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Network-Centric Command Decision Services (netCDS) for the Component Numbered Air Force (7th Air Force Korea and 13th Air Force)*

Topic 9-Collaborative Technologies for Network Centric Operations

Topic 7-Network Centric Experimentation and Analysis

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14. ABSTRACT

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Abstract

The structure of the United States Air Force is changing with Headquarters United States Air Force Program Directive 06-09, entitled “Implementation of the Chief of Staff of the Air Force Direction to Establish Force Component Organization,” As Component Number Air Forces (C-NAF) operationalize the directive, Command and Control systems must adapt with a network centric environment that supports distributed operations between the tactical and operational levels of war, to include reachback for shared resources and capabilities. C2 systems are required to enable the commanders to quickly focus on priority issues with appropriate and sufficient information to make decisions or to monitor tasks that the AFFOR Staff is executing. The AFFOR Staff requires enhanced situational awareness and collaboration capability to plan, monitor, and sustain operations. This requirement will enable the AFFOR staff to actively think and innovate with a focus on airpower analysis, planning, and execution — not a battle rhythm synchronized around static tools such as briefing slides and spreadsheets. This paper reports an action research case analysis of the employment of a network centric command decision service (netCDS) at the 7th and 13th Air Forces over an 18 to 24 month period. Critical guiding principals for this case analysis are the Network Centric Operations (NCO) framework, technology adoption and the Technology Transition Model as well as decision-making and human communication theories that can be used to examine and explain the behavior of users of network centric operation systems.

Keyword NCO, Network Centric Operations, netCDS, Component Number Air Forces

Introduction

The demands on the U.S. military today are to dynamically synchronize actions; achieve command and control (C2) agility; and increase the speed of command over a robust, networked grid (Alberts & Hays, 2003). To respond rapidly in less known or anticipated situations one force multiplier is technology. Though technology does not substitute for leadership, intelligence or training, effective use of warfighting tools can substantially stack the deck and make the difference between winning and losing battles, in the air, on land and at sea. The chariot, gunpowder, steam engine, hydraulic controls and the atomic bomb are all dramatic examples of technologies that allowed the possessor to leave opponents with little recourse.

To minimize risks to forces, the United States armed forces use technology as a "force multiplier" to win the day. The sacrifice of a larger force structure in order to leverage new technology is a concept that is continually being examined by nations and warfighters across the globe. Alberts, Garstka & Stein's (1999) seminal work on Network Centric Warfare exposed a foundation for military operations and the required changes in thinking on how to accomplish missions, interrelate, communicate and acquire systems to support military actions. Just as the introduction of air power has changed the nature of battle, the networked environments are changing all facets of the military. From the current structuring of C-NAFs in U.S. Air Force to the 5000-man super carrier and down to the individual infantryman, plans are continually being tested and implemented to leverage vast networks to better share information, improve responsiveness and multiply the effectiveness of forces.

This paper is a case analysis of the employment of a Network Centric Command Decision Service (netCDS) for 7th and 13th Air Force. To provide a context and framework for this analysis, theoretical foundations for decision making, communication and network centric warfare are reviewed along with the conceptual environment for the C-NAF with regard to the Combatant Command and Operational element. Once the foundation has been laid, a technology transition model will be provided as a guide to explain experiences employing netCDS at the 7th and 13th Air Forces.

netCDS

In overview, netCDS provides C-NAF C2 capability vertically from the tactical to the operational level and horizontally between the Joint and Coalition partners. The capability will evolve into a shared, user-defined set of near-real-time displays, decision aids, forecasting and planning tools providing an accurate status of forces, systems, and supplies.

The goal of netCDS is turning the AFFOR staff into a thinking, innovative, airpower machine focused on analysis, planning, and execution, not linked to a battle rhythm synchronized around PowerPoint slides, Excel spreadsheets, and briefing rooms. Technical solutions will occur incrementally and progressively from a C-NAF focused environment to the JTF environment. In short, netCDS is a suite of capability offered to a commander to increase shared situational awareness across functional elements.

Currently three discreet elements of netCDS are offered to provide a collaborative view of a functions within the C-NAF. First a master events log (MEL) allows critical events to be logged by event type and geographic location then assigned out to various staff elements with an alert system. The netCDS MEL capability is capitalizing on decades of action research on collaborative logging in military context (Briggs, Adkins, Mittleman, Kruse, Miller & Nunamaker, 1999; Adkins, et al, 2001; Kruse & Adkins, 2005) Second, a "mashboard" allows functional areas to create individual and command level views of various data and information required by the A-Staff to operate. The design of the "mashboard" is a drag and drop concept where functional "application like" widgets are dragged on to a "blank slate" to create a knowledge board for elements of the A-staff. Conceptually netCDS is focused on extracting data from services and allowing single point data entry multiple views.

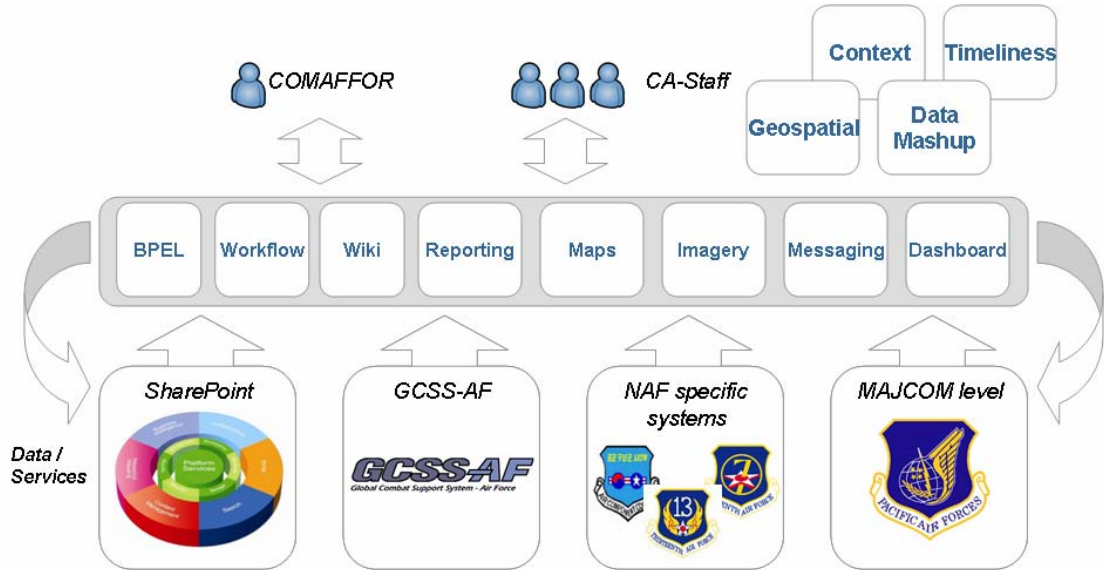


Figure 1 netCDS Conceptual View

Theoretical Foundations

The complex model underlying the Network Centric Warfare concept (Holloman, 2004; Wilson, 2004) is underpinned by research in the social sciences. Consequently, a wide variety of concepts are explored to gain understanding and provide explanation. By understanding the use of technology in decision-making by the individual, one can begin to extrapolate out to the use of networks by organizations.

