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POSTGRADUATE  
SCHOOL**

**MONTEREY, CALIFORNIA**

**DISSERTATION**

**MODELING MACRO-COGNITIVE INFLUENCE ON  
INFORMATION SHARING BETWEEN MEMBERS OF A  
JOINT TEAM**

by

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December 2006

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**MODELING MACRO-COGNITIVE INFLUENCE ON INFORMATION  
SHARING BETWEEN MEMBERS OF A JOINT TEAM**

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## **ABSTRACT**

Research exploring the effectiveness of joint military teams lacks the empirical robustness found in similar multicultural team research from the business domain. This research study broadens the study of effective military teams through an assessment of the factors that influence a joint team's effectiveness by capitalizing on the business and psychological communities' exploration of successful team performance. Specifically, in three empirical studies, this research examines several key elements of poor team effectiveness identified by the business community, namely cultural differences and personality stereotypes. Study One examined cultural orientation and service personality using a survey instrument. The results show that cultural and personality differences exist at significant levels between the services. The second study examined team information sharing processes in a wargame environment composed of homogeneous and heterogeneous four-person teams. The results revealed that participants in heterogeneous teams, cued to the presence of cultural and personality differences among team members, performed as well as homogeneous teams. The third study expands the knowledge space of the team experiment by developing an agent-based model replicating the wargame. The model accurately represented the experimental data, confirming our hypothesis that computational models coded with actual data sets from human experimentation are more robust than models coded with notional data sets. The results demonstrate that joint team effectiveness improves by incorporating methodologies used in the business and simulation science communities.

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## LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

|       |   |
|-------|---|
| ABN   | Airborne  |
| ADA   | Air Defense Artillery                                     |
| AI    | Artificial Intelligence                                   |
| AMC   | Army Material Command                                     |
| AO    | Area of Operations  |
| AO    | Area of Operations  |
| ARL   | Army Research Laboratory                                  |
| BDA   | Battlefield Damage Assessment                             |
| CAS   | Complex Adaptive System                                   |
| CCL   | Center of Connected Learning and Computer Base Models     |
| CERL  | Cultural and Emotional Research Laboratory                |
| CNO   | Chief Naval Operations                                    |
| CSIS  | Center for Strategic and International Studies            |
| CSM   | Command Sergeant Major                                    |
| CSQ   | Cultural Styles Questionnaire                             |
| DISA  | Defense Information's System Agency                       |
| DMSO  | Defense Modeling and Simulations Office                   |
| DoD   | Department of Defense                                     |
| EBO   | Effects Based operations                                  |
| ER    | Emotion Regulation  |
| EUCOM | European Command  |
| FAST  | Field Assistance Science and Technology                   |
| FFM   | Five Factor Model   |
| GUI   | Graphic User Interface                                    |
| HBR   | Human Behavior Representation                             |
| HC    | Homogeneous Control                                       |
| HC    | Horizontal Collectivism                                   |
| HE    | Homogeneous Experimental                                  |
| HI    | Horizontal Individualism                                  |
| HRED  | Human Research Ergonomics Directorate                     |
| HTC   | Heterogeneous Control                                     |
| HTE   | Heterogeneous Experimental                                |
| IAT   | Implicit Association Test                                 |
| IC    | Individualism Collectivism                                |
| ICAPS | Intercultural Adjustment Potential Scale                  |
| ICIAI | Individualism Collectivism Interpersonal Assessment Scale |
| IED   | Improvised Explosive Device                               |

|          |  |
|----------|--|
| JETI     | Joint Environmental Trust Indicator                                      |
| JIM      | Joint, Interagency and Multi-national                                    |
| JOC      | Joint Operating Concept  |
| JOpsC    | Joint Operations Concepts  |
| JTF      | Joint Task Force   |
| LIWC     | Linguistic Inquiry Word Count  |
| LTG      | Lieutenant General   |
| MAS      | Multi-agent system   |
| MORS     | Military Operations Research Symposium                                   |
| NCO      | Network Centric Operations   |
| NCOCF    | Network-Centric Operations Conceptual Framework                          |
| NCW      | Network Centric Warfare  |
| NEO FFI  | Neuroticism, Extraversion, Openness to Experience, Five Factor Inventory |
| NEO PI   | Neuroticism, Extraversion, Openness to Experience Personality Inventory  |
| NGO      | Non-governmental Organization  |
| NPS      | Naval Postgraduate School  |
| NSS      | National Security Strategy   |
| OFT      | Office Force Transformation  |
| OFT, OSD | Office Force Transformation, Office of the Secretary of Defense          |
| OIF      | Operation Iraqi Freedom  |
| OSD, NII | Office Secretary of Defense, Networks Information Integration            |
| PD       | Power Distance   |
| RPG      | Rocket Propelled Grenade   |
| SASO     | Sustainment and Support Operations                                       |
| SD       | Status Differentiation   |
| SFOR     | Stabilization Force  |
| SSTR     | Stability, Security, Transition and Reconstruction                       |
| SVI      | Schwartz Values Inventory  |
| SYMLOG   | System of Multiple Level Observation of Groups                           |
| TTP      | Tactics, Techniques and Procedures                                       |
| UA       | Uncertainty Avoidance  |
| US       | United States  |
| USJFCOM  | United States Joint Forces Command                                       |
| USSR     | Union of Soviet Socialist Republics                                      |
| VC       | Vertical Collectivism  |
| VI       | Vertical Individualism   |
| V,V,&A   | Verification, Validation and Accreditation                               |
| XML      | Extensible Mark-up Language  |

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# **I. INTRODUCTION**

## **A. THESIS STATEMENT**

Research exploring the effectiveness of joint military teams lacks the empirical robustness found in similar multicultural team research from the business domain. For more than thirty-five years the business community has focused on overcoming factors that limit or degrade effective team processes by evaluating and developing methods to integrate team members with diverse cultural orientations and personalities. The examination of identical challenges in the military environment is rare. We believe evaluating and developing methods to improve joint military team effectiveness utilizing the business community methodology will directly influence the survivability of the personnel and equipment deployed during Effects Based Operations (EBO). This outcome is even more important than a business in the global economy increasing its profit line. Due to the paucity of research within the military and to present a methodology for improving military team effectiveness, our goal is to explore the effect of cultural differences between the four military services on joint team effectiveness. Specifically, we examine the applicability of the business model for improved team information sharing in a joint team environment. In doing so we demonstrate these methods will advance joint team interoperability and enhance information sharing.

## **B. PROBLEM STATEMENT**

Operations in Iraq during April and May of 2004 illustrate the catastrophic consequences of poor information sharing between joint service units. Team members from one service detected the existence of an Air Defense Artillery (ADA) weapons systems in early April. The initial classification of that weapons system was a ZPU 4 after Battlefield Damage Assessments (BDA) from engagements on fixed and rotary wing aircraft revealed damage from this type of system. A team composed of several military services became responsible for the classification, location and destruction of that system and began a detailed search for possible hiding places. Fixed wing reconnaissance missions identified a possible hide location. Analysis determined the location to be in an adjacent service's area of operation (AO). The ZPU 4 was relocating

across this boundary, after engaging targets, then moving back to the other side of that boundary in Northern Iraq. Several attempts to locate and destroy the ZPU 4 while it was operational were unsuccessful. The team initiated contact with the adjacent service who had operational control of the area containing the hide position of the ZPU 4. The communications protocols required this information to be processed through established channels. The service responsible for the area of operations where the ZPU 4 hide location was located took no action to locate and destroy the ZPU 4 because that system was not engaging targets in their AO. Despite the identification and lethality of that system, it remained operational under the same movement conditions for another week. The failure to destroy this enemy asset resulted in the suspect ZPU 4 engaging and downing an MI-8 HIP transport rotary wing aircraft and killing all aboard. In total, three different services were involved in this incident and little action was taken to prevent the loss of life and equipment despite knowing the location and capability of the ZPU 4. The team who identified and attempted to coordinate the destruction of that system say that this incident still haunts them. As one member of the team put it, “It will haunt me knowing that I had put the clues together but still couldn’t stop it from happening.”

Operation boundaries between joint units are identifiable and exploited by our enemies. The above incident was preventable in two ways: first, by denying our enemies the ability to exploit our boundary, and second, by improving communications across service boundaries by members working in joint operation centers or on joint teams. It should be noted that many current research efforts attempt to examine and resolve problems identified at the multinational, interagency level. We contend that the above incident indicates the necessity to investigate the conditions that allow such an event to occur at the joint level prior to attempting to improve even more diverse multicultural teams.

Operational conditions often limit our ability to share information between similar units causing even greater challenges where physical and psycho-social boundaries exist due to service structure. These boundaries should permit good information sharing and coordination between the joint services occupying adjacent sides, while denying the enemy ready identification and exploitation of that same boundary. The explanation for

this lack of permeability between the joint services, while allowing operational access by our enemy, is a problem that requires analysis.

This research examines the possible factors that influence this lack of boundary permeability. We draw on the business and psychological domains where similar problems have been overcome successfully. Specifically, we examine several key elements of poor team effectiveness identified by the business community, namely cultural differences and personality stereotypes among team members. The focus of our research is joint team effectiveness during operations, where the battlefield or area of operation, is asymmetric. We hypothesize that applying solutions already developed in the business and psychological domains will result in comparable improvement to team processes in a military domain. To address this problem, our research strives to answer five research questions.

1. Can profiles of the military services indicate differences using the macro-cognitive factors of cultural orientation and personality as quantitative measures?
2. Do the service differences in cultural orientation and personality significantly impact team effectiveness during Effects Based Operations?
3. Can the business model for improving team effectiveness be applied to the military to improve information sharing and thereby affect joint team effectiveness?
4. Can computer simulations using agent-based models replicate human behavior experimentation results?
5. Can the reliability and validity standards of the social and behavioral sciences be incorporated into the simulation science Verification, Validation and Accreditation (VV&A) standards resulting in a model for Human Behavior Representation (HBR).

### **C. APPROACH**

This research proposed to answer the above questions in an unusual manner. The investigation began with a review of the literature focused on several domains. The review included documentation on the current transformation of the military. This was followed by a description of warfare symmetry specifically looking at asymmetric Effects

Based Operation (EBO) within a Network Centric Warfare (NCW) framework. The domains of cultural orientation and personality were reviewed thoroughly along with a review of team effectiveness, team cognition and team member stereotype. Finally, we explored computer simulations using agent-based modeling methods, combined with behavioral science, to develop models that identify problematic and systemic symptoms that negate our military force's ability to shape the battlespace.

The approach for this research involved three specific studies. Study One consisted of developing profiles of the four services using two reliable and valid surveys commonly used in the business community. These surveys were the Matsumoto Cultural Styles Questionnaire and the Neuroticism, Extraversion Openness to Experience Five Factor Inventory (NEO FFI). The surveys were placed in an online format for Study One participants and exact replications handed out to participants in Study Two. Additionally, to evaluate any potential stereotypes between joint service members, participants evaluated their service using the NEO FFI and evaluated the other three services using the same instrument. The use of standard culture and personality inventories is a common method for determining whether a group sees another group the same way the evaluated group sees themselves (McCrae, R., 2005). Differences may indicate a potential stereotype.

Study Two evaluated team effectiveness in homogeneous and heterogeneous team compositions during an actual wargame exercise with participants representing all four military services. Two conditions were established: a control condition and an experimental condition. Teams composed of military participants took part in a wargame requiring the sharing of information between team members to develop plausible courses of action. Team effectiveness was based on information sharing, number of courses of action developed, linguistic analysis, and behavioral analysis.

Study Three incorporated the cognitive and behavioral data generated from Study One and Study Two into an agent-based model. The NetLogo software model was coded to replicate the wargame and then implemented in a simulation to explore human behavior representation. We compared the data output from the simulation with the actual wargame results for performance to determine the accuracy of the model output.



The resulting data output was used to complete a complex team design matrix to include teams that were not part of the wargame experiment. The results from all three studies are detailed and documented for purposes of replication in future endeavors.

#### D. CONTRIBUTION

Integration of the four military services is the initial component of the State Department strategy to improve cooperation and communications between the military, multinational, interagency and Non-Governmental Organizations (NGO). Outlined during a briefing to the Military Operations Research Symposium (MORS) conference in November of 2005, Figure 1 presents the State Department model for this integration strategy.

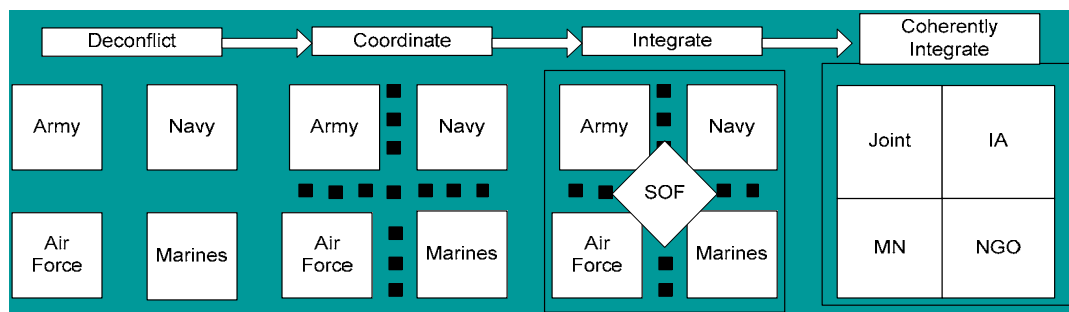


Figure 1. State Department Integration Strategy

Reading from left to right, the strategy suggested by the State Department begins by deconflicting the potential barriers that exist between the four service components. By deconflicting this area, enhanced coordination is possible and this is represented by the black blocks connecting the four military services. Enhanced Coordination leads to Integration of the four services and the Special Operations community, which results in Coherently Integrating all State Department organizations. The leadership from the Department of Defense (DoD), including the individual service components, documents in detail that the transformation process involves a cultural change. We review these documents in the literature review that follows. Our work advances research that contributes to both the State Department and DoD requirements.

Results from Study One revealed service profiles that distinguish the diversity between each service’s cultural orientation and personality disposition. These differences

may unintentionally increase communication barriers between the services. This finding supports the State Department focus of deconflicting the services.

Study Two determined that the adaptability of business domain solutions in team effectiveness problems to military environments is possible. Our finding contributes to DoD desires to develop quantifiable means to determine the progress of transformation of the military.

Study Three resulted in the development of several agent-based models revealing that human behavior representation could be accurately simulated in models populated with data from human experimentation. Further, we discovered complex experimental design matrixes could be completed that added robustness to research results. This effort contributed to the advancement of simulations that employ actual human behavior data as the input variables, instead of the current use of notional variables. Additionally, a model is presented as a possible method to evaluate simulation output by merging behavioral science reliability and validity techniques with simulation science VV&A methods. This combined approach contributes to more accurate evaluation of model output based on referent human behavior data sets.

Finally, our research is a unique first attempt to demonstrate how cultural orientation and personality differences can negatively affect joint team processes. Only military members were allowed to participate. Integrating multiple methods was an enormous undertaking but resulted in demonstrating that human experimentation can be coupled with simulations to make a significant contribution to joint integration.

## **E. DISSERTATION ORGANIZATION**

Chapter I introduces the foundation of the work and summarizes the reason the research is important, relevant, and unique along with a statement of the objectives and goals for the research. Chapter II reviews the relevant literature on transformation, effects-based operations, network centric warfare, macro-cognition, team effectiveness, and simulations. A summary of the literature establishes the empirical foundation for the research. Chapter III defines the methods and experimental design. The empirical measures for all studies are explained. Chapter IV provides the statistical analysis for the

studies. Chapter V details and explains the results of the research. This chapter contains conclusions reached from the experimentation process and describes research concepts and implementation details that the author was unable to accomplish due to time and/or technology constraints. Chapter VI advances potential future work and offers final comments.

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## **II. BACKGROUND AND RELATED WORK**

### **A. INTRODUCTION**

This section reviews the pertinent literature for each domain relevant to this research. A top to bottom review is undertaken to structure a logical case describing how the State Department's goal of coherent integration of all Department of Defense (DoD) assets may encounter systemic problems that have, and will continue, to disrupt that process. We begin with a description of the states of warfare where the lack of integration negatively influences the effectiveness of our military, followed by a narrative on transformation as the framework that will support the idea of an integrated military. The application of Network Centric Warfare (NCW) theory to warfare is discussed, focusing on the social and cognitive domains as methods to shape the battlespace. The cognitive and social domains of NCW are based on human behavior, so we provide a substantial review of the cognitive and social processes that influence behavior, and ultimately, team effectiveness.

We drew on the extensive literature available from the business and psychology domains on methodologies to improve team effectiveness within teams composed of members from multicultural or diverse backgrounds. Finally, we conclude with a review of agent-based simulations and application of these models in providing added description, understanding, prediction, and control of multicultural team development.

On May 2, 2003, President Bush announced that major combat operations were over in the battle of Iraq (Fox News Report, 2003). Typically, when the warfighting stops, the peacekeeping operations begin. This is true in the framework of a symmetric, attrition-based operation associated with large scale wars resembling World War I, World War II and Desert Storm. Unfortunately, the transition to peacekeeping in Iraq and Afghanistan was interrupted by resistance forces. These operations are described in various ways.

The United Nations uses the term "Chapter VI ½, Peace Building" (Doyle & Sambanis, 2006, p. 3). Gen. Krulak (1999) refers to this as "the three block war;" other

military professionals refer to this midpoint between war-fighting and peacekeeping as “peace enabling.” Current studies at the United States Joint Force Command (USJFCOM) use the term “Irregular Warfare” (Joint Warfighting Center, 2006).

These operations are characteristic of asymmetric Effects Based Operations (EBO) where resistance forces are not detoured by precision weapons and advanced technologies. In fact, the resistance forces used archaic methods and devices to erode the peace established earlier during the symmetric warfare period. How was this accomplished? Was this evolving aspect of the peace enabling operation predictable, and do methods exist that can counteract this type of insurgent resistance? Our research indicates that the answers to these questions require a study across several domains and begins with a description of warfare symmetry.

## **B. WARFARE**

This research is not an attempt to expand knowledge of an already rich body of work on warfare. We focus more on the symmetry rather than the function of warfare. For our purposes, symmetric warfare is associated with attrition-based operations, and asymmetric warfare is associated with effects-based operations. Smith (2002) provides an excellent summary of the symmetry of warfare in his book *Effects Based Operations*. A point worth making at this time is that there is a potential conflict of terms and meanings that could surface, biasing this research.

The basis for using asymmetric effects-based operations rather than peace enabling, irregular warfare, or three block war developed from the review of the literature. Another source of documentation outlining similar operations is DoD Directive 300.05 (2005) describing Stability, Security, Transition and Reconstruction (SSTR) operations. The documents supporting use of terms other than effects-based operations all have valid and similar constructs, despite their different definitions. Effects-based operations coupled with Network Centric Warfare provide a framework for research, a definition, and a means of measurement that other constructs had not developed at the time our research began. We do not make the argument that this is right or wrong. Analyst and military professions will determine the utility as transformation continues. The results from our research do establish a methodology that is transferable to any

construct regardless of term, definition, or meaning. Based on this construct, the remainder of our review focuses on effects-based Network Centric Theory.

Our work establishes the foundation for examining how transformation can be a force multiplier. Our focus will be more on asymmetric rather than symmetric warfare. We contend that the US military's ability and capability to conduct attrition-based operations will benefit from transformation, however, not to the order of magnitude that can be realized in effects-based operations.

Attrition-based operation involves forces with great means and great will to wage war (Smith, 2002, p. 16). "Great means" refers to the ability to bring a technological capability to the battlefield and "great will" describes the national desire to wage war and defeat an enemy by all political, economic, societal, and military means. Smith (2002) suggests that both of the World Wars, Desert Storm, and the US Civil war are examples of symmetric, attrition-based conflicts. Asymmetric effects-based operations differ from symmetric warfare in both means and will.

