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Ensuring Effective Information Flow through the JTB Enterprise in Support of Combat Operations

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Susan G. Hutchins[1], **Scot Miller**,[1] **and Chuck Deleot**[2]
[1] Naval Postgraduate School, Monterey, CA
[2] Science Applications International Corporation, Alexandria, VA

POC: Susan G. Hutchins
          Graduate School of Operational
          and Information Sciences
          1411 Cunningham Rd.
          Naval Postgraduate School
          Monterey, CA 93943
          831.656.3768
          shutchins@nps.edu

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The goal for this research is to develop recommendations to improve the Joint Improvised Explosive Device Defeat Organization (JIEDDO) Test Board (JTB) enterprise test process through enhanced information sharing. Due to the complexity of the environment, structure of the organization, socio-cultural factors, and lack of incentive to share knowledge among test conductors, the JTB is currently not accomplishing its mission as efficiently as possible. We report on the results of a knowledge engineering effort that was conducted on the critical tasks performed by users and the associated critical information that will contribute to increasing the efficiency of information flow between personnel in the JTB, working groups, test ranges, research facilities, and JIEDDO itself. The focus for this effort was on the following questions: What types of information are they seeking when using the JTB portal?; What types of questions are they trying to answer during their daily tasks, and how is this information obtained?; What types of products are produced?; and What procedural improvements can be implemented to enhance knowledge sharing? Improvements are needed to facilitate sharing results reported in capabilities and limitations documents in terms of how well the testing process supports the operational environment.

INTRODUCTION

Improvised explosive devices (IEDs) in Afghanistan are the main cause of death and injury to coalition forces. These IEDs are more lethal than in previous years, reflecting the insurgents' use of more powerful explosives and the increased vulnerability of troops who patrol more on foot than in the past. IEDs continue to harass, maim, and kill innocent men, women, and children, as well as numerous coalition and US forces. Currently, over 50 percent of deaths to US service members and two thirds of US casualties are caused by IEDs. To combat this terror, the US government has employed significant resources across a diverse range of dedicated researchers and testers. The urgency of their task cannot be overemphasized. However, in working so diligently to test the separate components of an IED defeat system and communicate their capabilities and limitations, opportunities are missed to make this critical information available so it can be effectively utilized the across the entire JTB enterprise. Along with the escalation in Afghanistan, the IED threat is expanding throughout the world with over 300 IED events per month worldwide outside of Iraq and Afghanistan (GAO, 1995).

With the escalation of the IED threat in Iraq, the Department of Defense (DOD) identified several counter-IED (CIED) capability gaps that included shortcomings in the following areas: (1) CIED technologies, (2) qualified personnel with expertise in CIED tactics, (3) training, (4) dedicated funding, and (5) the acquisition processes. For example, prior to the Joint Improvised Explosive Device Defeat Organization's (JIEDDO) establishment, many different DOD entities focused on CIED issues, but coordination among these various efforts was informal and ad hoc. DOD's efforts to focus on addressing these capability gaps culminated in the creation of JIEDDO, but its creation was done in the absence of the DOD having formal guidance for

establishing joint organizations. Moreover, DOD did not systematically evaluate all preexisting CIED resources to determine whether other entities were engaged in similar efforts.

The premise for the research reported here is that providing an increased focus on improving the management and availability of JTB enterprise information resources – including developing an effective collaboration process and tool set – will result in a more effective test process for the test centers and supporting research organizations. Implementing improvements in the form of new procedures and enhanced processes for information sharing should yield a better under-standing of the capabilities and limitations for the various IED defeat products, and in turn, lead to more effective IED mitigation in forward operating areas. Moreover, better coordination with program managers, other service and agency CIED initiatives, as well as coalition efforts, would also provide more effective management of the DOD CIED test and evaluation process.

BACKGROUND

The objective of this research is to analyze information sharing in the JTB organization through cognitive engineering. We describe how users decide what information to share and with whom. One goal of this research is to recommend means to do so more efficiently. Before considering their decision making process, however, one must have an understanding of the concepts that will be discussed in the remainder of this paper. This section provides a review of information sharing, organizational considerations, and cognitive systems engineering. This research focused on two questions. What impediments exist to information sharing within the JTB? How can those impediments be mitigated? Multiple secondary supporting questions were also considered.

Information Sharing: What it is and why People do it

Although information sharing seems like a straightforward concept, it has different connotations that depend on the context of the discussion. For example, in politics it often refers to interagency coordination, while in the medical field it refers to privacy of individual medical records. Because this project is focused within the Department of Defense (DoD), the definition and understanding of information sharing will be based on the Department of Defense Information Sharing Strategy (DoD Strategy). The DoD strategy is based on the National Strategy for Information Sharing (National Strategy) and the 2006 Quadrennial Defense Review (QDR), and it is implemented through the DoD Information Sharing Implementation Plan.

The National Strategy is focused on combating terrorism. The vision is stated, in part, to "establish a more integrated information sharing capability to ensure that those who need information to protect our Nation from terrorism will receive it and those who have that information will share it" (National Security Council [NSC], 2007, p. 2). It does an excellent job of providing guidance to that end, however, the closest that it comes to defining the concept is, "The exchange of information should be the rule, not the exception, in our efforts to combat the terrorist threat." (NSC, 2007, p. 1) The DoD strategy was published in response to the QDR decision to, "Strengthen its data strategy...to improve information sharing and information assurance, and extend it across a multitude of domains...[and] Develop an information-sharing strategy to guide operations with Federal, state, local and coalition partners." (U.S. Department of Defense [DoD], 2006, p. 59).

The DoD Strategy broadened the vision from terrorism to one that is applicable throughout its area of influence; the stated vision is, "**Deliver the power of information to ensure mission success through an agile enterprise with freedom of maneuverability across the information environment**" (U.S. Department of Defense [DoD], 2007, p. 3). (Bold text and underlining are included in the original.) The DoD Strategy definition of information sharing is **"Making information available to participants (people, processes, or systems)."** Information sharing includes the cultural, managerial, and technical behaviors by which one participant leverages information held or created by another participant" (DoD, 2007, p. ii). It is significant to note the definition specifies information sharing as a behavior, which means that it cannot be relegated to a task of an information system. The Strategy includes appropriate changes to the culture and approaches to implement, but it does not address what motivates people to share.

