, issues, discussions/implications, and solutions. These factors are listed as 12 KM themes in the Results section of this report.

3. RESULTS AND DISCUSSION

The interviews with SJFHQ personnel identified 12 problem areas related to KM for the SJFHQ transformation at EUCOM:

1. Lack of formal assessments/metrics
2. Inadequate staff training, specifically with regard to Joint policy, internal EUCOM tools and procedures, and specific technical skills with EUCOM information systems
3. Inadequate data and information management practices
4. Lack of business rules/standard operating procedures
5. Difficult-to-use or unreliable tools/technologies
6. Unclear or conflicting tasking across organizational codes
7. Task assignments not being made based on organizational/personnel strengths
8. Organizational/personnel issues (quality of life)
9. Inconsistent and/or poorly understood briefings and other information products
10. Reliability and accuracy of mission-critical data/information unknown, or significance under appreciated
11. General staff attitudes and morale
12. Situation awareness (both mission/tactical and organizational)

Each of these 12 KM themes is discussed below, with paraphrased representative comments and supporting data indicating KM strengths, issues, implications, and opportunities for improvement. A discussion section and a solution section accompany each KM finding. Supporting evidence from previous research (when available), implications of KM themes, and recommendations for improvements are identified within each discussion or solution section. Accordingly, each KM theme can serve as stand-alone guidance for future action items.

It should be noted that data collection efforts were limited in scope because of the single, brief nature of our visit. Consequently, cognitive task analyses and information requirement development were not done, but are strongly recommended as part of future efforts to more thoroughly characterize the KM issues at EUCOM (as discussed below).

3.1 BACKGROUND OF INTERVIEWEES

The majority of the 20 participants were Joint Staff officers and NCOs with varying amounts of joint command post experience. Despite the fact that many officers and NCOs were present, a few participants identified themselves as an augmentee, reservist, or civilian. Twelve of 20 participants shared a broad range of experience that related to most key roles in the JOC, while others had varying amounts of experience in areas of IS/KM, J2, J4, J5, and J6.

3.2 KNOWLEDGE MANAGEMENT THEMES, DISCUSSIONS, AND SOLUTIONS

3.2.1 Lack of Formal Assessments/Metrics

Theme and Supporting Data

Issue: There are no established performance-based metrics or assessments.

Participants indicated there are no performance-based measures that signify if and when they are performing at an acceptable level. To this end, there are no baseline measures of performance. Comments related to this issue included:

- Gut feelings are used as an indicator of whether we are doing better or worse.
- I know that I'm doing a good job when the boss does not get any phone calls regarding system failures.
- I'm unsure of which measures would reveal whether I'm doing a poor or good job.
- I do not receive any feedback indicating if the information I distributed was received, used, or useful.
- Currently, there are no assessments/metrics that I'm aware of.

Discussion: Without established assessments and metrics, EUCOM cannot measure whether transformation to the SJFHQ concept of operations results in improved performance or whether additional modifications are needed.

EUCOM has not developed baseline measures of performance essential to future SJFHQ performance comparisons; this will negatively impact EUCOM's ability to measure whether transformation to SJFHQ concept of operations is successful. Additionally, personnel are unaware what is expected of them and do not receive performance-based feedback to make improvements, if needed.

Solution: Conduct CTAs to develop specific, relevant metrics essential for measuring whether transformation to the SJFHQ concept of operations is a success[5]*. Development of performance-based metrics can also be used for evaluating, measuring, and influencing staff's attributes, behaviors, and outcomes.*

Performance appraisal (PA) is a formal system of evaluating, measuring, and influencing personnel. PA systems serve an important purpose in developing, managing people, and meeting organizational goals (Murphy & Cleveland, 1995). Underlying any good PA system is a well-designed, formal, and structured procedure of data collection that is used to develop valid and sound assessment metrics.

Performance is identified as the sum of human action and tasks in a specified environment under specified conditions, which reflect the knowledge, skill, and abilities required of personnel to meet EUCOM performance standards. By definition, performance is exclusively those behaviors or actions that are relevant to EUCOM goals and that can be scaled in terms of each individual's competencies. Therefore, Campbell, McCloy, Oppler, and Sager (1993) assert that performance is not the result of action, (as believed in classic theory) but is the action itself. This distinction is confusing in that "behavior is not always observable and can only be known only by its effects" (p. 40). However, actions such as solutions, statements, or answers produced as a result of covert cognitive behavior and totally under the control of the individual are considered points of performance.

[5] It is important to note the iterative nature involved in measuring organizational transformations.

CTA[6] allows researchers to link the concepts and reasoning behind complex cognitive processes to measurable behavior (e.g., duration of time to complete a specified task relevant to task mission completion, etc.). Its true potential is most evident when applied to tasks composed of complex, unobservable cognitive processes, such as those found at EUCOM. Therefore, CTA is recommended as a method for metric and assessment development. CTA provides a rich source of information that can be used to create human performance metrics and assessments/instruments[7].

CTA is the vehicle for baseline development and specifies the "way things are currently done." Not only do CTAs provide a description of the functional mechanics of EUCOM's major tasking components and how they combine to achieve its end goals, CTAs can serve as the fundamental guide for implementing change. Correspondingly, CTA can provide an overall blueprint for procedural, structural, and cultural improvements to support the SJFHQ concept of operations. To this end, comparisons between baseline values of performance and performance of the new concept of operations will provide valuable input to senior management and personnel throughout the EUCOM organizational transformation. It is important to note that successful assessment efforts are highly dependent on a systematic and continuous measurement process: a process of continuously measuring and comparing EUCOM organizational processes against previously developed organizational processes to identify possible beneficial actions.

3.2.2 Inadequate Training

Themes and Supporting Data

Issue 1: Formal job training and supporting guidance is obsolete, unknown, non-existent, or insufficient in meeting the needs of personnel currently being assigned to EUCOM staff.

Personnel universally indicated that on-the-job training (OJT) or "trial by fire" is the typical method of training. It is generally assumed that new staff has requisite training before they are assigned to EUCOM; however, this is often not the case. Additionally, personnel stated that both formal training and training necessary for coordinating agencies is not made available. OJT is hampered or ineffective due to negligible opportunities for hand-offs between outgoing and incoming staff. Further, rapid turnover of temporary staff precludes building of adequate knowledge before the next duty rotation. Representative comments expressed by participants included:

- Continuity plans or other supporting guidance are non-existent, incomplete, or not easily found on the shared drive.
- Lack of time or support as regulated by EUCOM policy to attend Joint Staff Force College (JSFC), a needed prerequisite for career development.
- Many of the current technology-based trainings are not useful.
- Joint Analysis Center, a coordinating/collaborating agency, does not understand EUCOM's organizational structure, procedures, and/or informational needs.
- We have struggled to learn the requirements and roles of our jobs, with little or no support from lessons learned, continuity books, guidance, or useful training courses.

[6] Previously defined in this paper (see p. 2)

[7] For example, metrics and assessment may be used to examine quality (e.g., information, work outputs/products, decisions), quantity (e.g., rate of throughputs such as messages per unit time, number of critical information updates per unit time, number of relevant versus irrelevant information feeds), timeliness (e.g., amount of time taken to gather, develop, and distribute information), SA (e.g., degree to which team members perceive and understand the events in the situation and can project future action items).

- OJT would be the best method for training, when integrated with mentoring, lessons learned, sample work products, and other supporting documents. However, many experts or experienced staff do not have the time to develop new staff through one-on-one mentoring, or create continuity books, sample work products, business rules, point of contact lists, and lessons learned.

Issue 2: Staff lack the knowledge, skills, and abilities (KSAs) needed to fulfill the needs of EUCOM tasks or to gain proficiency in task performance.

Participants reported that the reduction in permanent staff positions has resulted in an increase in augmented staff (reservists and temporary assigned duty personnel), who lack the experience and KSA required to perform critical tasks. Likewise, personnel who are considered the corporate knowledge holders or knowledge experts in a particular field are frequently moved to other areas of the command where they are functionally novices. Typical comments with regard to this issue included:

- Personnel arriving at EUCOM do not possess basic computer skills or knowledge of best practices.
- Large portions of our staff are reservists and augmentees, who often do not have the expertise needed to gain proficiency in job and task performance.
- Bringing augmented personnel up to a level of proficiency is a time-intensive process that ranges from several months to a year or more.
- High performing personnel are moved to other areas of the command due to secondary issues such as having required clearances rather than being assigned based on competency, and then are replaced with new, inexperienced augmentees and staff. Note: movement of staff reportedly occurs as a direct consequence of lack of security clearances for personnel who arrive at EUCOM and high turnover rates of surge personnel.

Discussion/Implications: Organizational efficiency is suffering as a result of a lack of standardized training.

Due to lack of standardized training, job consistency, and experience of augmented staff, EUCOM organizational efficiency is reported to have suffered in a number of areas including speed of command, quality of work, and accuracy of requested information. Achieving organizational efficiency will require appropriate and calculated training programs that foster knowledge development of EUCOM mission, policies, procedures and position-specific KSAs. EUCOM senior leadership has emphasized that knowledge is an absolute prerequisite for success in meeting EUCOM organizational transformation and information superiority goals.