Asymmetric effects-based operations involve forces with differing means and wills. One force is described as having great means but limited will, while the opponent is described as having limited means but unlimited will. These asymmetric operations adequately depict operations where insurgent, terrorist or tyrannical elements are involved against a government or nation. Smith (2004) provides examples of an asymmetric environment: the United Soviet States of Russia (USSR) conflict with Afghanistan, the French and United States (US) conflict with Vietnam, the US involvement in Somalia, and the current operation in Iraq (p. 18-23). In each of these examples, a nation's technological advantage had little impact on the enemy. The national desire of the "great means" country eroded over a prolonged conflict and the "unlimited will" adversary demonstrated amazing ability to adapt and evolve the longer the conflict lasted.

In the attrition-based operation, technology is a combat and force multiplier. In the effects-based operation, there are few examples where adding technology to the battlefield lessened the enemy's desire to wage war, although the lives of the young men

and women carrying on the day-to-day operations were better protected. What the technological advances fail to accomplish is to decrease the resistance forces' will to continue the fight. There may be a lull in attacks on the technologically superior force, but only until the enemy adapts and overcomes the technological advantage. To illustrate, helicopters in Somalia were a combat multiplier until the enemy developed a means to simply engage those rotary wing assets with modified rocket-propelled grenades (RPG's). Effective, new techniques, tactics, and procedures (TTP's) had to be developed to improve the survivability of the equipment and personnel. The enemy simply kept shooting at them, which requires little adaptability. Another example is the evolution of sophisticated Improvised Explosive Devices (IED) in Iraq. Technological advances stimulate IED improvements, which inspire further technological improvements with little impact on the resistance force's desire to wage conflict. The unintended characteristic of these back-and-forth technological stalemates is the impact of the desire to wage war on the part of the "great means" nation.

Examining the asymmetric battlefield reveals possible causes for a nation's will to erode. The desire of a nation to wage war crosses political, economic, societal, and military boundaries. Anytime an enemy degrades a nation's will to wage war, the effectiveness of ongoing operations suffers. This is a fact from history that is undisputed.

Brigadier General (BG) Huba de Czege (2006) describes this as "global transparency evolving over the past 40 years" and says that "human suffering on the battlefield is recognizable to all" (deCzege, 2006). With newscasts from Vietnam showing the impact of the brutality of war on that nation's citizenry, a national desire to support the fight ebbed in the United States. The enemy "gets into the heads" of their opponent in a manner that creates a decreased desire to continue the fight. There are those who believe it is possible to overcome an enemy's ability to accomplish the decay in a national will.

Nye (2004) writes that a nation's ability to shape the preferences of others is that nation's soft power. Employing soft power can be an effective means to win the hearts and minds of another nation's citizenry as well as its own. However, winning hearts and minds in the information age requires the reshaping of the thinking of technologically



advanced societies (deCzege, 2006). Sharansky and Dermer (2004) establishes several critical features for successful shaping of thinking, and ultimately, of behavior.

Democracies do not go to war with democracies (Sharansky & Dermer, 2004, p. 72). Given the opportunity, Sharansky claims, a nation's citizens respond to democracy over tyranny when afforded the opportunity to choose, and an environment conducive to choice. The soft power resources that create this environment are imbedded in a nation's values, cultural orientation, and policies, rather than by force or hard power (Nye, 2004, p. 45).

Hard power is the use of a nation's military or economic resources to induce a change in the behavior of another nation. Soft power attempts to shape the preferences of a nation thus altering its behavior. We contend that capitalizing on the soft power resources, in cooperation with hard power technology, is a combat multiplier in the asymmetric warfare environment. The result of combining hard and soft power dynamically alters a resistance force's ability to erode a nation's will unabated. The framework for this systematic integration lies in the concept of the State Department's coherent integration strategy for DoD and the process of transformation within the military.

Integration of the four military services is the initial component of the State Department strategy to improve cooperation and communications among military, multi-national, interagency, and Non-Governmental Organizations. Outlined during a briefing at the Military Operations Research Symposium (MORS) conference in November of 2005, Figure 2 presents the State Department model for this integration strategy.

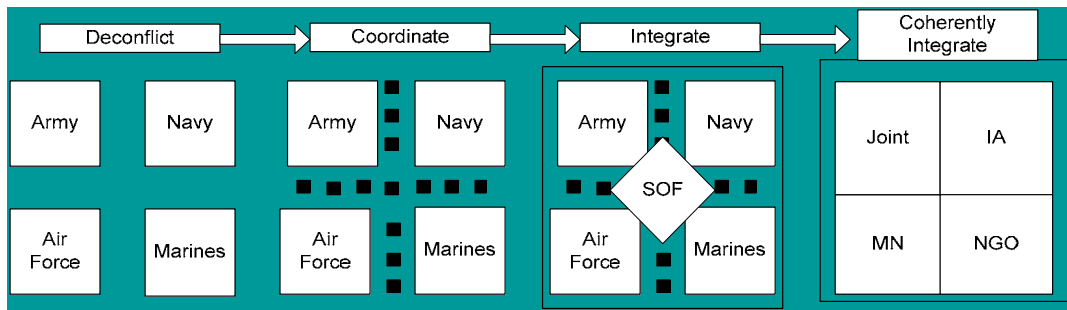


Figure 2. State Department Integration Strategy

The deconflicting of the military began with the initiative termed “transformation.” The process of transforming the military into an interoperable joint force goes beyond the acquisition of new technology or the development of sophisticated information platforms. The focus of transformation centers on shaping behavior. It is in this arena that transformation of the military will have the greatest impact. Using the fundamental principles offered by Smith (2002), Alberts and Hayes (2001), Cebrowski (1999) and Alberts and Garstka (2000), a foundation can be established to demonstrate the power of transformation to shape the behavior within a battlespace.

Shaping behavior, as a military principle, has not been well documented or investigated. This section established the significance of exploring the application of soft science to warfare on a broader scale. The next section reveals that the designers of transformation, as well as the four military services, all agree in principle, that shaping behavior is fundamental to transformation.

### C. TRANSFORMATION

The organization of Joint Forces Command (JFCOM) began in 1947 with the establishment of the United States Air Force and the designation of European Command (EUCOM). Despite more than a sixty year process to advance joint operations, the military is still developing strategies to achieve integrated joint cooperation. Unfortunately, progress is hampered by the services resistant to total cooperative

integration (New, 2004, p. 2). Retired General Tommy Franks summed up the problem as “historical differences between the services cause change to happen slowly” (New, 2004).

This resistance affects efficiency and impedes success during both symmetric and asymmetric warfare. Transformation of the defense community from platform-centric to network-centric orientation is an evolving process affecting many facets of the Department of Defense (DoD). President Bush (2005) stated that transformation is about changing values, attitudes, and beliefs, which ultimately changes behavior. Donald Rumsfeld, Secretary of Defense (2004) has determined that the most reliable barometer for gauging transformation success in the defense community is the way in which the culture is changing. The former Director for Force Transformation, Office of the Secretary of Defense, Mr. A. K. Cebrowski, identifies a three part strategy to achieve success: “transforming culture, transforming processes and transforming capabilities through force and military transformation” (Cebrowski, 2005). The key principles of transformation, referenced by the leadership, focus on a change in behavior and a change in culture within the military.

Transformation is not just about technology and advanced weapons systems. In a statement before the Senate Armed Services Committee in April of 2002 Cebrowski made the following comments:

Rather, it is more about culture, behavior and the creation and exploitation of promising concepts to provide new sources of military power. A military bureaucracy does not squelch innovation by modernizing its forces; innovation is undermined when experimentation and prototyping of new ideas is prevented, and when newly developed and fielded systems are subordinated to outdated operational concepts. (Roqin, 2006)

After the 9/11 attacks, President Bush (2002) explained that a “sense of urgency” now exists to accomplish the cultural shift from a conventional warfare doctrine to a doctrine that encompasses symmetric and asymmetric operations. The adaptation of the innovative ideas referred to by Cebrowski (2005) mandates the services to shift an individual service component-based philosophy to a joint integration-based philosophy.

The documentation from DoD provides some insight into the current state of that shift based on the concept of a cultural change.

The Annual Report to the President of the United States and Congress provides an analysis of the current state of the Department of Defense (DoD) and progress towards meeting established goals (Rumsfeld, 2004). This document includes three appendixes written by the service chiefs from the Army, Air Force and Navy. Reviewing the chiefs' cultural concepts indicates differences between the services' concepts of culture. For example, the Army views culture in terms of the "Warrior", the Air Force in terms of "Technology" and the Navy in terms of "Readiness" (Brownlee & Schoomaker, 2004; England, Clark, & Hagee, 2003; Roche & Jumper, 2004; Rumsfeld, 2004). Reviewing each of the service secretary's transformation roadmaps provides evidence that cultural barriers between the services do exist. Lacking a method to measure and evaluate these differences, boundary permeability between the services is difficult to determine.

Secretary of the Army, Honorable Mr. Brownlee, and the Army Chief of Staff, General Schoomaker, repeatedly indicate that joint interdependency is a primary goal for Army Transformation Roadmap (Brownlee & Schoomaker, 2004). Secretary of the Navy, Honorable Mr. England, the Chief of Naval Operations (CNO), Admiral Clark, and the Commandant of the Marine Corps, General Hagee, refer only to Navy and Marine culture in their Transformation Roadmap (2003) and in their testimony before the Senate Appropriations Committee – Defense (2005). The Secretary of the Air Force, Honorable Mr. Roche, and the Air Force Chief of Staff, General Jumper, indicate that cultural transformation is a goal, but focus primarily on internal Air Force processes in the Air Force Flight Plan (Roche & Jumper, 2004). The former Director for the Office of Force Transformation, Office of the Secretary of Defense (OFT, OSD), Mr. Cebrowski, surpasses all the services in emphasis on the need for cultural transformation. He states:

Military transformation is about changing the culture of the U.S. Armed Forces. Therefore, transformational activity must facilitate a culture of change and innovation in order to maintain competitive advantage in the information age. That culture must foster leadership, education, processes, organizations, values, and attitudes that encourage and reward meaningful innovation. Individually and institutionally, holding on to the past is a result of the natural need to define order in the

midst of instability. Individuals and institutions tend to follow what they know and do best because past success becomes the safest predictor of survival in the face of the future. (Cebrowski, 2005, p. 48)

The transformation literature further points out differences with the method that the services plan to achieve the DoD goals. However, the Office of Force Transformation (OFT) and the Office of Assistant Secretary of Defense, Networks and Information Integration (OSD, NII) are collaborating to correct this, using the theory of Network Centric Warfare (Garstka & Alberts, 2004). A method under development to achieve successful transformation is explained in Network Centric Operations Conceptual Framework, Version 2.0 (NCOCF). The NCOCF highlights that transformation of military culture is a very complex problem due to the services' own interpretation of their organizational culture, resulting in problematic development of research parameters (Garstka & Alberts, 2004, p. 38). The framework is based on Network Centric Warfare.

### **1. Network Centric Warfare**

Network Centric Warfare (NCW) is the emerging theory of war and is the primary process facilitating transformation (Alberts & Garstka, 2001; Alberts, Garstka, & Stein, 2003; Cebrowski, 2003; Garstka & Alberts, 2004; Wilson, 2004). The Department of Defense was platform-centric during the industrial age, but with the development of the information age, is now focused on network-centric operations. Figure 3 indicates that NCW supports the national security strategy through the transformation strategy.

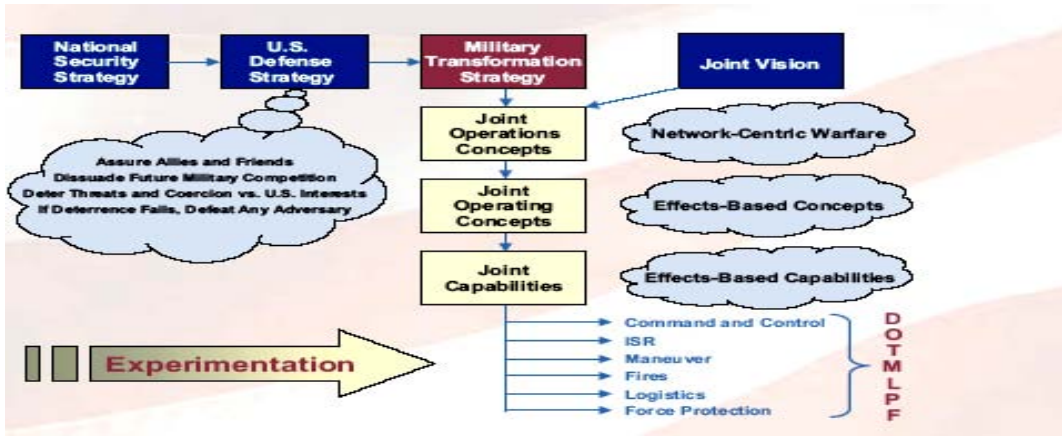


Figure 3. Military Transformation – Strategy to Concepts to Capabilities  
(Cebrowski, 2003, p. 7)

Note. DOTMLPF is an acronym for Doctrine, Organizations, Training, Material, Leadership, Personnel and Facilities.

Transformation strategy involves the Joint Operations Concepts (JOPsC) and their subordinate Joint Operating Concepts (JOCs) reflecting the vision of a network-centric joint force. The required capabilities of this force are expressed in terms of four key domains of warfare: physical, information, social, and cognitive. Figure 4 displays the relationships of the four domains.

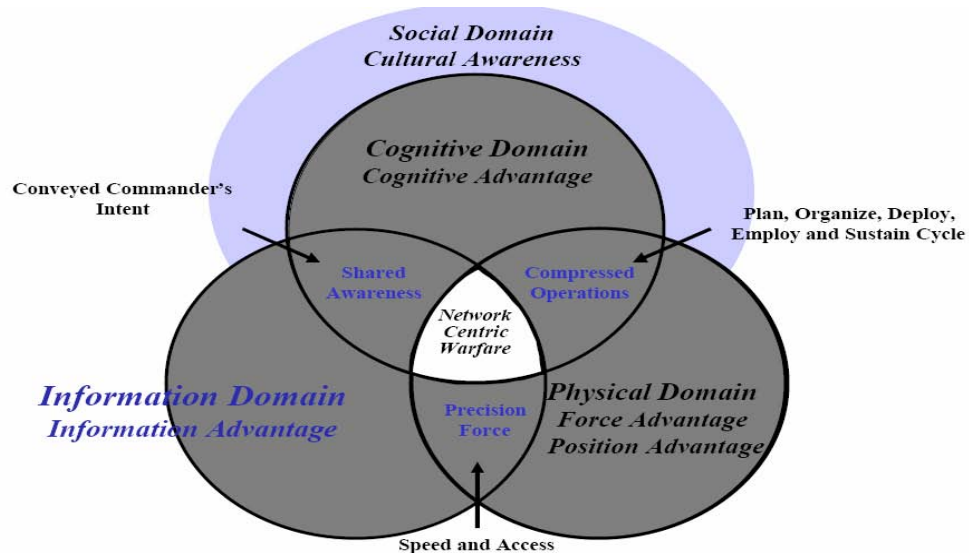


Figure 4. Network Centric Operation Domains  
(Garstka & Alberts, 2004, p. 24)

Network Centric Operations resides in the area of intersection of the three circular domains. The physical domain is where strike, protect, and maneuver occur in the operational battlespace, incorporating land, air, sea, and space together as one infrastructure (Garstka & Alberts, 2004). The information domain includes the creation, manipulation, and sharing of all types of information, and is considered the cyberspace for military operations. The cognitive domain is where perceptions, awareness, understanding, decisions, beliefs, and values of the individual members of the differing organizations are located (Garstka & Alberts, 2004). One of the foundation principles of NCW makes the distinction that no single service operates without other service support along with contractor, inter-agency, or multi-national interactions. It is the intangibles of the cognitive domain that Garstka and Alberts (2004) claim are the essential elements of NCO. The last domain, social, is an innovation of the NCO conceptual framework.

Cebrowski (2005) and Alberts (2004) describe the social domain as the domain of culture. Further, they define culture as the set of values, attitudes, and beliefs held and conveyed by leaders to society. This definition is similar to that developed within the cultural and cross-cultural research communities (Delobbe, Haccoun, & Vandenberghe, 1996; Ford, Kotze, & Marcus, 2005; Helmreich & Davies, 2004; Murray, 1999; Schein, 1990; Zakour, 2003). The importance of cultural understanding and integration, by the military, is highlighted in other sources.

The Department of Defense annual report to congress, outlining the parameters for evaluating change, often refer to a cultural change as one means of determining the success of transformation (Rumsfeld, 2004). Cebrowski (2002), in a statement to the Senate Armed Services Committee, expressed that transformation starts with culture first and that some tools are available to accomplish this culture transformation.

To maintain competitive advantage in the information age, transformation must achieve a cultural change. Researchers note that culture is the last thing to change in an organization. Consequently, the work on cultural change must begin first. There are some tools for that. The schoolhouse is one starting place, but that tends to take a very long time. However, education is a long-term investment we will make. There are other examples that go much faster. Experimental articles provide military personnel the opportunity to work directly with new physical prototypes while developing new concepts. The key advantage in the use

experimental articles is that they help people see the range of possibilities for performing operations in new ways that abstract discourses on innovative ideas cannot. This is crucial if the culture of change is to be widely adopted. (Cebrowski, 2002, p.5)

Note the emphasis on experimental articles as a key for cultural change. The transformation literature from DoD, and the four different services, discuss the significance that culture will play in the successful transformation from an industrial-based to an information-based joint military, but there is no clear definition of culture identified. Additionally, no clear metric is offered to measure success based on a change in culture. Garstka and Alberts (2004) offer the Network Centric Operations Conceptual Framework as the first documentation to define and measure culture, but this document lacks empirical validation. Others indicate that a cultural barrier may exist between the services.

## **2. Military Culture**

Carl Builder (1989), in his book The Masks of War, identified this problem fifteen years ago. His focus on the Air Force, Army and Navy systems indicated that each service has a personality and different traditions or values. In so doing, he actually identifies that each service has a culture intermixed with the service personality. This work was expounded upon by the Center for Strategic and International Studies (CSIS). The CSIS study indicated that cultural differences between the services impede successful joint integration (Dorn & Graves, 2000). There are research studies that assess and analyze culture where the military is the population of interest (Garamone, 2004; Hillen, 1999; Johannsen, 2004; Klein, Pongonis, & Klein, 2000; Neyer, Puck, & Koelling, 2004; Pierce, J. G., 2004; Ratner & Hui, 2003; Rubinstein, 2003; Simon, 2001; Tucker, 1995; Zakour, 2003). These studies conclude that differences in culture and personality exist, but fail to describe research where these differences could be overcome. Interestingly, a comparison of the literature between military and business indicates a staggering difference. The business community has undertaken enormous measures to limit the impact of cultural differences and personality stereotypes to insure success of organizations in the global economy. The importance that culture may play in successful transformation has not gone unnoticed.



Cultural differences matter. In a summary of the Institute for Defense Analyses workshop, sponsored by the Office of Force Transformation in 2003, three recommendations emerged.

1. Cultural changes that enable/facilitate transformation—critical changes in DoD culture that could lead, enhance, and accelerate the DoD transformation from an Industrial Age culture to an Information Age culture.

2. Obstacles to be overcome—effects and cultural traits that impede transformation and innovation.

3. Means to achieve the desired outcomes—ways in which cultural transformation can be influenced, positively or negatively. (Johnson, 2004, p. ES1)

The workshop participants agreed that cultural dimensions exist, and if not understood, can be a barrier to change. These barriers will impede the transformation effort if not understood at the mid-level leadership, which would result in failure to enable the target behaviors needed to develop joint innovation and risk taking (Johnson, 2004).

The panel recommended five actions, two of which relate to this proposed research. They are:

- Empower action by reducing cultural barriers and increasing behaviors related to joint innovation and risk taking.
- Assess the status of transformation. (Johnson, 2004, p. ES3).