Why people share information

The culture will not change, nor will the approaches be successful if individuals are not motivated to share and if they do decide to share, there is a difference between sharing information and sharing tacit knowledge. Research by Lam and Lambermont-Ford (2010) indicates there are three categories of motivation to share information: intrinsic normative, intrinsic hedonic, and extrinsic. Intrinsic normative motivation is sharing because one feels that it is the right thing to do. In the case of the research reported here, a member of the JTB organization who is motivated by intrinsic normative motivation would share information because he would consider it a job requirement. Intrinsic hedonic motivation involves sharing information because it makes one feel good, that is, because he may be helping war fighters. Extrinsic motivation is sharing information in return for something of value, for example, if it would get the person a promotion. What makes motivating an enterprise to improve information sharing challenging is that different members are motivated by different permutations of the categories and the permutation changes for each member changes throughout the day.

To further complicate the situation, the DoD definition specifies sharing of information held or created by another participant. Information held by another can be considered tacit knowledge or an information product. Tacit knowledge, similar to expertise, is understood without being part of a document. Information products, on the other hand, are tangible documents. People view the sharing of these two types of information differently. Essentially, one may share an information product because of intrinsic normative motivation, but require intrinsic hedonic motivation to share tacit knowledge. Another difference between these types of information is the medium used for sharing. Information products are easily shared via information systems. The unwritten nature of tacit knowledge, on the other hand, makes it difficult to document and disseminate. Tacit knowledge sharing also varies with the level of trust the individual has with his/her coworkers more than sharing information products (Constant, Kiesler, & Sproul, 1994; Holste & Fields, 2010). The higher the level of trust, the more tacit knowledge is shared.

Organizational Culture

Considering the complexity of different motivations for sharing information, an organization must create a diverse culture in order to stimulate as many members as possible to participate. Individual stimulation must be generated through an organizational culture that is strong enough and focused enough to influence a member's mindset. Although it is true that "successful

information sharing necessitates a mindset where information is continually shared as a normal course of work," (DoD, 2007, p. 5) establishing that mindset requires a strong supportive organizational culture. Many definitions of organizational culture are found in the research literature, and most are founded on an organization's values, beliefs, and norms. For the purpose of this research, the value considered is the sharing of information. Beliefs and norms will be addressed through policy and process, respectively.

Beliefs for any organization must be established by an authority figure and disseminated to the members. Because it originates from an authority figure, members accept it as legitimate and a single authoritative source provides the common description of the belief. To put it plainly, "to encourage sharing of work information, organizations need a clear policy." (Constant et al., 1994, p.418) When implementing the process to share information, a policy must not only exist, it must provide "clear, concise, and comprehensive guidance" (DoD, 2007, p. 11). Depending on the organizational structure, multiple policies may be required at different levels or knowledge hubs. It is essential that all policies are synchronized to avoid conflicting guidance (DoD, 2007).

The policy must direct members to take specific standardized actions, or norms, though the processes that it directs. While the most important aspect of information sharing is motivating individuals to participate, the organizational leadership must provide a standard process or set of processes to enable members to take action and streamline evaluation. In order to be effective, the processes must be created with the user in mind, assigned, enforced, and reviewed for barriers to their purpose. When creating the new processes, relating them to existing procedures or tasks will ease the transition to the new process. It will also speed the cultural assimilation or "user buy-in" that is necessary to be effective (McLaughlin, 2010).

Whether members lack the motivation to share, make errors, or deliberately intend to neglect the policy, the responsible member will need to enforce compliance with the process. The manner of enforcement will depend on the nature of the policy and procedure, lack of compliance, organizational structure, and multiple other variables to be deliberated by the responsible member.

Following implementation, the processes must also be reviewed at regular intervals in order to ensure that they are still applicable and identify barriers to compliance (McLaughlin, 2010). As organizations evolve, their processes must change to maintain applicability to the spirit and/or letter of the policy and evoke the organizational culture. Considering the nature of interaction required for information sharing, if one element of the organization encounters a barrier and fails to participate, the entire organization is affected. By identifying barriers to compliance, they can be addressed and mitigated to the greatest possible extent. Identifying the barriers to sharing and recommending ways to mitigate them is the central focus of this research.

Organizational Environment

Once the organizational culture has been established and conditions for motivating members to share information have been developed, the tools for members to share must be implemented. Social interaction, incentives, and information systems are the tools that create the organizational environment.

The social interaction aspect of the organizational environment is the most direct means to motivate information sharing. Methods of implementation include exploiting social networks, increasing interaction, and increasing collaboration. Exploiting social networks essentially puts the power of peer pressure to work. By studying the social networks of an organization, it is possible to identify members who act as sharing hubs within their network, bridges to other social networks, and links to providers (Sun, 2010).

Something as simple as including greater social interaction can improve the environment. Ironically, as individual communication technology continues to evolve, people spend less time communicating face to face. In light of that trend, research has found that "the best organizational policy may be simply to create occasions for people to talk and exchange knowledge, opinions, and advice" (Constant et al., 1994, p.419). Sharing tacit knowledge may also increase because McAllister's research (as cited in Holste & Fields, 2010) has shown that "higher levels of affiliative behavior (taking a personal interest, passing on information, helping another with tasks) increased affect-based trust among professional peers" (Holste and Fields, 2010, p. 136).

Increasing collaboration among members improves the organizational environment by increasing trust and incorporating social interaction. The ability of an organization to collaborate on a large scale requires a well established operational environment, but benefits can also be obtained through small scale collaboration exercises. The benefits are greatly based on trust, which, according to McAllister and Dietz (as cited in Holste & Fields, 2010), "may be increased through frequent direct engagement of coworkers in collaborative processes – especially situations that illustrate interdependency and provide opportunity for workers to demonstrate individual competency (Holste & Fields, 2010, p. 136).

Many organizations decide to include incentives in the environment to extrinsically motivate members to share information. In order to be effective, the incentives must fit the type of information to be shared and the tools available (Hansen, Nohria, & Tierney, 1999; Sun, 2010). For example, if the goal of the organization is for the members to share more information products, the incentive should be related to the number of products created or entered into an information system. If the goal is to increase the sharing of tacit knowledge, incentivizing document creation would be ineffective. Rather, the incentive should focus on productive social interaction which results in the passing on of tacit knowledge.

Information systems are often seen as the silver bullet for solving information sharing issues. When considering including an information system, the planners must consider whether to use a codification or personalization strategy. While all information sharing strategies are unique, they can be categorized as a codification or personalization strategy. In codification, information is "extracted from the person who developed it, made independent of that person, and reused for various purposes" (Hansen et al., 1999, p.108). An information system with a large repository to mine for information would be appropriate for this type of strategy. In personalization, on the other hand, the information is largely tacit, so a large repository would not be appropriate. An information system for that strategy would be more effective if it were based on interpersonal communication and included tools for collaboration. Of course all organizations will have some aspects of each category in their strategy, but only one should be followed to ensure unity of effort (Hansen et al., 1999).