Solutions: Develop and provide "EUCOM Basics" and "Core Competency" training courses and mentoring programs to be available at EUCOM. Develop a training strategy and process evaluation. Identify critical skills and the assumed background knowledge expected for critical staff positions. Develop strategies for providing onsite short courses to address critical competencies on an as-needed basis.

EUCOM's most valuable resource is its human capital. As EUCOM undergoes organizational changes to its culture, goals, and structure, it is critical to bolster KSAs of the existing workforce to match the need, vision, and mission of the organization. Correspondingly, three types of continuous learning efforts should be developed and provided to all personnel, and possibly a few supporting agencies (e.g., Joint Assessment Center [JAC]): (1) a "EUCOM Basics" course, (2) a "Core Competency" course, and (3) a mentoring program to assist in transition with staff rotation.

Additionally, a condensed Joint Staff Force College (JSFC) course could be offered to those personnel who are interested in career development in lieu of being sent to the war college for an extended period of time. The EUCOM Basics is envisioned as an indoctrination course that personnel would attend onsite[8] to achieve familiarization with the organization's mission, vision, critical points of contact, policies, and procedures. Likewise, the Core Competency course would be attended by personnel onsite, but would provide position-specific desired behaviors[9], knowledge, skills, and abilities. It is recommended that Core Competency courses be augmented by assigned mentors using supplemental learning aids such as best practices, technical tips, work-arounds, lessons learned, continuity books, guidance, standardized templates, established lists of points of contact (POCs) , and quick reference guides.

Interviewed personnel strongly suggested that all learning aids should be captured and shared for reference purposes in both an easily explorable online form and in hard-copy format (e.g., quick reference guides). Additionally, personnel requested the distribution of frequently asked questions (FAQs) and tutorials annotated with usage tips for major tasks. Lastly, personnel suggested the dissemination of system learning aids and POCs for technical assistance. Lesson aids captured in electronic format should be well organized, easily accessible, and supplemented with search engine capabilities. Through these recommended measures and by adopting a culture of continuous learning, EUCOM can invest in both its own human resources as well as the ability to adapt to any transformation challenges.

A Caveat

The scope of successful training programs is not limited to classroom teaching in and of itself, but also requires forethought with regard to training strategies. Developing an effective training strategy involves many steps, starting with the identification and validation of training needs and ending with the evaluation of how effectively new KSAs are applicable to and supported by the performance environment. Erroneously, training is often considered to be limited to the training session during which employees learn new KSAs. This specific training session, however, is just one piece of the process in which new KSAs are not only acquired, but also integrated into an organization. Each organization acts as a unique system, and training is an intervention that affects many aspects of that system to various degrees. Correspondingly, there are many aspects of the system that can either help or hinder the success of a training intervention. These factors should be considered in the design of an effective training process.

By evaluating the training process, EUCOM can gain a comprehensive picture of how specific training exercises fit into the bigger organizational picture, and of how training dollars impact organizational performance.

Training Process Evaluation Components

- Identification of training and organizational objectives
- Evaluation of current training processes (plans and practices)
  - Identification of steps/functions that are not executed as planned
  - Identification of steps/functions that are practiced despite plans
  - Mapping of plans and practices to objectives

[8] Supporting agencies could attend EUCOM Basics by means of video teleconferencing or computer-based training.
[9] Some examples of desired behaviors provided during the interviews included: "Successful performer is self-motivated, inquisitive, and aggressive—must work to project needs of other staff and senior leadership. Waiting for things to come to you is a kiss of death to your own and overall mission effectiveness."

  - Assessment of training intervention strategy
  - Identification of strengths/weaknesses (with respect to organization objectives)
- Design and implementation of revised training concept of operations
  - Procedures for conducting training needs assessment
  - Recommendations for distribution of training content development
  - Recommendations for training intervention/implementation
  - Procedures for KSA evaluation
  - Procedures for evaluation of training transfer
  - Procedures for evaluation of training effectiveness (with respect to EUCOM's organizational objectives)

3.2.3 Inadequate Data and Information Management Procedures

Theme and Supporting Data

Issue 1: Data and information are abundant, but not organized and accessible.

Participants revealed that data and information, posted on a shared drive, are not organized by any business rules such as naming conventions or use of command specific folders. Consequently, personnel reported difficulty in locating and accessing needed information. Comments that speak to this issue included:

- The Public drive or "P drive" hosts valuable information; however, it is unknown where to locate and/or access this information. One participant summarized the problem when he stated, "the biggest problem is knowing where to find what you need—and then getting it."
- Electronic documents are not archived and are often lost.

Issue 2: Access/permission issues that extend from network drives to Web spaces are problematic.

- Often, linked information is stored in password-protected locations that we do not have access/permissions to.
- When accessing information on our network, the links are frequently broken.

Issue 3: Managing e-mails is problematic.

Participants reported difficulty managing an overwhelming volume of e-mail traffic. Comments made related to e-mail issues included:

- I receive up to 150+ e-mails a day—most of which are spammed or irrelevant to my job duties.
- E-mails are not tagged with status, importance, relevance, or timeline cues.
- We spend a lot of time reviewing our e-mail content and deciphering its underlying action items, status, and importance.
- Using Microsoft® Outlook® has its benefits and consequences to information management. A benefit of Outlook is its ability to automatically store, save/archive, and sort (by date, from, and subject only) my e-mails messages. Often, I refer back to my stored and saved e-mails for clarity of my taskers and for cutting and pasting needed information into DEP or Op requests. However, Outlook does not allow me to sort my e-mails by user-defined categories, block irrelevant messages, tag time-critical e-mails, or flag important e-mails that are sent from senior-level management.
- Reviewing and manually sorting e-mails are time consumers that occupy a large portion of my workdays.

- E-mail is an ineffective form of communication.

Discussion:

EUCOM personnel manage the majority of their data and information through three independent means: the shared drive, e-mail, and the morning brief. Interview data revealed that reference-based information and materials are managed on the shared drive, dynamic information is shared and managed by e-mail, and static information is distributed and managed during the morning brief. Participants reported that current data and information management means are inefficient and ineffective because of information stovepiping, staff inability to search, locate, and access information stored on the shared drive, and difficulty in tracking information content contained within the many daily e-mails pushes. Subsequently, personnel are unable to determine the status, attributes, and dynamics of relevant elements in the environment, and thus unable to fuse these disorganized elements into a combined operational picture that is easy to interpret, store, and retain. If personnel were equipped to locate, access, and fuse multiple information sources, senior-level leaders and staffs could easily determine its relevance to operational goals. In addition, senior decision makers could use this value-added knowledge when projecting and predicting future courses of action (COAs).

Interview results clearly reveal the need for shared SA by bringing multiple sources of information together on large-screen shared displays. The Proximity Compatibility Principle (PCP) from the human factors literature (Wickens & Carswell, 1995) states that all information facilitating task completion should be integrated as much as possible into a coherent display. According to this principle, tasks that require users to integrate information are best served by well-integrated and easily understood displays. Many cognitive tasks performed by EUCOM personnel require decision-makers to rapidly fuse information from multiple sources. Currently, these sources of information are distributed spatially within EUCOM or at remote locations (e.g., JAC), and monitored individually by different officers and NCOs. In order to acquire and maintain accurate SA, seniors rely on these officers and NCOs to present them with accurate and relevant data, which then requires rapid assimilation to information and experiences already possessed. Alternatively, a more dynamic Web-based approach is suggested and discussed below.

Solutions:

Effective command-level functioning requires a high level of SA. To support improved SA, information received at different times, from different sources, must be fused together in a format that is both meaningful and useful. Through this process, the raw information is transformed into knowledge. Due to the diverse nature of the information received, EUCOM is in need of a significant departure from common practice, where nearly all information is stovepiped and managed by e-mail, the shared drive, and the daily brief[10], to a network-centric information management system. Specifically, it is recommended that EUCOM use the Web as a collaborative information management tool to provide a new and more effective way to collect, manage, display, and use information. This tool will address support for shared SA by bringing multiple sources of information together in one shared environment.

Through use of Web-based technologies, senior and junior personnel alike have the ability to create Web pages and sites to store and present knowledge in an easily accessible and dynamic environment. Fundamentally, adoption of this Web-based approach is intended to allow personnel to

[10] Issues concerning the daily brief are discussed in detail below.

share operationally relevant information with senior leaders and their staffs. Within this network-centric environment, data is processed, formatted, and stored by "information producers"[11] in such a way that it represents meaningful knowledge to the "information consumers." To facilitate information production, a number of tools have been designed in the past to meet 14 user requirements determined through cognitive task analyses with JOC senior staff (Moore & Averett, 1999; Smallman, Oonk, & Moore, 2001a). Many of these requirements were echoed in the knowledge engineering interviews at EUCOM. Specifically, these needs included shared SA, integrated information, intuitive graphical interface, consistent look and feel, supplemental information, mission goals and objectives, connectivity/collaboration, cognitive support, drill-down, information age and reliability, flexible configuration, and tactical overlays. Given the successful implementation of these tools (Majeranowski, 2003; Oonk, Smallman, Moore, & Morrison, 2001; Schermerhorn, Oonk, & Moore, 2002), and similarly expressed user needs among SJFHQ personnel, we are recommending EUCOM adopt these previously designed concepts and tools as a model or "how-to guide" for building their own customized Web-based information infrastructure.