Both actions emphasize the team process as the military transforms. The impact of culture on transformation has been a theme contained in the transformation literature since the beginning of the process, and provides support that this is an important area to research. Unfortunately, there is a lack of cultural research with the military as the target population.

The significant impact that culture plays in military team relationships is not well documented nor empirically examined. Although there is a large body of research investigating the impact of culture in the psychology and business literature, there is limited empirical study where the military is the principle population of investigation. Business and psychology's interest in culture evolved from the need to expand globally

in the market place in order to understand the most effective method to market and serve customers. Companies' organizational teams changed structurally, incorporating members from other cultures to facilitate success as an organization merges into the global marketplace. This resulted in group dynamics changes. It is no different for the military.

The decreasing size of the US military requires members from different services to work closer in joint teams. There is increasing emphasis on multinational cooperation and formation of coalition teams. Current empirical research analyzing or measuring the cultural dimensions of the services, the impact of these dimensions across the force structure, or the interrelationship of military culture and personality effect on operational efficiency is critical. It does not seem wise to begin an investigation into teams composed of multinational members before an understanding of the joint team is begun. There is anecdotal evidence that a cultural difference does exist between the services and that these differences may have an impact on effective communication and decision-making. What is lacking are empirical results focused on methodologies or assessment packages that provide the leadership with a basic understanding of the potential impact that cultural differences and personality stereotypes have on a joint team's operational effectiveness. Research efforts still focus on the coalition team or the cultural profile of an opposing force. There are examples where the boundaries between the services hampered operational efficiency.

In the summer of 2003, assigned as the junior Forward Area Science and Technology (FAST) advisor of a team sent forward by the Army Material Command (AMC), I was afforded the opportunity to witness first hand joint and multinational combat and support operations. The research as the FAST team member resulted in traveling over 17,000 miles in Iraq, visiting every deployed Army division, contact with all four services, and interviews with more than 800 military, civilian, and other nationality personnel.

It was disappointing for the science team to observe that as resources such as power, conditioned air, water purification, and bandwidth improved, a transition from interdependence on each other between the joint force to autonomous operations

occurred. Several examples illustrate this point. At Tallil Air Base outside of Ah Nasiriyah in July 2003, during an interview with the soldiers from the Quartermaster unit, it was revealed that the U.S. Air Force units occupying the airfield were told to deny access to anyone not Air Force to the phones, internet, and conditioned air areas. Upon investigation, this was found to be true and it had serious implications to the interdependent relationships on that installation, which includes all service components, the Italian military force, and the Korean military component working in neighboring Ah Nasiriyah. This incident was not limited to the airfield. The Air Force, Marines and Army had fuel points designated strictly for their service's transportation vehicles, all within one-quarter mile of each other on Tallil Air Base, and each providing the same type of fuel. In June, when first visited by the FAST team, fuel could be obtained at any of the fuel points regardless of service, but by July, strict rules were in place at each fuel point restricting use of a service's fuel point by a different service.

Culture was not the primary factor of investigation during early research efforts. The focus, at the time, was to try to get the U.S. and multinational partners to be more culturally sensitive to the Iraqi culture, not to each other. The actual transformation of culture from separate services to an effective joint culture is unknown. Shrinking budgets, reduced manpower, and expanding missions require interdependence between the services. As this interdependence creates the establishment of diverse groups to perform in teams composed of members from joint services, the exploration, evaluation, and measures of team effectiveness is mandatory.

Researchers must develop quantitative as well as qualitative assessment and analysis methods that insure that the ongoing change within the military is occurring as the leadership envisioned, and is not just a hope (Cooke, Salas, Kiekel, & Bell, 2004). A former battalion commander once asked a battery commander "What are the soldiers doing?" The battery commander replied, "I hope they are in the motor pool." The battalion commander then let the battery commander know that he wanted to "get out of the hoping mode and get into the knowing mode" (Klein, 1994). The same is true for transformation. Applying quantitative methods to measure the success of transformation is basic to understanding change. By doing so, the leadership can get away from hoping

transformation is occurring, into knowing transformation is occurring, by quantifiable means. How to develop methods to experiment, gather real time data, evaluate, and intervene where necessary, is a complex problem (Builder, 1989; Cooke, 2005).

Cultural differences affect planning, problem detection, situation awareness, uncertainty management, and decision making in teams (Klein, Pongonis, & Klein, 2000, p. 2). In particular, the differences between the services, given historically different information processes that separate the various armed services and functions, may require a "forcing function" to implement change, according to Retired General Tommy Franks (New, 2004). Maj. Gen. Marilyn Quagliotti, Vice Director of the Defense Information Systems Agency (DISA) indicates that the process of transformation may take over ten years to accomplish and will be culturally painful (New, 2004).

Examining the successful methods from other domains indicates that simple and effective methods do exist. These methods are applicable to the military environment. A review of culture, personality, and team effectiveness follows.

## **D. CULTURAL RESEARCH**

### **1. Overview**

The word "culture" comes from the Latin root *colere* (to inhabit, to cultivate, or to honor). Webster's dictionary (2005) refers to culture as the shared attitudes, values, goals and practices. Sir Edward B. Tylor wrote in 1871 that "culture or civilization, taken in its wide ethnographic sense, is that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society." Culture has been distinguished from the other elements of action by the fact that it is intrinsically transmissible from one action system to another, from personality to personality, by learning, and from social system to social system, by diffusion (Merriam-Webster, 2005). Most research studies identify culture as the values, norms, and goals that distinguish one group or category of people from another (Wikipedia, 2005).

Psychologists, at one time, believed it was possible to measure human attitudes in order to predict behavior. Sophisticated testing indicated that attitude was more complex than originally believed (Hills, 2002). They discovered that defining and measuring an attitude was difficult and began to break the idea of attitude into parts such as values, norms, and beliefs.

Psychology examined these parts by trying to classify them, however, the evolution of different research domains resulted in corresponding differences in definition. The evolved domains are: cross-cultural psychology, cultural psychology, psychological anthropology and indigenous psychology (Adamopoulos & Lonner, 2000). This project focuses on cultural and cross-cultural psychology.

Cultural psychology views culture as the scientific study of the relationship between human culture and human psyche. It is about how culture and psyche make each other up. Cross-cultural psychology is the study of similarities and differences in the psychological functioning among various cultures and ethnic groups by evaluation and assessment of change in those functions (Adamopoulos & Lonner, 2000). These functions focus on the effect culture has on the thinking and behavior of the individual. One other source for defining culture does relate to the military and is contained in the Human Systems Integration literature.

Culture is defined as a group's way of thinking (beliefs, values, and other assumptions about the world) and doing (common patterns of behavior, including language and other forms of interaction (Harris, Hart, & Shields, 2003). Harris, Hart and Shields (2003) point out that culture serves as a lens by which the world is viewed. Successful cultural alignment requires a shared mindset which is a fundamental assumption for this research (Harris, Hart, & Shields, 2003). Unfortunately, the diversity of definition for culture is not easily overcome. The next section summarizes the cultural literature.

## **2. Early Research**

Cattell (1905) conducted the first empirical research examining culture (Hofstede & McCrae, 2004). Cattell reported that his research indicated twelve different dynamic and general principles of culture (Cattell, 1950). Cattell, Graham and Woliver (1979) summarize the approach used in the cultural research as similar to Cattell's earlier approach to defining the factors of personality dimensions. Cattell (1950) termed the cultural principles as dimensions that included: magnitude of population, cultural pressure, affluence, conservative patriarchalism, order and control, cultural integration and morale. Hofstede and McCrae (2004) cite that the Cattell dimensions were difficult to

interpret and focused too much on economic development. Researchers interested in culture advanced cultural research past the economic view by focusing on a values approach.

The concept that emerged from the values approach was to examine the beliefs and attitudes a person holds. Viewing culture based on a values schema developed in Kluckhohn (1949). The schema suggested that human social groups have a limited number of universal problems to respond and answer to (Hills, 2002). The solutions to these problems are restricted in number and collectively known. He theorized that humans share biological traits and characteristics. These form the basis for the development of culture and the fact that people typically believe that their own cultural beliefs and practices are normal and natural, and those of others are strange, or even inferior or abnormal (Hills, 2002). Kluckhohn defined a value as: "a conception, explicit or implicit, distinctive of an individual or characteristic of a group, of the desirable which influences the selection from available modes, means and ends of action" (Kluckhohn, 1951, p 395).

This work was expanded upon by Florence Kluckhohn and Fred Strodtbeck (1961) whose Value Orientation Theory is referenced in the culture literature as the groundwork for today's culture research (Berry, Poortinga, Segall, & Dasen, 1992; Cattell, Graham, & Woliver, 1979; Cooke, 2005; Delobbe, Haccoun, & Vandenberghe, 1996; England, 2001; Ford, Kotze, & Marcus, 2005; Helmreich & Davies, 2004; Hillen, 1999; Hofstede & McCrae, 2004; Klein, Pongonis, & Klein, 2000; Marcus & Gould, 2000; Murray, 1999; New, 2004; Pierce, J. G., 2004; Pierce, L. & Bowman, 2004; Rubinstein, 2003; Salas, E., Dickerson, Converse, & Tannenbaum, 1992; Schein, 1990; Simon, 2001; Soeters, 1998; Trompenaars & Hampden-Turner, 1998; Zakour, 2003).

Kluckhohn and Strodtbeck (1961) theory is based on three assumptions:

- There is a limited number of common human problems for which all peoples must at all times find some solution.
- While there is variability in solutions of all the problems, it is neither limitless nor random but is definitely variable within a range of possible solutions.

- All alternatives of all solutions are present in all societies at all times but are differentially preferred. (Hills, 2002; Kluckhohn & Strodtbeck, 1961)

They believed that a society is most influenced and recognizable by the method by which problems are solved. They suggested that a society develops methods to solve problems that are reflective of the society's values. Consequently, measurement of the preferred solutions would indicate the values advocated by that society. Kluckhohn and Strodtbeck (1961) suggested five basic types of problem to be solved by every society:

- On what aspect of time should we primarily focus — past, present or future?
- What is the relationship between humanity and its natural environment — mastery, submission or harmony?
- How should individuals relate with others — hierarchically (which they called "lineal"), as equals ("collateral"), or according to their individual merit?
- What is the prime motivation for behavior — to express one's self ("being"), to grow ("being-in-becoming"), or to achieve?
- What is the nature of human nature — good, bad ("evil") or a mixture? (Hills, 2002; Kluckhohn & Strodtbeck, 1961)

It is from the five basic types of problems that the idea of cultural dimensions is derived. These dimensions include mastery and harmony, good and bad, being and becoming. Other researchers have developed their own concepts, but stay focused on the idea that culture is identifiable by a limited number of constructs.

Aberle, Cohen, Davis, Levy and Sutton (1950) identified nine functional prerequisites of a society. These prerequisites included factors such as: communication, role differentiation, developing a shared cognitive orientation with common goals, developing norms for attempting to reach these goals, and regulation of expression of needs and feelings

Despite these researchers' efforts, only recently have cultural and cross cultural researchers begun to define and measure quantitatively these dimensions. There are many ways to classify the thinking and the behavior associated with culture and to examine

culture across differing ethnic groups and societies. The lack of an agreed-upon definition complicated the development of measures of culture, but this is not uncommon in social psychology research. Cultural researchers face the same problems social psychology researchers struggle with: objective quantification of research results that explain human thinking and behavior. Dr. Geert Hofstede is one researcher whose efforts are the most influential in the attempt to develop definable and measurable domains describing culture.

Many projects reference the cultural work of Dr. Hofstede (Balaziuk, Roszkowski, & Yeager, 2003; Costa, P. T. J. & McCrae, 2005; Delobbe, Haccoun, & Vandenberghe, 1996; Erickson & Peick, 2004; Ford, Kotze, & Marcus, 2005; Helmreich & Davies, 2004; ITIM, 2003; Johannsen, 2004; Klein, Pongonis, & Klein, 2000; Licht, Goldschmidt, & Schwartz, 2004; Marcus & Gould, 2000; Matsumoto, 2004; Matsumoto et al., 2002; Matsumoto & LeRoux, 2003; Matsumoto, Weissman, Preston, Brown, & Kupperbusch, 1997; Matsumoto, Yoo, & LeRoux, 2005; McCrae, R. R., Zonderman, Costa, Bond, & Paunonen, 1996; Mohammed & Angell, 2003; O'Mara, Heacox, Gwynne, & Smillie, 1996; Peabody, 1985; Pierce, J. G., 2004; Pierce, L. & Bowman, 2004; Pierce, L. G., Bowman, & Sutton, 2001; Ratner & Hui, 2003; Rubinstein, 2003; Schein, 1990; Simon, 2001; Soeters, 1998; Soeters & Boer, 2000; Triandis, 2001; Trompenaars & Hampden-Turner, 1998; Zakour, 2003). Hofstede's research is reviewed next.

### **3. National Dimensions -Hofstede**

Hofstede began his research investigating national cultural differences using a data base he created. His data collection effort involved one company, IBM, which has been an ongoing source of research debate for some time (Ratner & Hui, 2003). The data was collected from seventy-one different countries, subsidiaries of IBM with an initial sample of 117,000 company employees (Berry, Poortinga, Segall, & Dasen, 1992; Delobbe, Haccoun, & Vandenberghe, 1996; Erickson & Peick, 2004; Helmreich & Davies, 2004; Hills, 2002; Hofstede, 2001; Hofstede & McCrae, 2004; Johannsen, 2004; Klein, Pongonis, & Klein, 2000; Marcus & Gould, 2000; Neyer, Puck, & Koelling, 2004; Pierce, J. G., 2004; Pierce, L. & Bowman, 2004; Ratner & Hui, 2003; Rubinstein, 2003;



Schein, 1990; Simon, 2001; Soeters, 1998; Soeters & Boer, 2000; Trompenaars & Hampden-Turner, 1998; Wikipedia, 2005; Zakour, 2003). The data came from survey responses specifically aimed at identifying basic employee values and the accompanying situational attitudes. Hofstede (2005) explained that IBM had a strong corporate culture in those days, with a singular product line. Hofstede pointed out the tightness of the organizational structure was such that the samples of employees from around the world were very similar except for nationality (Hofstede & McCrae, 2004). Additionally, the survey was linguistically available in twenty different languages with only local idiom adaptations. After receiving the data, Hofstede conducted a statistical analysis of the data.

The factor analysis resulted in three orthogonal factors, which were expanded to four dimensions after national wealth was incorporated into the analysis. Hofstede labeled the four emerging dimensions: power distance (PD), uncertainty avoidance (UA), individualism/collectivism (IC), and masculinity/femininity (Hofstede, 2001). Further research by Hofstede (2005) expanded the application of these dimensions to include an organizational context, however, Hofstede's primary focus is still national dimensions. The following explanations of the dimensions do include Hofstede's interpretations at both a national and organizational level.

**a. *Power Distance***

Power distance focuses on the degree of equality, or inequality, between people in the country's society. Hofstede (2001) says power distance is the extent to which the less powerful in a society accept and expect power to be unequally distributed. High Power Distance indicates inequalities of power, wealth, or status are predominate in the society. These societies are likely to follow a caste system, not allowing citizens of lower status or position the privileges available to those in higher status. Low Power Distance indicates that the society de-emphasizes the differences between its citizens' power and wealth. In these societies, equality and opportunity for everyone is stressed (Erickson & Peick, 2004; Ford, Kotze, & Marcus, 2005; Hofstede, 2001; Hofstede & McCrae, 2004; Klein, Pongonis, & Klein, 2000; Marcus & Gould, 2000; Pierce, J. G., 2004; Pierce, L. & Bowman, 2004; Soeters & Boer, 2000).

Empirical research of companies with a high power distance indicates that these companies are tall organizations with multiple layers of supervisors and management. The ideal supervisor is characterized as a well-meaning autocrat and exhibits paternal character. Subordinates in these organizations expect to be told what to do, how to do it and when to do it with little input or opinion. The leadership style is authoritative. Contrasting high PD to low PD reveals organizations that are flat in structure or with fewer supervisory layers. The ideal boss is characterized as resourceful and democratic. Subordinates expect to be consulted and made a part of the product action team. The leadership style is consultative, where all members of the team are seen as having valuable input and information for team and organizational effectiveness (Erickson & Peick, 2004). The Hofstede normed means for PD from the most recent data are provided in appendix E.

***b. Uncertainty Avoidance***

Uncertainty Avoidance focuses on tolerance for uncertainty and ambiguity within the society. High Uncertainty Avoidance indicates the country's low tolerance for uncertainty and ambiguity. This creates a rule-oriented society that institutes laws, rules, regulations, standards, and controls meant to reduce the uncertainty. Low Uncertainty Avoidance indicates that the country has less concern about ambiguity and uncertainty. There is a higher tolerance for a variety of opinions. This is reflected in a society that is less rule-oriented, more readily accepts change, and takes more and greater risks (ITIM, 2003).

Uncertainty avoidance (UA) should not be confused with avoidance of risk (Soeters & Boer, 2000). Hofstede (1991) reports that countries with low uncertainty avoidance have a more natural response during periods of ambiguity, due primarily to simpler and fewer rules and regulations. High UA organizations are characterized by being risk avoidant. The supervisors do not allow innovation and tend to be critical of the organization. This trait is often found nationally and the country is typically very homogeneous, such as Greece. Low UA organizations are diverse and value risk as an instrument of motivation. Supervisors look for innovation among the workers and take great pride in their organization (Hofstede, 2001; Wikipedia, 2005). Hofstede reports that differences in UA can be seen in the unique coping mechanisms seen in an

organization as well as the way stress management skills are used (Balaziuk, Roszkowski, & Yeager, 2003). The Hofstede normed means for uncertainty avoidance from the most recent data are provided in appendix E.

*c. Individualism/Collectivism*

Individualism/Collectivism focuses on the degree that reinforcement of individual or collective achievement and interpersonal relationships exist within a society (ITIM, 2003). High individualism indicates that individuality and individual rights are paramount within the society. Individuals in these societies form a larger number of relationships (ITIM, 2003). Low individualism, or collectivism, is characterized by close relationships with others. These cultures support extended families. Loyalty for the group is viewed with great importance in exchange for protection (Hofstede & McCrae, 2004).

Organizations whose nature is individualism have loyal employees who are more mobile than collective organizations (Erickson & Peick, 2004). The reward system differs from collectives but both are considered effective for the group structure. Individualism organizations see the members as individuals and insure input from all levels of the organization on decisions (Balaziuk, Roszkowski, & Yeager, 2003). These organizations can be viewed, at times, as quick deal organizations with interest to the short term, instead of lasting long term relations. Collectivism organizations have very cohesive structures with the group interests viewed as more important than the individual (Hofstede, 2001). Long term relations with others is a primary concern and reward systems focus on this. There is less mobility in these groups and the employees are seen in a family, or social context (Erickson & Peick, 2004). Hofstede (2001) cites that individualism organizations rank personal time, freedom, and challenge as their top priorities, where collectivism groups rank training, physical condition, and use of skills as more important. The Hofstede normed means for individualism/collectivism from the most recent data are provided in appendix E.

*d. Masculinity/Femininity*

Masculinity/Femininity centers on the degree that the society reinforces, or does not reinforce, the traditional masculine work role model of male achievement, control, and power (ITIM, 2003). It refers to the distribution of emotional roles between

men and women (Hofstede & McCrae, 2004). High masculinity shows that the country experiences a high level of gender differentiation. In these cultures, males dominate a significant portion of the society and power structure, with females being controlled by male domination. Low masculinity indicates the country has a lower degree of differentiation and discrimination between genders. In these cultures, females are treated the same as males in all aspects of the society (ITIM, 2003).

Research indicates that organizations high in masculinity are gender-defined socially. Men are assertive and usually in charge. Managers are seen as cultural heroes and treated with respect (Erickson & Peick, 2004). Women are not seen as equal and are not an important part of the decision making process. In low masculinity organizations, equality of the genders is maintained and important (Balaziuk, Roszkowski, & Yeager, 2003). Supervisors are not gender-defined. Selection for management is based on ability. Wages are generally equal across genders and everyone is seen as an employee (Erickson & Peick, 2004). The Hofstede normed means for individualism/collectivism from the most recent data are provided in appendix E.

