Network Centric Warfare in the U.S. Navy's Fifth Fleet

Web-Supported Operational Level Command and Control in Operation Enduring Freedom

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Abstract

This case study was commissioned by the Office of Force Transformation in the United States Department of Defense to examine the employment of Network Centric Warfare (NCW) systems and practices in the U.S. Fifth Fleet's Commander Task Force Fifty (CTF-50). The staff and commander of CTF-50, embarked on the nuclear aircraft carrier USS Carl Vinson (CVN 70), led a coalition force of 59 ships in combat operations against Afghanistan during the execution of Operation Enduring Freedom (OEF). The task force adopted a number of networking and collaboration tools that had significant effects on how CTF-50 was able to plan and execute missions in the Arabian Gulf and Afghanistan. This case study draws on NCW, technology adoption, decision-making and human communication theories to examine and explain the behavior of NCW system users.

1. Introduction

Traditionally, the U.S. armed forces have looked to technology as a "force multiplier" to win the day while minimizing risks to the army or fleet. The U.S. military is quite willing to sacrifice larger force structure in order to leverage new technology that could be pivotal. Network Centric Warfare, the leading edge theory on military operations requires changes in thinking on how to accomplish missions, interrelate, communicate and acquire systems to support military actions [1]. Just as radio communications changed the nature of battle, the networked computer is expected to change all facets of the military. From the 5000-man super carrier, down to the individual infantryman, there are plans being tested and implemented to leverage vast networks to better share information, improve responsiveness and multiply the effectiveness of forces.

This case study data was gathered at the U.S. Fifth Fleet's Commander Task Force Fifty (CTF-50) the execution of Operation Enduring Freedom (OEF). The commander and staff of the task force, aboard the USS Carl Vinson, adopted a number of simple networking and collaboration tools that had significant effects on how CTF-50 was able to plan and execute missions in the Arabian Gulf and Afghanistan. CTF-50 was able to successfully implement NCW tools and techniques where others have failed. This paper seeks to outline their experiences and possible explanations for their behavior.

2. Background

Structurally, the U.S. Navy is currently separated into geographically based fleets. The Fifth Fleet, based in Bahrain, is responsible for supporting United States Central Command (CENTCOM) – the theater commander of forces operating in the Middle East.

Fifth fleet has limited organic forces. Instead, ships and battle formations from the other fleets are usually trained and sent to the Fifth Fleet area of responsibility (AOR) for duty. Often the ships and boats that rotate into Fifth Fleet have trained for deployment in Second Fleet (Norfolk, Virginia) or Third Fleet (San Diego, California). Usually these deployments last six months, however, this varies greatly as the Navy's requirements around the world are addressed.

Typically one Carrier Strike Group (CSG) is on station in Fifth Fleet at any given time. In routine deployments this flotilla is based around an aircraft carrier and includes a Destroyer Squadron (DESRON), submarines and an Amphibious Ready Group (ARG). The wide-ranging capabilities of these ships, sailors and marines allow for a great deal of flexibility in dealing with contingencies. There are times, nonetheless, when such a force is not large enough or needs to be realigned to meet a specific situation. When such operational needs dictate, the CSG can be expanded to include other naval forces.

On the 12th of September 2001, the Carrier Group Three (CARGRU 3) staff aboard the USS Carl Vinson (CVN 70) arrived in the North Arabian Sea. Although the staff had prepared for a typical deployment, they were soon thrust into a mammoth mission expansion with their designation as the U.S. Fifth Fleet's Commander Task Force Fifty (CTF-50). Ultimately, CTF-50's efforts culminated in leading a coalition force of 59 ships in combat operations against Afghanistan during Operation Enduring Freedom (OEF).

One of the hallmarks of CTF-50's successful prosecution of OEF was arguably the best employment of Network Centric Operations (NCO) ever seen above the tactical level. The University of Arizona's Center for the

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Management of Information (CMI), at the behest of the Department of Defense's Office of Force Transformation, developed a case study from research into the nature of CTF-50's experiences.