Decision Action Cycles

A general pattern for the command and control of forces is that the commanders and staffs try to generate understanding of the situation and anticipate potential enemy actions. In effect, this is a theory building process around a current situational picture that leads to actions to expand options and to limit those of the opponent. By doing this, the commander creates effects that allow the control of conditions and continues to force his will on the enemy until victory is attained. These sequences are intuitively recognizable but, as with most decision theory, the iterative nature is largely ignored as decisions and accompanying situations are typically viewed as discrete events. In an adversarial conflict, each decision and action builds on the last.

Air combat actions in Korea, allowed U.S. Air Force Colonel John Boyd understand decision cycles and competition. Boyd (1987) posits that in competitive asynchronous engagements a faster decision cycle is an inherent advantage. The theory is that before one can take an action against an enemy, one must first observe the situation, create a mental model and then decide on an option based on the mental model. By interfering with this decision cycle, one can impede the opponent and cause ineffective counteractions. Each time an opponent acts, there is the ability to disrupt the enemy's decision-action cycle. Thus, whoever can act first has an advantage because of the changing of the situation. This causes the opponent to either act inappropriately or to restart the decision cycle. This is often referred to as "getting inside" of the enemy's decision cycle (Boyd, 1987).

The process is generalized to larger scale where one can find historical situations where this has been true. In the early stages of WWII, the French had a large well-equipped standing army. In spite of this, the French army quickly dissolved in the face of the fast-paced German blitzkrieg. The French were not defeated because they were outfought on an individual level. Rather, the defense disintegrated because the Germans were operating at a pace the French were totally unprepared to match.

Applying this methodology can provide distinct advantage, provided the opponent does not disengage or purposefully slow down the battle. The advantages of a compressed decision-action cycle are not realized in the single masterstroke. One can really only expect to maintain a competitive advantage through repeatedly forcing the enemy back on their heels and wresting control of the situation from them. Commonly, the application of this theory is referred to as speeding up the operational tempo (OPTEMPO).

This is the core of Network Centric Operations - to network the force so that the common goals (commander's intent) and accurate situation awareness can be shared throughout the battlespace. This awareness, in turn, allows units to support each other and the master plan without resorting to the traditional military hierarchy or bottlenecks.

Network Centric Warfare

In the 1990's there was widespread acceptance of Boyd's theories on decision-making among adversaries and a broad understanding of how to defeat the enemy. There was, however, a need for an extended theory that could integrate the sea change brought by new information technologies with the aggregated concepts of modern warfare.

In 1997, Cebrowski and Garstka published "Network-Centric Warfare: Its Origin and Future." This article marked the nascent effort at bringing the lessons learned in business, economics and technology into the realm of the warfighter. The basic premise of Cebrowski and Garstka was that the leveraging of networks was driving massive changes throughout the world. Furthermore, the military could take advantage of the power of the network to become more responsive, flexible and lethal.

Indeed, the industrial and business communities were rapidly accelerating through a "revolution in business affairs" presaged years before. Economist Ronald Coase (1937) revealed that proportionately large amounts of organizations' resources are focused on activities within the firm. Additionally, he posited that the transaction costs of doing business outside of the firm are the primary driver of organizational size.

For instance, U.S. car manufactures grew to mammoth size and scope to gain efficiency in making all parts internally vice finding external contractors to provide parts. The advent of the Internet has changed this concept rapidly. Efficiency is no longer gained with making all the parts in a world where businesses can quickly and easily find materials, goods and services from a wide range of vendors around the world that deliver all over the planet.

A recent example is China's entrance in the motorcycle business in Vietnam. This development has pushed Japanese powerhouse corporations to rethink manufacturing. China makes motorcycles with parts and pieces produced in hundreds of separate factories while Japan uses a more traditional manufacturing model. The end result is that China produces a bike that retails in Vietnam for around $400 USD while Japanese motorcycles cost 3 to 4 times as much. Of course maintenance and durability are other issues not included in the original price model but the point is the advantages realized through leveraging lower transaction costs.

Lowering the transaction cost is the life blood of the Network Centric Operations concept and is allowing the warfighter the advantages being realized in the business world. Specifically, the view is that the extensive use of networks can lower transaction costs of sharing information to negligible levels. This in turn, opens a flood of accurate and timely information to every level of the warfighting organization.

The individual warfighter in a well networked environment knows to a high degree of certainty the current situation, the goals, and the plans of the force. The networked warrior is freed to act and react with unmatched speed in the battlespace. According to Boyd's theories (1986, 1987), a higher operational tempo creates an untenable state of affairs for the opposition. A concerted force comprised of independent, yet harmonized commands can eliminate the traditional bottlenecks inherent to a hierarchical force.

Undeniably, a primary goal of Network Centric Operations is that of self-synchronization – a state where diverse and distributed commands can act with unity of effort primarily through a thorough understanding of the commander's intent and common situation awareness (Alberts, Garstka, and Stein, 1999). The commander's intent supplies the strategic and tactical goals explicitly crafted to ensure that the force understands the desired end state for the operation. Accurate situation awareness in turn, is a necessary precondition for effective decision making (Endsley, 1995; Klein, 1998).

Situation awareness (SA) cannot be provided as directly as the commander's intent since SA is an aggregation of information and intelligence from throughout the battlespace. All members of the force need to maintain a degree of SA so that they can act in concert with the whole. Nevertheless, they cannot afford to bog themselves down with the minute details of every aspect of the operation. Striking a proper balance between enough and too much incoming situational data continues to be a problem for the military.

Network Centric Operations Conceptual Framework

A high-level conceptual framework provides a mechanism for making informed predictions about the application of technology and combat power. The Network Centric Operations Conceptual Framework (CF) is an effort at bringing all of the varied hypotheses together in one model (Hollowman, 2004).