Organizational Structure

The structure of an organization establishes the relationships and authorities of suborganizations. In doing so, it impacts all other elements of information sharing between personnel who are part of the organization. However, because the organizational structure is influenced by many other factors, even if information sharing is a high priority, the strategy must be flexible for proper integration. The organizational structure can create barriers to information sharing, which must be recognized, mitigated, and reviewed as it evolves (McLaughlin, 2010). Therefore, planners must understand both hierarchical and non-hierarchical organizational structures and how information typically flows within them.

Hierarchical organizations separate areas of expertise in order to process information prior to disseminating it to other areas of expertise as input or informing a decision maker. Processing by areas of expertise ensures accuracy and streamlines information tracking. Sharing information between sub-organizations with different areas of expertise is relatively difficult due to both culture and communication equipment connectivity.

Non-hierarchical organizations integrate areas of expertise into work teams in order to "decentralise authority, share information, diffuse and distribute competency" (Klenke, 2006, p. 231). Integration of expertise fosters "innovation, product customization, and technological leverage" (Klenke, 2006, p. 231). Ensuring thorough dissemination of corroborated accurate information to all work teams and consensus building are challenges in this structure due to both culture and communication equipment connectivity. Trust is more significant in non-hierarchical organizations in order for consensus building to be effective.

Cognitive Systems Engineering

Cognitive Systems Engineering is a process used to design computer systems based on integrating the fields of human factors, human-computer interaction, cognitive psychology, computer science, artificial intelligence and other related fields. One of the approaches to cognitive systems engineering is participatory design, which places a premium on the active involvement of workplace practitioners...in design and decision-making processes.

Contextual Inquiry

The goal of contextual inquiry is to "support, extend, and positively transform the work of individuals, teams, and businesses through computer systems" (Holtzblatt & Jones, 1993, p. 177). To reach that goal, it attempts to identify a process for designing systems that support people who engage in similar work in many different business contexts and cultures...an expedient process for gathering user information in the time available…a means of gaining appropriate and helpful information about users' work (Holtzblatt & Jones, 1993, p. 177).

The contextual inquiry method is particularly useful because of its structure, which provides a utilitarian balance of theory and practice. It was conceived to be used with other forms of design. The formative principles of context, partnership, and focus, "guide our interaction with users

regardless of the specific technique or meeting structure that we employ" (Holtzblatt & Jones, 1993, p. 179). At the same time, it provides the researcher with detailed steps to put the principles into practice through interviews and analysis.

Analysis of the interviews is best done by a group, but can be done by an individual when appropriate. The product created through contextual inquiry analysis is the affinity diagram. The diagramming process "is a way to synthesize qualitative information into conceptual groupings" (Holtzblatt & Jones, 1993, p. 203). It starts by refining the focus for analysis and reviewing the interview transcripts in that light. During the review process, significant aspects are recorded in detail and capsulized on note paper. They then name the groups, which become level one of the affinity diagram. The analysts group and name the groups two more times, resulting in a three level hierarchy of concepts to guide the engineering of the system (Holtzblatt & Jones, 1993).

Joint Improvised Explosive Devise Defeat Organization

Prior to JIEDDO's establishment in 2006, no single entity was responsible for coordinating the DOD's CIED efforts. JIEDDO was established to coordinate and focus all CIED efforts, including ongoing research and development, throughout DOD (DoD Directive 2000.19E, 2006).

JIEDDO Test Board. The JIEDDO Test Board (JTB) was also formed under DOD Directive 2000.19E in February 2006. This directive gives the JTB the authority to synchronize all test and evaluation events which fall under the JIEDDO influence and to coordinate with military departments to decrease the possibility of redundant testing. The directive specifies five specific areas of authority that are delegated to the JTB, which include the following: (1) track and identify all JIEDDO test events; (2) use testing sites and laboratories to collaborate, thus decreasing redundancy of testing; (3) scheduling authority for testing events: (4) coordination and reporting of new technology assessments to the Combatant Commanders; and (5) provide recommendations to the JIEDDO Integrated Product Team (DoD Directive, 2006). These five areas of authority have shaped the JTB into its current state, which includes organizations, processes and products.

The following section delineates some of the findings in a GAO report regarding JIEDDO's management and operations.

Government Accountability Office Report

A government accountability office (GAO) report was mandated by congress to address JIEDDO's management and operations. The GAO report assessed issues regarding (1) capability gaps that were initially identified during an assessment of DOD's effort to defeat IEDs and how these gaps and other factors led to the development of JIEDDO; and the extent to which: (2) JIEDDO has maintained visibility over all CIED efforts; (3) JIEDDO has coordinated the transition of JIEDDO-funded initiatives to the military services; and (4) JIEDDO has developed criteria for the counter-IED training initiatives it will fund. To pursue these objectives, GAO reviewed and analyzed relevant documents and met with DOD and service officials. The following paragraphs elaborate on the GAO Findings.

Lack of Awareness. JIEDDO and the services lack full awareness of CIED initiatives throughout the DOD. The primary reason for this lack of awareness is that JIEDDO and the services lack a comprehensive database of all existing CIED initiatives, limiting their knowledge of CIED efforts across DOD. Although JIEDDO is currently developing a management system that will track initiatives as they move through JIEDDO's acquisition process, the system will only track JIEDDO-funded initiatives – not those being independently developed and procured by the services and other DOD components or agencies. A second contribution to the lack of awareness is the services lack full knowledge of those JIEDDO-funded initiatives that bypass JIEDDO's acquisition process. With limited visibility, both JIEDDO and the services are at risk of duplicating efforts.