The primary goals of this research were to find out how NCO technologies and processes influence self-synchronization, speed of command and mission effectiveness. Although the CMI researchers found ample evidence of the efficacy of NCO, interesting ancillary issues arose with regard to leadership, collaboration and technology adoption issues.

3. Theoretical Foundations

Though this case study is primarily based on the Network Centric Warfare conceptual framework, an important note is that such a complex model is underpinned by research in the social sciences. Consequently, the researchers drew on a wide variety of concepts to understand and explain the actions of the subjects.

3.1 Decision Action Cycles

In a conflict situation, a general pattern emerges for the command and control of forces. Commanders and staffs try to understand the situation and anticipate potential enemy actions. In effect, this is a kind of theory building about the situational picture. They then try to take action to expand their own options and to limit those of their opponent. By doing so, the commander hopes to control the conditions and continue to force his will on the enemy until victory is attained.

Boyd found that in competitive asynchronous engagements a faster decision cycle is an inherent advantage [2]. By interfering with this decision cycle, one can impede the opponent and cause paralysis and ineffective counteractions. 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 [2].

3.2 Network Centric Warfare

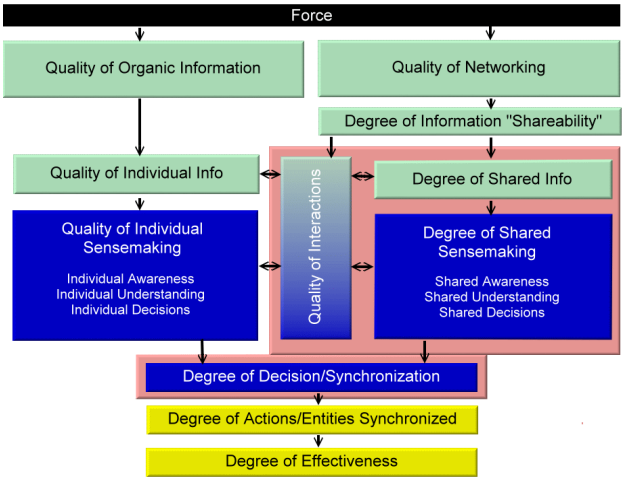
In the 1990's there was widespread adoption of Boyd's theories on decision-making among the military. Acceptance of Boyd's theories provided a broad understanding of how to defeat the enemy. There was, however, a need for an extended theory that could integrate the sea change brought by new information 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 this work 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.

Undeniably, a primary goal of NCW 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 [1]. 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 [3,4].

Situation awareness (SA) cannot be provided as directly as command 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.

3.3 NCW Conceptual Framework



NCW Conceptual Framework

The next step in the evolution of NCW was the development of a high-level conceptual framework that could begin to provide a mechanism for making informed predictions about the application of technology and combat power. The NCW Conceptual Framework (CF) is an effort at bringing all of the varied hypotheses together in one model.

The CF 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 CF 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.

3.4 Human Communication

In a networked environment, communication channels are often narrowed by medium choice. The NCW 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 Navy message, e-mail, text messaging or chat. Ellis presents an examination of the relationship between language and communication that is particularly relevant in an NCW environment because regardless of oral or literate cultures, human beings use language to exert control [5].

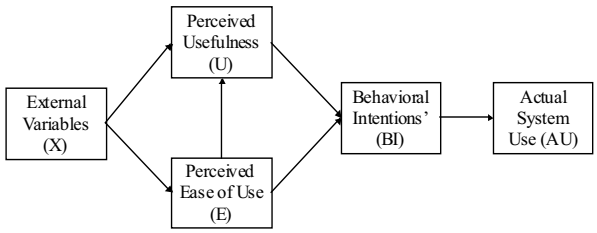
In a NCW environment, language is especially important because the information exchange process is both conversational and critical. Senders often use unformatted text and verbal commands over noisy and broken communication circuits to transmit messages. Hence, the language used in a NCW environment has neither the formal structure of standard Navy message traffic nor the unrecorded free flow of face-to-face oral communication.