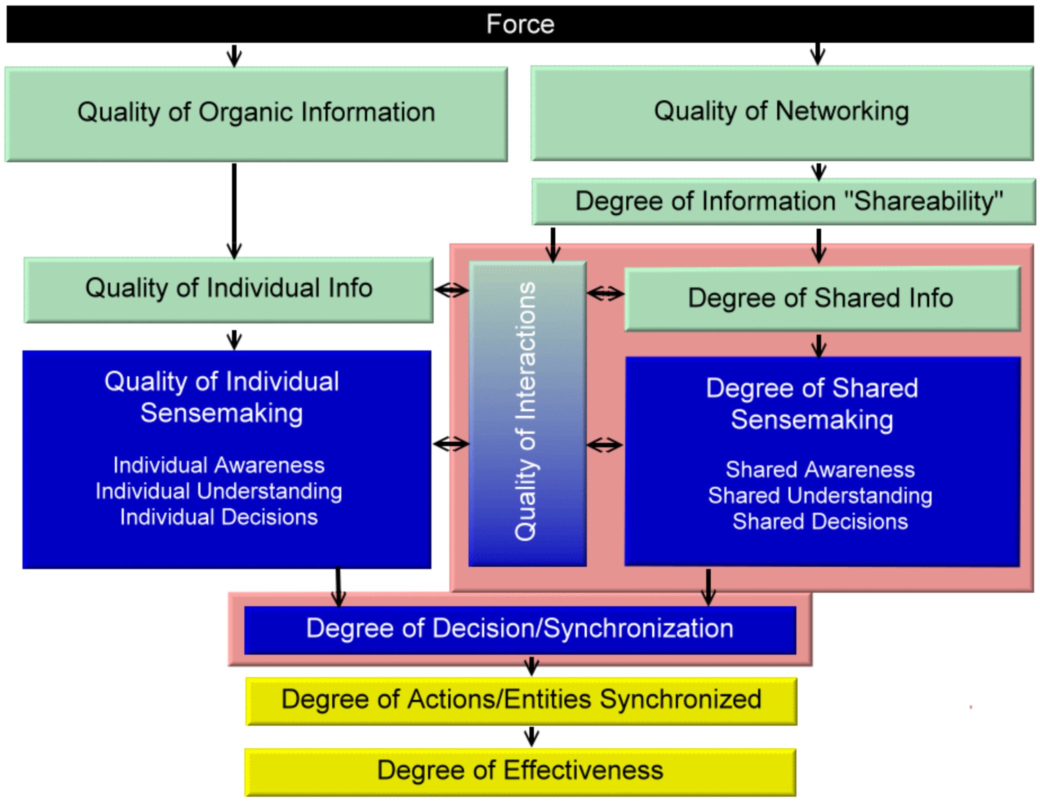


Figure 2 Network Centric Operations Conceptual Framework

The Network Centric Operations Conceptual Framework is comprised of four dimensions: (1) the physical domain - the tangible world of objects and actors; (2) the information domain – the figurative space where information resides and is transferred; (3) the cognitive domain – the seat of individual and group thought, sensemaking and awareness; and (4) the social domain – the intersection of people living and working together, either in person or through the network.

Briefly, the Network Centric Operations Conceptual Framework posits that an individual (or group) needs accurate and timely information to build situation awareness and understanding in the *cognitive domain*. The network allows the participants to both push and pull information from the *information domain*. By doing so, the aggregation of synchronized actors creates a virtual team in the *social domain* that works together toward common ends. Ultimately, the shared understanding allows warfighters to make effective decisions in line with the plans and goals of the group that can be enacted in the *physical domain*. Effectively, the team members working in parallel are able to accomplish far more through enlightened self-organization than would be possible through traditional hierarchical organization.

Within the conceptual framework, individuals decide and act independently, but always within the context of the group norms and expectations. As per Coase's (1937) expectations, the network nullifies transaction costs, which affords the opportunity to utilize smaller more responsive and flexible units. For instance, instead of fielding a self-supporting armor brigade, one might be able to send a cavalry troop that has a smaller footprint and can instantly gain greater firepower through the network. Information superiority allows forces to eliminate command bottlenecks, be more efficient and flexible, and, in the end, be more effective.

Human Communication

In a networked environment, communication channels are often narrowed by medium choice. The Network Centric Operations environment capitalizes on distributed assets so a rich face-to-face medium is usually not practical. Instead, the majority of the communication occurs over voice radio or computer-mediated channels in the form of standard military formatted messages, e-mail, text messaging or chat. Ellis (1999) presents an examination of the relationship between language and communication that is particularly relevant in Network Centric Operations environment because regardless of oral or literate cultures, human beings use language to exert control. For decades, scholars have studied human expression in an oral and a written form to determine the effects of language use on human interaction (Bernstein, 1975, 1981; Bradac, Bowers, & Courtright, 1979; Burgoon & Miller, 1971; Ellis, 1982, 1992; Ong, 1982). In a Network Centric Operations environment, language is especially important because the information exchange process is both conversational and critical.

Senders often use unformatted text and verbal commands over noisy and broken communication circuits to transmit messages. Hence, the language used in a Network Centric Operations environment has neither the formal structure of standard military message traffic nor the unrecorded free flow of face-to-face oral communication. Therefore, language use in a Network Centric Operations environment is unique and demands attention. Often senders and receivers are only sending written text to convey intent, yet the interaction is "conversational" in a text chat. The exchange between sender and receiver is instantaneous and informal, so the opportunity for misunderstanding of the sender's message in a text chat is increased compared to the formal structure of standard message traffic.

In addition, few social context cues (i.e., status cues, vocal inflection) are available in an operational Network Centric Operations environment to distract the communicators or to enhance the meaning of the message (Fowler & Wackerbarth, 1980; Hiemstra, 1982; Rice & Love, 1987; Sproull & Kiesler, 1986; Williams, 1978), especially if communicators have little or no history interacting. Which is often the case in a military operation and a reason exercises to practice interaction? In Operation Enduring Freedom many of the Naval personnel that interacted in the networked environment had no history other than common training. The lack of social context cues in a network environment can be both a positive and negative. On the one hand, users can focus on the actual message without necessarily thinking about the sender. On the other hand, Network Centric Operations participants require contextual background to assess the validity and priority of a message.

One method of acquiring context information is by evaluating language style of the sender. Adkins and Brashers (1995) found that language style has a significant impact on impression formation in computer-mediated environments. Specifically, the user of an explicit language style in a computer-mediated group is perceived as more credible, attractive, and persuasive than the user of an abstract language style while contrasting language styles caused perceptions to be more extreme than if users shared a common language style.

In a Network Centric Operations environment language style is exposed and tailored with the usage of network enabled tools. Large numbers of participants are the force multiplier in a networked environment. The transparent nature of the networked environment allows a lot of eyes on messages so leadership can provide the rudder correction in style and content that is required to convey meaning.

Technology Adoption & Transition

One of the primary theories of technology adoption is the Technology Acceptance Model (TAM). TAM is a causal model of actual system use that posits actual technology use (AU) is directly caused by behavioral-intentions (BI), a measure of the strength of ones intentions to perform a specific behavior. Intention is a useful construct because it can be measured well in advance of actual use (Davis 1986; Davis 1989).

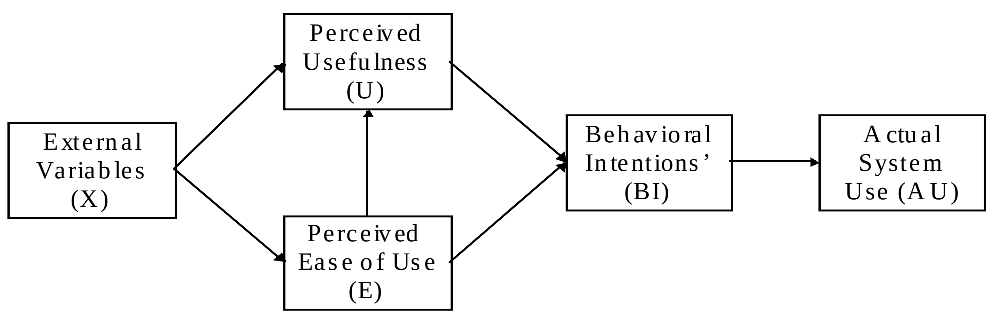


Figure 3 The Technology Acceptance Model (TAM) From Davis, 1986, 1989, 1993

TAM further posits that BI will be determined by two attitudes: perceived-usefulness (U) of the technology for getting the job done and perceived ease-of-use (E), or the degree to which using the technology will be free of effort.