As stated earlier, debate continues about the validity of characterizing a nation's values by four dimensions based on research data from one company. Hofstede and McCrae (2004) cite four different research efforts to investigate the validity and reliability of Hofstede's conclusions.

Inkeles and LeVine (1940, p.17) reviewed a large number of research articles from anthropology and sociology. Their findings were that "standard analytical issues" surfaced. These are summarized as:

- Relation to authority
- Conception of self, including masculinity and femininity concept
- Methods of dealing with conflict or dilemmas included control of aggressiveness, and expressive versus inhibited effect (Hofstede & McCrae, 2004)

Hofstede and McCrae (2004) concluded that these three issues represented the four dimensions of culture very well. Relation to authority reflected power distance, conception of self reflected masculinity and individualism, and dealing with conflict

reflected uncertainty avoidance (Hofstede & McCrae, 2004). In all of the Hofstede writing, care is taken to empirically substantiate any claim. This is a rare occurrence where no empirical evidence to support the above conclusion is offered.

Despite the ongoing discussion as to the true reliability of the Hofstede measures, his work is highly cited. The 1980 “Software of the Mind” book is referred to in over 1300 documents and was recently re-released in 2005. A concise review of all research utilizing the Hofstede dimension is outside the scope of this review. There is agreement and disagreement among researchers. This dissertation will not review the debate as the Hofstede review is meant to provide an understanding of one central theory of cultural dimensions and the empirical support for the concept.

Other researchers have developed theories more associated with an organizational view of a cultural, rather than a national view. Reviewing these theories, their development and empirical studies, follows.

#### **4. Theories Beyond Hofstede**

##### ***a. Hall***

Hofstede identifies Hall among the world’s finest anthropologists and refers to Hall’s research as a valuable, often cited research. Hall views culture as a communication process with three parts: words, material things, and behavior (Hall, 1977; Hall & Hall, 1990). The domains that Hall believes represent culture are time, space, context, information flow and interfacing (Hall & Hall, 1990).

Time is a fundamental domain of all cultures. Hall (1990) viewed the time domain as monochromic or polychromic. Monochromic time is seen as doing one thing at a time in an orderly uninterrupted manner. This is a very individualistic domain. Polychromic time involves simultaneous occurrences of several things at once. This domain is viewed as very collective, with greater involvement with people. Hall believed that Americans and many western cultures were monochromic. He indicated that Mediterranean and Arab countries are primarily polychromic. Hall (1990) also viewed space as another core system in all cultures.

Space is key to unlocking the mental model of a people. Spatial relationships are highly indicative of the communication permeability between groups

and cultures. Polychromic cultures see private space as interfering in the communication or informational flow, where monochromic cultures see the same space as functional and time-efficient. Coupled with context (high/low) Hall (1990) considered low context cultures as compartmentalized, which is characteristic of monochromic cultures. These cultures require lots of background information and dislike interruptions. Low context cultures can be overloaded easily with too many messages and fall behind with the overload. High context cultures are well informed, with broad access to information, and open communication flow. They require a minimum of background information and do not get overloaded from interruption or large message flow. Both space and context focus on another of Hall's domains: information flow (fast/slow).

Fast information flow cultures are characterized by people who are expected to read others' minds. Information flows freely and rigidity is avoided, in contrast to slow information flow cultures, where information is apparent and characterized by rigid rules of sharing (Hall & Hall, 1990). Hall believed that this dichotomy could not be over-emphasized and that one of the major failings of business meetings with opposite cultures was the domain of information flow. Another aspect of information flow is message speed (fast/slow).

Message speed involves decoding a message and acting upon it. Hall (1977) believed everything in life could be placed on a line from slow to fast along a message spectrum. Sending a fast message to a slow-format person will often be missed or misinterpreted. Fast messages are characteristic of newspapers, cartoons, and television. Slow message speed is characteristic of books, diplomacy, and culture. The essence of this concept focuses on the fact that the nature of relationships with other cultures requires time, and that message speed is an important aspect of information flow. The final domain Hall identifies is interfacing (Hall, 1977; Hall & Hall, 1990).

Interfacing has two features. First, there are basic differences in the ways a culture develops methods to meet the daily needs of the people. Hall sums up these differences by stating that it is easier to get things done at home than in another culture's setting. Second, top management insures the success of interfacing with another culture (Hall & Hall, 1990). Hall (1990) believed that five principles were the basis for

interface: first, the higher the context of either culture, the more difficult the interface; second, the more complex the domains, the more difficult the interface; third, the greater the cultural difference, the more difficult the interface; fourth, the more levels of a system, such as management levels, the more difficult the interface, and lastly, a low context, highly evolved, mechanical system tends to produce less interface problems than multilevel systems of great complexity. Interface or interaction with other cultures is the focus of the next researcher, Dr. H.C. Triandis.

***b. Triandis***

Triandis has explored cultures since the mid 1970's and developed a theory of culture termed "cultural syndrome" (Triandis, 1994). This idea of cultural syndromes is similar to the dimensions of Hofstede. Triandis defines a syndrome as the shared patterns, beliefs, attitudes, norms, roles, and values organized around a theme (Triandis, 2001). Triandis identified three syndromes, the first being complexity/simplicity. The second is tight/loose, and the third is individualism/collectivism. Within the individualism/collectivism syndrome there are two cultural attributes: horizontal and vertical. Horizontal culture refers to equality while vertical emphasizes hierarchal. Triandis explains that horizontal individualism (HI) is characterized by all people being equal but unique, and horizontal collectivism (HC) as characterized by a merging of one's self into the group, without suggesting that there is a status difference. Vertical individualism (VI) is characterized by the individual being distinct, and the best, in relation to others, where vertical collectivism (VC) is accepting of the hierarchy and status is determined by authority (Triandis, 2001). Empirical research by Triandis exploring the individualism/collectivism and horizontal/vertical relationships has resulted in several pertinent findings.

Triandis concluded that collectivists use indirect communications more than individualists based on research conducted by Holt-Graves (1997) and Hu (1994). HI members will email individuals more than groups, while VC members do the opposite. HI's communicate multidimensionally, while VC's normally communicate vertically. HC's share information with the in-group but hesitate to expand beyond that

group, while VC's limit communication to higher status members. VC's are more abrupt with lower status members in communications.

Triandis' work is primarily focused on the IC syndrome but he does offer other relational designs. Collectivism cultures are observed primarily in tight and simple societies. Societies where tightness exists have many norms. Punishment for violation of a norm is severe. Individualism cultures are maximized in loose, complex societies. Looseness is exhibited in societies with few norms and deviation from the norm is tolerated. Triandis (2001) indicates that there is more research needed on this hypothesis.

Triandis (2001) found that over twenty different measure methods were used in empirical research from 1986 to 1998. He discovered that despite the methods being correlated, there were separate factors in the analysis that was defined. The problem is one of quantitative versus qualitative research. Triandis argues that cultures can only be compared quantitatively using etic factors or pre-established categories for organizing and interpreting anthropological data. Qualitative analysis must be used for emic factors or categories recognized within the culture being studied. This is a controversial statement. Organizational cultural studies appear to be emic. Researchers believe that quantitative measures can and are being developed to provide robustness to cultural research (Hofstede & Hofstede, 2005; Matsumoto, Yoo, & LeRoux, 2005; Trompenaars & Hampden-Turner, 1998). Despite this difference of opinion, Triandis is a well respected and often-cited researcher. The debate on organization measures provides the framework for examining researchers who believe culture can be quantified as Hofstede has. The next researcher's work is primarily focused on business and organizational culture.

*c. Hampton-Turner and Trompenaars*

Hampton-Turner and Trompenaars (1998) view culture as a layered construct consisting of three layers: outer, middle, and core. The outer layer contains the explicit layer being the observable reality of language, food, building style, fashion, and art (Trompenaars & Hampden-Turner, 1998). The middle layer contains the norms and values of a group. Norms indicate how a group should behave and the values expressing the criteria for how members of a group desire to behave when given other choices



(Trompenaars & Hampden-Turner, 1998). The core layer is the implicit or survival level and represents a group's basic assumptions and methods to effectively deal with their environment (Ford, Kotze, & Marcus, 2005). Hampton-Turner and Trompenaars hypothesize that culture is the way a group of people solve problems, and reconcile dilemmas, and are connected to the three core layers. Every culture distinguishes itself from another by that culture's orientation or what Hofstede referred to as "dimensions."

These orientations are more business and managerial focused than nationally focused. The research of Hampton-Turner and Trompenaars comprised over 50,000 cases where participants were managers representing one hundred different countries. Their test instrument was a survey which revealed five orientations that arise from relationships with other people: universalism/particularism, communitarianism/individualism, Neutral/Emotional, Diffuse/Specific, and Achievement/Ascription.

Universalism cultures believe there is one good approach to follow which is well defined and can be applied to any given situation. Particularism cultures view each situation as having unique circumstances, with obligations to relationships being primary to the approach to follow. Communitarianism and individualism are very similar to Hofstede's individualism/collectivism dimension. The communitarianism cultures view themselves as a part of the group, where the individualism culture is focused on where the individual believes his/her contributions to the community are most needed. Neutral and emotional orientations center on whether emotional expression is accepted. Neutral cultures rarely show emotional behaviors in social or business interactions, believing that emotional responses hinder group productivity. Emotional cultures tend to express feelings and see these expressions as useful and natural behaviors.

Diffused and specific describe the relationship between members of differing cultures. Diffused relationships take into account the whole person, whereas specific focuses only on the matter at hand. This orientation has a large impact on countries doing business together where one is diffused and the other specific. Often the diffused culture will disregard specific cultures who offer a better product or service for a culture that provides more personal contact. Achievement and ascription orientations are

closely related to Hofstede's power distance dimension. Ascription refers to status of an indicator of importance of the individual being based on birth or kinship as opposed to achievement where an individual's status is based on accomplishment. This orientation includes the Hofstede masculinity dimension as status due to gender or age and is considered part of this orientation (Trompenaars & Hampden-Turner, 1998). These orientations are used primarily by Hampton-Turner and Trompenaars to describe methods and considerations for doing business with other cultures. Hofstede and Trompenaar have a running debate in the literature over the reliability and validity of each of the orientations and dimensions. The arguments for each are sound. Other researchers have focused their work on a values approach rather than on the behavioral theory.

*d. Schwartz*

Schwartz uses a different approach than the other researchers (Dahl, 2004). His research explores value types and value dimensions instead of the behavioral approach, which dominates most other theories.

The research led to the identification of ten individual value types and seven value dimensions. Schwartz believed that all ten value types are found in every culture at the individual level and are motivational in nature. The value dimensions and level of importance of each dimension varies from one culture to the next.

The method Schwartz chose to examine these values was to develop a 57-item survey called the Schwartz Values Inventory (SVI). Schwartz administered the survey to forty-one diverse groups in thirty-eight countries. The participants were asked to rate each of the fifty-seven values on a scale from 0 to 7, where "0" is not important, "1" is opposed to one's values, and "7" is very important (Schwartz 1984, 91). Participants were asked to assess the fifty-seven items on how important the value was as a "guiding principle of life" (Dahl, 2004). The survey was administered in the participants' native language. Participants, although comprised of diverse groups, represent two specific populations: educators and students (Krukenberg, 2005). The survey was developed to avoid ethnocentric bias by including values from around the world and items from cultural-specific questionnaires. The results yielded two models: one composed of ten distinct value types and one composed of seven value orientations.

The ten value types are displayed in the circular diagram in Figure 5.

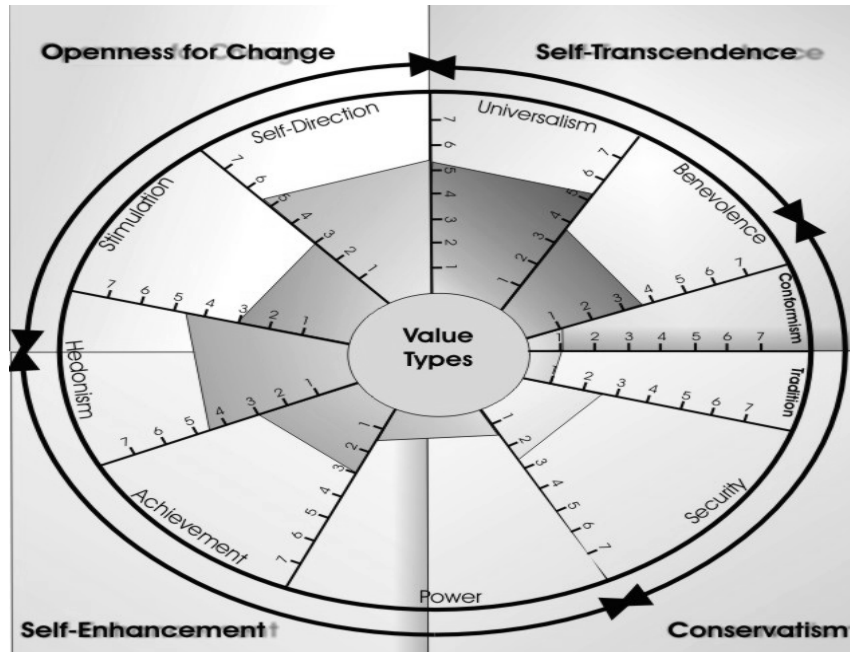


Figure 5. Schwartz Values Types (Krukenberg, 2005)

Schwartz (2001) considered each broad value type to represent a number of separate values combined to create a joint ‘idea’ (value type). Values located in the ‘power’ value type represent an individual that values social status and prestige or control and dominance over people and resources. High scores in the ‘achievement’ value type indicate a high priority for personal success and admiration. ‘Hedonism’ represents a preference for pleasure and self-gratification. ‘Stimulation’ represents a preference for an exciting life. ‘Self-direction’ is a distinct group of values that value independence, creativity, and freedom. The ‘universalism’ value type represents a preference for social justice and tolerance, whereas the ‘benevolence’ contains values promoting the welfare of others. The ‘conformity’ value type represents obedience and the ‘tradition’ value is representative of a respect for traditions and customs. Lastly, the ‘security’ value type is a value orientation for the safety, harmony and welfare of society and of oneself (Dahl, 2004).

The ten individual types are scored to indicate the strength of that value as a guiding principle of life for that individual. Additionally, Schwartz derived seven value

dimensions when he analyzed the values at a cultural level. These are: conservatism, intellectual autonomy, affective autonomy, hierarchy, egalitarianism, mastery and harmony.

Schwartz represented his seven dimensions in four domains concerning major social group issues in terms of two bipolar generalizations: autonomy (affective or intellectual) versus conservatism and hierarchy (mastery versus harmony) versus egalitarian commitment (Krukenberg, 2005). Although not a part of the bipolar generalizations, Schwartz did make a distinction between the mastery and harmony dimensions as part of the hierarchy domain.

Mastery groups and individuals should master, control, and change the social and natural environment through assertive action in order to further personal or group interests. There is a cultural emphasis on getting ahead through active self-assertion (ambition, success, daring, competence). Harmony means the world is accepted as it is. Groups and individuals should fit harmoniously into the natural and social world, avoiding change and self-assertion to modify them (unity with nature, protecting the environment, world of beauty). Schwartz is not the only researcher to examine the idea of individual cultural orientation. Dr. David Matsumoto (1983) has focused on individual cultural dimensions for over a decade. The next section examines his work

## **5. Individual Dimensions - Matsumoto**

Dr. Matsumoto began his research of cross-culture in 1983. Since then his work has evolved to the development of the Cultural and Emotion Research Laboratory (CERL) at San Francisco State University. It is a social science facility examining the relationships between culture and human emotion. The CERL has developed two psychometrically reliable measures: The Intercultural Adjustment Potential Scale (ICAPS) and the Cultural Styles Questionnaire (CSQ).

The ICAPS development took place over a six year period. Initially it was developed to measure the adjustment of Japanese sojourners to the United States. The current research involves seventeen different research studies with over 2500 participants, which has resulted in a 55-item test that assesses the potential to adjust well to a new or different culture. These studies have tested the ICAPS's internal and

external reliability as well as the internal, external, and predictive validity (Matsumoto & LeRoux, 2003). Table 1 provides a sample of the research efforts, participants, what the study tested for, and what was accomplished.

Table 1. Summary of Initial Validation Studies of the ICAPS

| <b>Study</b> | <b>Scientific Issue Being Tested</b>                                    | <b>What was Accomplished</b>   | <b>Participants</b>                             |
|--------------|---|--|---|
| 1            | Item reduction;<br>Predictive validity                                  | The 193 items were correlated with indices of intercultural adjustment. The least important items were eliminated, resulting in a 153-item test.   | Japanese international students                 |
| 2            | Further item reduction;<br>Predictive validity;<br>Internal reliability | The items were correlated with indices of adjustment. The least important ones were eliminated, resulting in a 55-item test, which we call the ICAPS-55. Internal reliability of the final 55 items was established. | Japanese international students                 |
| 3            | Temporal and parallel forms reliability                                 | English and Japanese versions of the ICAPS-55 were found to be equivalent. Scores on the tests were found to be consistent even though after time has elapsed between administrations.                               | Japanese international students                 |
| 4            | Predictive validity   | The ICAPS-55 was correlated with a variety of measures of adjustment.  | Japanese international students                 |
| 5            | Construct validity;<br>Discriminant validity;<br>Incremental validity   | The ICAPS-55 was correlated with a variety of personal and psychopathology measures.   | American university students                    |
| 6            | External validity   | Changes in ICAPS-55 scores were associated with participation in an intercultural adjustment seminar.  | Japanese exchange students                      |
| 7            | Norming   | Factor analyses of the ICAPS-55 confirmed the existence of the four primary factors of the psychological engine—ER, CT, OP, and FL.  | Japanese and American students and non-students |

|    |   |  |  |
|----|---|--|--|
| 8  | External validity                                     | The ICAPS-55 was associated with a number of characteristics of this group of experts that differed from the norm data.  | Japanese and non-Japanese intercultural counselors and consultants |
| 9  | Predictive validity                                   | The ICAPS-55 was correlated with a variety of measures of adjustment.  | Japanese business-persons and housewives                           |
| 10 | External validity                                     | Changes in the ICAPS-55 were associated with participation in an intercultural training seminar.   | Japanese international students and full-time workers              |
| 11 | Predictive validity                                   | The ICAPS-55 predicted marital and life satisfaction for the women in these marriages.   | Japanese women in international marriages                          |
| 12 | Predictive validity                                   | The ICAPS-55 predicted culture shock, adjustment, and life satisfaction for these students, even though the ICAPS was administered prior to their sojourn, while the students were still in Japan.                     | Japanese international students                                    |
| 13 | Predictive validity                                   | The ICAPS-55 predicted subjective adjustment for international sojourners from many different countries and cultures to the U.S., and Americans who have sojourned abroad.   | Non-Japanese sojourners  |
| 14 | Predictive validity;<br>Parallel forms<br>reliability | The ICAPS-55 predicted subjective adjustment and life satisfaction in Spanish speaking immigrants and sojourners from Central and South America. English and Spanish versions of the test were found to be equivalent. | Central and South Americans  |
| 15 | Incremental validity                                  | The ICAPS-55 predicted adjustment above and beyond that already accounted for by the big five personality dimensions.  | American university students                                       |

|    |  |   |                              |
|----|--|---|------------------------------|
| 16 | Convergent validity; Predictive validity; Incremental validity | The ICAPS-55 was correlated with a variety of personal and psychopathology measures, and predicted adjustment above and beyond that already accounted for by the CPI. | American university students |
| 17 | Predictive validity  | The ICAPS-55 predicted actual behaviors above and beyond that already predicted by emotion recognition.   | American university students |

*Note.* (Matsumoto, Yoo, & LeRoux, 2005)

A factor analysis of the data revealed six primary components or dimensions. These were: emotion regulation, openness, flexibility, creativity, critical thinking, and autonomy. The most empirically consistent and strongest predictor of adjustment is emotion regulation (Matsumoto, 2004). Matsumoto incorporated the scale for emotion regulation (ER) with three other scales he developed to create the Cultural Styles Questionnaire (CSQ).