There are few social context cues (i.e., status cues, vocal inflection) available in an operational NCW environment to distract the communicators or to enhance the meaning of the message [6,7,8,9], especially if communicators have little or no history of interaction. For example, when the force was assembled in Operation Enduring Freedom many of the personnel that interacted in the networked environment had no history other than that which common training provided.

One means of acquiring context information is by evaluating language style of the sender. Adkins and Brashers found that language style has a significant impact on impression formation in computer-mediated environments [10]. 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. Several assumptions illustrate language impacts in a NCW environment. Language style creates distinguishable impressions of the sender and communicates beyond the content of the message. O'Barr suggested that message form must support content or people will question the validity and sincerity of the message [11]. Past research supports O'Barr's contention that every message has both content and relational meaning and that these two levels of meaning affect impression formation [12].

3.5 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, the key indicator of success for technology transition.



Technology Acceptance Model (TAM) [13,14]

TAM posits that actual technology use (AU) is directly caused by behavioral-intentions (BI), a measure of the strength of ones intentions to perform a specific behavior [13,14]. Intention is a useful construct because it can be measured well in advance of actual use.

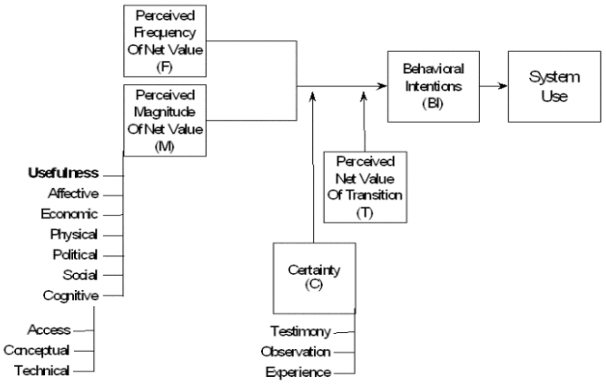
TAM further posits that BI will be determined by two attitudes: perceived-usefulness (U) of the technology for getting the job done and perceived ease-of-use (E), or the degree to which using the technology will be free of effort.

3.6 Technology Transition Model

During the course of research with the U.S. Third Fleet, a new, somewhat richer model emerged [15]. The result is the Technology Transition Model (TTM). While TTM springs from TAM, it does not replace it. 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.

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.



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. 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.

Dimensions of Net-Value

There may be a number of dimensions for perceived-magnitude-of-net-value. Davis [13,14] 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 [16, 17]. 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.

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.

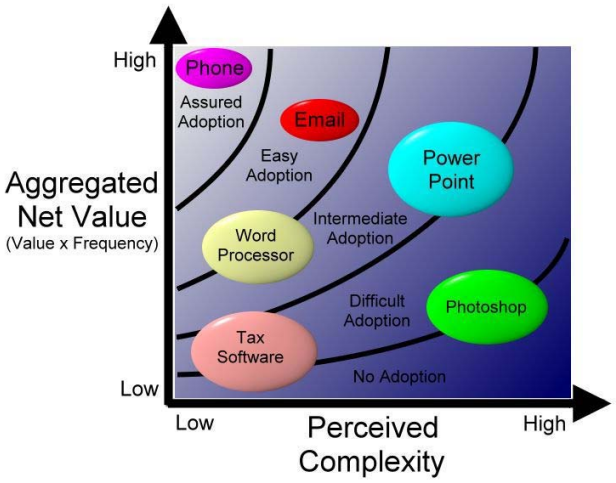
Perceived-Net-Value-of-Transition

While F and M relate to a comparison of the existing system to the proposed system, perceived-net-value-of-transition (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.

Certainty

People develop their attitudes toward a new technology based on exposure to the information system. Briggs, Adkins, Kruse, Miller and Nunamaker identified three kinds of exposure: testimony, observation, and experience [18]. 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.

3.7 Technology Transition Simplified



Simplified Technology Transition Model Representation

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 users 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.