U and E may seem at first to be very similar, but they are quite distinct. U is the degree to which one believes that using the technology will lead to improved job performance: *"Will I do my job faster? Will my boss be happier with my results?"* On the other hand, E is the degree to which one believes the technology will leave ones mind free to work. *"Will I remember how these menus work? Will I have to fight with the network?"*

TAM proposes that a myriad of external variables (X), like system-design-characteristics and self-efficacy, may combine to change one's perception of usefulness and ease-of-use. The model also posits that an increase in E should cause an increase in U. The unspoken assumption underlying this proposition may be that cognitive resources are limited, therefore the cognitive load imposed by the tool will interfere with task performance. If the tool is easy to use, it will be more useful for the task than if it is hard to use.

During the course of nearly a decade of research with the U.S. Navy's Third Fleet, a new, richer model emerged with the Technology Transition Model (TTM) (Briggs, Adkins, Mittleman, Kruse, Miller & Nunamaker, 1999). TAM predicts and explains a state-of-mind achieved after a one-hour exposure to technology; TTM attempts to explain what causes a group of technology users to become self-sustaining.

The Technology Transition Model

Like TAM, TTM posits that actual system use is a function of Behavioral Intentions (BI). However, it posits that BI will be a multiplicative function of perceived-magnitude -of-net-value and perceived-frequency-of-net-value.

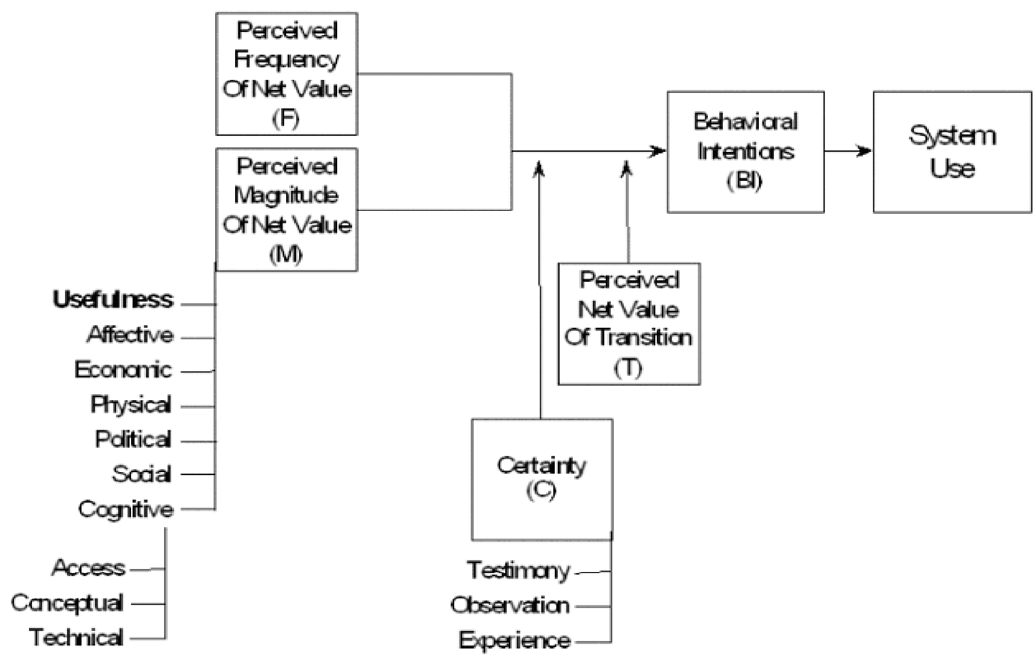


Figure 4 Technology Transition Model

Perceived-Magnitude-of-Net-Value

Perceived-magnitude-of-net-value (M) is defined as an attitude, a subjective assessment of the probable consequences of changing from existing technology to the proposed technology. Note that M is not a measure of how big the differences will be, but of how the prospective user feels about those differences. Upon being exposed to the technology, prospective users will synthesize a holistic sense of how their lives will be different if they change to the new technology. That perceived difference will evoke an affective judgment, for example, *"overall, this will be good for me"*, or perhaps, *"life is going to get a lot worse."*

Dimensions of Net-Value

There may be a number of dimensions for perceived-magnitude-of-net-value. Davis (Davis 1986; 1993; Davis, Bagozzi, Warshaw, 1989) identifies a most prominent instance of perceived-value as usefulness, the degree to which the user believes the technology will enhance job performance. If the user thinks the new tool will greatly improve job performance, this might be an instance of a positive perceived-value. However, there are other dimensions of perceived-value such as: affective, economic, physical, political, social and cognitive.

Prospective users may synthesize a variety of competing values of different magnitudes and directions into an overall assessment (Robey, 1979; Nickerson, 1981). For example, the users might believe that a new technology would substantially improve organizational profitability (large positive economic value) but that it might cause the users to lose a modicum of influence with managers (small negative political value). They might find the new system somewhat more awkward (small negative cognitive value) and therefore a lot more frustrating (big negative affective value) than the present system. However, it might be that the new technology provides a forum for more frequent exchanges of ideas among friends (modest positive social value). In the end, the prospective users generate an overall net assessment of how much they will like or dislike the changes engendered by the new system. We call this final assessment the perceived-magnitude-of-net-value of the change (M). M may be positive or negative.

M pertains to a comparison of the existing system to the proposed system. It is a net assessment, not an absolute assessment. For example, the old system might be terribly difficult to use, a negative cognitive value. The new system might also be hard to use, also a negative cognitive value in absolute terms, but if it does not seem as hard to use as the old system, the result may be perceived as a net positive cognitive value.

TTM posits that any number of factors external to the individual may be perceived as creating positive or negative value along one or more dimension in one or more directions simultaneously. Thus, in TTM the dimensions of value subsume and explain the effects of the external factors, so there is no separate construct in the model to represent them.

Perceived-Frequency-of-Net-Value

Users also consider how frequently (F) they expect to derive the net-value they perceive. Will they derive value moment-to-moment? Daily? Twice a year? TTM posits that F and M combine multiplicatively to cause BI. F may be zero or positive, it cannot have a negative value because there is no frequency less than zero occurrences per time unit.

No matter how high M becomes, if F is zero, BI will be zero. Likewise, no matter how high F becomes, if M is zero, BI will be zero. A small positive perceived-net-value obtained frequently may lead to a positive BI. Likewise a large positive M and a low F may lead to a positive BI. If M becomes negative, BI may also become negative, and the user may actively avoid system use.

Among other things, this model suggests that a frequent minor irritation, such as, having to reset a server twice a day, may be sufficient to outweigh larger, but less-frequent benefits.

Perceived-Net-Value-of-Transition

But what of a technology that engenders a small positive M and a low F? Will it be accepted? That may depend on perceptions of switching costs and benefits. TTM posits that users also attend to the perceived-net-value-of-transition (T) when choosing whether to accept a new technology. While F and M relate to a comparison of the existing system to the proposed system, T represents the value derived from the transition activity itself, apart from the value the new system will deliver. For example, the learning curve for the new system would represent a negative cognitive value. On the other hand, a trip to San Francisco for training classes might be perceived as having positive economic, affective and social values. Being regarded by one's boss as the project champion for new technology might offer positive political and social values, while having to shepherd the multitude of technical difficulties of establishing the new system might be a negative cognitive value. In the end, the prospective user will synthesize the perceived values associated with effecting the change into a subjective judgment of the net-value-of-transition (T).