Figure 1 presents a conceptual depiction of the potential "room for growth" for the JTB enterprise that can be realized by an increase in information sharing. This includes developing greater awareness of other service, agency, and Coalition CIED programs through increased knowledge sharing.
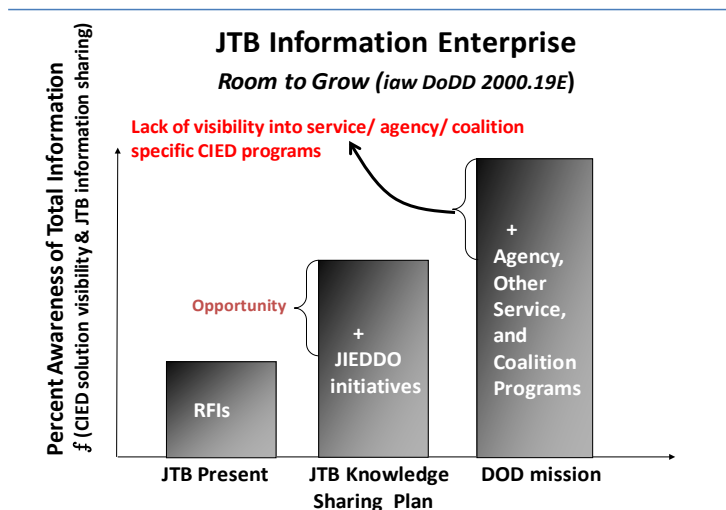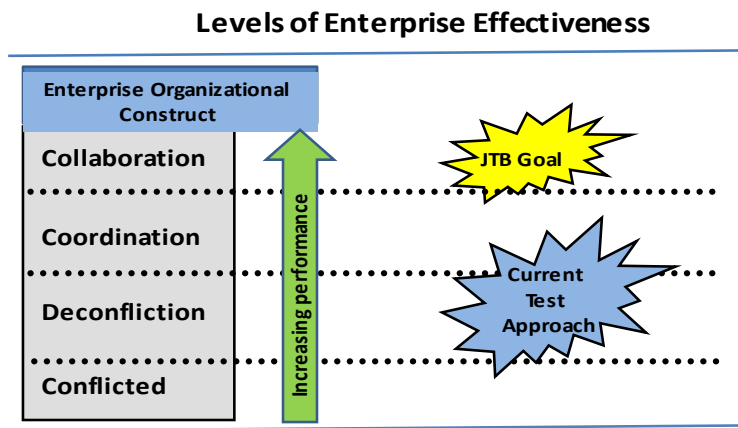

Figure 1. Percent of the JTB Information Enterprise that is Knowledge Enabled.

Funding Mismatches. JIEDDO faces difficulties with transitioning Joint IED defeat initiatives to the military services, in part because JIEDDO and the services have difficulty resolving the gap between JIEDDO's transition timeline and DOD's base budget cycle. As a result, the services are mainly funding initiatives with funding for overseas contingency operations rather than their base budgets. Continuing to fund transferred initiatives with overseas contingency operations appropriations does not ensure funding availability for those initiatives in future years since these appropriations are not necessarily renewed from one year to the next.

Information Sharing Gap. A potential information sharing gap has been observed between testers at research sites and within the JTB. Several factors contribute to this lack of information sharing, including (1) the complexity of the environment, (2) the structure of the organization, (3) socio-cultural factors, and (4) lack of incentive to share knowledge among test conductors. This confluence of factors results in a situation where the JTB is currently not accomplishing its mission as efficiently as possible.

Figure 2 depicts levels of enterprise effectiveness and compares the current level of effectiveness for the JTB Enterprise with the target goal. NATO (2005) uses this net-enabled scale to describe the evolution of an enterprise effort. At the lowest level of the continuum, a conflicted enterprise refers to a situation where members get in the way of each other, such as in the case of fratricide, and or blue-on-white engagements. A deconflicted enterprise refers to working out conflicts between members, often by time or space. A coordinated enterprise refers to engaging in explicit discussion to synchronize efforts. Collaboration refers to working with a jointly developed shared purpose. Research shows that enterprises that operate at these higher levels outperform enterprises that are operating at the lower levels. Our objective is to develop recommendations to improve the JTB enterprise test process through improved information sharing and collaboration among all stakeholders so as to move the JTB Enterprise up the net-enabled scale.

Levels of Enterprise Effectiveness

[1] Placement of the JTB on this scale was made by the JTB Director, Mr. Scott Dellicker, in April 2010.

Figure 2. Comparison of current level of effectiveness and goal for the JTB Enterprise.[1]

Sharing information across research, development, test, and evaluation (RDT&E) efforts affords the potential to accelerate successful solutions and should lead to improved performance regarding JTB management of the CIED test and evaluation process. RDT&E activities typically operate within their own timelines and "stovepipes." Differences in organizational structure, funding methods, legacy operational rhythms, requirements and priorities, andlevels of inter-organizational collaboration, coupled with a strong emphasis on accelerated fielding, create an environment where there is insufficient synergism between the test centers.

We predict that modifying the current information sharing processes will promote greater collaboration, synergy, and ultimately performance improvements, resulting in improved product evaluation. A wealth of embedded expertise and knowledge resides in the JTB however a continuous improvement program is needed to better serve operators, and to make the best use of taxpayer investment. The current process is capable of being expanded within the existing distributed organizational capability of the JTB to provide a robust T&E process for all service, agency, program manager, and coalition initiatives.

Objectives for Improving the JTB Test Process

Our overarching objective is to assist the JTB in its effort to provide enhanced support to the end user, that is, the warfighter in theater. One goal for this research is to answer the following question: In what way can the JTB functional process be improved, specifically in terms of information sharing among all stakeholders, where the primary focus is on the test offices and directors who plan and execute tests? Based on what was learned during this research, a second goal is to develop requirements and recommendations for improvements to the technology and processes employed. Fundamental information sharing objectives that support the DOD Directive 2000.19E include:

- Reduce time spent by stakeholders, managers, leaders, researchers, developers, and test and evaluation activities to understand what is going on, where, and by whom.
- Facilitate and encourage greater cooperation and collaboration. JIEDDO supports work that is used directly and daily to fight war, and hording of information and ideas slows JIEDDO progress and needs to be eliminated.
- Reduce redundant efforts so as to make best use of scarce resources.
- Expose awareness of the diverse and talented human and physical resources that comprise the numerous JIEDDO efforts.
- Ensure the right information is getting to the operators at the right time, in a way that maximizes their situational understanding of IEDs and CIED techniques in the least amount of time.

Process Improvement Approach

The JTB has a history of highly productive responses to satisfy exacting test requirements in a very demanding environment. However, that same "can-do" attitude and fast-paced response cycle often creates a situation where there is little time to share what has been learned, or to learn how to coordinate most effectively with other disparate organizations within the JTB Enterprise. This lack of coordination and collaboration between stakeholders is exacerbated by the fact that many of the organizations perceive themselves as competing with one another for funding. This presents an information sharing challenge. DODD 2000.19E directs specific functions that are to be performed by the JTB, yet with unfilled billets and recent JIEDDO upheaval, it has been difficult for the JTB to achieve optimal performance as the world's premier provider of CIED test services.

CIED Solution Process Initiation. Four principal processes are in place for developing and testing CIED solutions. First, requests for information (RFI) from forward operating units comprise some 300-plus requests per year. Second, JTB program manager initiatives currently include, 600-plus initiatives, with between 200-300 new initiatives entering the test cycle each year. Third, Special Operations Command (SOCOM), coalition, and other service programs submit their own requests and the number of these requests is unknown. Because these other services and agencies, such as SOCOM, manage their own test, evaluation, and fielding of CIED solutions, these cases present situations where the JTB does not have visibility into the test and evaluation process, nor the results. Forth, Coalition initiatives are pursued ad hoc, directly with the test centers.