The CSQ is an individual measure of a person’s cultural orientation. The four scales are similar to the Hofstede dimensions but do not infer a national characteristic like the Hofstede claims, according to Matsumoto (2005). The scales and their connection to Hofstede are:

- Collectivism/Individualism, same as Hofstede
- Status Differentiation, Power Distance
- Emotion regulation, Uncertainty Avoidance
- Mastery, Masculinity/Femininity

Interviews with Dr. Matsumoto provided insight into the development of the term “emotion regulation” and the relationship with uncertainty avoidance. The discussion concluded that the terms related similarly to power distance and status differentiation (Burnett & Thomas, 2005). The development of each scale, the empirical study of that scale, and the association to Hofstede follow.

*a. Collectivism/Individualism*

Of all the dimensions referred to in this dissertation, this construct is consistently mentioned in almost all theories. Triandis (2001) states that no construct has

a greater impact on cross-cultural psychology than this one. Matsumoto (1997) developed the scale he used to measure individualism/collectivism (IC). Measuring the IC dimension in individuals can lead to understanding the nature of different groups and the relative importance of this dimension within that group (Matsumoto, Weissman, Preston, Brown, & Kupperbusch, 1997). Empirical work mapping the IC tendencies of a person or group allows examination of the interrelationships between people or groups who have the same or different tendencies. The Matsumoto work developed over a course of six experiments. The result scales were called the Individual Collectivism Interpersonal Assessment Inventory (ICIAI). Analysis of the data from the six studies indicated that the ICIAI did detect cultural differences between and within group samples.

Masumoto (2001) argues that having an individual scale for IC allows researchers to eliminate the assumption that individuals from a particular country implies a homogeneous representation of that country. Instead, measuring IC individually within a group accounts for IC covariance, refining the ability to test cultural versus individual differences on behavior (Matsumoto, Weissman, Preston, Brown, & Kupperbusch, 1997). The inclusion of the IC scale in the CSQ provides a means to account for these differences in examining both organizational and national cultural differences. The second most researched cultural construct is power distance, which is included in the CSQ as status differentiation.

***b. Status Differentiation***

The Hofstede (2005) explanation of power distance accurately summarizes status differentiation. Matsumoto (2004) refers to status differentiation as the degree that cultures discriminate behavior differences between people that are based on a person's rank, status or power. Like power distance, individuals who are high in status differentiation will be subjugate to persons they believe are higher in status than themselves. Conversely, persons with low status differentiation see people as more or less the same.



*c. Emotional Regulation (ER)*

As described above, the ER scale is the most consistent and predictive indicator scale for cultural adjustment. Comparing emotion regulation to uncertainty avoidance, Matsumoto (2005) states that cultures high in uncertainty avoidance (UA) are most likely characterized by low levels of emotion regulation, while cultures low on uncertainty avoidance have high levels (Matsumoto, Yoo, & LeRoux, 2005). This may at first be confusing but intuitively makes sense. The more emotionally regulated someone's emotions are, the less the effect of uncertain situations.

The last scale utilized in the CSQ is the Mastery/Harmony scale similar to Hofstede's Masculinity and Femininity dimensions.

*d. Mastery/Harmony ( Masculinity/Femininity -Schwartz Values)*

Matsumoto did not develop the scale included in the CSQ for mastery/harmony. He utilized the inventory developed by Schwartz (1994) reviewed previously in this document.

The mastery/harmony dimension concerns the relationship of humankind to the natural and social world (Licht, Goldschmidt, & Schwartz, 2004). Mastery indicates getting ahead through active self-assertion and is similar to Hofstede's masculinity dimension. The concept behind mastery is to master, change, and exploit the natural and social environment. Harmony is the opposite and similar to Hofstede's femininity dimension. Harmony refers to an emphasis on accepting the social and physical world as it is, trying to comprehend and fit in rather than change or exploit it (Licht, Goldschmidt, & Schwartz, 2004).

In summary, Matsumoto's work provides a framework for examining the cultural dimensions of individuals within a team, then making organizational determinations about the group's orientation. This is helpful in two ways. Firstly, no general assumptions about the group's orientation, based on nationally or organizationally normed values, are involved. The individual's and team's orientation are specific for this team. Secondly, the measurement scale is adaptable to an organization's specific structure. Currently, research by Sutton and Ungvarski (2005) is being analyzed to

determine whether a modified CSQ for the military maintained the validity and reliability of the unrevised scale. The development of such a scale adds power for the use of the CSQ in its original or revised form.

The Matsumoto CSQ offers researchers an inexpensive, reliable instrument to evaluate cultural orientation. Further research as to the applicability of the scale, in comparison with Hofstede's, requires time. There is supporting evidence that the use of the Matsumoto scale can provide a researcher with an effective method to measure culture.

This review is not an exhaustive study of all the available research. It does provide the breadth of the business community's interest and usage of culture as a means to identify, improve, and integrate members from differing cultures into productive teams. Although not extensively discussed, the groundwork for including a study of potential personality stereotype in evaluating team effectiveness is evident. Like Hofstede's cultural orientation, personality has an extensive research basis. In fact, Hofstede often teams with McCrae, one of the developers of a largely utilized assessment of personality, for evaluation of the culture and personality macro-cognitive process' impact on organizational effectiveness (Hofstede & McCrae, 2004). The next section reviews this specific personality literature as another team effectiveness measure for the military.

## **E. PERSONALITY RESEARCH**

Psychology defines personality as the distinct pattern of behavior, thoughts and feelings that characterize a person's adaptation to life (Rathus, 1996). Many researchers believe that personality is the stable disposition of a human and is commonly referred to as a trait. This is the approach we will pursue in the relationship that personality has to performance and team process.

The study of personality has evolved since the study of human behavior began. A key area of interest is the effect that personality may have on performance. Current theories indicate two primary taxonomies (Matthews, Davies, Westerman, & Stammers, 2000). First, Eysenck and Eysenck identify three primary dimensions of personality: extroversion, neuroticism and psychoticism. McCrae and Costa rival this theory with an

approach often referred to as the “Big Five” (McCrae, R. R., Zonderman, Costa, Bond, & Paunonen, 1996). Their approach expands on the Eysenck dimensions by replacing psychoticism with three other dimensions: openness to experience, conscientiousness, and agreeableness (Matthews, Davies, Westerman, & Stammers, 2000). Costa and McCrae have refined their Big Five model and termed the resulting research instrument the Extraversion, Neuroticism, Openness to Experience – Personality Inventory (NEO PI). The NEO – PI consists of 240 items that measured the five personality domains across six facets per domain (Costa & McCrae, 2003). A truncated version of the NEO-PI was developed for use when time availability for testing was limited (Psychological Assessment Resources, 2003). This version consists of twelve items per domain in a sixty item inventory termed the Neuroticism Extraversion Openness to experience Five Factor Inventory (NEO FFI).

A large data base exists indicating the substantial empirical use of the NEO PI and the NEO FFI (Psychological Assessment Resources, 2003). The research provides the foundation for use of the NEO FFI as a measure of personality providing a comprehensive sketch of a person’s emotional, attitudinal and motivational style. Each domain encompasses a specific personality factor.

Agreeableness is the measure of interpersonal tendencies. Considered the altruism factor, empathy, humility, and willingness to cooperate are characteristic of this measure. A study examining performance in army military teams, based on group personality composition, determined that homogeneous groups avoid personality-related conflicts where agreeableness was similar (Halfhill, Nielson, Sundstrom, & Weilbaeher, 2005). The documentation for professional researchers also indicates that agreeableness is not a virtue on the battlefield due to the heterogeneous nature of conflict. This point is opinion and not a valid conclusion based on empirical evidence. The conclusion based on research is that agreeableness is not a significant factor for gauging a team’s performance (Halfhill, Nielson, Sundstrom, & Weilbaeher, 2005).

Conscientiousness is the trait of being painstaking and careful (McCrae, C. N., Stangor, & Hewstone, 1996). This factor may be viewed as a person’s character (Psychological Assessment Resources, 2003). Low scores in conscientiousness are

considered by Barrick (1998) and PAR (2003) as the weak link in a team-constraining performance. Moreland and Levine (1992) concluded that low conscientiousness of members in small teams can affect performance if members with higher conscientiousness spent time trying to resolve personality differences. There is disagreement among researchers with these specific conclusions, but many support the view that teams attempting to resolve personality conflicts are distracted from task accomplishment. Often these teams are unaware that this dynamic is occurring.

Extraversion is a factor many consider very influential on team effectiveness. Studies of pilots by Novella and Youssef (1974) characterized the military pilot as more extroverted and independent than the general population. This was the conclusion reached by Callister (1999) based on his research of Air Force pilots (n = 1301) using the NEO PI to measure pilot personality. Judge and Bono (2000) determined that extraversion played a significant role in transformation leadership prediction of leader effectiveness (Pike, Hills, & MacLennan, 2002). Costa and McCrae (1989) concluded that extraversion is the most important conceptual advance in research using the five factor model.

Neuroticism may be the most misunderstood factor of the NEO FFI. Abnormal psychologists have used neuroticism as a means to interpret a person's maladjustment or psychologically distressed condition. This has led to a misrepresentation of the definition of neuroticism as a personality trait. Neuroticism indicates an individual's emotional stability. Individuals who score high in neuroticism have a tendency toward negative effects like anxiety, where lower scores indicate sound emotional stability (Psychological Assessment Resources, 2003). Research of neuroticism is often contradictory. Studies that show high levels of anxiety linkage to poor performance also show that the same levels of anxiety, when viewed in a motivation context, are performance enhancers (Matthews, Davies, Westerman, & Stammers, 2000). Interpretation of research results, with neuroticism as a variable, must be well documented for clarity.

The last personality factor is openness to experience. It is the least known of the factors but one of the most widely researched (Psychological Assessment Resources, 2003). Openness is often related to intelligence and may be an acceptable predictor of

training performance (Matthews, Davies, Westerman, & Stammers, 2000). Some researchers report that military populations may view openness as a weakness or too artistic to characterize the military (Burnett & Thomas, 2005). Regardless of the perception, openness is a valuable factor of measurement, and inclusion in military research is applicable.

The use of the NEO FFI as a measurement instrument is valid for assessing individual personality traits. There are indications that the NEO FFI has been the scale used in military populations, but in comparison to the research by business and psychology, is more prevalent. Recently, a trend has developed to combine cultural and personality studies. Research by Hofstede and McCrae (2004) make a strong case for examination of culture and personality together.

In any correlation analysis of the relationship between culture and personality, extraversion produced the highest correlation with each of the personality factors,  $r = .64$  ( $p < .001$ ). Openness to experience had a positive relationship with uncertainty avoidance, but a negative relationship to power distance (Hofstede & McCrae, 2004). Terracciano and McCrae (2005) examined the relationship between personality factors and cultural data from fifty countries. Their findings provide strong evidence for the existence of a universal connection between personality and culture. However, a contradictory study of forty-nine countries ( $n = 3989$ ) indicated evidence of in-group perceptions, but were not descriptive of the people themselves (Terracciano & McCrae, 2005). Actually, this research supports the hypothesis that stereotypes about a group perpetuate information processing bias. The seminal research of Hofstede and McCrae seems very applicable to a military setting. Diverse teams composed of members with potential personality stereotypes may have a significant impact on the operational effectiveness of the team. The next section highlights this research.

## **F. TEAM EFFECTIVENESS RESEARCH**

Salas and Fiore (2004) cite that given the critical utilization of teams across a full spectrum of domains, it is important to understand the factors affecting team performance and effectiveness. For our purposes, team is defined as two or more members interacting dynamically, interdependently, and adaptively toward a goal (Salas, E., Dickerson,

Converse, & Tannenbaum, 1992). Further, we describe military teams as those formed rapidly in a joint effects-based environment characterized as asynchronous, and culturally diverse, having heterogeneous knowledge among members who rotate frequently (Hayne, Smith, & Vijayarathy, 2005). These teams are formed with the primary functions of sharing information, developing strategies, and decision-making. Research indicates that teams with these functions must develop a shared cognition capability referred to as team cognition (Hayne, Smith, & Vijayarathy, 2005; Salas, E. & Fiore, 2004).

### 1. Team Cognition

Team cognition is defined as the cognitive development that arises during complex and dynamic interactions when members in a team are engaged in task accomplishment (Salas, E. & Fiore, 2004). The concept of team cognition fits well into the Network Centric Operations Conceptual Framework (NCOCF) previously discussed (Garstka & Alberts, 2004). Although a complicated diagram, Figure 6 provides a visual representation of the framework for processing information from individuals and teams to the network within the context of NCOCF.

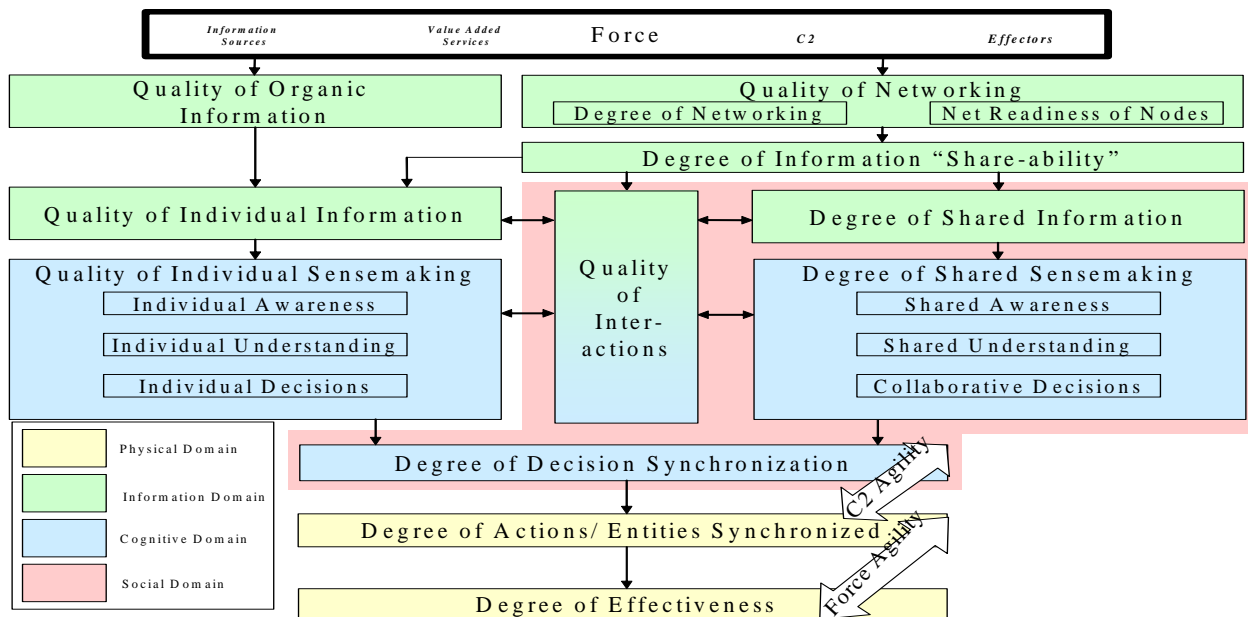


Figure 6. Network Centric Operations Conceptual Framework (Garstka & Alberts, 2004, p. 15)

Each area is color-coded representing a different aspect of one of the four domains of Network Centric Warfare. The area in blue highlights ( Quality of Organic Information, Quality of Individual Information, Quality of Individual Sensemaking, Quality of Networking, Degree of Information Shareability, Quality of Interactions, degree of Shared Information, Degree of Shared Sensemaking, and Degree of Decisions Synchronization) defines the cognitive and information domains. The red area(Quality of Interactions, Degree of Shared Information, Degree of Sensemaking and Degree of Decision Synchronization) is the social domain and encompasses the regions of quality of interactions, shared information, shared sense-making, and degree of decision synchronization. For our purposes, we refer to this entire region of the NCOCF as the team cognitive area. We conclude that the design of a team's cognitive capability rests on the ability of the individual members to share information implicitly and explicitly. A concern of researchers interested in team cognition centers on quantitative measurement of the quality of interactions among team members and team performance.

Research of team cognition measurement is still limited in scope, especially when the military is the experimental population. Many of the techniques under development are relatively new. Cooke (2005) identified four challenges for satisfactory empirically-based measurement of a team's cognition.

The first challenge involves definition, a recurrent theme in social science research. Team cognition research follows one of two paths: information processing or ecological approaches (Cooke, Salas, Kiekel, & Bell, 2004). The information processing approach conceptualizes team cognition as shared mental models among the team members. Each member has an individual model of the task, technology, and team that enables the team to implicitly coordinate, anticipate behavior, and perform effectively if the models are concurrent. Cannon-Bowers, Salas and Converse (1993) theorize that mental models are the heart of situational awareness.

The ecological view theorizes that team cognition resides outside the team. Cognition invokes the interactions between team members and the environment (Cooke, 2005). Research indicates that similar cultures (equal dimensional values) tend to communicate more implicitly than unlike cultures (dimensions with greater separation).

Nods, gestures, and signals are understood by like cultures and provide intuitive means to relay information without vocabulary. Unlike cultures require explicit communication to pass information and provide understanding. Recall culture is both a social and cognitive phenomena (Garstka & Alberts, 2004). Team cognition is hampered where implicit communication is not effective. Other researchers have supported this view.

Lausic (2005) found that communication among effective teams had ten different patterns of communication where less effective teams used only four. Her study indicated that effective teams used implicit means of communication more often than the less effective teams (Lausic, 2005). Studies of air traffic controllers point out that implicit communication is a highly evolved skill among airport tower teams (Stanton et al., 2005). Studies of control room operators in nuclear power plants also confirm that highly effective teams use implicit communication. It is interesting to note that the research confirms that more than 50 percent of the nuclear power company's significant events are human performance related, where teams do not function or interact effectively (Frye, 1988). An example of where team effectiveness failed and led to a disastrous outcome can be illustrated via the events of the aviation accident of Avianca flight 52.

Cultural diversity and team communication were determined to be factors in the accident that took seventy-three lives (Helmreich & Davies, 2004). Investigators determined that the crash occurred because the aircraft ran out of fuel. Differences in power distance between the captain and crew from Columbia, South America, coupled with poor communication between the American air traffic controllers and the Avianca crew, resulted in a breakdown of leadership which contributed to the crash (Salas, E., Burke, C. S., Fowlkes, J. E., & Wilson, K. A. , 2002). The misunderstanding in communications between the tower and crew resulted in the crew focusing on interpreting the communications network rather than monitoring the actual condition of the aircraft. This was a preventable accident.

Research indicates that methods do exist to improve communications and lessen the impact of diversity among team members that limits effective information sharing. The next challenge is to develop methodologies that are applicable to homogeneous and



heterogeneous team types, whether formed for long-term purposes or assembled quickly for short operational duration. The development of holistic versus collective metrics for homogeneous and heterogeneous team types are the second and third challenges identified by Cooke (2005).

Metrics for heterogeneous teams differ from homogeneous teams. The shared mental model of the homogeneous team can be represented with each member of the team focused on a single knowledge referent or holistic knowledge approach. The heterogeneous team is more complex due to diversity and focuses on a role-specific knowledge referent or collective knowledge approach. This complexity decreases the effective measurement of team cognition when individual measures are used as a representation for collective aggregation of the team's cognition (Cooke, 2005; Cooke, Salas, Kiekel, & Bell, 2004). The holistic approach to cognitive measurement is a better predictor of team performance due to its direct link with performance. Unfortunately, researchers are still faced with development of this type of measure versus the collective measures, which link only to individual perception and lack a team predictive quality. An aspect of holistic measure that may be promising is the study of communications between team members.