Web-Based Concepts and Tools

A number of tools have been developed to facilitate the production, formatting, dissemination, and Web-based presentation of information so that it is easily shared and understood. These tools allow information products to be created and continually updated by information producers. The network-centric concept is composed of information products, which are stored in shared locations accessible to information consumers via a standard Web browser. Other Web-based tools allow consumers to easily access and flexibly configure the display of the information products on large or multi-monitor display systems. A schematic of the Web-based concept is shown in Figure 1. The following sections describe the major products stored in the network workspace, and the hardware and software tools used to create them.

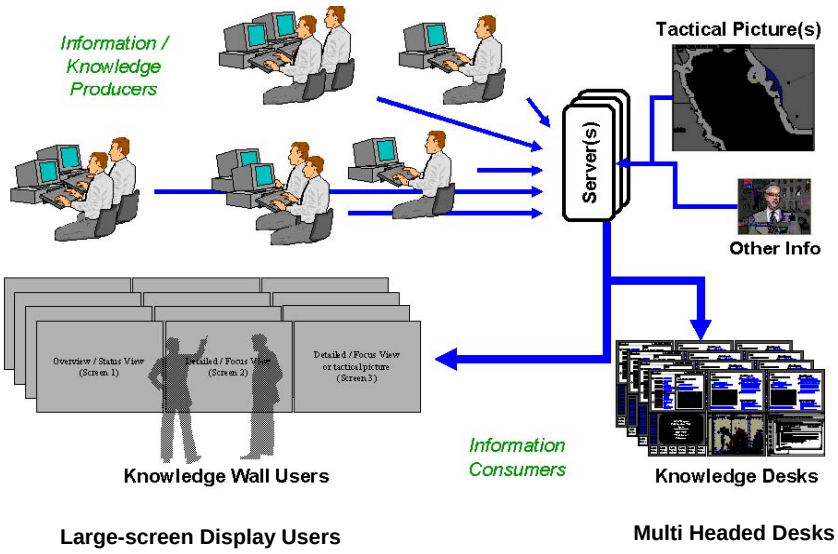

Figure 1. Concept diagram of the Web-based concept.

[11] " Information producers" process data and store resulting information in a way that represents meaningful knowledge to consumers. "Information consumers" then access this information for decision making and situation awareness.

Tool: Summary Views

Summary Views, created by the various information producers, are the "entry points" to the functionally based (e.g., intelligence, operations, logistics) Web pages. They function as high-level views of the operational picture consisting of single-page distillations of current status and events, critical updates, related information, relevant graphics, etc. These pages are designed to enable users to rapidly gain SA of the overall mission status through a consistent and intuitive graphical format. Consistency in the placement of information on displays conforms to human factors principles for information presentation, and allows users to scan for information efficiently and to integrate information from multiple sources (Mayhew, 1992; Wickens, 1992). Consistent formatting also allows users to acquire and integrate information rapidly from multiple Summary Views and to prioritize knowledge retrieval from the Web. An example Summary View is shown in Figure 2. Summary View features include:

- Color-coded operational status information across three time periods: Today (within 24 hours), Tomorrow (24–48 hours), and Long-Range (more than 48 hours) and three colors: Green (least critical), Yellow (moderately critical), Red (most critical).
- Alerts, impacts and links to status-related information.
- A "focus area" for a picture or other document related to the operational situation.
- A time stamp indicating when the Summary Page was last updated.

Most elements on the Summary Views can be linked to additional information (using hyperlinks) to initiate drill-down access to more detailed information. Information producers may link to Web pages (including other Summary Pages), Microsoft Office® documents, graphics, and many other types of information.

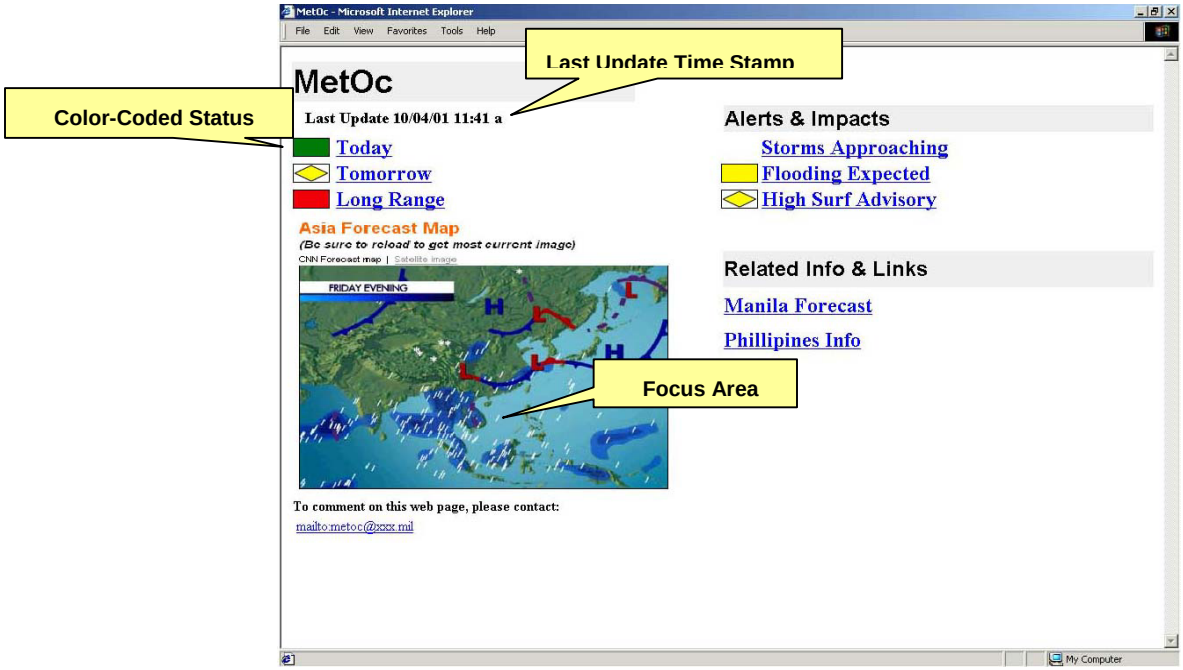

Figure 2. Example Summary View.

Hardware: Knowledge Web Viewer Hardware

Large-screen displays (LSDs) are used to access the Web-based knowledge and information. Specifically, a wall-sized shared display consists of contiguous display windows that bring together information from multiple sources. The fundamental concept behind the LSD is that providing a processed and fused presentation of the "information space" on a single large display should support cognitive processes such as data integration, pattern recognition, event memory, and distributed cognition among information consumers. The LSD is intended to be large enough to provide a shared operational picture to multiple personnel, to promote shared SA, and to provide focus for collaboration among its users (Bolstad & Endsley, 1999). Smaller single-user displays also facilitate Web-based information consumption and have the additional purpose of information production.

Tool: Web Software

Several Web-based software tools have been developed that enable:

- Information producers[12] to easily create and disseminate the Web-based information products.
- Information consumers to easily access and configure the display of these products.

These tools were developed using an iterative design process, involving (1) the identification of core information requirements via structured interviews with subject-matter experts (Moore & Averett, 1999; Smallman, Oonk, & Moore, 2001b), (2) development of basic design requirements and storyboard concepts by human–computer interface designers, (3) review of these concepts by subject-matter experts and selected fleet representatives to determine how well they met the identified needs, (4) reevaluation and reworking of these concepts until they met with approval with regard to function and features and (5) development via rapid prototyping. This process has yielded Web-based tools that are both easy to learn and feature easy-to-use interfaces that facilitate rapid production, dissemination, and access of information and knowledge-based products. Features that are familiar to most users, such as "point-and-click" and "drag-and-drop," are included where possible, while unnecessary features and functions are suppressed or removed. The Web-based tool set includes the following software: operationalizing information templates, tactical tool, and Web Viewer.

Operationalizing Information Templates

Information producers can create and update Summary Views using software (Moore & Averett, 2000b; Averett & Moore, 2001) designed and developed to operationalize the information template approach.

Using this software, information producers with no knowledge of HTML editing can create HTML-based Web content. They can easily indicate status information (shape and color) using pull down menus and can add hyperlinks to most fields of the template. Once published, the similarly HTML-based Summary Views are made available on the LSDs using standard Web-hosting software (e.g., Microsoft's Internet Information Server). Because of the inherent flexibility of the software to display or link to virtually any kind of information product, the user gains the ability to provide all relevant information associated with each of the template information requirements. Figure 3 shows the user interface that supports the Summary View template.

[12] Producers process data and store the resulting information in a way that represents meaningful knowledge to "consumers." Consumers then access this information for decision making and situation awareness. It is important to note that users of this proposed Web-based concept could be producers, consumers, or both.