Figure 3 portrays what we envision as part of the process improvement approach for the JTB enterprise collaboration workspace. The JTB Portal provides the critical linchpin between all stakeholders in the JTB enterprise collaboration workspace.
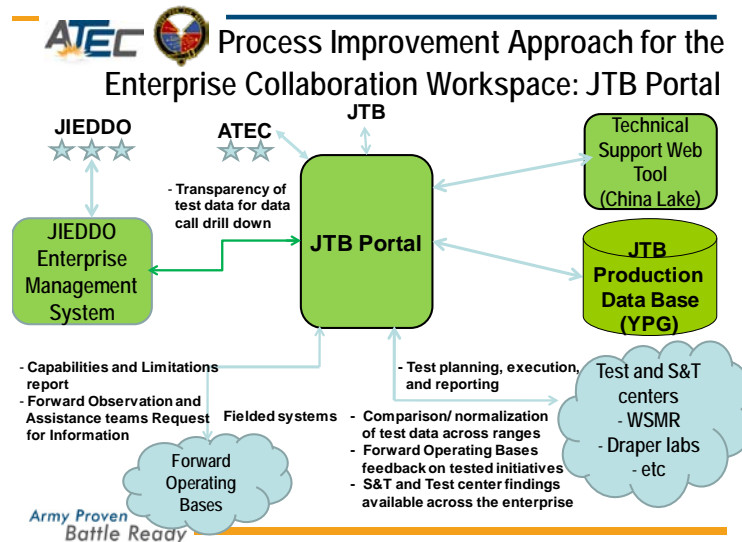
Figure 3. Process Improvement approach for the JTB enterprise collaboration workspace.

DOD Architecture Framework

Managing a large number of organizations that employ sophisticated systems and technologies in pursuit of joint missions requires a structured, repeatable method for evaluating investment alternatives, implementing organizational changes, and deploying new technologies (DOD, 2007). Towards this end, the DOD Architecture Framework (DODAF) was established as a guide for the development of architectures. The DODAF provides guidance and rules for developing, representing, and understanding architectures based on a common denominator across DOD, Joint, and multinational boundaries. Architecture is defined as the structure of components, their relationships, and the principles and guidelines governing their design and evolution over time. (DOD Integrated Architecture Panel, 1995, based on IEEE STD 610.12).

METHOD

In this section we describe an end-user analysis that was conducted to gain insight into the information sharing process across the JTB Enterprise and a knowledge engineering effort to describe the current state of information sharing within the JTB organization. Both of these analysis efforts were conducted by graduate students at the Naval Postgraduate School, Monterey, CA, as part of the research for their master's thesis (Gill, 2011; LaViolette, 2011). A third thesis on this topic made recommendations for improving information flow through the JTB enterprise based on the results of the first two (Bowman, 1022). Both researchers interviewed subject matter experts to better understand the current processes employed by all stakeholders and learn where gaps and shortcomings exist.

Information Sharing End-User Analysis

An information sharing end-user analysis was conducted to: (1) identify activities and organizations with relationships to the JTB; (2) map and identify the flow of information through different JTB nodes and activities; (3) define and describe process threads currently used by the JTB; and (4) develop and display process threads in an operational view (OV)-6 DOD Architectural Framework.

Interviews. Structured interviews were conducted with personnel from different organizations throughout the JTB, including personnel from the JTB, JTB staff, test ranges, and end users. The data gathered from interviews was entered into an architecture documentation tool (ProVision) which affords a visual display of the organization and mission thread. Interviews were conducted to determine the current processes used within the JTB; explore various means to share information, such as the use of a web-based portal, Sharepoint portal, or other collaboration software; solicit ideas regarding potential areas for improvement; and explore whether an incentive program would motivate use of any additional means to share information.

Participants. Eleven participants from the following organizations were interviewed: three personnel at Yuma Proving Ground: analyst branch, theater support, and test officer; one at China Lake: Electronic Warfare/C4ISR Test and Evaluation; one at Aberdeen Proving Ground: operations research; one at Naval Postgraduate School: Advanced Communications Working Group; four at the JTB: Operations Plans, Foreign Release, External Support, and Support Division; and one at Naval Air Warfare Center Point Mugu, Joint Electronic Warfare Laboratory (JEWL).

Modeling tool. Metastorm ProVision Federal provides a tool for business process analysis, including process modeling, simulation, Six Sigma, and other optimization methods. The ProVision tool includes the ability to display organizations graphically, in a way that is consistent with the DODAF, and to model the processes conducted by the JTB enterprise, such as the request for information (RFI) process. Information about the process is added to each node and decision point, such as the duration of activities and processing performed within each node. Information included at critical decision points can be modified in order to conduct "what if" scenarios, for example, adding personnel to a node, varying the time required to respond to an RFI, and so on. The objective is to produce a detailed explanation for all stakeholders to gain a better understanding of the processes and factors that influence these processes. Variables that can be manipulated include varying the activities performed within a node, adding or subtracting personnel and organizations, changes in funding, and so on.

A DODAF, OV-6c, or "swim-lane" chart, was produced to graphically represent how information is passed through the various nodes engaged in the testing process. The first step entailed documentation of the entire process with emphasis on specific contributors and their functions. Contributors to the process include personnel at the JTB headquarters, test sites, contractors, working groups, and military organizations. All nodes involved in the JTB enterprise were identified along with the data and products passed between each node in order to: (1) provide an accurate representation of the way information flows during the CIED test development process; (2) identify the main decision points; and (3) determine where bottlenecks occur. Each node was

examined to determine how information is produced, the extent to which the information is used, what other nodes use this information, how it is transmitted, and how it pertains to the end user.

Knowledge Engineering Effort

A knowledge engineering effort was conducted to describe the current state of information sharing. The goal was to identify information sharing issues within the JTB organization. For this research, the JTB enterprise is defined as including the JTB, test ranges, working groups, and research facilities. A semi-structured set of interview questions were developed to: (1) identify the types of information that are not being shared; (2) identify inhibitors to information sharing; (3) develop recommendations for information sharing and (4) solicit recommendations for improvement. Interviews were conducted with subject matter experts between October 2010 and January 2011.