As indicated earlier, teams do communicate differently depending on the degree of likeness. Even diverse teams who are becoming cohesive may indicate this likeness in both written and verbal communication. Burnett (2002) used the Linguistic Inquiry Word Count (LIWC) developed by Pennebaker (1997) to compare subjective reports of ad hoc and established groups with verbal interactions of the group. The results indicated slight support for use of verbal interactions to determine the cohesion of ad hoc and established groups. Other interactions may also provide holistic measurement methods to investigate teams. The final challenge Cooke (2005) addresses is embedding and automating measurements that provide real-time assessment to group members.

Current measurements are anecdotal and can only provide teams with results after the fact. This method lacks value in assisting a team during a task. Cooke (2004) advises the development of software to assist in the further development of measures. Within the military community, research is just beginning to explore embedded training and the

benefits of this approach. Behavioral experimentation is another focus of research but still lacks the real-time assistance attribute that heterogeneous teams require. The business community has taken a different approach to solving this problem.

The rapid expansion of many businesses into the global economy required innovative development of methods to improve heterogeneous team effectiveness. Adler (1997) estimated that nearly 10,000 companies are involved in global operations (Salas, E., Burke, C. S., Fowlkes, J. E., & Wilson, K. A. , 2002). These businesses require multinational as well as organizationally diverse teams to compete effectively in a global marketplace. Two organizations, Systematic Information Services Inc. and Sun Microsystems, have determined that specific intercultural trainings might result in savings from \$30,000 to \$190,000 per employee (Krukenberg, 2005). The methodologies currently used by these global organizations focus on cultural understanding of the team members. Research shows that team members understanding of their own, as well as the other members' cultural orientation, limits the potential negative impact of diversity on team effectiveness. As described in the section on culture, having a basic understanding of one's own cultural orientation, as well as the other team members' orientation, results in improved team performance, better team processes, and shared commitment to success.

Recall that culture is both a social and cognitive phenomena (Garstka & Alberts, 2004). It is the cognitive domain that contains the "attitudes, values, and beliefs" as fundamental characteristics of the individual. The importance of understanding one's own culture and personality, as well as others' cultural orientation, may influence the quality of interactions and the degree that information is shared in diverse teams.

The sharing of mental models from member to member and the holistic understanding of the combined mental models between team members is a critical process to insure successful team effectiveness. Team efficiency improves when team members have adequate shared understanding of the task, the team, the equipment, and the situation (Duncan et al., 1996). The effectiveness of teams rests in their ability to share information and develop the shared understanding and shared awareness that enables efficient performance. The next section reviews information sharing.

## **2. Information Sharing**

An integral part of NCOCF is the quality of information flow among the team members and other networked organizations (Garstka & Alberts, 2004). The information sharing between individuals within similar and differing organizations can and will dynamically affect the decision-making process. Researchers have investigated information quality for many years and developed theories primarily centered on mathematical or probability formulas to illustrate information entropy.

Shannon (1948) developed the theory commonly referred to as the “Shannon Entropy” where information is described as the average amount of information in a probability distribution. Atkinson and Moffat (2005) state that information entropy is essentially a measure of uncertainty. The example they use describes a comparison of a push and pull system. In the push system, a single source is the decision maker and pushes information to other sources. There is limited shared awareness among all members, which may lead to higher levels of uncertainty. In the pull system, all sources are involved in information sharing thus expanding shared awareness and understanding. Uncertainty in the pull system is generated in two ways. Either the information flow is so great that important facts can be missed, causing members to doubt they have all the significant information, or the source of the information is not trusted.

Uncertainty is a perception and therefore a cognitive factor. Psychologists view information sharing as a process where the information process is an implicitly cognitive one. One method to describe the level of uncertainty is based on the flow of information. Figure 7 provides an illustration of increased uncertainty due to increased flow and elements.

|              |             | <b>Dynamics: Rate of Change</b>   |   |
|--------------|-------------|---|---|
|              |             | <i>Low</i>  | <i>High</i>   |
| <b>Scale</b> | <i>Low</i>  | Information, awareness and understanding needed for decision making is known and available<br><b><i>Low Uncertainty</i></b>         | Information, awareness and understanding needed for decision making is constantly changing<br><b><i>Moderate Uncertainty</i></b>              |
|              | <i>High</i> | Information, awareness and understanding needed for decision making is known but overwhelming<br><b><i>Moderate Uncertainty</i></b> | Information, awareness and understanding needed for decision making is constantly changing and overwhelming<br><b><i>High Uncertainty</i></b> |

Figure 7. Uncertainty: Scale and Dynamics (Garstka & Alberts, 2004, p. 37)

As Figure 7 illustrates; low uncertainty is characteristic of a low number of elements, processes, and rates of change. Uncertainty increases as the elements, processes, and rates of change increase. This differs from uncertainty generated from not trusting the source of information. The cause for this has been linked to stereotype behavior (Marcus & Gould, 2000; Matsumoto, Yoo, & LeRoux, 2005; Trompenaars & Hampden-Turner, 1998).

Stereotype is often confused with bias and prejudice. Bias and prejudice are defined in terms of the individual. Bias can be a positive or negative subjective opinion toward a principle, person, or group (Random House, 1980). Prejudice is described as a preformed judgment even more unreasoning than bias toward a principle or person or group. Stereotype is defined as a standardized concept or image invested with special meaning and held in common by members of a group (Random House, 1980).

Researchers have measured the level and effect of stereotype against another group for several years. Typically, self-assessment measures have been employed to try to describe this phenomena. Trompenaar (2000) attempts to describe stereotype between groups using overlapping offset normal distributions. Cultures that are similar tend to speak to each other from the shared area of the overlapping distributions, while cultures that are different tend to share from the tails of the distributions. Trompenaar views the tails as areas of limited understanding and trust. Adler (2000) agrees with this assessment. As members of one group gain real knowledge about themselves and members of other groups, the subconscious inaccurate evaluation gives way to reality.

Hofstede (2005) indicates that this emergent reality establishes the environment for true integration and improves members' group interactions. The core of the process may be viewed as trust.

Stereotypes within an organization can be explored in a person-based or a category-based trust environment according to research developed by Adams and Webb (2002). Their literature review of trust, within small military teams, provides an interesting insight into the problem of stereotypical behavior in joint ad-hoc teams (Adams & Webb, 2002). Ad-hoc teams do not have the opportunity to develop person-based trust due to the limited interactions between group members. Category-based trust theorists argue that the category a person belongs to can serve as a substitute for personal knowledge (Adams & Webb, 2002). A leader starting command of a new unit can trust his soldiers without ever having seen them perform. The leader believes that his soldiers are representatives of a system of military training and expertise that has produced soldiers shown to be worthy of trust for generations (Adams & Webb, 2002). Category-based trust can emerge even in circumstances that preclude the development of person-based trust where there has been no opportunity to learn from personal interaction (Adams & Webb, 2002). Unfortunately, boundaries between the services limit the development of category-based trust forcing trust to develop by person-based means. This requires direct communication by the members of the diverse team.

Adler (2002) describes communication in a culturally diverse group as encoding and decoding messages sent between two or more people in a number of manners. Information is sent verbally, in writing, by facial expression, or by behavior. The presence of cross-cultural factors can cause misinterpretation or misunderstanding of the information being shared simply due to diverse cultural orientation (Adler, 2002). With the evolution to interdependency based on the DoD transformation process, it is critical for researchers, system developers, and system designers to understand the impact of these cultural differences or stereotypes on the teams that will implement and conduct operations using the Network Centric Warfare (NCW) theory.

A point to stress here is the lack of joint tactical and operational level training prior to deployment into an asymmetric-based environment. The category-based theorists

maintain that trust is acquired from experience within the organization. The development of trust outside the organization depends more on person-based interactions between organizations. The potential for a stereotype to limit person-based trust is far greater than category-based. This lack of trust occurs from the stereotypical beliefs, feelings, and expectations about members of another group (Kunda, 1999). The differences in group members, based on cultural differences and personality stereotypes, are complex problems to solve.

The complexity is described by Fiore and Schooler (2004) as a problem conceptualization dilemma. Group members tend to share information that is believed to be common to all members of the group and not information that is unique (Fiore & Schooler, 2004). Group members tend to try to solve a problem instead of determining what the problem is and using the group's expertise to develop courses of actions to implement. Information sharing thus becomes disjointed or withheld, decreasing the permeability of communication flow between members (Fiore & Schooler, 2004). Garstka and Alberts (2004) identified three categories for problems like these and the level of uncertainty matched to each.

- “Simple Problems” (characterized by low levels of uncertainty)
  - Nature of problem is well-defined and commonly accepted — well-established mental models of problem exist.
  - Solution strategy exists, is well understood, and practiced.
- “Complex Problems” (characterized by medium levels of uncertainty)
  - Number of elements is large and dynamic but well-defined and commonly accepted mental models exist.
  - Alternative solution strategies (suggested by mental models) exist and must be evaluated individually across time and space.
- “Wicked Problems” (characterized by high levels of uncertainty)
  - Nature of problem is poorly understood (many dynamic elements) with multiple points of view existing across different stakeholders and/or experts — no clear mental model of problem exists.

- Solution strategy depends upon the understanding of the nature of the problem — without mental model of problem, it is difficult to develop a solution strategy. (Garstka & Alberts, 2004, p. 37)

Although a detailed discussion is outside the scope of this document, “wicked problems” are an area of research that certainly influence the effectiveness of teams. A condensed review provides some clarity about the potential impact “wickedness” has on team efficiency.

### **3. Wicked Problems**

Rittel and Webber (1973) developed the theory of “wicked problems” as a means to distinguish a simple problem from a complex problem. The theory advanced the hypothesis of “wickedness” as a way to describe a complex problem whose characteristics follow a distinct set of indicators (Roberts, 2000). These indicators are:

- There is no definitive formulation of a wicked problem.
- Wicked problems have no stopping rule.
- Solutions to wicked problems are not true-or-false, but good-or-bad.
- There is no immediate and no ultimate test of a solution to a wicked problem.
- Every solution to a wicked problem is a “one-shot operation”; because there is little opportunity to learn by trial and error, every attempt counts significantly.
- Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well described set of permissible operations that may be incorporated into the plan.
- Every wicked problem is essentially unique.
- Every wicked problem can be considered a symptom of another problem.
- The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem’s resolution.
- The planner has no right to be wrong. (Jeff Conklin, 2005; Whelton & Ballard, 2002)

Wicked problems are associated with social complexity and can be a characteristic of a team composed of culturally diverse members (Institute, 2005). This theory may provide some insight into a solution of transforming culture within DoD and, in particular, the military services. Garstka and Alberts (2004) indicate that wicked problems are at the challenging core of successful implementation of Network Centric Warfare theory.

Conklin (2005) explains that wicked problems, when coupled with social complexity, results in fragmentation. Fragmentation is one of the key factors in why the typical waterfall solution of problem solving is not effective with these types of problems. In fact, when comparing diagrams of the stair step waterfall problem-solving process to wicked problems, the results resemble the diagram in Figure 8.

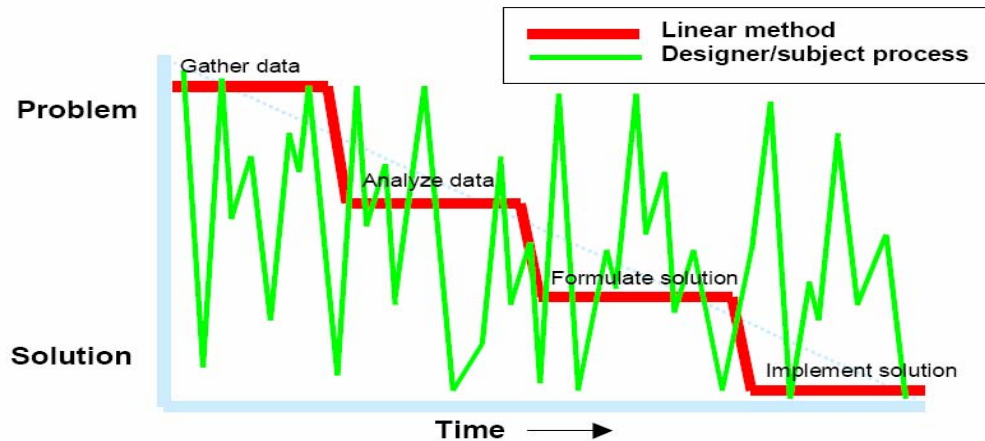


Figure 8. Waterfall diagram for decision making (Conklin, 2005, p. 5)

Fragmentation is what interferes with arriving at a solution for a problem and, in fact, pulls the problem apart (Conklin, 2005). The members of a team experience anxiety, begin to blame others for the state of the problem, and cause fragmentation. As these conditions arise, further fragmentation occurs and the team process suffers. Because it points deep into the culture and practices of project work, it is difficult to observe fragmentation directly (Conklin, 2005). The solution to fragmentation is to explore smaller parts of the problem to clarify understanding and awareness among team



members instead of trying to solve the entire problem. Fragmentation decreases as shared understanding and shared awareness increase, two areas indicated as significance for Network Centric Warfare.

We propose to focus on a smaller portion of the transformation problem, specifically, the application of business solutions to the military environment. NCW has tremendous potential to provide a combatant commander operationally superior forces, but this requires teams that are integrated for maximum performance. Cultural differences and personality stereotypes limit the effectiveness of these teams if members do not fully understand the potential impact of their differences on the team process.

In conclusion, team effectiveness is a complex research domain. Despite the prevalence of literature from the business community, the military has limited empirical study of successful business models in application to a military team. Our review indicates that culture and personality are macro-cognitive processes that may influence the effectiveness of a team's efficiency and performance. The environment of the asymmetric effects-based operation complicates the ability of teams now composed of different military organizations to operate as effectively as possible. Our research specifically answers the question: "can the business model be applied to a military homogeneous and heterogeneous team resulting in similar improvements in team effectiveness and information sharing as achieved in the business environment?"

The experimental design for an evaluation of military homogeneous and heterogeneous teams is based on a wargame with four potential seat locations for the participants. The resulting matrix of possible teams is thirty-five with no adjustments for seat position. Accounting for each service location at each of the four possible seat positions in the heterogeneous condition requires the evaluation of 512 team designs. Using a minimum of ten trials per design and per condition results in over 5000 team experiments to reach a minimum degree of designs for evaluation. A researcher working seven days a week and conducting eight experiments a day would require over three years to complete the research. This is impractical.

Our solution to the problem focuses on the computer science domain, specifically agent-based modeling. We contend that gathering limited data from actual human

experimentation, and populating a model replicating the experiment, will produce results applicable to a complete human experimental test. The last section of this review examines agent-based modeling and simulation. Further, we propose a model combining the reliability and validity components of social science with computer science Verification, Validation and Accreditation (V, V & A) standards as a method for input and referent output of data-based simulations.

#### **G. HUMAN BEHAVIOR REPRESENTATION USING AGENT-BASED MODELING**

Human behavior representation (HBR) is a term from the DoD modeling and simulation community that describes the modeling of human performance that is represented in military simulations (Pew & Mavor, 1998). Since our work is directed toward the military community, this is the term we will use to denote the representation of human behavior or performance in a modeling and simulation environment.

Any realistic modeling of human behavior starts with a cognitive design that enables computer agents to behave within a model that is representing actual human behavior. This process is a maturing science. We contend that as neuroscience and cognitive sciences unlock the brain's processes, the fidelity of the agents' replication of human behavior will have an equal and like advance. Prior to reviewing HBR, a discussion of human cognition is useful.

Cognition is generally defined as the acquisition of knowledge (Reed, 2004). Typically, a definition of cognition is specific to the relevant domain of study. Since our research focuses on psychology and computer science, the definition we propose centers on those domains. Cognitive and performance psychology view cognition as human information processing. The information received by sensory inputs is transformed, reduced, elaborated, stored, retrieved, and used by each human (Reed, 2004). Information passes through different stages where it is transformed and transmitted. Researchers have varying opinions and models to describe the process.

Historically, the study of mental processes was a philosophical subfield until the development of methods to experimentally examine learning and memory (Kandel, Schwartz, & Jessell, 2000). Until the late 1950's, the study of the mental processes was

largely ignored due to a behaviorist view focused only on input and output observations of behavior in humans and animals. Researchers believed that human behavior could only be studied with rigorous empirical methods developed for the physical sciences. This approach led to the erroneous belief that the mental processes between input and output behavior were irrelevant (Kandel, Schwartz, & Jessell, 2000). The emergence of cognitive psychology redirected scientific study of behavior by exposing the weaknesses of the behaviorist approach and demonstrated that there is a neurological as well as biological influence affecting human behavior (Kandel, Schwartz, & Jessell, 2000; Matthews, Davies, Westerman, & Stammers, 2000). This approach maintains that the mental processes are an information processing system and has led to the development of several theories to explain that process. However, attempting to empirically quantify the internal processes of the brain and create empirically sound models is problematic.

Most internal processes of the brain are inaccessible, at this time, to experimentation and analysis (Kandel, Schwartz, & Jessell, 2000). The complexity of the mental process was one of the reasons behaviorists avoided this aspect of behavior as part of their theoretical structure. Today, cognitive science is advancing the study of information processing but it is difficult to determine which emerging theory is more accurate than another. Computer science is one domain that has contributed significantly to the advancement of the study of cognitive neural science beginning with the emergence of artificial intelligence.

The term artificial intelligence (AI) emerged in 1956 from MIT professor, John McCarthy. During a conference sponsored by McCarthy, Newell and Simon (1956) described artificial intelligence's rational agents as being capable of thinking non-numerically (Russell & Norvig, 2003). These rational agents are central to the theory of artificial intelligence.

Agents are anything that can perceive an environment through sensors and act on that environment (Russell & Norvig, 2003). A collection of agents is commonly referred to as a Multi-Agent System (MAS). The combination of multi-agent systems that are interactive within a given environment is further defined as a Complex Adaptive System (CAS) (Ferber, 1999; Holland, 1996). The interactions among computer agents is referred

to as message passing or information sharing which produces changes in each agent's common environmental picture (Hiles, 2004; Holland, 1996). Describing the environmental architecture has led researchers to develop different models representing the different layers of the cognitive structure.

Wray (2005) refers to a polymorphic architecture consisting of several layers of the cognitive process. There are three specific layers Wray (2005) defines as one approach to describe agent architecture. The three layers are proto-, micro-, and macro-cognitive.

The proto-cognitive layer is the perception level where information is acquired, processed, and transferred. The SWARM model is an example of this cognitive layer. The micro-cognitive layer typically represented by Anderson's (1973) Adaptive Control of Thought – Rational (ACT-R) model, is characterized as the expertise level and allows for expert-based pattern recognition. Information is then processed to the macro-cognitive layer where information reasoning occurs (Hayne, Smith, & Vijayasarathy, 2005; Wray, 2005). The Soar model developed by Simon and Newell (1983) is a typical representation of the macro-cognitive layer (Wray, 2005). It is this level that our research contends is the layer in human cognition where information processing is influenced most by the cultural and personality trait's effects on behavior. Modeling these processes in a military context to represent human behavior, using an agent based model, is the focus of our work.

For clarity, we need to define the terms 'model' and 'simulation'. Pew and Mavor (1998) assert that a definition for a model has different meanings for different domains. For our purposes, we are adopting the definition used by the Defense Modeling and Simulation Office (2005) being that "a model is a physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process." Pew and Mavor (1998) point out that the term model implies that "human and organizational behavior can be represented by mathematical or computational formulas, programs or simulations." A simulation is a method to implement a model over time (Defense Modeling and Simulations & Office, 2005). Pew and Mavor (1998) combine the model and simulation definitions and recommend terming human representation in military

environments as denoting a computer-based model that mimics either the behavior of a single human or the collective action of a team of humans. The model we will use as the Human Behavior Representation model for our experiment is NetLogo.