Certainty

People develop their attitudes toward a new technology based on exposure to the information system. Briggs, Adkins, Kruse, Miller and Nunamaker (1998) identified three kinds of exposure: testimony, observation, and experience. Testimony may be as informal as a conversation at a water cooler or as formal as a refereed academic article. Observation may range from a glimpse of a video clip to several days of watching over people's shoulders as they use the technology. Experience may range from a few minutes of hands-on playing to days of intensive use for mission-critical applications.

Whatever the form of exposure, the prospective user will use it to form some assessment of not only the magnitude of the perceived-net-value, but also some degree of certainty (C) about that assessment. Certainty is a subjective probability that an expected net-value will actually be obtained.

Technology Transition Simplified

A much simplified description of TTM theory is that successful adoption of new technologies is based primarily on two factors: (1) Perceived Net Value - the benefit that warfighters expect to experience each time they use a technology combined with the frequency that they anticipate using the technology, and (2) Perceived Complexity - the cognitive effort associated with using the technology.

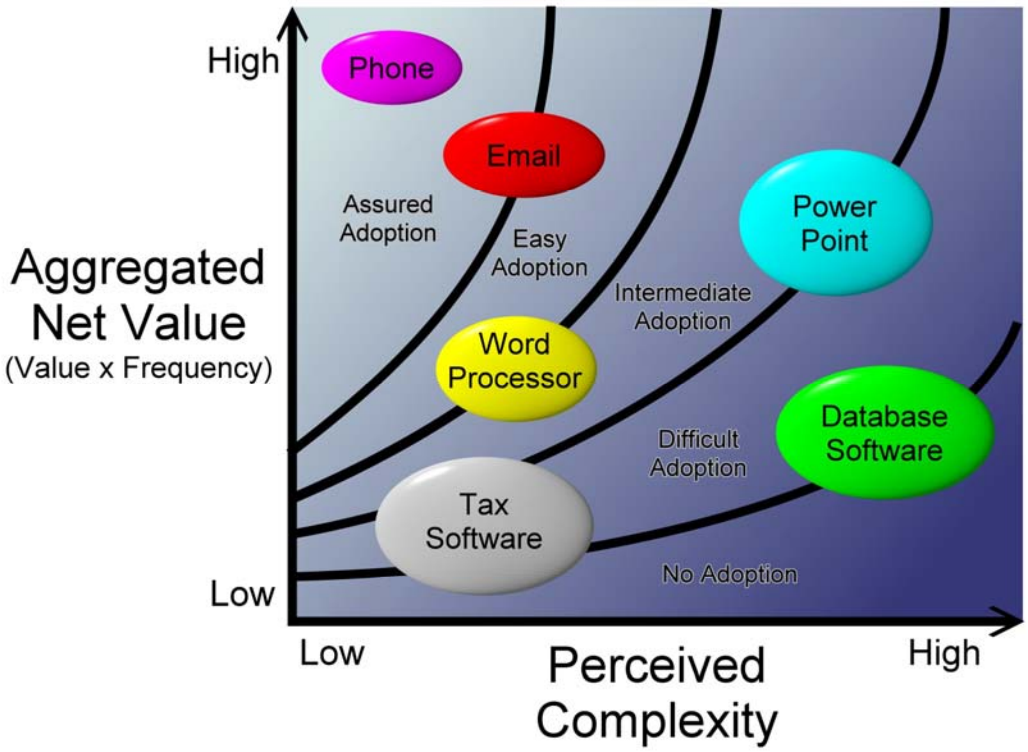


Figure 5 Simplified Technology Transition Model Representation

A relatively simple and frequently used technology like email is easily adopted as users realize significant value on a daily basis. A technology with little benefit and/or low usage frequency may not be able to overcome its perceived complexity to achieve a successful adoption. Users are not willing to put forth the effort if they do not expect to gain a net benefit. On the other hand, users will go to extensive lengths to adopt complex, but very useful technologies. For instance, enterprise resource planning systems like SAP are extremely complex and expensive. Many users are willing, however, to take on a high level of complexity in order to gain the great benefits that have been demonstrated in other environments.

Research Context

Network Centric Operations Technologies

A recent study of Commander Task Force – 50 during Operation Enduring Freedom revealed simple collaborative tools such as chat rooms, a webportal (Knowledge Web) and CommandNet, can tie warfighters together in a novel ways to increase mission effectiveness (Kruse & Adkins, 2001). Capitalizing on this knowledge, an effort is in progress to employee a collaborative environment with Component Numbered Air Force (C-NAF) Command and Control capability focused on the A-Staff. This capability is the Network-centric Commanders Decision Services (netCDS). As this project began the Air Force was in the process of structuring under General Jumpers guidance, so in addition to introducing netCDS the organizational structure for the C-NAF is reviewed. Then the results of an action research approach with netCDS environments are discussed.

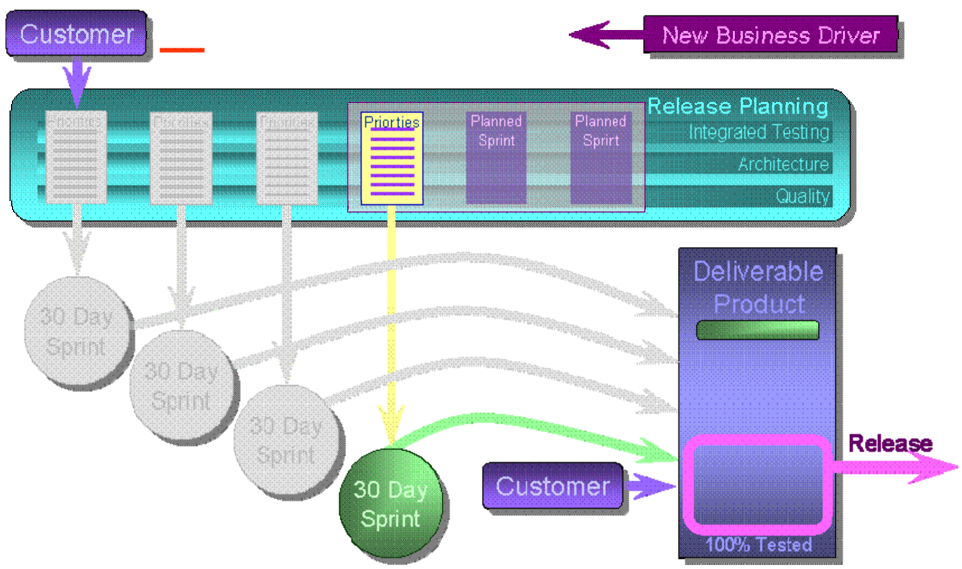
The effort is exploring a net-centric concept that would support distributed operations between the tactical, operational, and strategic levels of war, including reachback for shared resources and capabilities. Conceptually and practically netCDS leverages existing systems to enable the COMAFFOR to quickly focus on priority issues with appropriate and sufficient information to make decisions. A critical aspect of netCDS is the capability to monitor tasks that the AFFOR Staff is executing, providing them enhanced situational awareness and collaboration capability to plan, monitor, and sustain operations. Through a fast paced interactive problem identification and solution development iteration consistent with action research, the netCDS environment evolves into a shared set of user defined, real-time displays, decision aids and planning tools providing an accurate status of forces, systems, and supplies from the Wing level up to operational views that is able to be replicated for all C-NAFs. In an ideal model, the reach back and access of information should run directly from Wing level to NAF to MAJCOM and further to allow warriors to fight while providing capability for insight, oversight, planning, and execution worldwide.