Figure 4 presents a conceptual depiction of the JTB portal which is viewed as the CIED test and evaluation enabler. This diagram resembles a service-oriented architecture – which is a good metaphor for what the JTB is going to develop. Different members of the enterprise, such as the test centers, research activities, and the JTB, all have critical information, and databases, which are necessary to complete enterprise work. The key to a more efficient and effective CIED development process is to improve information sharing across the enterprise, as represented by the blue enterprise "bus". Unfortunately, while the JTB and JIEDDO were borne from threats encountered in Iraq and Afghanistan, the IED challenge is worldwide. While establishing databases, processes, and technologies is crucial to the JTB, a broader perspective is necessary to ensure enterprise success. This is similar to other large organizations that utilize multiple data sources and several business processes, to provide products to customers across the globe.
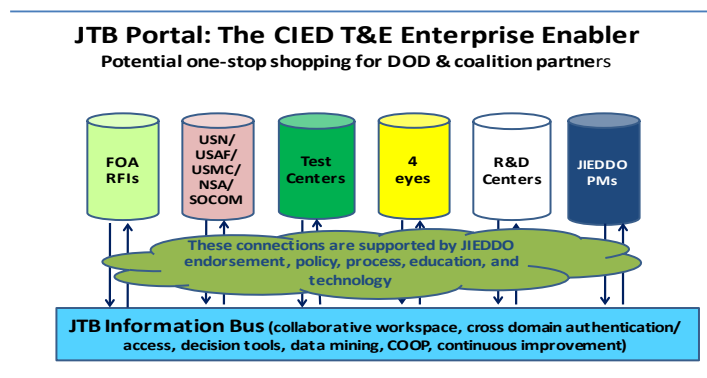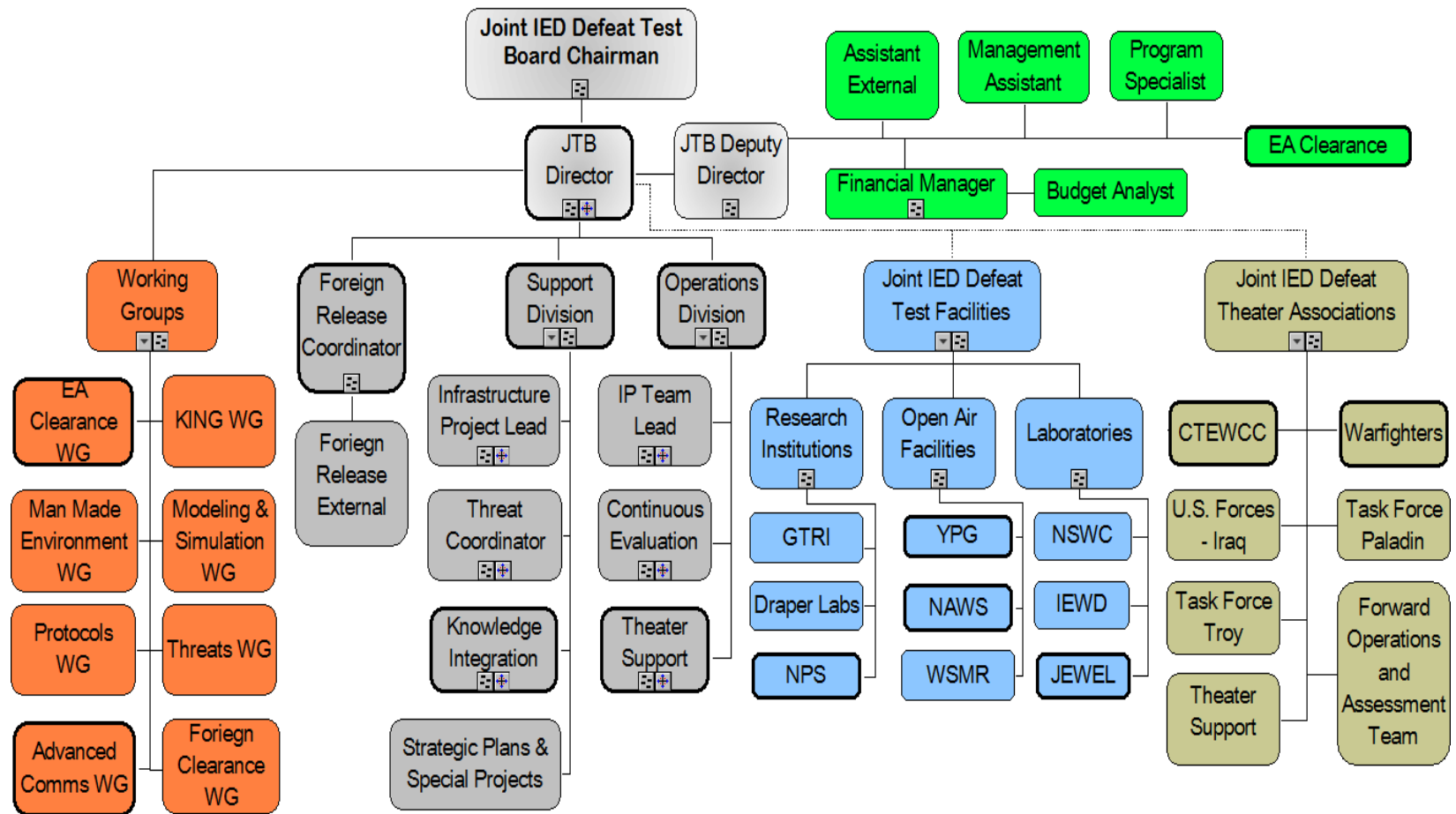

Figure 4. The Counter-IED test and evaluation enabler: The JTB Portal.

RESULTS

Joint Test Board

The JTB Enterprise is comprised of a diverse group of organizations that support the warfighter at many distributed locations and at many levels of the organization. Figure 5 presents a DODAF Model of the JTB Enterprise.

Figure 5. Organizational Model of the Joint IED Defeat Organization Test Board.

Request for Information (RFI) Process

After conducting a review of the JTB organization and the way data and information flow between various nodes in the organization, it was evident that there is one process which encompasses the entire enterprise. The JTB request for information (RFI) process ties many JTB activities together and requires the organization to communicate on a variety of levels. These JTB activities include but are not limited to open air test ranges, modeling and simulation groups, testing labs, armed forces (including Allies), and the JTB itself. The RFI process can be initiated by personnel in many locations who enter their request using the Theater Support Web Tool (TSWT) in order to input information which will assist the JTB's determination as to how to resolve the issue. Several options are available to satisfy the RFI: documentation, modeling and simulation, laboratory testing, and open air testing. All activities have the ability to review and track an RFI regardless of the method used to resolve the RFI.

If resolution of the RFI includes documentation only, the proper documentation, which could be in the form of test reports or manufacturer's documents, is then forwarded to the activity that initiated the RFI. When other methods of satisfying the RFI are used, any node in the organization has the ability to reach back to the activity who submitted the RFI in order to ensure testing is done properly, efficiently, and correctly. Upon completion and resolution of testing by the activity responsible for responding to the RFI, the activity then posts the results of the testing, in the form of a test report, to the JTB web portal providing all interested activities access to the results. While there are many activities that play important roles in this process there are two activities which are consistently part of the process regardless of the method of resolution, the Knowledge and Information Networking Group (KING) and the JTB. The JTB makes the decision regarding the type of resolution required to satisfy an RFI and the KING is responsible for maintaining the JTB web portal which is vital to the flow of information for all activities.