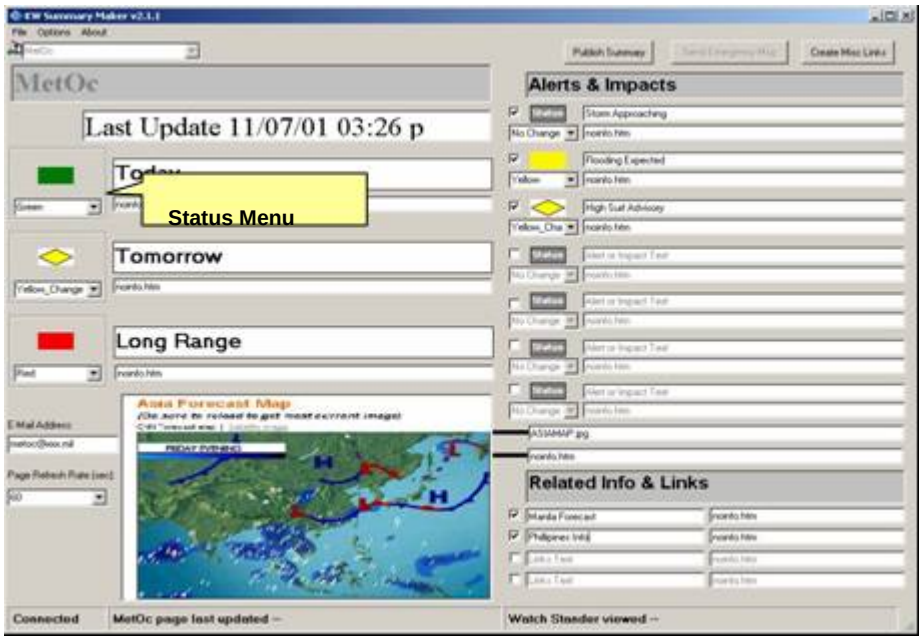

Figure 3. User interface for Summary View.

The Tactical Tool

TheTactical tool (Bank & Moore, 2000; Quinn & Moore, 2003), allows information producers to rapidly produce and distribute interactive graphics-based tactical displays with the additional ability to include drill-down, value-added information and hyperlinks to other information resources. An advantage of this tactical tool over currently used tools is that it enables multi-layered tactical graphics to be authored by novice users, published in HTML format, and later edited as needed (see Figure 4). This allows rich graphics-based information products to be quickly and easily developed in a single application, saving considerable time over the older, less efficient process of creating single-use, single-layered custom tactical graphics with a combination of nonintegrated applications (e.g., tactical software, various photo/art/drawing applications, and Microsoft PowerPoint®).

The Web Viewer

Information consumers can easily access and configure the display of Web-based information products using Web Viewer (WV) software (Moore & Averett, 2000a). WV software is a special-purpose Web browser that enables display and control of multiple browser windows on multiple monitors and facilitates navigation and display of information and knowledge residing in the network workspace. It also allows display of non-Web content, such as Microsoft Office software and products. WV software features a simplified set of familiar Web browsing controls that provide easy and rapid access to Web-based content. The software can be run on single-display computer systems but is optimized for clustered multi-display systems of up to six monitors. Figure 5 shows the WV software running on two displays. WV software may be used on wall-sized shared displays as well as on smaller, desk-sized units

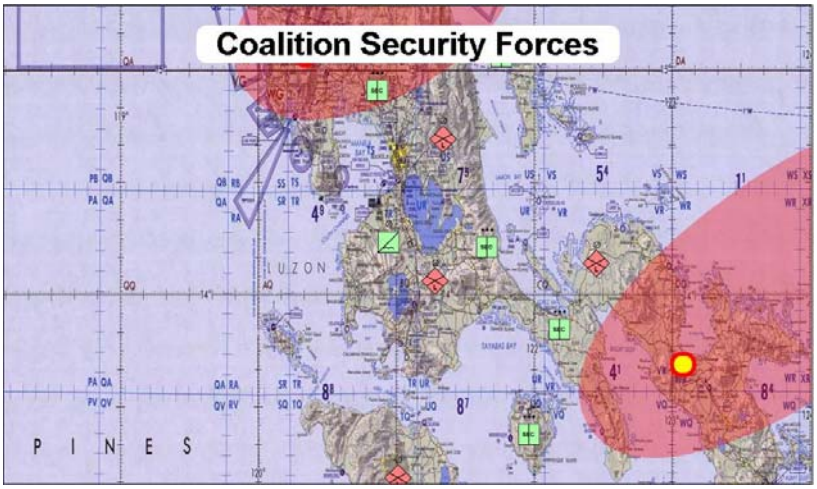

Figure 4. Example output created with the Tactical tool.

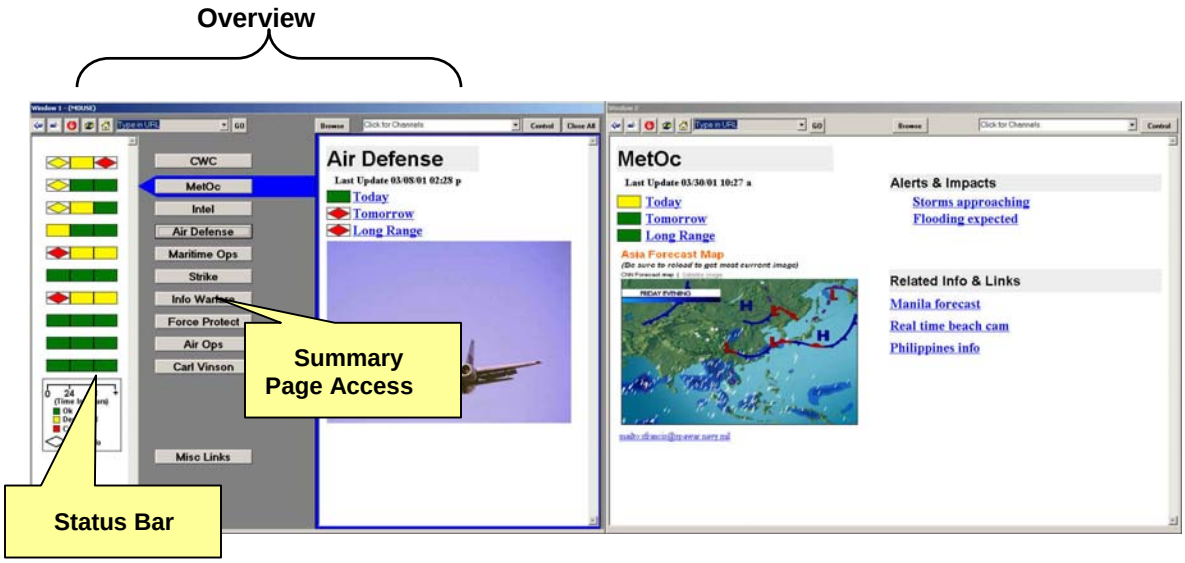

Figure 5. The Web Viewer: Two-headed display.

The WV "Overview," shown on the left screen in Figure 5, is both a shared SA tool and a Web-based navigation tool. To enhance shared SA, the Overview combines the color-coded status information from all Summary Views into a comprehensive status bar display. This enables consumers to view and quickly integrate information "at a glance" and thus maintain SA regarding mission status. Navigation features of the Overview allow users to easily access information in the Web. These features include:

- *Easy Access to Summary Views*: Each button on the Overview is associated with one of the primary operational cells that publish information to the network workspace. These buttons allow users to easily access a high-level status summary associated with each functional area by left clicking with the mouse on the appropriate button. If users want to see further information, they can easily display the entire Summary View (and drill down as desired) on any other WV window by right clicking on one of the buttons.
- *Text Color Change*: The color of the button text indicates which operational cells have published information since the WV user last accessed that Summary Page. This feature allows information consumers to instantly realize whether updated information is available from information producer cells.

When all parts (concepts and tools) are used in concert, the Web provides users with the ability to display and fuse information into a meaningful and useful format for quick consumption and informed action.

Along these same lines, a Web-based approach would provide persistent, interactive SA supporting transformation of the morning brief to a dynamic, on-the-spot information exchange system. Traditionally, Microsoft PowerPoint is used to brief senior commanders and their staff once a day. Often, staffs and support personnel use a variety of real-time and non-real-time resources to prepare these PowerPoint presentations several hours before the commanders are briefed. Therefore, information briefed to the commanders can be several hours old. In contrast, a Web-based approach provides continuous updates as events occur and features near-real-time information with the added feature of time-sensitive tags, providing commanders and staffs access to both current information and the priority of this information at all times. In short, all personnel, not only those who viewed the morning brief, could attend briefings already aware of critical issues, the latest intelligence, and current and unfolding events. As a result, the daily brief is transformed from an information dissemination meeting into a tactical planning discussion and guidance session. Additionally, transformation to a Web-based approach would free up commander and staff resources essential to prepare for the EUCOM organizational transformation (e.g., guidance development, posting lessons learned, developing best practices for communicating commander intent) and maintaining its success.

A Caveat

Success of a Web-based approach ultimately rests on EUCOM's ability to develop and enforce business rules. Implementation of a Web-based approach will require that personnel strictly adhere to these business rules when collecting, producing, displaying, and managing information in a Web-based environment. Best practices are identified linked activities that cross the boundaries of traditional operations, and therefore satisfy or exceed the needs and expectations of an organization. Business rules are the practices and processes that define how an organization works. For example, once business rules are identified, established, and distributed, personnel can refer to them to guide work-related behaviors, such as what is necessary and expected of them and others when performing their jobs. When business rules are used in concert with Web-based technologies, the SJFHQ team, composed of operational planners and information C^2 specialists, becomes a more efficient cross-functional unit with enhanced SA and improved responsive C^2 capabilities.