NetLogo is a cross-platform multi-agent programmable modeling environment developed by professors and students at Northwestern University from the Center of Connected Learning and Computer Based Modeling (CCL) (Wilensky, 2005). It is a JAVA based program, which uses a scripting language to program the models. It is well suited for modeling complex systems or environments developing over time (Wilensky, 2005). The programmer or modeler can give instructions to hundreds or thousands of independent “agents” all operating concurrently. This capability allows for the exploration of the connection between the behavior of individuals and the patterns that emerge from the interaction of many individuals (Wilensky, 2005).

NetLogo has been widely used and contains a modeling library with hundreds of working models. A model developed by Cities (2004) explored information processing in a complex system. Cities (2004) examined information entropy in this simulated environment to determine the level of accuracy a decision maker could expect from information retrieved from differing departments. Capitalizing on that model, we developed a similar model to replicate the wargame for our experiment. Figure 9 provides a screen shot of the model developed.

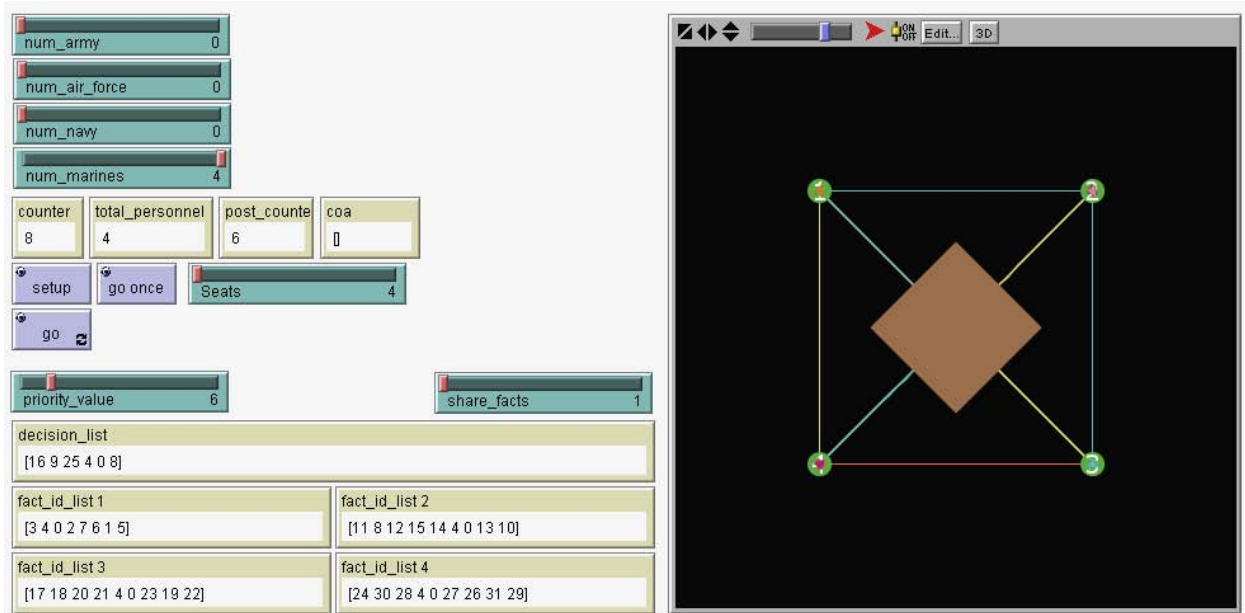


Figure 9. NetLogo screen shot of replicated wargame

The results of the development of the model are contained in the next chapter. Recall our purpose for developing the NetLogo model is to assist in completing the team matrix from the wargame experiment. Several techniques are used to explore data output from agent models.

It should be noted that to date, very little verification and validation of these types of models is available due to the complexity of the environments and the ability to change the parameters quickly. Computer scientists believe these models accurately describe a behavioral space and indicate emergent behavior of the agents. Psychologists disagree and refer to the agent behavior in terms of movement strategies or programmer definition. Our belief is that these models do provide an environment to examine complex systems and analyze the output data.

The output from these models can then be compared to human experimentation results. Before a model can be used with confidence, it must go through a process of verification, validation and accreditation referred to by DMSO (2005) as V,V&A (Pew & Mavor, 1998). Verification determines whether errors in coding or programming logic exist (Pew & Mavor, 1998). Validation of a model is determined by how closely the results from the output resemble reality (Defense Modeling and Simulations & Office,

2005). Populating the models with real data from scientifically sound experimentation allows for an interpretation of the results beyond what the models populated with notional data allow. The process of verification, validation and accreditation, where human behavior data is used to populate the model, requires social and behavioral science reliability and validity standards to be maintained.

Figure 10 provides a model for inclusion of the reliability and validity standards of the social sciences.

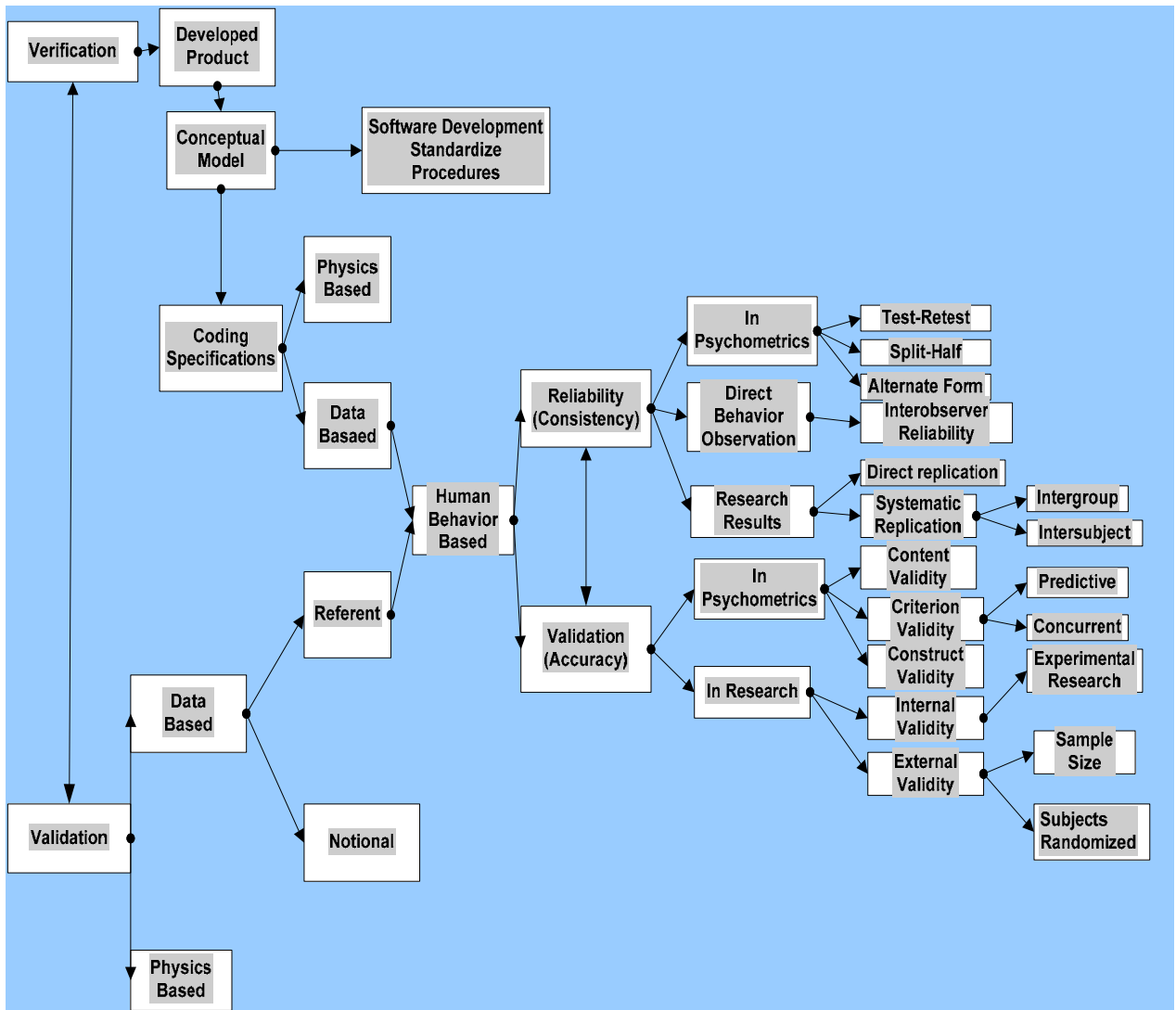


Figure 10. Model of VV&A coupled with social science reliability and validity measures. From “Introduction to Experimental Psychology” by E. Conrad and T. Maul, 1989, p. 74. Defense Modeling and Simulation web site “Verification, Validation and Accreditation Recommended Practices Guide” vva.DMSO.mil.

Notice that the reliability and validity aspects of the model fit nicely in a data-based model as input and referent measures. We contend that insuring the data used to populate models, where human behavior representation is a goal, requires the same standards of reliability and validity as the social sciences. The actual human behavior data can also be used as the referent to the simulation outputs. This is the methodology we will use to examine the data input and data output from the NetLogo simulation.

In summation, the use of human subjects for experimentation requires time, coordination, and precise design implementation. Using models to assist in design and research question development may improve human research if the model can be populated with data resembling real human behavior. The research of culture and personality indicates that these domains are measurable. Using the data from culture and personality research provides an opportunity to investigate the impact of these macro-cognitive processes on team information sharing in homogeneous and heterogeneous military teams. The domains are broad enough to be meaningful, when examined across a population, as the research in the business community has shown. The next section summarizes the key points from the literature.

## **H. SUMMATION OF LITERATURE REVIEW**

Transforming the military requires cooperation by all the services and DoD agencies. Resistance to change within the military is not uncommon and is identified as one of the major blocks to progress by every level of leadership from the commander-in-chief, secretary of defense, the service secretaries and chiefs, to the major combatant commanders. Once independent organizations with minimal dependence due to air, land, and sea cold war philosophies, these same organizations now find heterogeneous missions common with the emergence of asymmetric warfare.

The realization that technology and sophisticated symmetric warfare strategies are not as effective against a resistance force with “limited means” but “unlimited will” to fight has been painfully slow. The loss of life and equipment, both military and civilian, has decayed the national will to maintain support of our military efforts for peace-enabling, resembling of past conflicts where an asymmetric environment was present. Alternative means to sustain the national and political will, coupled with methodologies



to cripple and deteriorate the “unlimited will” of an enemy, are critical for success in this environment. Transformation is the key to maintaining our ability to wage symmetric as well as asymmetric warfare.

Transformation is the theory to shift the military from an industrial-based platform to an information-based platform. Fundamental to transformation success is the emergence of Network Centric Operations (NCO). The four domains of Network Centric Operations: physical, information, cognitive, and social are intertwined to insure that the right force mix is at the most strategically significant location with the correct systems to defeat any threat (Alberts & Garstka, 2001). NCO identifies the social domain, characterized as the domain of culture, as the key domain influencing the other three domains. At this level, culture is ill defined and often a term used to describe concept versus reality. The establishment of the Network Centric Operations Conceptual Framework attempts to correct the problem of definition and measurement but lacks empirical analysis. This is not true of the research by the psychological and business communities. Both domains have determined that cultural orientation influences productivity at the individual and team levels.

Extensive empirical research within the business community indicates that methodologies exist to overcome the potential negative impact of team member diversity on team effectiveness. Business teams from culturally different segments of the organization are joined together in order to improve business integration into a global marketplace. The development of methods to insure team efficiency resulted in business and psychological measures being developed and implemented to insure heterogeneous teams, composed of culturally and personality-diverse members, could perform unabated, regardless of stereotype or miscommunication. These factors are cognitive in nature.

Cognition is viewed by many researchers in the cognitive and computer science domains as an information processing system. Based on the research from the business and psychological communities, further examination of the impact of cultural differences and personality stereotype on the information sharing procedures within a military team is important. Culture can be viewed across several domains. Researchers, such as Hofstede, believe culture is primarily a national dimension with organizational influence.

His seminal work beginning in the early 1970's established the possible cognitive nature of culture, and by factor analyses, developed the "Software of the Mind" theory (Hofstede & Hofstede, 2005). From his research, the dimensions of power distance, uncertainty avoidance, individualism and masculinity have evolved. By comparing one country's dimensions to another, relationships can be grouped together between countries that share similar dimensional characteristics. Hofstede's national dimensions of culture, which focus on status, individuality, and uncertainty, have led other researchers to develop theories focused more at the organizational level.

Hall (1977), Trompenaar (1998), Schwartz (1999), and Triandis (2001) individually developed theories at the organizational level. They offer organizations methods and techniques to evaluate the effect of differences on processing information, team effectiveness, and global interactions. Disagreement among these researchers is limited in the literature with each routinely citing another's research especially when characterizing the domains of individualism and status. Where differences do exist, focus is primarily on terminology of the dimensions.

Triandis views culture as a syndrome primarily influenced by individualism and collectivism societies with either horizontal or vertical relationships (Triandis, 2001). Hall views cultural differences in terms of communication processing with the key factors being time, space, context, information flow, and interface (Hall & Hall, 1990). Trompenaar, using a layered approach to explain culture, believes that these orientations explain the way an organization solves problems and reconciles dilemmas. His seven variables are: universalism/ particularism, diffuse/specific, communitarianism/ individualism, neutral/specific, achievement/ascription, time, and context. Additionally, Trompenaar (1998) suggested the distributions of a cultural orientation, when overlaid, indicated that the level of stereotype lay in the tails extending beyond the distributions. Schwartz (1999) approaches culture behaviorally to explain his values and dimensions. His research identifies ten value types contained within the seven dimensions of autonomy: (affective/intellectual), conservatism, hierarchy (mastery/harmony), and egalitarian. The business community and psychology are rich with empirical studies. Businesses today routinely incorporate cultural metrics into normal business plans to

insure global relativity and smooth organization team effectiveness. However, teams formed in organizationally diverse manners, which are foundationally ad-hoc, may need further refinement of the cultural structure. To accomplish this, individual metrics have been developed.

Matsumoto (2005) has investigated culture for two decades and devised a means to measure individual cultural orientation using the Cultural Styles Questionnaire. The metric measures an individual's orientation for status differentiation, emotion regulation, individualism, and mastery. In doing so, team scores can be combined to determine an ad-hoc team's cultural orientation. Matsumoto provides a metric to determine whether a rapidly assembled team has cultural barriers that may limit effectiveness. Military teams are characteristic of these types of teams with the evolution of asymmetric effects-based operations based on Network Centric Operations doctrine.

The business world is rich with empirical research exploring cultural relations among people. Whether the cultural examination is a dimension, syndrome, domain or orientation, the evidence from research indicates that culture is a macro-individual difference that can be measured. The true variation in the dissimilarity, whether called an individual difference or a national difference, is still a debated subject.

There are researchers who believe culture is simply a modifier of behavior and not to be viewed as a higher level construct (Hills, 2002; Parsons & Shils, 1951). We contend this is not true but rather that culture is a macro level individual difference like personality or intelligence (Hofstede & McCrae, 2004). Culture orientation can be measured; it has a cognitive component that influences behavior and this behavior influences performance (Cole, 1988). The same argument is held by social scientists for intelligence and personality influence on individual and group behavior (Matthews, Davies, Westerman, & Stammers, 2000). Viewed in this manner, culture can be defined, measured, analyzed, and results interpreted as other macro level differences are. Further, these differences can be viewed, measured, and interpreted in the team setting.

Like culture, personality is another macro level process that researchers have used to examine the impact of personality on team effectiveness. Personality is believed to be

a stable trait within humans allowing for the development of measures and analysis methods. McCrae and Costa (1989) developed the Neuroticism, Extraversion, Openness to Experience Personality Inventory (NEO-PI) as a means to evaluate personality. Often referred to as the five-factor model, the factors examined are: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness.

Neuroticism refers to a person's tendency to experience negative feelings and the effect that high or low levels of neuroticism have on that person's emotions. Extraversion is seen as a person's engagement in the external world and is considered one of the influential factors in a team's effectiveness. Openness to experience refers to a person's imaginative or creative interest. Despite a large body of research examining openness, much is still unknown about its influence. Agreeableness is viewed as the individual's differences in cooperation and social harmony. Studies indicate the significance of this measure in a homogeneous environment, but find limits to accuracy in more heterogeneous studies. Conscientiousness focuses on how an individual controls and regulates their impulses and relates to a person's character. Hofstede and McCrae (2004) have determined that a connection exists between the cultural dimensions and personality types. Although they disagree about which factor influences the other, they suggest research will benefit by investigating both. The business and psychological domains have focused their cultural and personality research on team effectiveness.

A team is defined as two or more members interacting dynamically, interdependently, and adaptively toward a common goal (Salas, E., Dickerson, Converse, & Tannenbaum, 1992). Team effectiveness is seen as the successful integration of all team members with diverse backgrounds. The business community understands the importance of successfully integrating all members of the team and that cohesive teams must communicate effectively. This social component identified as one of the four domains of Network Centric Operations accounts for the influential effect on military teams that are formed with the primary functions of sharing information, developing strategies, and decision-making. Research indicates that teams with these functions must develop a shared cognition capability referred to as team cognition (Hayne, Smith, & Vijayasarathy, 2005; Salas, E. & Fiore, 2004).

Cognition is an information processing system. Members develop mental models of the task at hand and the social implications involved in completing the task. Researchers have struggled to develop empirically sound experiments that investigate the team cognitive process and have identified four challenges (Cooke, Salas, Kiekel, & Bell, 2004).

The first challenge is one of definition, a common factor in social science research. Defining team cognition is subject to interpretation. Researchers are still attempting to identify what the true components of team cognition are. For our purposes, we adopt the information processing approach which views team cognition as the sharing of individual mental models of the task, technology, and team that enable the team to implicitly coordinate, anticipate behavior, and perform effectively if the models are concurrent (Cooke, Salas, Kiekel, & Bell, 2004; Salas, E. & Fiore, 2004). Measurement conceptualizes the last three challenges identified by Cooke (2005). The challenges of measurement focus on differences in team structure: homogeneous or heterogeneous. Developing a metric that captures both structures requires the combination of single knowledge referent and holistic methods. This is a complex problem. There are indications that evaluating the communications between group members may provide a method for further refinement of metrics. The final challenge is developing a method to embed the measurement instrument and provide members feedback that adds real-time assistance to the team instead of the current anecdotal system.

The sharing of mental models from member to member, and the holistic understanding of the combined mental models between team members, is a critical process to insure successful team effectiveness. The effectiveness of teams rests in their ability to share information and develop the shared understanding and shared awareness that enables efficient performance.

Information sharing is an integral part of Network Centric Operations Conceptual Framework. The information sharing between individuals within similar and differing organizations can and will dynamically affect the decision-making process. Mathematics has determined that information will be disrupted in a system. Atkinson and Moffat (2005) state that information entropy is essentially a measure of uncertainty and can be

characterized by the flow of information and the trust between the members of the system, or for our purposes, the team. Uncertainty increases as the elements, processes, and rates of change increase. Contributing to uncertainty is the element of trust between members of the team, which is influenced by personality stereotype. This results in what Rittel and Webber (1973) termed a wicked problem. Conklin (2005) asserted that these types of problems can only be tamed by examining smaller parts of the problem space so that fragmentation of the problem does not occur.

Our research focuses on the smaller part of the transformation problem: military team effectiveness influenced by cultural diversity and personality differences. To accomplish this requires a large number of military teams as participants. Our approach will combine human experimentation with a human behavior representation model to replicate the human experiment.

Human Behavior Representation (HBR) is a term from the DoD modeling and simulation community that describes the modeling of human performance that is represented in military simulations (Pew & Mavor, 1998). The emergence of artificial intelligence in the 1950's led to the fields of computer science and cognitive science jointly attempting to represent human behavior in a meaningful manner. The development of agents to represent human performance has advanced as neural science develops methodologies to explain the cognitive processes that lead to behavior, and psychology has interpreted those behaviors. Our study chose the NetLogo model developed at Northwestern University to replicate our human experiment.