A relatively uncomplicated and frequently used technology like email is easily adopted as users realize

significant value on a daily basis. A technology with less benefit and/or low usage frequency may not be able to overcome its perceived complexity to achieve a successful adoption. For instance, although tax software may be quite easy to use, one may not be willing to put forth the effort to realize benefit only once per year on April 14th. On the other hand, a user may be willing to take on a fairly complex technology if the perceived rewards are evident. Each user's perceptions are different, but the bottom line is that people are not willing to adopt new technologies if they do not expect to gain significant return on their investment of time and effort.

4. Research Context

CTF-50 utilized a number of different technologies during the deployment, but the key collaborative tools that tied the users together in a novel way were chat rooms, Knowledge Web (KWeb) and CommandNet [19].

Chat is a relatively ubiquitous technology that was primarily used in the civilian world for social interaction. Generally, the way chat works is that different channels or virtual rooms are set up on a server. These rooms are typically arranged to support a specific interest group. Within naval commands, the researchers have observed rooms centered on such interest groups as meteorology and oceanography (METOC), tomahawk land attack missile (TLAM) targeting, and logistics. Chat rooms were spawned and died as needs and interests changed in CTF-50. Ad hoc chats were also set up for specific conferences between users.

The knowledge web (KWeb) is a web-based information system originally developed by Space and Naval Warfare Systems Center SSC. At its core, KWeb is a web publishing system with specialized icons to indicate changes and priorities for web based information. Thus, users could quickly and easily find changes on the system to update their SA, while those posting information had a structured and accessible place to synthesize data for the rest of the users.

CommandNet is a web-based logging tool for recording and sharing critical incidents over the network. Contributors make chronological entries within themed logs. These entries give a running explanation of the important actions happening within the command. It provides a simple means for tracking decisions and events.

5. Methodology

Yin proposes five components of case studies as a guide: (1) identify the major question(s); (2) provide propositions; (3) identify the unit of analysis; (4) outline the logic linking the data to the propositions; and (5) provide the criteria for interpreting findings [20]. This research investigates CTF-50's use of Network Centric Warfare capabilities to enable self-synchronization, speed of command and mission effectiveness. The nature of the questions led the research team to use an explanatory-exploratory case study, hence there are no propositions. In this case study the unit of analysis is at the individual and organizational level. The criteria for interpretation of the findings are verifiable evidence of Network Centric Warfare capabilities enabling self-synchronization, speed of command, and mission effectiveness.

Interviews were conducted with staff members of CARGRU 3 and Commanding Officers of ships in the battle force. Interviewees were chosen by location, access and functional experience. The researchers requested interviewees that used NCW capabilities to fight the war. Interviewees were recommended by the commander of CTF-50 and CARGRU 3 staff members. In addition to senior staff members and operational users, bandwidth limited users were sought out for interviews. Prior to the interview, the subjects received a 3 slide "pre-brief" to introduce the researchers and the topics for the interview.

6. Findings

As per the expectations set forth by NCW conceptual framework, CTF-50 experienced many improvements in operations and decision-making. There were, however, effects that were not in line with NCW's current explanations of the social domain. In response, the greater portions of the findings are discussed with respect to the social and cultural implications for adopters of NCW technologies and operations.

Predictive Value of NCW Conceptual framework

CTF-50 found benefits from the widespread implementation of NCW supporting technologies and processes. In accordance with NCW conceptual framework, the task force experienced improved ability to share information, propagate and maintain situation awareness, and brought these improvements to bear in support of combat operations. The following are several specific areas of interest that the research team looked at when gathering data.

Breadth and Depth of Information Dissemination

A key indicator of NCW 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 NCW conceptual framework. Although this is not necessarily a variable set forth explicitly in NCW 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 NCW practices as the force did not even have the preconditions established to exercise NCW operations.

The task force staff and commanders displayed numerous and widespread evidence of extensive and broad-based information sharing. One could argue that much of the information that was shared on the KWeb was already available through the common operational picture (COP), email and record message traffic. This argument, however, really ignores the importance of information accessibility, or "share-ability" in NCW parlance.