3.2.4 Lack of Business Rules/Standard Operating Procedures

Theme and Supporting Data

Issue: Best practices are not identified and business rules are obsolete, unknown, non-existent, or insufficient.

A consistent theme running through all interviews was that best practices have yet to be identified and business rules are obsolete, unknown, non-existent, or insufficient. This issue also has implications for the development of desired concept of operations. Comments that related to this theme were:

- There are no explicit business rules with regard to managing data and information on the shared drive:
  - No one cleans and deletes files on shared drives.
  - Documents and files are not tagged, stored, or archived.
  - Some staff link documents and/or folders that are password protected and therefore, do not permit others to access.
- Reference materials and guidance are either not developed or not posted in a central location.
  - We lack developed guidance materials and quick reference guides to assist us with our daily job duties, such as VIP lists, common acronym lists, shared POCs, coordinating/collaborating agencies home pages saved as "favorites," helpful links (e.g., search engines, weather links, Internet sites that are helpful in gathering intelligence and operations information), and shared calendars.
  - Certain directorates have created helpful reference guides and job guidance, but these are not stored in a central location for others to access. For example, an order tracker tool was developed in Microsoft Excel, but many are unaware of its existence, and therefore do not benefit from its utility.
- New technologies are not presented with best practices, quick reference guides, templates to automate routine tasks, help features, or references/POCs for technical and operational support.
- We are unaware or unclear of:
  - Tasking responsibilities, timelines, workflow processes, job roles, and responsibilities
  - Protocol for unique situations (e.g., intrusions, data spills)
  - When to use chain of command (some senior management use chain of command and other do not)
  - Authorized service interruptions (ASIs)
  - User manuals and fixes.
- Data/information dissemination does not include age, source, validity, changed information, and status of information. E-mail traffic excludes priority and nature of message (e.g., immediate taskers, for SA only, top priority) in the subject line.
- Currently, order development is an extremely time consuming and iterative process. Asynchronous and synchronous collaboration tools would assist us with real-time or near-real time development of orders.
- Often, senior-level staff is difficult to locate. In addition, we have no way of leaving messages for call back purposes.
- There are no set procedures on how or where to organize and display static versus time-critical information. Additionally, there are no business processes in place to make certain that information has been received.

Discussion:

Business rules, written or unwritten, are the practices and procedures that define how an organization operates. Written business rules provide a methodology for documenting what personnel should do (practices) and how (procedures), and are applicable to human and computer systems and informational architectures. Business rules therefore provide guidance to personnel with regard to simple and complex practices, procedures, and related constraints that govern the operation of a business on a daily basis. Simple business practices, for example, include such areas as:

- When should an operations (Ops) order be developed?
- Who should have access to Ops information?
- How should orders be distributed?
- What technology should be used to generate an Ops order?

There are also more complex procedures that describe and map the organizational processes of selected functional task units, such as the steps required by the J3 shop when developing an Ops order. This mapping process, typically illustrated in flow charts or diagrams, is composed of inputs (the task to be performed), throughputs (a list of action steps or activities required), outputs (products produced), personnel (individual or team/sub-unit) with tasking at these action steps, primary function performed by the personnel at each step (e.g., coordinating, compiling, synthesizing), and the flow of information/communication through the process.

Established business rules are a useful mechanism for evaluating how practices and procedures are currently implemented and identifying those areas that are no longer valid or useful, and therefore are in need of re-engineering. The output from such an evaluation is termed "best practices." Specifically, best practices are identified linked activities that cross the boundaries of traditional operations, and therefore meet or exceed the needs and expectations of an organization.

Currently, EUCOM has not mapped its business rules or established best practices that provide personnel with direction and guidance for using technology and accomplishing work activities. As a result, personnel are uncertain and/or confused about their job tasks, duties, and goals. Equally important, a lack of business rules and best practices diminishes EUCOM transformation efforts and its ultimate success. Business rules and best practices are powerful tools that communicate to personnel what EUCOM expects and needs from their personnel in order to achieve its vision of providing a real-time, network-centric, C^2 capability. The EUCOM transformation is not simply a matter of organizational structure alone but the establishment of an effective relationship between structure, staff, strategy, system, style, skills, and superordinate goals (the "Seven S's"; Mintberg & Quinn, 1991). Each of these elements incorporates unique behaviors and data formats, and thus requires an integrated set of business rules to cooperate seamlessly and efficiently.

Solution: Develop Business Rules and Establish Best Practices

The Comprehensive Solution

A business rules approach requires scoping (identifying specific areas of interest), discovery (documenting current business rules), analysis (evaluating what is working and what is in need of re-engineering), and design-to-implementation (developing, testing, and validating newly established business rules, and implementing to all personnel when refined). It is important to note that the design-to-implementation phase is an iterative, ongoing process that will result in long-term incremental improvements to EUCOM organizational operations.

To employ a comprehensive business rules approach, the authors suggest EUCOM establish a lab-based environment and acquire the skills of business process experts responsible for conducting

experiments in the lab that target discovery, analysis[13], and design-to-implementation phases listed above. The lab would be used to support a sample of EPOC representatives with the requisite expertise to operate as a cross functional team under specific routine and unique operational conditions. While performing under these conditions, business process experts would take the role of documenting business rules and making suggestions for reengineering the process. In addition, business process experts could perform periodic, random "freezes" throughout the experiment, where user (EPOC representatives) displays or work processes are temporarily frozen and experts could query users regarding suggestions to make business rules more effective and/or efficient. The intent is to leverage personnel expertise, while gaining "buy in" of the process. After completion of the first experiment, experts should have the data necessary to develop and modify business rules. A second experiment, using the same group of participants, should follow shortly and focus on the testing and validation of the newly developed business rules. Working in the same operational conditions, participants would walk through a simulated exercise wherein they would use developed business rules to carry out the experimental tasks. During the experiment, participants could freely comment on business rule accuracy and offer any additional suggestions for change. After any needed changes, business rule implementation could be initiated on a larger scale as a trial run with either a larger sample size or all personnel from the representative population. While this process would be required for all business rule developments across the EPOC, once established and disseminated, business rule management could be handed off to selected personnel. Similar to the "buy in" process discussed above, business rule management facilitates individual involvement in managing and changing the business rules, placing personnel in control of capturing, maintaining, and reporting business rule issues. Likewise, these personnel or rule managers could develop reference materials and guidance to assist personnel with routine job duties, and couple these with business rules that explicitly indicate where these materials are located and how others can add relevant reference materials to the shared location. Rule managers are charged with the development of technology-specific best practices, quick reference guides, templates to automate routine tasks, help features, and points of contact for technical liaisons and operational support. If new technologies are adopted, the appointment of rule managers must occur early in the developmental cycle to allow sufficient time for developing and distributing business rules and support materials slightly before technology installation.

Unwritten business rules also exist and include scenarios that are unique or rare. Although it is unlikely that each unwritten business rule scenario will frequently occur in a real-time operational environment, a situation that has not been analyzed in depth carries a potential cost that outweighs the benefits of ignoring these possibilities. Unwritten business rules can be taken into account whenever a process is developed or re-engineered, without the need to standardize every business rule scenario. The authors suggest an examination of these unwritten rules in depth, and an estimation of the risk to exposed EPOC personnel in each scenario. Once this risk is assessed, EUCOM may choose to take specific action for high-risk scenarios and to ignore other potential situations that carry lesser consequences. In such cases, unwritten business rules can be overlooked in an informed choice, and not in an unanticipated oversight with potentially dire ramifications.

Other Less Time-Intensive, but not as Comprehensive, Business Rule Solutions

Similar to the lab-based approach listed above, this method requires implementing a lab-based environment with day personnel responsible for developing business rules, job-specific reference/guidance materials, and technology-specific rules and guidance. Additionally, joint force exercises are valuable opportunities to build business rules and procedures.

[13] CTA, as previously discussed, could also be used to achieve the discovery and analysis phases.

Specific Business Rule Solutions Based on Comments Made in the Interviews

1. Identify "Public, Semi-Public, and Private" groups. Public groups allow junior-level staff to move less time-critical information to chat rooms, allowing watch personnel to maintain SA by monitoring key chat environments. Semi-Public groups allow personnel to chat in real-time and work in spaces designated for developing documents (e.g., orders). Private groups allow decision-makers to receive and review time-critical information, initiate chats and video teleconferences, and use whiteboard capabilities. Business rules for each type of group may involve designating a network workspace where shared revisions may be stored, maintaining participant lists of which elements should be invited to join the groups (e.g., JAC representatives and advisors), granting permissions for larger reader groups with limited writing privileges, establishing a shelf life (perhaps time based) of information, developing archiving rules and archiving information based on mission and personnel status, and managing access to these resources by user groups.

2. Build business rules regarding how to most quickly move the most time-critical intelligence to a designated location, indicate its priority, and be certain target personnel have received the information. Mechanisms for information transfer could include use of red phones to alert personnel of imminent threats, secure chat rooms to push time-sensitive intelligence, and Summary Views to rapidly tag and summarize time-critical information. Information should be tagged as having amplified importance when viewed by target personnel, while remaining unamplified when viewed by non-target users.