Several key principles within the component NAF headquarters concept need to be expressed to provide context for this research. In a brief to the U.S. Senate in February of 2005, General Jumper outlined the following structure. The component NAF headquarters commander is the USAF component commander to their respective unified, sub-unified or JTF commander. COMAFFOR for assigned and/or attached USAF forces is the component NAF Commander. The component NAF commander is positioned to be the C/JFACC, and should be prepared to command a JTF, although the component NAF headquarters is not designed to be a stand-alone JTF headquarters. Each component NAF headquarters is sized and tailored based on specific mission and AOR. The component NAF headquarters provides a ready transition to war because it is staffed with an AOC entity and an AFFOR A-Staff and tasked as the operational warfighting echelon. The component NAF management functions will be minimized or eliminated to allow the component war fighting headquarters to focus on warfighting. Component NAF headquarters management functions will be transferred to MAJCOMs, centers and agencies that support the component MAJCOM and subordinate units.

A long term vision provides C-NAF C2 capability vertically from the tactical to the operational and horizontally between the Joint and Coalition partners. The netCDS service is a shared, user-defined set of near-real-time displays, decision aids and planning tools providing an accurate status on forces, systems and supplies. Concepts discussed are the history of requirement emergence, spiral system development and transition to the warfighter in 30 day and quarterly cycles, using the technology transition model a guide at C-NAF installations and key results.

Agile Methodology

The team uses an agile development and delivery methodology, Pathfinder, is focused on rapid delivery, stakeholder involvement, and program status transparency. The stakeholders and the solution team work together to solution the solution roadmap and the solution backlog. The solution roadmap identifies the release milestones in broad terminology and the solution backlog contains a prioritized list of the functionality or requirements. The team accepts an amount of functionality that it will deliver in a sprint or approximately 30 calendar days (Fig. 6).



A sprint review, scheduled at the end of the sprint, demonstrates to stakeholders what the team has accomplished. The stakeholders are encouraged to give feedback and add, remove, or modify the solution backlog. The solution at the end of a sprint is considered to be in a releasable state. If the stakeholders determine that the solution has releasable value then the solution is released. The stakeholders have continual visibility into the status of the project.

Quality is handled by test-driven development (TDD) and a continuous integration environment. TDD is the process of developing the acceptance, unit, and integration tests before developing the software. Continuous integration is automated testing frameworks being continually executed as the software is developed. The goal is uncovering bugs or issues with the software as early in the development cycle as possible.

Results

Currently netCDS is a collaborative environment supporting the Air Force Forces (AFFOR) staffs at the 7th and 13th Air Forces and at the Secretary of the Air Force staff. After dozens of 15 and 30 day sprints, numerous capability testing opportunities and a few successful evaluations of netCDS during exercises and demonstrations a story is unfolding. Currently there a three capabilities under evaluation, a Master Events Log (MEL) used by the AFFOR Staff (A-Staff) at 7th and 13th Air Force for event collaboration and shared situational awareness; a data management capability to use for tracking and status monitoring for Aircraft Maintenance and Munitions to collect, aggregate, and communicate the current and forecast levels; and mashboard "widget" based display capability for multi-level command briefing.

Recall the netCDS MEL capitalizes on decades of action research on collaborative logging in military context (Briggs, Adkins, Mittleman, Kruse, Miller & Nunamaker, 1999; Adkins, et al, 2001; Kruse & Adkins, 2005). Key tenants of the capability are one entry point with multiple views. As analysis of netCDS usability is done more linkages between the MEL and "mashboard" viewers are coming out with innovative participants. Another tenant to keep the interface simple to allow quick training for warfighters who often have to augment a command and flexibility that enables the database to be accessed with a variety of tools. Figures 1 & 2 display the information presented on the main tab to the collaborative logging tool and the event creation tab.