The interviewees mentioned that the KWeb pages had a relatively steep learning curve. They required users to spend a significant amount of time learning the topology of the KWeb. They also stated, nevertheless, that once a person was familiar with the site they could more easily find regularly needed data than was ever the case before. KWeb was the "go to" place for the most recent and accurate information regarding the operation. Voice circuits, record message traffic and e-mail no longer carried the most accessible or up to date and accurate information. Critical information was being shared with users from multiple services, government agencies, ships and land based installations.

Moreover, users did not resent this "ramp up" period. Instead, they viewed it as the price of having the critical situation awareness that was required for operation. Generally, the thought was that the unfamiliarity of KWeb caused users some extra work, but that this work was an investment that paid off greatly after each user had mentally mapped out the KWeb pages. Not only could they find the data they regularly needed, but supplementary data was often referenced as users sought to become more generally knowledgeable about the conduct of the task force's operations and the war as a whole. This was especially true for watch standers at various operations centers as when the battle tempo was low they surfed for information and made themselves more effective.

An additional consequence of the predictable organization of information in the task force was that any concerns about information overload quickly evaporated. The synthesized and formatted KWeb information afforded users at all levels the opportunity to avoid sifting through large amounts of raw data themselves. Thus, the users developed a division of labor that allowed for a greater aggregated efficiency. Additionally, the expert synthesis of data brought a higher quality of information to users than they would be able to generate on their own. Essentially, all the information consumers using KWeb acted as editors and veracity checkers. When posted information conflicted with another source "electronic conversations" brought the issues up and often a more accurate information picture was posted after a discussion. Below is an example, that supports the discussion of breath and depth of information sharing during OEF.

A telling example of this kind of enhanced information brought to the larger community was with the aviation weather reports. Usually, weather is widely distributed in a standard text format. It requires, nonetheless, time and skill for each aviator or squadron to make useful sense of this raw data.

Within CTF-50 the METOC section brought this cryptic data together and published it in a graphical map format that was accessible and understandable to many more people. The net effect of this for the squadrons was that they were able to plan missions more quickly and select munitions and tactics that were more appropriate to the environment.

Speed of Command

Clearly one of the more important prescribed effects of NCW organization is the ability to significantly enhance speed of command throughout a force. CTF-50 certainly experienced real changes in the time that was required to plan and execute missions. The way this played out operationally was, nonetheless, surprising in light of NCW conceptual framework.

CTF-50 interviewees credited the new IT tools with making the staff and commanders more agile. The staff displayed different behavior than was expected by the research team. Coming into this case study the researchers anticipated finding an increased operations tempo as a result of the increased use of NCW tools. This did happen, but was less quantifiable than projected.

Instead, it appeared that the efficiencies gained through the application of NCW capabilities were from a gain in system slack. This makes sense in that the strike aircraft had to fly long distances to attack targets in Afghanistan. As such, the primary weapons systems employed by CTF-50 were already fully tasked. Speeding up the command's decision cycles did not appreciably alter the amount of time and effort it takes to fuel, arm, maintain and fly combat missions.

The gains afforded by the NCW systems and procedures did not, however, go to waste. Instead the staff used this extra time for contingency planning. The subjects often spoke of the great depth in "what if" discussions after the daily staff meeting. The staff officers felt NCW capabilities gave them excellent situation awareness and the time to do more tactical and strategic thinking. One particular element several staff members mentioned was that the information required for these "informal" in depth discussion was always available at any terminal. They no longer had to run to a stateroom, ready room of operation center to get information critical to the discussion.

Another important, but often overlooked, gain for the staff was an increased ability to sleep and wind down. The senior leaders encouraged rest and relaxation among the staff. In the high stress environment of OEF being

well rested provided opportunity for optimal performance from the staff when the operations required execution.

Divisions of Responsibility

The community of warriors has adopted a similar, but very specialized form of this structured interdependence. Military interaction is not based around financial transactions. Instead, military interactions are based upon a complex structure of supporting roles. From a functional standpoint, each type of unit provides a specific type of support to the whole. For instance, the aircraft carrier is able to launch strike missions because the cruisers and destroyers are providing air defense.