3. Build a reference library that provides watch standers quick access to a wide range of reference data. Reference data is a valuable source of information for on-the-spot cross-referencing, intelligence gathering, and condensing existing information into reports. Build business rules regarding the maintenance of a reference library, such as who should add documents, and what format these documents should take.

4. Build business rules regarding the creation of dynamic user-defined reference pages, including a current situation report page, updated continuously to reflect real-time unit movement/ origin/destination developments, status of troops and/or supplies, and consequent implications to mission objectives. Create an additional reference page for watch turnovers—a running log of indications and warnings for information passed from watch officers to action officers, allowing the quick assimilation of situation awareness for new personnel coming on watch. Create a tasking matrix, with key information on the personnel responsible for specific tasks, timelines, status of tasking, and mission goals—all linked to the reference page. Investigate supporting agency sites as resources for additional information linked to the reference page.

5. Use a Web-based approach for planning, briefing, and operations. To accomplish this, personnel must rapidly and continually populate the Web with mission relevant information, amplifying data, indicators of status, time stamps, impacts and implications, and reference materials. Web-based intelligence should be available at all times to all personnel that require it, and should take the form of Web pages that are user defined, functionally specific, and present an overview of all command elements. To successfully use and maintain a network-centric system, business rules are needed and may include, but are not limited to guidelines for when to post information, the identity of information producers and consumers, the meaning of status symbols, how best to present information (e.g., graphically, text), where to present time-critical versus less time-sensitive information, where to post reference material, who should be the point of contact for the Web pages, how to link information, and what information should be posted.

3.2.5 Difficult-to-use or Unreliable Tools/Technologies

Theme and Supporting Data

Issue 1: Official messaging tools are inadequate and difficult to use.

The majority of personnel noted major issues with the Defense Messaging System (DMS) and Automated Message Handling System (AMHS). Paraphrased representative comments related to this issue included:

- E-mail addresses are incorrect, the system is too slow, and releasing messages can be cumbersome.
- Updates to the Personal Address Book (PAB) are not announced or obvious.
- Searching for messages by use of keywords in AMHS does not work correctly.
- Both DMS and AMHS still use Napoleonic codes and require the users to manually sort messages.
- Messaging systems are inadequate. We need a better way to keep track of messages; the current systems do not provide search, archive, and filter tools.
- No one likes working with DMS; it needs to be Web-based, searchable, and easy to use.
- Systems do not automate routine tasks.
- We need a system to indicate force availability, deployment requirements, and implications to the mission.
- Given the number of orders, it is very difficult to track all related orders. Made much harder with Operation Iraqi Freedom (OIF) and abandoning of force flow process. Current requirement is to issue hundreds of operations orders. SECDEF [Secretary of Defense] seems to want much finer control and knowledge of who is doing what at the unit level. Very hard to keep track of which units are on which ships/which supplies are on which ships.
- We need a system to conduct real-time order development. Currently, the process is very iterative and time consuming. Also, with many amendments and supplements it is difficult knowing what the most current draft order document is.

Issue 2: Participants reported hardware, new systems, software changes to old systems, stovepiped databases, connectivity, and red phones are problematic.

- New systems are not tested before installation and therefore are filled with bugs. In addition, new tools do not support doctrinal processes.
- Red phone conference call system is not user friendly.
- Bandwidth is a problem.
- We need better, faster computers.
- Separate stovepipe databases that do not talk to one another or are not compatible with one another. USEUCOM should migrate to one LAN [local-area network] with multi-level security.
- Software changes were made to mission-critical systems without warning or any assessment of operational impact (e.g., AMHS). In addition, changes break existing best practices.

Discussion:

An increase in orders due to OIF, coupled with many tool and system issues, has resulted in personnel spending a large portion of their time performing trivial tasks (e.g., manually sorting messages, locating correct e-mail addresses, developing work-arounds, trying to figure out systems).

Consequently, these tasks have negatively affected workflow processes, timeliness and quality of products developed, information delivery, workload, and situation awareness.

Solution:

Solution for Message Tool

Messaging tools are in need of re-engineering. The development of three systems is recommended: a template-based order management system, a database/document management system, and a status tracking system.

A template-based order management system is suggested to assist personnel in quickly developing orders. A few elements should be taken into consideration when building an Order Management System:

- Build a tool that guides the user through steps in generating orders. A Microsoft Word® document template or something similar can fulfill this function. Ideally, this tool would have embedded references to applicable guidance documents, and generic samples.
- When building Word Document templates, find prototype orders that address similar or routine order topics. The preferred means of generating templates is to use successfully transmitted orders as prototypes.
- Revise e-mail fields within the templates. Considering the high personnel turnover at EUCOM, revise all e-mail addresses to reflect the title of the user instead of the name of the user.
- Supplement the system with a status Web page for all developing orders, with hot links showing force availability, who is available to fill deployment requirements, location of forces available, and projected implications.

A database/document management system is suggested for the order generation process, as well as an index that links to all related orders from the inception of the mission, sorted by both tasks and units affected.

- *Order generation process:* Select asynchronous and synchronous collaboration tools for managing real-time editing of orders. After development, archive orders to a shared location. For successful implementation, the development of business rules, technical support references and guidance to assist users with the selected collaboration tool(s) are needed. For example, chat rooms can enable real-time sharing of operations development and intelligence analysis. Consequently, the expertise of the JAC is available to the operating forces within minutes and provides a platform for rapid coordination and de-conflictions. In addition, it provides the ability to move intelligence more rapidly and seamlessly to the team members and move products and analysis at the theater level.

A status tracking system is suggested for tracking the status of all orders in progress. Create a status tracking Web page for all orders in process with hot links showing primary cognizance and current status in overall process (e.g., series of check marks with actual and anticipated completion for each phase). Also show drop-dead (late date)/anticipated date for handling of requests and summaries of status.

Solution for New System Installations

The authors recommend the development of a prototyping capability within EUCOM's KM division. The KM branch would validate all significant hardware, software, and space configuration changes through actual use by a limited subset of users. A notional concept of operations may include warfighters reporting to a prototype facility to do business as if they were performing in actual

command spaces: working through the same issues on the same day, but in parallel. This allows identification of what does not work, documents best practices and work-arounds, and focuses on developing processes and requirements via technical solutions.

Solution for Software Changes to Old Systems

Chart changes made to software anytime there is a significant change in software revisions and provide training guidance that identifies what has been changed and how to use the system, given the changes. In addition, identify what daily tasks are going to be performed by a significant number of people who will be impacted by the software change, then create a tutorial that quickly explains how to accomplish those tasks with updated software, hardware, or procedural guidelines. This tutorial is recommended for any software changes that could negatively impact mission-critical systems.

3.2.6 Unclear or Conflicting Tasking

Theme and Supporting Data

Issue: Personnel are universally frustrated with who is doing what and redundant tasking discovered after the fact.

Personnel are frustrated with who is doing what. Paraphrased representative comments and observations related to this issue included:

- Delegation of tasking is not tracked. At times, tasks are duplicated because staff is unaware who is doing what.
- Tasks can fall between the cracks despite personnel efforts because of unrelated activities (e.g., calling people to see who is doing what) that are unnecessary to the mission.
- E-mail is the current tool of choice for delegating tasks, but is often ambiguous regarding requests for actions, priorities, and expectations for follow-through.
- We spend a lot of time connecting the dots (e.g., who is doing what).
- It was embarrassing when multiple EUCOM personnel, including myself, duplicated a task that required reporting a specific answer to an external coordinating agency. After reporting my findings, the coordinating agency asked “Don’t you know what your own guys are doing?”
- I’m unsure why certain tasks are important to some seniors, but not others.
- Some personnel do not follow the chain of command, which makes tasking boundaries even more confusing.
- Trying to keep track of who is doing what, and how they are doing, is a full-time job in and of itself.

Discussion:

Personnel are frustrated with task uncertainties, duplicating efforts, and spend excessive time trying to figure out who is doing what. Interviews revealed this issue is particularly problematic with primary and secondary tasking across J-codes.

Solution:

Consider developing a Web-based task management system that allows personnel to easily access, manage, and monitor task responsibilities, status, timelines, interdependencies, and implications. Development of such a system can be built using Microsoft Exchange technology or Windows® SharePoint™ Services. In such a system, task managers (e.g., team chiefs) can delegate tasks, enter

descriptions of tasks, set milestones, and indicate task interdependencies and implications in a variety of graphic, text-based, and Gantt formats, while personnel can monitor and indicate task progression. Business processes are equally important as technical tools when designing a Web-based task management system. For example, an e-mail delegating a task to specific personnel can be sent, and a checkbox created on a task list that is associated with the staff's e-mail address[14]. Delegated personnel must indicate receipt of tasks by acknowledging the checkbox within a certain time. If personnel have any questions, a point of contact is provided.

Similar to the Web-based approach outlined above, tasking Web pages must have a similar look and feel throughout to promote intuitive use and support rapid acquisition of information. In addition, show primary cognizance and status of the overall process (e.g., a series of check marks with actual and anticipated completion for each tasking step), indicators, priorities, alerts, and amplifying information where needed.