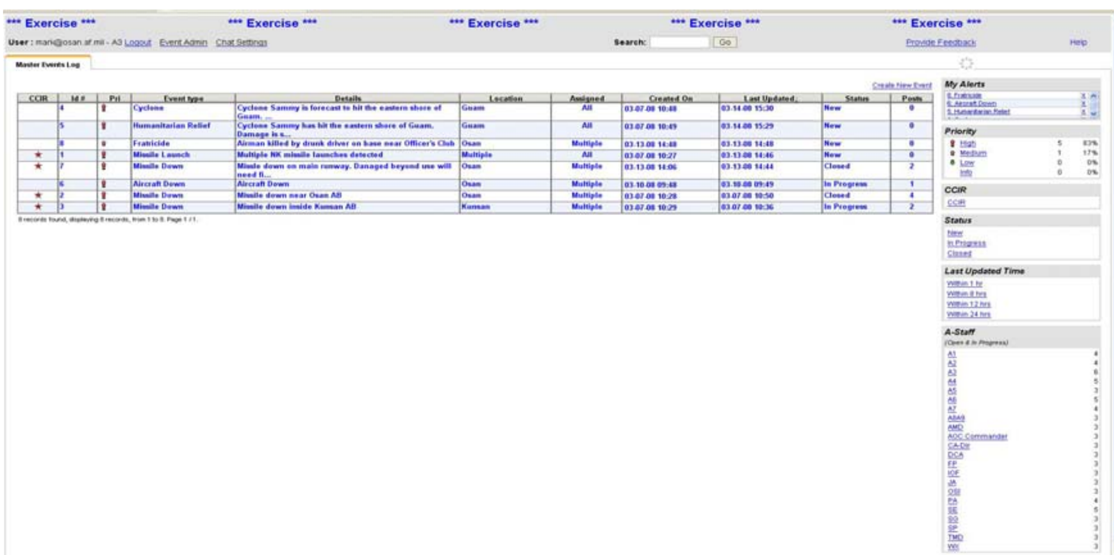


Figure 6 Master Events Log

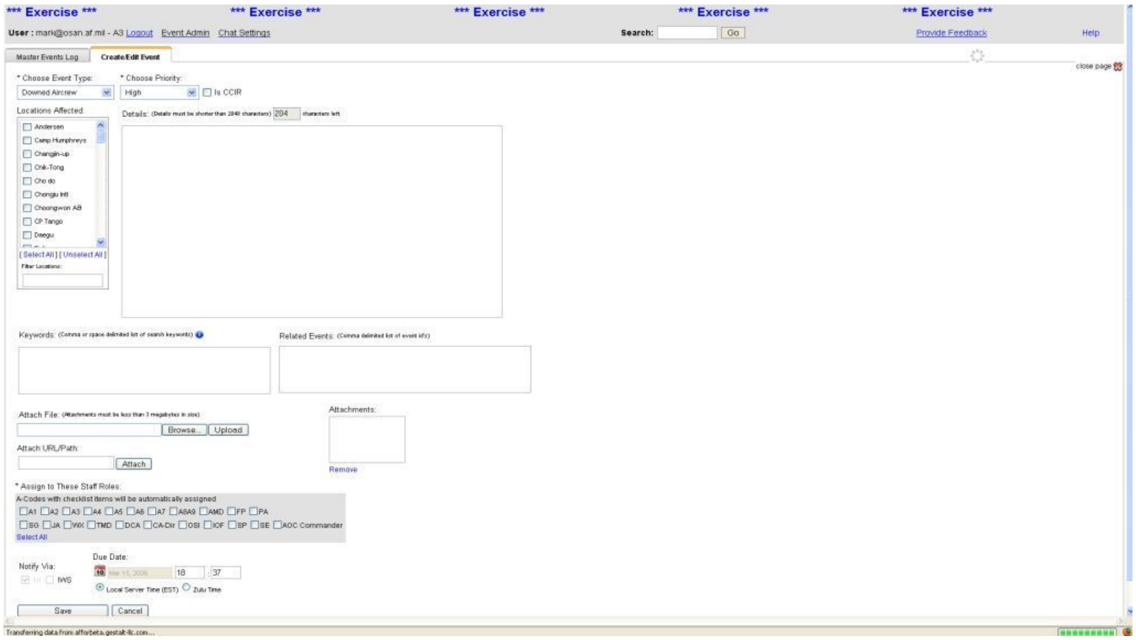


Figure 7 Master Events Log "Create Event Tab"

There are several goals for netCDS including: using the MEL to consolidate a variety of disparate information sources to reduce the number of systems interactions for the A-Staff; developing improved methods for netCDS data filtering capabilities to reduce data noise to the user; and to develop a dynamic method to facilitate parallel planning while avoiding confusion in providing requirements documents with prioritized transportation movement. All this is to be accomplished with the goal of 80% of the capabilities being researched for each component NAF being usable by other component NAFs.

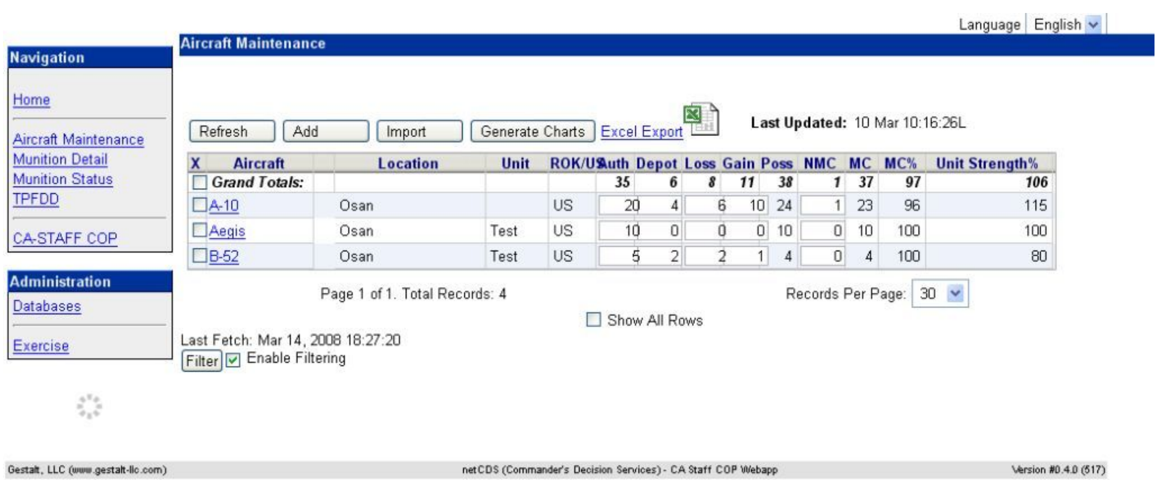


Figure 8 Aircraft Maintenance Data Management

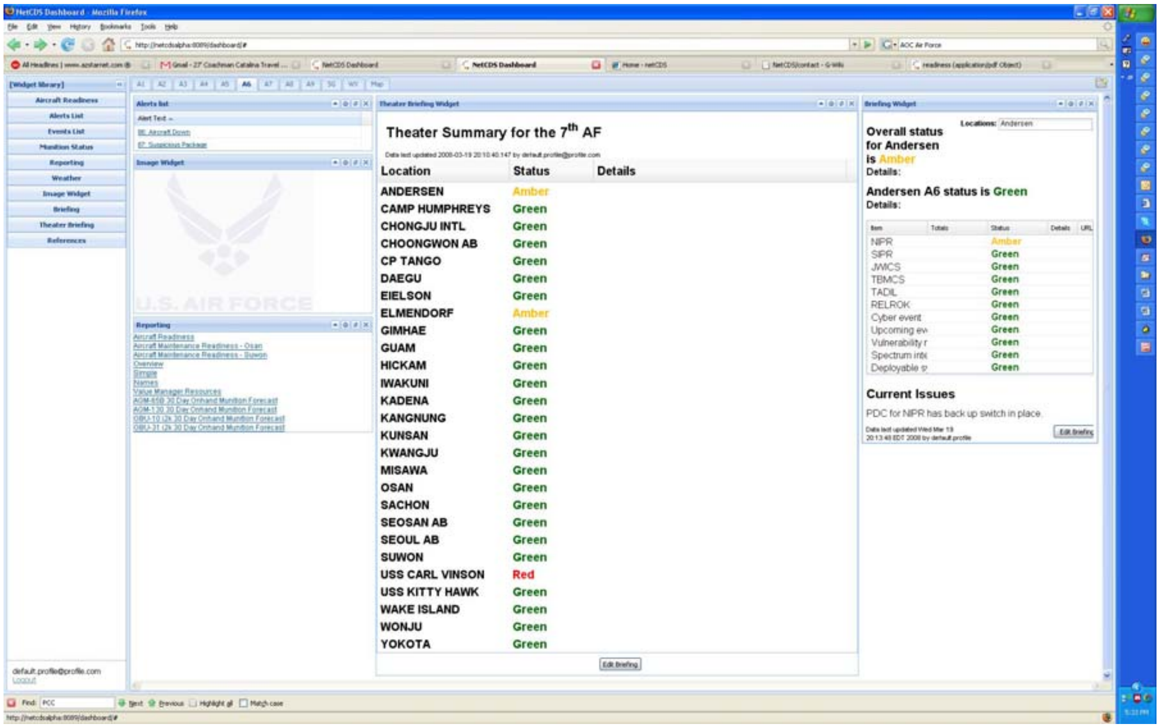


Figure 9 netCDS Dashboard

The results discussed in this section are from the view point of the authors and do not adhere to the rigors of a structured case analysis. Future research will focus on a more rigorous approach to analysis of this broad research into collaborative environments.

Breadth and Depth of Information Dissemination

A key indicator of Network Centric Operations success that the researchers looked to in this case study was the breadth and depth of information dissemination. This maps to what is called "degree of shared information" within the Network Centric Operations conceptual framework. Although this is not necessarily a variable set forth explicitly in Network Centric Operations literature, it does act as a good measure of the potential for shared battlespace awareness. Breadth and depth of information dissemination was selected as it is a precondition of situation awareness that people have access to information about the battlespace. Without widespread access to salient information, one can easily say that combat success had nothing to do with Network Centric Operations practices as the force did not even have the preconditions established to exercise Network Centric Operations.