Soldiers often speak of the intense bond they feel in combat. Combat veterans experience an overwhelming motivation to not fail the unit. Thus, in the military sphere the societal requirements for trust and understanding are driven to unparalleled levels. A failure of one person to understand his mission can be catastrophic, and only through an extensive network of trust and interdependency can commanders be liberated to worry about anything but their own units' security.

Typically, trust is greatest among those within the immediate unit. The rifle platoon members or shipmates become the soldier or sailor's clan. As one moves farther out from this core group, the less one feels affiliation and trust. Thus, a sailor may have complete trust in his shipmates, somewhat less in the Navy as a whole, and may be a little suspicious of the Air Force.

To overcome these all too human reactions, the militaries of the world have developed a very explicit division of responsibilities. This affords everyone the ability to know who is responsible for dealing with any given threat. Without these trust relationships commanders will tend to become paralyzed, isolated and ineffective as they abandon their missions to defend against every potential threat.

Within the specific task areas, warfighters have tended to break up such responsibilities spatially. For instance, each infantry battalion is given a sector that they are responsible for controlling, or each cruiser is given an area of the sky to defend. Commanders are generally given a fair amount of latitude within their sectors as long as they meet their responsibilities and coordinate with adjacent units with like missions.

The primary casualties of this structure are efficiency, and by extension, effectiveness. Such a rigid system does not allow for rapid or flexible responses. Thus, a common situation on the battlefield finds some units over tasked while others have little to do. The division of responsibilities is often set up to minimize cognitive load and confusion. Moreover, changes are difficult to make in such an arrangement once the system elements are established.

Network Centric Warfare, on the other hand, demands speed, initiative and independent action. NCW owes much of its power to the increased ability of units to maximize their own effectiveness. Rather than wait to be directed to take action, commanders are free to use situation awareness to act on their own initiative as long as the action supports the mission and commander's intent. This tends to drive out inefficiencies and allow commanders to actively engage the enemy more often and for greater duration. This in turn will overwhelm the enemy that is not as flexible and responsive.

An example, of increased speed of command occurred when a pilot had to bail out over the Indian Ocean.

I look at one log that has the coordinates of the bailout. Surface ship heading north towards the bailout area didn't have the same communication ability. I pulled the lat/long and gave it to the surface ship in a chat and he said thank you then did his mission. It was fast and efficient SAR [search and rescue]. The network centric capabilities saved time and allowed the SAR team to act faster. – Battle Watch Captain

6.1 NCW Mandated Changes

Network-centric operations demand a high degree of trust and understanding among all of the players. This is, nonetheless, hampered by the distributed nature of the participants. Although the major players within CTF-50 had met, they still faced the problems associated with building and maintaining trusted relationships. In lieu of the rich interactions that take place in a face-to-face environment, they were forced to create new norms for behavior, accountability and reward around artificial networks.

Two theories that can help to explain the competing factors in supporting trust and understanding over networks are social presence theory and media richness theory. Capabilities of NCW such as CommandNet, KWeb, e-mail and instant-messaging (IM) have become standard communication tools over the world. The NCW environment is unique because, although it allows for relatively high-speed interaction between participants, it also "filters out" certain informational cues [8,9,21,22]. For example, chat generally transmits only text-based (including "rich" or "styled" text) messages, thereby omitting some nonverbal cues or channels that are typically used to transmit contextual and social information. Two theories have been developed to explain cross media differences: social presence theory and media richness theory [22,24].

In the first, social presence is defined as a subjective, cognitive synthesis of all of the many factors that reflect the social immediacy or intimacy of a communication medium. It is creating a sense of "being together with another" in a virtual environment, including primitive responses to social cues, awareness of the physical presence of an embodied other (co-presence), mutual awareness, and psychological and behavioral engagement (Biocca, Harms, & Burgoon, in press). Social presence

depends on the visual nonverbal cues transmitted, the apparent distance of the target person(s) being communicated with, and the "realness" of those being communicated with [21].