3.2.7 Organizational/Personnel Strengths

Theme and Supporting Data

Issue: Personnel are highly motivated, believe what they do is important, and are open to change initiatives.

Interviews revealed personnel are highly motivated, maintain a positive attitude, and believe what they do is important and necessary. Staffs recognize the need for change and are willing to embrace change initiatives if it will improve the organizational process. Senior leaders have change infrastructure in place to support the organizational shift. A shift to the SJFHQ concept of operations provides EUCOM with an opportunity to facilitate and manage change.

Discussion:

Considering that personnel are motivated and open to change initiatives, solicit input with regard to development of business rules, policies, and training area needs from subject-matter experts. If corporate knowledge holders are leveraged, personnel will take pride and ownership in the change process and increase its chances for success.

3.2.8 Organizational/Personnel Issues

Theme and Supporting Data

Issues: Current manning levels are only one layer deep and do not allow room for expansion to handle crises/multiple missions or additional taskers. Often, personnel arriving at EUCOM are incapable of easing the workload.

Paraphrased representative comments and observations related to this issue included:

- There is a linear relationship between Ops tempo and number of hours we work. For many of the staff the normal Ops tempo is already 16–18 hours; during crises, the requirement goes to 72 hours.

[14] The ongoing task/e-mail list also serves as a useful a point of contact list if the task manager must contact those responsible for certain tasks.

- Often, personnel arrive at EUCOM underqualified, without proper clearances, and lack basic organizational or computer skills needed to perform their assigned job duties.
- Demand for reduced manning, recurring turnover, and reorganization of staff results in EUCOM's inability to handle crises/multiple missions or additional taskers.
- Inexperienced augmentees make up a large portion of the staff.
- Development of and preparation for the brief is personnel intensive, taking time away from additional taskers and ability to adjust to Ops tempo.

Discussion:

Currently, there is no method to adjust to the pace of operations or make accommodation for increasing tempo. Consequently, personnel do not have the time or resources to enhance theater analysis and planning, hindering EUCOM's transformational goals.

Solution:

Avoid movement of personnel trained in elements of the command. Ensure personnel have the needed training (e.g., "EUCOM Basics and Core Competency" courses), clearances, and computer skills before fulfilling their billets. Capitalize on Military Occupational Specialties (MOS) if possible. Finally, use a network-centric approach for day-to-day operations and on-the-spot briefs.

3.2.9 Briefings and Other Information Products

Theme and Supporting Data

Issues: Intent of morning brief is unclear; development of morning brief is labor intensive; feedback from senior staff is limited; Commander's information requirements, priorities, and intent are not communicated.

Participants revealed that the development process of the morning brief and a lack of communication with regard to the morning brief's purpose are problematic. Additionally, a lack of feedback from senior staff and guidance from the Commander results in task uncertainty among the staffs. Paraphrased representative comments and observations related to this issue included:

- No one knows the intent of the brief. The lower echelons of the command believe that morning briefings are to provide SA to senior commanders, but the upper echelons of the command believe the exact opposite.
- Brief is not worth the time being put into it.
- We spend too much time on the morning briefs. The night shift is consumed with briefing development and the day shift's personnel devote the morning (approximately 0600–1100) to its production (e.g., editing, multiple briefing evolutions, dry runs) and presentation.
- Limited and/or unclear feedback from senior staff causes knee-jerk reactions to respond to topics that require no actions or trigger a herd mentality—duplication of efforts/work by staff in an attempt "to keep the boss happy." This issue is aggravated by a lack of role clarity among senior staff so that multiple subordinates in different divisions are directed to address the same tasks whether or not it is appropriate.
- The Commander's intent is unclear and his priorities and information requirements unstated, resulting in a lack of closure at the end of the morning brief.
- Following the brief, senior staff adjourns to the Senior Decision Cell (SDC) where decisions are made and transformed into daily taskers that are delegated throughout elements of the

command. Staff stated decision choices are not shared with the lower echelons of the command, resulting in an unawareness of the overall mission and task interdependencies.
- There is an expectation that people in the JOC have the best available information at all times.

Discussion:

The morning brief is manpower and time intensive. In addition, once the brief is presented, information is not carefully tracked until the next briefing cycle. Instead, personnel are reacting to tasks that resulted from that day's morning brief. In addition, it is not obvious to personnel the purpose of the brief or what the General needs or wants today and how these vary from the previous day.

Solutions:

A two-pronged solution to this theme is recommended: (1) use the Web-based approach (described above) to conduct morning staff meetings[15] and (2) make Commander's intent, priorities, information requirements, and senior staff feedback explicit at the end of the morning staff meeting and distribute to all personnel as a Web page published shortly thereafter. The Web page can be posted within the task management system or on the overview page.

3.2.10 Reliability and Accuracy of Some Data/Information

Issue: Reliability of data is negatively impacted by aged information that is no longer valid and information provided by technology or other sources that is not complete.

Personnel revealed information reliability and accuracy is problematic. Paraphrased representative comments related to this issue included:

- GCCS [Global Command and Control System] tracks are not regularly updated. I can always notice when tracks are not updated, because they tend to migrate toward the center of the display for a period of time.
- Information displayed on the common operational picture (COP) is not reliable or very helpful to the user.
- Joint Assessment Center (JAC) doesn't always provide J2 with needed information.
- Information internally posted on the Web is not complete or accurate and therefore I do not trust it.
- I receive incomplete or vague order requests, which require much of my time in tracking down what the requestor really wanted.

Discussion:

Personnel spend a large portion of their time requesting, clarifying, and tracking down information, which would be unnecessary if information originally provided were correct and complete. Additionally, SA is compromised by displays that are not updated regularly or present unreliable and incomplete information.

[15] Because the Web-based approach is continuously updated with information, commanders will have access to current information at all times; as a result, they can attend the morning staff meetings already aware of critical issues, the latest intelligence, and current and unfolding events. This will allow the entire focus of daily meetings to shift from traditional updates and presentations to problem-solving and planning sessions.

A similar topic is the reliability of the information source. The source of information is a key factor for mid-level and senior-level staff in determining the value of a given item of information. Before making a decision based on displayed information, the observer must judge the trustworthiness of the source. For this reason, personnel should be provided with graphical indicators of how accurate the information is, the relative quality of the data, and the identity of the person responsible for developing the information.

Solution:

Development and consistent application of business rules are needed to overcome this issue. Specifically, business rules need to direct personnel to determine the following:

- What information is needed
- Who is responsible for providing or posting such information
- When does information need to be provided or posted
- How to present this information

In addition, provide templates or examples to guide information providers in what these information products should include and how they should be structured.

3.2.11 General Attitudes and Morale

Theme and Supporting Data

Issue: Work is unevenly distributed—staff members who are competent and motivated are overworked. Personnel do not know what is expected of them. Career development is stunted as a consequence of current policy and delayed performance awards.

Personnel expressed that morale is gradually decreasing, as a result of long hours, work and task uncertainty, and a lack of support for career development. Paraphrased representative comments related to this issue included:

- "EUCOM 50" does the majority of the work; i.e., there are approximately 50 personnel at EUCOM who do most of the work. It is critical to your job to find out who these people are, so that you're working with and talking to the right people. Most personnel must learn along the way who are the EUCOM 50—it would have been nice to have a point of contact list up front as well as their areas of expertise.
- Not everyone works long hours; there are many personnel who work their regularly scheduled hours.
- I'm working outside my MOS and am not challenged by my work.
- Many staff members expressed their frustration with regard to not knowing the Commander's priorities/intent, the status of tasking and/or resources for order completion, and the standards expected of them when performing their jobs.
- Resulting from EUCOM policy—all billets must be filled at all times—personnel are denied the opportunity to attend the Joint Staff Force College (JSFC), a needed prerequisite for career advancement.
- Awards are not handled in a timely fashion and, at times, have negatively impacted the staff (e.g., paperwork not completed until after staff have left EUCOM; career and/or pay advancements overlooked). Delayed awards are directly impacted by supervisors who are overworked, staff that is focused on and consumed with operations, and bureaucracy that slows

down the process (e.g., the amount of paperwork required and disparate departments handling the process).

Discussion:

Work distribution is uneven. As a result, otherwise motivated, qualified, and competent staff members are tasked more frequently. This leads to eventual degradation of work quality due to (1) a lack of time to develop high-quality products or (2) burnout. In addition, personnel who are denied JSDC classes, work outside of their MOS, and not provided with timely awards are frustrated with EUCOM practices and policies. An additional source of frustration is EUCOM's fragmented culture that leads personnel to work in a vacuum, often unaware of task interdependencies, duplication of efforts, and the existence of subject-matter experts who hold corporate knowledge.

Solution:

As mentioned previously, a condensed, onsite Joint Staff Force College (JSFC) course is recommended for those personnel interested in career development. Likewise, job and EUCOM specific training courses would help to even out the work distribution by ensuring that all personnel could perform the duties required of them, and would assist personnel in knowing what is expected of them. Coupled with Commander's intent, information requirements, and priorities, these additions would help improve morale at EUCOM. Mechanisms should be put into place to assess task distribution and look for tasking bottlenecks and define baseline performance criteria for various staff positions.