The research team is evaluating a coordinated flow of information within the Staff at 7th and 13th Air Forces. Prior to the evaluation period, data was continuously flowing over email, voice, IWS chat, etc. Numerous staff hours were consumed by individuals monitoring the electronic data flow, capturing significant events, and communicating the events through the events logger, email, voice, etc. The focus of the coordinated staff event log is to capitalize on technology similar to CommandNet (Kruse & Adkins, 2005) to reduce the manpower effort and complexity, while providing a repeatable structure for the A-Staff to share situational analysis. The team is providing a structured collaboration system for the staff that is based around the core tenants of trainability, repeatability, consistency, and interoperability. The tool is an evolution of an existing bulletin board websites and logbooks to a dynamic commander's view of the battlesapce, and all associated staff views, which can be used to fuse information into the desired single viewpoint.

After two evaluation periods at 7th and 13th Air Forces, MEL has improved the breath and depth of information dissemination across the staff. A supporting event for this claim is that the Air Combat Command (ACC) commander at the 7th Air Froce asked for the tool to feed into his view of the battlespace directly into the ACC Portal. Hence, the MEL enables cross pollination of information across the environment and expanding the scope of the effort.

A second supporting element is that the Pacific Area Command Center (PCC) director at 13th Air Froce is now posting events that are shared and replied to by all concerned A-Staff identified as required to assess impact of the event. This is in place of e-mails with long strings of names on the "To:" and "Cc:" line that made tracking impact of events challenging. In addition, the Chief of Staff is posting guidance directly into an event posted in the MEL. Also there is a current effort to involve the Air Operation Center into a process for the MEL usage.

Future capabilities and vignettes for breath and dissemination of information will be reported after major exercises in MAR08 as well as JUL08 as they are captured at the 'tip of the spear.' There is a effort to influence cultural change by pushing the web based data entry to the lowest level possible for information to be consistently entered in the system. Once captured, the information will feed to the Staff for generation of the requisite SITREPS, and parsing into a dynamic view of the world.

Social Domain of Network Centric Operations

The Social Domain of Network Centric Operations conceptual framework is the least developed and tested. Social issues do, however, remain central to the way that actors within groups behave. Society and group interaction shape and mediate our actions and decisions to a greater extent than most people are aware.

Humans evolved, for the most part, in small familial and clan groups. The myriad forms of descent and clan affiliation are a testament to how important our forbearers found it to establish strong links to those around them. The clan sought shelter and food together and came to see survival as being tied directly to the group. Though one could argue that modern civilization has taken us beyond the need for such close affiliation in our day to day interactions, the reality is that we still have a desire to establish a feeling of connectedness and trust. Moreover, this need colors our organizations, actions and communication.

As societies grew larger, the challenge to maintain close personal ties to every individual in the group increases. The need to establish an “us” and “them” did not diminish as can be seen in religious and nationalistic movements throughout history. Additionally, social mores were codified into laws that helped to pull together whole nations. In the absence of a web of personal relations, the rule of law allows people to go out and interact with people throughout the world with predictable results. The certainty associated with predictability allows people to think, act and grow beyond means of an individual or a small group.

An oft cited example is that of the car rental. Because of an established network of laws and business relations, amazingly one is able to go out and rent a car across the globe as easily as in your own county. Such structured systems help to establish trust in lieu of actually getting to know someone to personally establish confidence. The car rental company trusts the credit card company, which in turn relies on a demonstrated history of dependability by the renter as well as governmental driver evaluation.

The A-Staff continuously replicates and stores data, in slightly different formats, to accommodate views that must be provided across the chain of command (CFC, USFK, PACAF, PACOM, etc). This process creates multiple redundancies in presentation, practice, and information flow and takes up A-staff time and impedes effectiveness.

The shift from the current ‘tactical document’ methodology used within C-NAFs to a system based approach where the data is ideally transferred from the statement of requirement to netCDS in a transparent manner has some technical challenges. Yet elements within the social domain at a staff present more challenge than the technical elements. At 7th Air Force the netCDS team has moved from a “monster” spreadsheet and manual data entry to using a capability for tracking and status monitoring of the Maintenance and Munitions. The use of the capacity has fostered an environment where the tool was trusted and used to directly brief the command staff during one evaluation period and yet not used during another evaluation period. Hence while the capability has not changed in form or function the social cultural norms of creating and delivering a “brief” are still impacting behavior. Again the capability is still being used yet the information is pushed into a “Powerpoint slide” vice being viewed directly from netCDS. Future evaluation periods will be reviewed to determine how the social elements are impacting the transformation process.

Co-evolution of TTPs

During a recent evaluation period the MEL was implemented across the A-Staff. A conversation with a director during the implementation period revealed that since there were no standard operating procedure (SOP) deployed for how the capability should be used he would continue to deploy information via e-mail. Social pressure and guidance from leadership encouraged the director to establish an SOP that could be passed down across shifts and the capability was adopted though the resistance to change is still being seen. An interesting side note in this regard is that no matter how strongly the end-state of network centric operations, shared situational awareness or self-sychronization, is desired by the individual warfighter or command the challenges consistently seems to be with individuals. Hence the tenets of TTM come into come into play as we develop and experiement with capabilities.

Previously, information was not circulated as widely because it was unwieldy and inefficient to do so. The MEL and the portal at 13th Air Force have significantly lowered the barriers to widely sharing information. Staff officers simply posted critical documents on a portal and referred to them in a log event so the document was posted once vice e-mailed to multiple users. Because these documents are automatically shared, the staff as a whole can be better informed and more responsive as previously narrowly distributed information was made available to everyone. Also if changes to the document are required, updates can be made once for all to see.

The impact of the social elements will be of particular interest as information is used to produce computer generated views of typical brief information, SITREPS, MUREPS, COA's, etc. as required by the various 'audiences' across component C-NAF, utilizing user configurable UI's based upon Web 2.0 concepts. Exploring a 'next generation' version of a common operational picture is envisioned with the 'answers'. The commander will have continuous access to capabilities specifically unique to needs of the commander. Requirements are for a capability that is "near" real-time and dynamically linked to either the systems or people any point in time and with a quick glimpse, get accurate shared situational awareness, where the issues are, impacts to operations and to being done to remedy them. Automated data feeds are important, but a human must remain in the loop element to allow overriding of this data as needed, such as an automatic color status indication.

Conclusion

Lewin's concept of action research dovetails well with the agile development, experimentation and employment of a network centric operation capability such as netCDS. The reflective process of progressive problem solving linked with a theoretical frame for technology transfer allows systematic development to improve the way "players" address issues and solve problems. The objective of netCDS is to capitalize on agile development strategy and practice to provide warfighter netric centric functionality that is adaptable and deployable using the tenets of the technology transition model. A spiral of steps, each of which is composed of a circle of planning, action, and fact-finding about the result of the 30 days of development is ideally suited to support a stakeholder driven C2 strategy. The development and employment of a netCDS for 7th and 13th Air Force using the agile development methodology and the technology transition model success has been shown as use across the A-Staff, ACC and AOC is becoming integrated. This case study is a preliminary investigation of the both the agile development methods and the network centric operational capability of a C2 system that supports the commanders information requirements and decision needs.

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