The RFI process encompasses the entire JTB enterprise, such that all organizations with ties to the JTB play important roles in satisfying an RFI. The activities conducted to satisfy an RFI encompasses seven "swim lanes", which involve eighteen organizations, thirteen of which are within the JTB sphere of influence. Responding to an RFI involves a dynamic process and includes four decision points. The time to resolve an RFI is variable due to varying levels of complexity of a range of RFIs.

Activities and Decision Points

The JTB RFI Process includes nineteen activities. Each activity represents an action taken by the parent organization. Table 1 describes the activities and decision points contained within the RFI Process.

Table 1. JTB Activities Included in the Request for Information Process.

Generate RFI	Once an end user or theater support personnel have determined the need for information, the Theater Support Web Tool (TSWT) is utilized in order to generate a request for information.
RFI Status: Open	The status of an RFI becomes open once it has been submitted through the TSWT.
Submit Documentation	Proper documentation is located and posted to the JTB Portal and sent to generator of RFI

Compatibility Test Planning	During the test planning phase information is gathered, based upon RFI input, and test is scheduled and planned based upon current protocols.
Compatibility Test Execution	Execution of testing occurs once the test plan has been developed and permission has been granted.
Compatibility Test Report	Upon completion of test, a quick look is generated and submitted to all subscribers of RFI. The test report is drafted and submitted for approval. Once approved the test report is posted to the JTB SIPRnet web portal.
Performance Test Planning	During the test planning phase information is gathered, based upon RFI input, and test is scheduled and planned based upon current protocols.
Performance Test Execution	Execution of testing occurs once the test plan has been developed and permission has been granted.
Performance Test Report	Upon completion of test, a quicklook is generated and submitted to all subscribers of RFI. The test report is drafted and submitted for approval. Once approved the test report is posted to the JTB SIPRnet web portal.
Lab Test Planning	During the test planning phase information is gathered, based upon RFI input, and test is scheduled and planned based upon current protocols.
Lab Test Execution	Execution of laboratory testing occurs once the test plan has been developed and permission has been granted.
Lab Test Report	Upon completion of test, a quicklook is generated and submitted to all subscribers of RFI. The test report is drafted and submitted for approval. Once approved the test report is posted to the JTB SIPRnet web portal.
M & S Test Planning	During the test planning phase information is gathered, based upon RFI input, and test is scheduled and planned based upon current protocols.
M & S Test Execution	Execution of modeling and simulation testing occurs once the test plan has been developed and permission has been granted.
M & S Test Report	Upon completion of test, a quicklook is generated and submitted to all subscribers of RFI. The test report is drafted and submitted for approval. Once approved the test report is posted to the JTB SIPRnet web portal.
Post Test Report to JTB Portal	Once testing is completed the testing agency posts the report to the JTB Portal in order to provide information to the JTB Enterprise.
JTB review	JTB inputs test report data to database
Theater Support Review	Theater Support Elements review and disseminate information to End Users
Utilization	End Users apply results and modify TTPs based upon new information

Impediments to Information Sharing

One impediment to the flow of information was identified which involves the *rotation of personnel in theater*. A recommendation to address this issue is to have a static email address, that is, TFP_ewo@email.smil.mil, to avoid loss of continuity between JTB members and personnel in theatre. A theme that was identified in the interview data involved *uncertainty over what information is available to request*. This included the following topics: (i) no policy is in place to enforce information sharing within the JTB organization; (ii) members of the JTB desire increased familiarization with personnel and their expertise; (iii) face-to-face introductions would facilitate interaction; and (iv) publishing a directory and organizational chart would enable members to contact others more easily.

Another theme identified as an impediment to information sharing involved the *non hierarchical organizational structure of the JTB enterprise.* This theme included the following topics: (i) geographically separated organizations with personnel who operate under multiple tasking organizations yet are working on related issues; (ii) whether all members have shared goals; (iii) problems finding points of contact; (iv) lack of trust and/or ignorance of other organizations; (v)

security classification and foreign release issues, where coalition partners do not receive information for months after it has been available to U. S. members; and the related issue that (vi) sharing with coalition partners requires additional processing requirements.

Preliminary Results: State of Information Sharing

Critical factors for success in an organization include senior management acting as an advocate for change regarding doctrine, organization, and resources. The information sharing lead needs to direct a phased collaborative improvement program for the enterprise. Personnel are needed to provide test enterprise content management and portal technical support.

Barriers to Information Sharing

Barriers to information sharing were recognized in the categories of motivation, organizational culture, organizational environment, and organizational structure. The type of motivation most often recognized for causing a barrier was intrinsic hedonic motivation. Individuals were motivated to not share their information in order to make them feel better. The feelings were often in regard to maintaining a reputation, attaining power over others, or protecting the purity of their information.

Organizational culture barriers were individually and collectively the most common data points of all categories in the analysis. While the number of data points is not necessarily as relevant as their substance, it is significant that this category received so much attention by the participants. Beliefs were essentially policy or higher headquarters issues and norms were related to process and procedural issues. Individuals did not share information because the organization did not have the formalized policy, process, or procedures in place to create a culture that encouraged sharing.

Participants recognized personal interaction as the most significant cause of barriers regarding the organizational environment. Few data points related to information systems, and none related to incentives. Personal interaction issues centered on the participants not sharing information or being able to access information due to a lack of personal points of contact in other parts of the organization. It is interesting to note that the same number of data points recognize personal interaction as an enabler to information sharing, but for different reasons. Relatively few data points indicated information systems was a barrier to sharing information is also significant, when considering what aspects of the organization to fix or enhance to improve information sharing.

The non-hierarchical aspect of organizational structure contained more data points than the hierarchical aspect. Issues centered on the dynamic and dispersed structure and the JTB's lack of authority to control its sub-organizations, which results in each sub-organization being managed as a separate 'stovepipe'.

Enablers for Information Sharing

Enablers for information sharing were recognized in the categories of motivation, organizational culture, and organizational environment. No enablers were recognized relative to organizational structure Intrinsic and intrinsic hedonic motivations were essentially equal influences for enabling information sharing. Participants made the decision to share information because they

felt it was the right thing to do and/or because it made them feel good that they were helping the war fighters.

Both norms and beliefs were recognized as organizational culture enablers. Norms related to cooperation between ranges as well as between ranges and modeling and simulation. Beliefs recognized an increasing leadership focus on information sharing.