Daft and colleagues explain why managers overwhelmingly prefer oral communication, even when other channels are available [22,25]. The argument is that communication media can be characterized in terms of their "richness" or ability of information communicated on the medium to reduce equivocality. The media possessing higher degrees of each of these attributes, speed of interaction, cue multiplicity, language variety, and personal focus are considered richer. Daft, Lengel and Trevino report media high in richness are preferred for communication that is high in equivocality [25], and that media low in richness are favored for communication that is unequivocal. Face-to-face communication is considered the richest medium, followed in descending order by the telephone, addressed written communication, and unaddressed written communication.

The overall ratings of communication media are similar for both social presence and media richness theories (although reached in theoretically distinct approaches).One clear implication from both theories of cross-media differences is that some media are thought by communicators to be more successful at conveying information than others.

As a communication channel becomes leaner it becomes necessary for actors to be more and more explicit in their communications. For instance, two staff officers working in a room together can easily monitor each others' demeanor, work load and actions and glean a great deal of information. If they are separated, however, they no longer have access to all of this observed contextual information. To make up for this, the officers now have to give each other overt updates. Previously to NCW capability one officer was immediately aware of an emergency phone call to another officer in the operations center, now the officer only knows about the emergency if he is purposefully brought into the fold.

Fortunately, another framework, known as channel expansion theory, does give some hope for better use of currently available technologies to build trust and understanding [26]. The crux of channel expansion theory is that as users become more familiar with a particular communication medium they become more skilled in pushing greater amounts of information through that channel.

Chat is a good illustrator of this idea. As users become more familiar with chat, they tend make the most of established conventions by utilizing a whole range of emoticons, common acronyms and abbreviations to transmit social context. For instance, a simple acronym like ROTFL (rolling on the floor laughing) can easily set the tone that might otherwise require a paragraph of prose.

This was certainly the case at CTF-50. Chat rooms were numerous and varied. They ranged from one-on-one communication between the admiral and his commanders to the massive "Kmart" chat that held hundreds of participants. Interviewees all echoed the idea that chat became the primary mode for dialog. Several interviewees mentioned that radio circuits were silent and the Task Force Command Center became strangely quiet when users switched to electronic chat.

Potentially more rich communication channels such as video teleconferencing (VTC) were also pushed aside in favor of chat. VTC was seen as a good tool for a very narrow range of high level communication among senior officers. Within CTF-50 itself, however, VTC was viewed as something with little bang for the buck. In line with TTM, too much time, expense and bandwidth were required to gain marginal returns. The simple and effective tool often trumps the more complex one.

Developing Trust

The research findings at CTF-50 were very much in line with the expectations set by media richness, social presence and channel expansion theories. Again and again, the researchers found that chat emerged as the primary mode of communication for developing immediacy and comradeship. These running dialogs helped to build the common situation awareness required for NCW operations. The users learned to expand the chat channel by communicating more explicitly and frequently about issues. Additionally, the "lurkers", those who just monitored chat rooms, were able to stay abreast of happenings throughout the task force. A frequent complaint about chat was when your lost connectivity you lost the text or when you just come into a chat you do not see the history.

Another mode of electronic communication that was instrumental in the success of CTF-50 was KWeb, the fleet's web intranet. As was outlined above, the task force commander made an early commitment to the extensive use of KWeb. What is more, the CTF-50 commander constantly enforced this commitment through some subtle and not so subtle actions. For example, the researchers found that one of the keys to the successful use of KWeb was the insistence of the admiral on making it his central mode for gaining situation awareness.

Typically, in high-level naval commands the presentation software PowerPoint is king. Staff officers succeed or fail on their ability to put together and brief from electronic viewgraph presentations. They spend much of their duty day gathering and formatting information for presentation the next day at the commander's morning brief. The commander of CTF-50 fundamentally changed the way that his staff worked by breaking with this convention.

He, and his chief of staff, felt that the staff was expending too much effort in creating these briefs and making the information "pretty". Additionally, he felt that

the information was often not the most current and that the effort put into making briefing viewgraphs was often wasted, as they were not used by anyone after the brief.