3.2.12 Situation Awareness[16] (Mission/Tactical and Organizational)

Theme and Supporting Data

Issue: Technologies and processes intended to support SA do not support personnel in gaining a shared mental model.

Personnel stated that common operational picture (COP), status of operations, available forces, actual and potential implication, and status of information are lacking. In addition, JOC turnover process is inadequate, and senior management is difficult to contact. Paraphrased representative comments related to this issue included:

- COPs are not built to meet consumer needs and are viewed by combatant commands as having low utility.
- SA with regard to status of operations, available forces, and actual and related potential implications are lacking.
- JOC turnover process "is inadequate" and would benefit from an improved implementation methodology.
- Status of new, changed, and released information is not explicitly known.
- It is difficult to contact senior-level staff on the phone, and there is no mechanism in place for leaving messages for immediate callbacks.

[16] Although SA is described throughout this paper, this section focuses on the *elements* of SA that are in need of improvement.

Discussion:

Currently, personnel build the COP daily by manually drawing single-use pictures over map images. Reportedly, not only is this process time consuming, but also does not meet user needs to perceive and understand the status of the situation. Similarly, status of operations, available forces, and implications are not presented on the COP or elsewhere. Personnel stated that the "boss" is always asking for status updates that are unknown to those individuals. Therefore, personnel spend countless hours on the phone attempting to ascertain situation status and awareness. An additional area of status that is not relayed satisfactorily is the JOC turnover process. Apparently, this process is neither fluid nor comprehensive and leaves many gaps in the status of past and current events. Finally, finding SA holders and senior staff when needed can be an issue. Personnel report that when they need to gain direction from senior-level staff, it is difficult to contact them by phone, and as a result, workflow processes are slowed.

Solution for the COP

The authors recommend that EUCOM acquire or build a tactical tool that permits information producers to create interactive tactical pictures that provide value-added information and hyperlinks to other documents. Additionally, the tool should provide multiple views of the tactical picture (e.g., ground and air, or on multiple scales, or multiple missions) with overlays that are easily published in a Web page. This allows graphics-based information products to be quickly and easily developed, saving considerable time over the current less efficient process of creating single-use, single-layered custom tactical graphics with a combination of non-integrated applications (e.g., tactical software, various photo/art/drawing applications, and Microsoft PowerPoint).

If the COP is viewed in a shared environment, position the COP in the center of the large-screen display(s). The display of supplemental information, beyond the tactical picture, should be presented on peripheral windows or monitors, thus surrounding and embedding the tactical displays in a rich context. It is important to note that peripheral displays must be visible and legible at a distance. Peripheral information could serve the purpose of alerting the user of updates or current problems related to non-tactical, supplemental information. Peripheral information may also include risk assessment/management discussions, communication status, weather information (with the primary focus on how weather affects other operations), and what assets (friendly and enemy) are available (Oonk, Smallman, & Moore, 2001).

Displayed data must be presented in a consistent format that is intuitive and easy to use. Staffs should display graphically intuitive images that do not need to be learned. Terms that are specific to particular command elements should not be included in shared display environments.

Solution for General SA

With increasing reliance of warfighters on information technology, a serious look into multi-display workstations is recommended. As a result of watchstanders typically integrating across eight or more different products/documents, they are continually switching between these documents to gather information and gain SA. If provided with 2–3 head displays, an Intelligent Voice Solutions (IVS) switching platform, or a similar solution, information can be displayed in two geographically diverse co-located facilities. From this perspective, the watchstander with a 2–3 head display could set up a display available for sharing information with others (e.g., e-mails, chat) on the left monitor and "shared" displays for briefs and custom views of the operational picture in the center and right monitors that could be seen on a large-screen display elsewhere. Additionally, if EUCOM were to adopt chat and collaboration spaces, these would demand additional onscreen "real estate" for monitoring multiple rooms.

Solution to SA of Operations, Available Forces, Impacts, and JOC Turnover

Build Web pages and business rules around a situation report page and a watch turnover page. The situation report Web page can provide constant updates to show what units are under way or airborne and from where, status of troops and/or supplies, and implications to the mission. Additionally, information should explicitly reveal if events are proceeding according to plan and are within mission parameters, and alerts should occur when events deviate from acceptable parameters. The watch turnover page can provide running indications and warning logs of everything the watch officers have passed in the action officers chat room to quickly regain SA for someone coming on watch.

Solution for New, Changed, and Released Information

As mentioned above, the use of a Web-based approach that provides information consumers with status of new, changed, and released information is recommended.

Solution for Contacting Senior Level Staff on the Phone

Consider building business rules around communication devices that alert senior-level staff that they are needed. For example, invest in one-way text pagers[17] that display a two-digit number representing who is attempting to contact them and what type of communication they should use (2 represents Ops, 3 represents pick up red phone). If there are issues knowing who is where and when, use Microsoft Outlook to create calendars (e.g., travel, TDY, meeting) and distribute in a shared location.

[17] One-way text pagers are suggested as they are not restricted in classified spaces.

4. CONCLUSIONS

EUCOM is currently undergoing a significant transformation from a command organization focusing on overseeing and facilitating communication and coordination among its subordinate units to a concept of operations known as Standing Joint Force Headquarters (SJFHQ) intended to provide real-time, network-centric, C^2 capability. For this transformation to be successful, EUCOM must implement significant changes to their command facilities, supporting technologies, organizational structure, and internal processes.

Based on interviews with 20 EUCOM staff members, 12 areas related to Knowledge Management were identified as influential in the SJFHQ transformation. These areas included a wide range of factors, including lack of formal metrics, inadequate training, lack of business rules, poor user interfaces, and low staff morale. Recommendations were made for improving these areas using various human factors, systems engineering, and knowledge management interventions.

Future efforts could include studies that use structured knowledge management exercises to collect qualitative and quantitative human performance data. These data could serve as the basis for evaluating interventions designed to increase the effectiveness and efficiency of knowledge management tasks in the SJFHQ. Specifically, the authors suggest the following:

Step 1: Consider and select high-payoff solutions/targets for change implementation.

Step 2: Consider CTAs and develop Information Requirements to develop baseline and customize solutions.

Step 3: Select and customize metrics to measure and validate selected solutions.

Step 4: Obtain senior staff “buy-in” and then direct coordinated, unified change across EUCOM.

Step 5: Knowledge Management team measure effects of change and refine as necessary.

Step 6: Conduct assessments to measure effectiveness of change implementations.

Step 7: Refine processes and metrics as necessary and re-measure iteratively.

5. IMPLICATIONS

Despite the information and knowledge management issues noted at EUCOM, the organization is functional, but only as a result of strong personnel efforts and the development of numerous work-arounds and accommodations. In other words, EUCOM is functional in spite of the system, not because of the system. EPOC is a significant step toward more efficient operations; however, EUCOM will require additional systematic improvements to meet the SJFHQ concept of operations. Specifically, the current system is not likely to be able to support multiple, simultaneous, or dissimilar joint operations. Fortunately, EUCOM senior leaders are extremely motivated and willing to take the necessary steps to facilitate change. The solutions provided in this report will supply them with useful information for their efforts to radically transform EUCOM to its desired C^2 status.

Change effort(s) that have the highest operational payoff will require senior-level staff to analyze options and strategically institutionalize the transformation. For this reason, it is suggested that senior-level staff analyze outcome scenarios to determine their potential costs and judge whether these costs outweigh benefits from not acting on them. It is equally important to compare an in-depth analysis of solutions and to estimate the consequences of implementing one solution over another. Once solutions are selected, EUCOM will experience a series of demands in the change process that, when strategically planned for and met, will lead to a successful transformation of its C^2 structure and function. These demands include:

- A need for a systemic change process that accounts for the alteration of many policies, practices, and procedures and the need to coordinate them.
- Change efforts will need to be dynamic and iterative, with the focus on continual change.
- Transformation will require considerable innovation and learning as personnel implement new structures and behaviors, assess their effectiveness, and modify their behaviors if necessary.
- The change process must appeal to the interests of personnel undergoing the transformation, including new personnel and senior-level staff.
- Change needs to occur at multiple echelons of the command for new strategies to result in changed behaviors. Senior leaders must formulate a corporate strategy and clarify a vision of what SJFHQ must become in order to support the transformation. Middle and junior levels need to integrate this strategy and vision into daily operations by supporting changed structures, procedures, and behaviors.

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14. ABSTRACT
This report describes the results of knowledge engineering conducted during the period 20–31 October 2003 at the request of the United States European Command (USEUCOM), commonly referred to as "EUCOM." The work is intended to identify baseline technology utilization and operational practices, which might then be used to assess the impact of changes brought about as they transform the command in accordance with guidance issued by the Office of the Secretary of Defense (OSD). The transformation can be characterized as a desire to move from a command organization focusing on the oversight and facilitation of communication and coordination among subordinate operational units to a concept of operations known as Standing Joint Force Headquarters (SJFHQ), which will involve network-centric, command and control (C^2) capabilities, with increased speed of command, greater flexibility in addressing command operations, and more efficient use of limited staff manpower. The issues highlighted in this report are being provided to assist EUCOM in identifying opportunities for improvement and making strategic decisions in determining where limited resources might be most effectively applied.

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