Organizational environment enablers were related to information systems and personal interaction. As with the barrier section, no data points were noted under incentives. Information systems data points mostly related to the JTB portal and provide a good source of feedback for developers and considerations for future improvements. Participants also recognized the importance of e-mail and the telephone, which ties in the personal interaction aspect. While personal interaction was recognized as a barrier due to the lack of personal points of contact, once those points of contact are made they are recognized as enablers. Another aspect of personal interaction recognized as an enabler was the opportunity to communicate face to face, whether to create points of contact or exchange information between existing relationships.

Participant Recommendations for Improvement

Participant recommendations for improving information sharing were recognized in the categories of organizational culture and organizational environment. No recommendations were noted regarding motivation or organizational structure. Both beliefs and norms were recognized by organizational culture recommendations. Recommendations for beliefs centered on improving leadership and increasing standardization. Norms mostly dealt with different aspects of dissemination, to include improving processes, procedures, and visibility.

Organizational environment recommendations were shared between personal interaction and information systems; again, incentives were not noted. Personal interaction recommendations focused on meeting in person and dissemination of a complete organizational chart with amplifying information. Information system recommendations included some specific types of information to be included in a central repository of information, as well as improvements for the current JTB portal.

Affinity Diagram Conclusions

We identified individual issues, leadership considerations, management, information sharing, and information availability as focus areas. When considering how designing an information system can improve information sharing, leaders and planners must home in on what aspects can be feasibly addressed by technology. For example, it would not be feasible to focus the time, effort, and resources necessary to directly target individual perception. However, by targeting other focus areas, individual perception may be influenced. Narrowing the focus to targeting relevant data points under management, information sharing, and information availability would be a good starting point. Planners should also consider feasible data points from other categories and how changes in the targeted data points may also indirectly address other categories and data points.

Recommendations

The most common barriers were organizational culture, both beliefs and norms, and personal interaction. In order to mitigate those barriers, we recommend that the JTB create a position to

focus specifically on information flow inside and outside of the organization. The position would initially be concerned with improving information sharing by recognizing and mitigating barriers by being a 'go to' person for information dissemination and access issues.

Areas recognized as enablers that should be enhanced are the organizational culture norm of cooperation between test ranges and the information systems aspect of the organizational environment. To enhance cooperation between ranges, we recommend increasing meetings between testers from different ranges. Including the actual testers is significant because they are the people who generate the information that everyone else will share. If they create a culture that includes sharing, it will influence the motivation of others and the norms of the organization. Also, the positive image of information systems by the participants leads to the recommendation to enhance the capability of information systems to share information. Investing in JTB portal improvement and including some of the user recommendations would increase sharing capability and let the members of the organization know that their leadership values their input.

The following is a list of specific recommendations based on interviews with members of the JTB enterprise.

Facilitate information sharing, particularly with operational users
- Implement static email addresses for war fighters to avoid loss of continuity of contact with personnel in theatre as part of the turnover process, such as TFP_ewo@email.smil.mil.
- Prioritize JTB information technology efforts supporting operational users

Processes reach across the enterprise yet processes do not have any policy or guidance on how they work.
- Recommend capturing and documenting current processes in order to write guidance which would describe the RFI process

JIEDDO has a very informative Facebook page.
- The JTB can either promote itself through the JIEDDO page or create one of their own. The Facebook page would promote the JTB and provide an unclassified way to keep in touch with end users and keep them informed on JTB activities.

Promote knowledge of and interaction with the JTB. Most end users interviewed have experience with IEDs however many have not heard of the JTB or the products produced. End users receive most of their information from Battalion HQ, Relief in Place/Transfer of Authority, and/or lessons learned. The JTB interacts with the end users indirectly or not at all. The only direct link between the JTB and the end user is a one-week, pre-deployment training.
- Recommend some sort of JTB-centric marketing in order to promote products and mission
- End users would like a pamphlet which would have the most updated test results, such as a Quarterly Newsletter.
- Provide an agenda for the next semiannual meeting to promote information sharing.
- Have test agencies, theater support organizations, end users, and KING work together in order to develop products for an E-5. Turn test results into actionable information.
- Promote understanding of the key information flows and decision points between all stakeholders within the JTB enterprise. Without someone to pull together the disparate information sharing initiatives, the JTB runs the risk of duplicating efforts and building technologies which are incompatible.

Design Information Technology (IT) strategic plan. IT policy and protocol for portal usage is important for JTB effectiveness and transparency. None of the JIEDDO SIPR websites are linked to the JTB Portal. Each working group has the ability to post information, yet the last entry was posted more than a year ago. Some working groups have not posted since 2009. Test agencies have the ability to post reports to the portal. KING administers and maintains the portal and KING develops spreadsheets to display test results.

- Include an Information Czar, Chief Information Officer and host an annual IT review
- Discuss IT issues with YPG/APG/JTB/CL
- Design IT Policy and protocol for portal usage. The CIO must have authority! There is no evidence that post-event analysis directly influences the infrastructure in a near real-time manner.
- Continue evolving the JTB Portal as an enterprise collaboration workspace

Reinstitute test officer for JTB Working Group. Of the three major sources for CIED product testing, JTB only routinely receives test articles from two. There are limited measures of effectiveness or performance to support a JTB continuous process improvement cycle.

- Actualize the JTB responsibilities set forth in DODD 2000.19E
- Reinstitute test officer for the JTB Working Group
- Assign a Knowledge Manager for Working Groups
- Provide a top down IT investment strategy for JTB support and improvement, or migration to meet the requirements of DODD 2000.19E.
- Provide a standardized process/ data structure for test centers.

Information sharing within the JTB would improve if JTB leadership provided a system that could enhance the building of personal relationships and standardize the information sharing process in order to improve its quality and timeliness, while improving information visibility and access. Whether or not that is feasible is up to the JTB leadership. A recommendation more applicable at this point is that any improvements to information systems within the JTB should at least include a review of the affinity diagram because it is customized for the JTB. Other organizations can reference the diagram as an example of how to customize their information technology strengths and weaknesses.

Future Research

Future research on incentivizing information sharing for JTB members may prove useful. None of the participants provided data points that related to incentives and there were few data points related to extrinsic motivation, but that was likely due to the focus of this research being to identify barriers and mitigate them. Because there is no incentive system, it is not a barrier, but follow on research could focus on incentive systems for government employees and contractors. While intrinsic and intrinsic hedonic motivations are powerful, there is always a point where some extrinsic motivation can make the difference between deciding whether or not to share.

Final results will be provided to follow-on researchers in the areas of web portal development and 3-D tool development to present CIED solutions in a format that provides the most effective support to the war fighter in theater. Results and recommendations from this research will provide ideas for further analysis to provide input to enhance the JIEDDO test process system.

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