In response, the staff was instructed to completely abandon traditional viewgraph presentations [27]. Instead, they would be expected to maintain current web pages that they could then brief from. The admiral believed that this would not only cut down on the staff's workload of building disposable briefs, but would also give the fleet an invaluable tool for situation awareness. The N2 stated she now had a deputy that could perform valuable work other than creating daily PowerPoint briefs for the boss. Staff officers' web pages were updated incrementally as new information arrived. As such, the best information was readily found on the KWeb. There was no need to call the Intel officer and ask what was happening, one could simply go to the web page and see the most recent developments.

6.2 Changes in Work Norms

Previously, information was not circulated as widely because the formats, media and transportation of information were unwieldy and inefficient. The KWeb significantly lowered the barriers to widely sharing information. Staff officers and enlisted personnel simply put the work they would have spent on PowerPoint shows into maintaining their web pages. Because these were automatically shared, the staff as a whole became better informed and more responsive as previously narrowly distributed information was made available to everyone. The chief of staff even found that watch standers were studying the KWeb out of curiosity and a desire to understand the operation.

After a time, other important secondary benefits to KWeb were found. Although the staff did not recognize it immediately, they found that the development of trust within the task force had changed. Prior to NCW capabilities the staff had developed working relationships through the aforementioned personal networks, now people were creating close working ties through chat and monitoring KWeb pages. The constant updating of available information allowed widely distributed users to feel that they had the best information available. Thus, the users were able to trust that supporting warfighters "had their six" and were able to focus on being effectively doing their job.

The measure of success among the staff became how good and current your web page was in KWeb. In effect, the staff found that one could trust a person who was diligent in putting out quality information for the group. The admiral reinforced this new means for gaining status by giving public recognition to the best information providers. At first, the concern was that people would hoard their information; soon the opposite was true and staff members were actually competing to share more and better information with the staff.

Another benefit was gained through an elimination of duplication of effort. Case in point, in most commands the JAG officer will work with the commander to develop rules of engagement (ROE) to govern the use of force in the battlespace. On the carrier each squadron then sends some savvy junior officer to get this guidance and boil it down into a simplified ROE card that can be carried into the cockpit and easily referenced. One of the problems of such a system is that each squadron would have different short versions of the ROE distributed to their pilots and that each of them might have subtle errors that could cause serious problems. In CTF-50, the JAG officer made up both long and short versions that could be downloaded. This eliminated extra work and the potential for error.

Originally, many on the staff were fearful that the KWeb would just add work rather than make them more efficient. The exact opposite was true. The commander made a point that he did not expect perfection on the KWeb. Formats were intentionally kept simple and trivial errors (e.g., spelling) were ignored. The admiral was well aware that a common mistake of staff officers is to be too conservative and play it safe in an effort to avoid getting in trouble. In response, he told everyone that he wanted people to give their best information estimates on KWeb and that no one would get their head cut off for making a mistake. Drafts documents were allowed and the petty officers were given the authority to publish on their own without having their work vetted through several layers of superiors.

7. Discussion

This case study identifies and ties together many different sociological and technological theories. Ultimately, through a better understanding of what makes up a successful collaborative environment the researchers hope to facilitate the push towards more effective and efficient network centric operations. Such understanding has profound implications for the United States, coalition partners, and even potential adversaries. One of the big criticisms of NCW is that it costs too much in terms of hardware, software and training to be widely implemented by coalition forces that have only a fraction of the United States' defense information technology budget.

The researchers' experience, nonetheless, suggests that much of this could be avoided through a more focused understanding of NCW requirements and human nature. First, no system is going to be useful if it is not used. As per the Technology Transition Model, CTF-50 users adopted and used the KWeb and other tools because (1) they were simple, (2) provided value, and (3) there was high frequency of use. Information systems which provided NCW capabilities have been shown to be a critical "weapons systems".

Although this case study proved to be fruitful it does have many of the shortcomings associated with qualitative research. First, this study is missing much of the quantitative data that would help to confirm the efficacy and efficiency of NCW in a fleet staff. For instance, the case study is lacking "hard" data such as server logs and message counts. In response to these shortcomings, the researchers feel that the best avenue for future work should be in doing a more comprehensive study with one or more carrier strike groups.

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