NetLogo is a cross-platform multi-agent programmable modeling environment from the Center of Connected Learning and Computer Based Modeling (CCL) developed by professors and students at Northwestern University (Wilensky, 2005). It is a JAVA based program that uses a scripting language to develop models. It is well suited for modeling complex systems or environments developing over time, as our experiment does.

The use of a model to replicate the experiment can provide researchers a useful tool provided the model follows certain standards. In the behavior and social sciences,

these standards are the measures of reliability and validity. In the computer sciences, the standards are verification, validation and accreditation. Merging these standards provides a framework to develop an agent model. This accomplishes two things.

First, the output from large simulations developed from the models provides the opportunity for researchers to evaluate possibilities not previously considered. Human experimentation and sample sizes are often limited by the availability of participants. Agent modeling overcomes this limitation as long as the results are not improperly used. The challenge for developers is to adhere to strict verification and validation standards in model development, just as the human behavior scientists must adhere to reliability and validity standards in their experiments.

After reviewing the literature, several questions arose that our experimentation will address. The last section will detail the research questions and hypothesis for our research.

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### III. METHODOLOGY

This section will describe the methods for each of the three studies. There are no results provided. Our experiment incorporated all the aspects from the literature we reviewed to develop the methodology and experiment we accomplished. The results from this experimentation answered five research questions.

1. Can profiles of the military services indicate differences using the macro-cognitive factors of cultural orientation and personality as quantitative measures?
2. Do the service differences in cultural orientation and personality significantly impact team effectiveness during Effects Based Operations?
3. Can the business model for improving team effectiveness be applied to the military to improve information sharing and thereby affect joint team effectiveness?
4. Can computer simulations using agent-based models replicate human behavior experimentation results?
5. Can the reliability and validity standards of the social and behavioral sciences be incorporated into the simulation science Verification, Validation and Accreditation (VV&A) standards resulting in a model for Human Behavior Representation (HBR).

We answered these questions by experimentation across three separate studies. Study One was developed to investigate each military service's cultural orientation and personality. Study Two was a wargame designed to examine information sharing in homogeneous and heterogeneous teams composed of military participants. Study Three replicated Study Two using the NetLogo Model populated with the behavioral data from Study One and Study Two.

The design of these studies is based on the belief that the business construct can be used to evaluate and examine military team effectiveness. Developing profiles of service culture and personality to explore potential barriers to team effectiveness in homogeneous and heterogeneous teams should indicate specific differences in cultural orientation, personality stereotype, and performance resemblant to teams in business

organizations. Homogeneous teams should share more information and outperform heterogeneous teams. Based on our research questions and methods, we believe experimentation will yield the following results:

#### Study One

a. Cultural orientation differences measured by the Matsumoto CSQ variables for status differentiation and emotion regulation will be evident in a least one of the services when compared to the others.

b. Personality type differences measured by the NEO FFI for extraversion, neuroticism, and openness to experience will be evident in a least one service when compared to the other services.

c. Personality stereotypes measured by the NEO FFI will be evident between at least one of the services when compared to the other.

#### Study Two

a. Homogeneous teams will outperform heterogeneous teams in the control condition for percentage of facts shared.

b. No significant difference for performance will be evident between the homogenous control team type and the heterogeneous experimental team type for percentage of facts shared.

c. Linguistic analysis of composite team communications will reveal differences between the homogeneous and heterogeneous team types for word count, pronoun usage, and social variables as measured by Linguistic Inquiry Word Count (LIWC, fully explained in the method section).

d. Linguistic analysis of team participants' communications will reveal differences between the homogeneous and heterogeneous team types for word count, pronoun usage and social variables as measured by Linguistic Inquiry Word Count (LIWC).

e. Linguistic analysis of team participants' communications will reveal differences between the four services for word count, pronoun usage and social variables as measured by Linguistic Inquiry Word Count (LIWC).

## Study Three

a. No performance differences between the data collected from the wargame and the data collected from the replicated wargame using NetLogo.

This chapter provides the methods for the experimentation.

### A. STUDY ONE

Study One consists of two parts. The data collection method for this study was an online survey. Participants completed the Matsumoto (2005) Cultural Style Questionnaire (CSQ) for Part A of Study One and the McCrae and Costa (2002) Neuroticism, Extraversion and Openness to Experience Five Factor Inventory (NEO FFI) for Parts B and C. Due to the proprietary nature of both instruments, a copy of the complete survey is unavailable. Appendix G provides the information to contact Dr. Matsumoto and Professional Assessments Resources (PAR) Corporation to obtain permission to receive copies of their inventories. A sample of the online version of the instrument is located in appendix C.

For analysis purposes, the surveys are identified as Part A, Part B and Part C. The actual surveys were combined for online presentation. The following sections describe each survey individually followed by combined detailed sections for participants, materials, and procedures.

#### 1. Part A – Cultural Orientation Evaluation

##### a. Hypothesis

$H_0$  = No difference for Status Differentiation or Emotion Regulation between the individual services

$H_1$  = At least one service is different in Status Differentiation

$H_2$  = At least one service is different in Emotion Regulation

##### b. Instrument - Cultural Styles Questionnaire (CSQ)

For this experiment, a 4 (Group Type; Army, Navy, Air Force, Marines) X 2 (Cultural orientation; Emotion Regulation, Status Differentiation, design was accomplished. (The surveys for the two orientations of mastery and individualism/collectivism were collected but are not part of the statistical analysis.)

Study One Part A was designed to identify the cultural orientation of a participant. Understanding each service's cultural orientation may provide insight into methods that would lessen the potential negative effects of differences and develop more effective team processes.

Each participant's cultural orientation is examined by a separate survey for each of the four orientations. The Collectivism/Individualism scale consists of nineteen items measured on a seven-point Likert scale anchored from 0 (Very Appropriate) through 6 (Not at all Appropriate). The Status Differentiation scale consists of fifteen items measured on a seven-point Likert scale from 0 (Not at all Important) to 6 (Very Important). The Emotion Regulation scale is a fourteen-item inventory measured on a seven-point Likert scale anchored from 1 (Strongly Disagree) to 7 (Strongly Agree). The Mastery scale consists of twenty-one items adopted from the Schwartz Values Inventory. The items are measured on a seven-point Likert scale from 1 (Strongly Disagree) to 7 (Strongly Agree).

## **2. Part B – Personality Domain Evaluation**

### ***a. Hypothesis***

H<sub>0</sub> = No difference for Extraversion, Neuroticism or Openness to Experience between the individual services.

H<sub>1</sub> = At least one service is different in Extraversion.

H<sub>2</sub> = At least one service is different in Neuroticism.

H<sub>3</sub> = At least one service is different in Openness to Experience.

### ***b. Instrument - NEO-FFI***

For this experiment, a 4 (Group Type: Army, Navy, Air Force, Marines) X 3 (Personality domain: Neuroticism, Extraversion, Openness to Experience) design was accomplished. (The surveys for agreeableness and conscientiousness were collected but are not part of the statistical analysis.)

Each domain of the inventory consists of twelve questions totaling sixty items rated on a five-point Likert scale anchored at 1 (Strongly Disagree) through 5 (Strongly Agree). Scoring the NEO FFI requires summing the responses and transferring the total to a scale provided. The scale indicates a normed T-score from 25 to 75 for each respondent. Additionally, each score is placed in one of five categories ranging from

very low to very high. (Scores for any respondent who left ten or more questions blank, failed to answer fewer than six domain-specific questions, or answered with only neutral responses, were not calculated.)

At the end of the NEO FFI are three questions that are used to check for validity. Scores for any respondent who did not answer the three questions are not calculated.

### **3. Part C– Personality Stereotype Evaluation**

#### **a. Hypothesis**

H<sub>0</sub> = No difference between the service perception for Extraversion, Neuroticism and Openness to Experience.

H<sub>1</sub> = At least one service is perceived differently in Extraversion.

H<sub>2</sub> = At least one service is perceived differently in Neuroticism.

H<sub>3</sub> = At least one service is perceived differently in Openness to Experience

#### **b. Instrument – NEO FFI**

For this experiment, a 4 (Current Service: Air force, Army, Marines, Navy) X 4 (Rated Service: Air Force, Army, Marines, Navy) x 3 (Personality domain; Neuroticism, Extraversion, Openness to experience) design was accomplished. (The surveys for agreeableness and conscientiousness were collected but are not part of the statistical analysis.)

Part C uses the NEO FFI to measure a participant’s potential stereotype against another service. The respondents were asked to rate each item for the NEO FFI as they believed a member of another service would respond to that item. The data collection for Part C was synonymous with Part B. Differences between group responses may indicate a potential stereotype. The same evaluation for Part B pertains to this part.

### **4. Combined Survey Methodology**

#### **a. Participants**

Two hundred thirty-five military personnel participated in the online version of the survey constructed for Study One. Table 2 provides the participant breakdown by service.

Table 2. Online Survey Participants

| Current service |        | Data Collection Method |
|-----------------|--------|------------------------|
|                 |        | On Line                |
| Air Force       | Male   | 8                      |
|                 | Female | 8                      |
| Army            | Male   | 65                     |
|                 | Female | 2                      |
| Marines         | Male   | 123                    |
|                 | Female | 14                     |
| Navy            | Male   | 14                     |
|                 | Female | 1                      |
| Totals          |        | 235                    |

*b. Materials/Apparatus*

As described above, the instrument was a combined Cultural Styles Questionnaire and the NEO FFI personality inventory.

*c. Procedures*

Prior to completing the online survey, participants were provided a log-in password to a secure website. After providing informed consent by initialing a block after the informed consent document, each respondent answered a series of demographics questions. Prior to presentation of each survey, an instruction screen was presented to clarify how to complete that survey. This method was administered for each survey until completion of the entire combined survey.

After completing the section on the four surveys for cultural orientation, three questions were asked. Question one asked each participant to indicate, from a list of positive and negative words, which words accurately portrayed each service's attributes. Respondents were not required to provide a response for each service for each word, but only whether that word was an attribute of a specific service. This was followed by question two, a fill-in-the-blank allowing the respondents to list any attributes not listed in the previous question but that the participant felt was an accurate attribute of a service. Question three asked each participant to indicate on a scale from "strongly adverse" to "very willing" a participant's desire to work on a team with each service. (Appendix C provides the framework for these questions.) The prompt questions

were followed by the five personality surveys. After completing the five surveys for personality, two additional questions were asked of each participant.

Question one asked: “If you could influence or recommend one change to improve joint team effectiveness, what would you recommend?” Participants typed their response in the block provided. This question was followed by a second prompt: “Use this block for any additional comments. Also, you can use this section to revise an answer or add to an answer since you are unable to go back in the survey to do so.”

After completing the survey, each participant was presented with a screen providing a debriefing form, with instructions on ways to receive information about the survey and study results, and how to contact the researchers.

## **B. STUDY TWO**

The purpose of the team exercise was to collect data on the interactions between team members during a course of action analysis in a wargame experiment. There is no previous experiment to provide reliability or validity measures for this experiment. The design of this experiment was a 4 (Service: Air Force, Army, Marine, Navy) x 4 (Seat position: Seat one, Seat two, Seat three, Seat four) x 2 (Group composition: Homogeneous, Heterogeneous) x 2 (Group type: Control, Experimental) design where four-person teams were alternately assigned to the control or the experimental condition. The dependent variable was the percentage of total facts shared. The individual participant analysis dependent variables were the percentage of facts shared by seat position.

The development of the thirty-two facts used for this experiment occurred in February 2006. A five-member panel discussed and developed the thirty-two facts for the wargame experiment using the Joint Tactics, Techniques, and Procedures for Joint Intelligence Preparation of the Battlespace (Joint Publication 2-01.3) and the Joint Intelligence Preparation of the Battlespace (JIPB) checklist. The panel consisted of the primary researcher (command sergeant major–retired), an Army lieutenant colonel, a Marine major, a Navy lieutenant commander, and a retired Air Force first sergeant. The primary researcher did the initial evaluation of a potential fact list and presented the list to members of the panel. (Note — except for the Army CSM and the Army LTC, each of

the panel members was located at different installations. Communication was face to face with the primary researcher but the panel was never co-located for discussions.) After discussion, each member separately rated the developed composite fact list by order of importance. The initial list was reduced to thirty-two facts based on the order of merit list and inter-rater reliability results. Further refinement of the list included the descriptions to be used for each fact and which facts would be grouped together for each participant. Possible courses of action (COA) were discussed and a list of the six most likely COA's was developed. Eight pilot wargames resulted in only minor changes to the documentation needed and none of the facts were changed. The hypotheses investigated for Study Two are grouped by composite team results and by individual participant.

**1. Hypothesis - Composite Team Analysis (Twenty-six teams)**

The composite team consisted of the twenty-six teams from the wargame data collection. Recall, we hypothesize that homogeneous teams will outperform heterogeneous teams due to cultural and personality differences. Heterogeneous teams will demonstrate improved performance when cued to this fact. Additionally, linguistic analysis will be sensitive to differences in team type. The primary hypotheses evaluated were:

**a. Team Type – Control Condition**

H<sub>0</sub> = No difference for performance between team types

H<sub>1</sub> = Teams in the homogeneous control condition will outperform the teams in the heterogeneous control condition.

**b. Team Type – Experimental Condition**

H<sub>0</sub> = Difference for performance between homogeneous control and the heterogeneous experimental teams will be evident.

H<sub>1</sub> = No differences between the homogeneous control and the heterogeneous experimental teams.

**c. Team Type - Linguistic Analysis**

H<sub>0</sub> = No difference for language usage between team types

H<sub>1</sub> = The LIWC will be sensitive to differences between team types for word count, pronoun usage, and social variables.



## 2. Hypothesis – Team Analysis by Individual Participant

The individual participant analysis allowed for the evaluation of the cultural and personality factors in the analysis by service. The 104 participants were grouped by service to evaluate the above hypothesis for within group differences and between group differences. Recall from Study One that the cultural orientation for Emotion Regulation and Extraversion was significantly different between the services. Further, indications of stereotype were present between the services. We hypothesize that these differences will be present in the team experimentation. The hypotheses are:

$H_0$  = No evidence of cultural or personality differences between the services in the wargame experiment.

$H_1$  = At least one service is different in emotion regulation.

$H_2$  = At least one service is different in extraversion

It is evident that a number of complex designs will be explored to determine whether the hypotheses are true. Recall, as in the team composite evaluation, we contend that the heterogeneous experimental team will perform as well as the homogeneous control team given the cue to cultural and personality effect in the experimental condition. The same analysis as the composite team is undertaken, with the addition of examining within and between service differences, to determine further the effect of the cue in the experimental condition. The hypothesis for this evaluation is central to our research.

We withhold a list of hypotheses at this time and will provide each hypothesis in the results section corresponding with that analysis.

### *a. Participants*

Twenty-six four-person teams from across the United States participated in the wargame. The teams were all male. This was not by design. The different commands who provided volunteer participants determined the availability of the participants and who would be on what team. The lack of female participation was not requested by the researcher. Table 3 provides participant breakdown by service.

Table 3. Wargame Survey Participants

| Current service |        | Data Collection Method |
|-----------------|--------|------------------------|
|                 |        | Wargame Method         |
| Air Force       | Male   | 19                     |
|                 | Female | 0                      |
| Army            | Male   | 32                     |
|                 | Female | 0                      |
| Marines         | Male   | 36                     |
|                 | Female | 0                      |
| Navy            | Male   | 17                     |
|                 | Female | 0                      |
| <b>Totals</b>   |        | 104                    |

Additionally, Table 4 below provided the participant breakdown by service and location where the wargame and survey data was collected.

Table 4. Wargame Participants by Service and Location

| Team # | Team Members | Location | Team Structure | Team Condition | Team Type | Number of Participants by Service |           |           |           | Total      |
|--------|--------------|----------|----------------|----------------|-----------|-----------------------------------|-----------|-----------|-----------|------------|
|        |              |          |                |                |           | AF                                | A         | M         | N         |            |
| 1      | 4AF          | TAFB     | Homogeneous    | Control        | HC        | 4                                 |           |           |           | 4          |
| 2      | 4AF          | TAFB     | Homogeneous    | Experimental   | HE        | 4                                 |           |           |           | 4          |
| 3      | 4AF          | SAFB     | Homogeneous    | Control        | HC        | 4                                 |           |           |           | 4          |
| 4      | 4A           | FS       | Homogeneous    | Experimental   | HE        |                                   | 4         |           |           | 4          |
| 5      | 4A           | FS       | Homogeneous    | Control        | HC        |                                   | 4         |           |           | 4          |
| 6      | 4A           | FS       | Homogeneous    | Experimental   | HE        |                                   | 4         |           |           | 4          |
| 7      | 4M           | 29P      | Homogeneous    | Control        | HC        |                                   |           | 4         |           | 4          |
| 8      | 4M           | Q        | Homogeneous    | Experimental   | HE        |                                   |           | 4         |           | 4          |
| 9      | 4M           | Q        | Homogeneous    | Control        | HC        |                                   |           | 4         |           | 4          |
| 10     | 4N           | DLI      | Homogeneous    | Experimental   | HE        |                                   |           |           | 4         | 4          |
| 11     | 4N           | DLI      | Homogeneous    | Control        | HC        |                                   |           |           | 4         | 4          |
| 12     | 4N           | DLI      | Homogeneous    | Experimental   | HE        |                                   |           |           | 4         | 4          |
| 13     | 3A1M         | FS       | Heterogeneous  | Control        | HTC       |                                   | 3         | 1         |           | 4          |
| 14     | 3M1A         | FS       | Heterogeneous  | Experimental   | HTE       |                                   | 1         | 3         |           | 4          |
| 15     | 1AF3A        | TAFB     | Heterogeneous  | Control        | HTC       | 1                                 | 3         |           |           | 4          |
| 16     | 3M1A         | 29P      | Heterogeneous  | Experimental   | HTE       |                                   | 1         | 3         |           | 4          |
| 17     | 3M1A         | 29P      | Heterogeneous  | Control        | HTC       |                                   | 1         | 3         |           | 4          |
| 18     | 3M1A         | FS       | Heterogeneous  | Experimental   | HTE       |                                   | 1         | 3         |           | 4          |
| 19     | 3M1N         | 29P      | Heterogeneous  | Control        | HTC       |                                   |           | 3         | 1         | 4          |
| 20     | 3M1N         | 29P      | Heterogeneous  | Experimental   | HTE       |                                   |           | 3         | 1         | 4          |
| 21     | 2AF2A        | SAFB     | Heterogeneous  | Control        | HTC       | 2                                 | 2         |           |           | 4          |
| 22     | 2AF2A        | SAFB     | Heterogeneous  | Experimental   | HTE       | 2                                 | 2         |           |           | 4          |
| 23     | 2A2M         | FS       | Heterogeneous  | Control        | HTC       |                                   | 2         | 2         |           | 4          |
| 24     | 2A2M         | FS       | Heterogeneous  | Experimental   | HTE       |                                   | 2         | 2         |           | 4          |
| 25     | 2A2N         | DLI      | Heterogeneous  | Control        | HTC       |                                   | 2         |           | 2         | 4          |
| 26     | 2AF1M1N      | TAFB     | Heterogeneous  | Experimental   | HTE       | 2                                 |           | 1         | 1         | 4          |
|        |              |          |                | <b>Totals</b>  |           | <b>19</b>                         | <b>32</b> | <b>36</b> | <b>17</b> | <b>104</b> |

Note. AF – Air Force; A – Army; M – Marines; N - Navy

TAFB – Tinker Air Force Base, OK; SAFB – Sheppard Air Force Base, TX; FS – Fort Sill, OK;

29P – Twenty-nine Palms, CA; Q – Quantico, VI; DLI – Defense Language Institute, Monterey, CA

The team structures were homogeneous (all one service) or heterogeneous (a mixture of services). Each group was divided by condition (control, experimental). The condition determination was an alternating selection method. (Team one was in the control condition, team two the experimental, team three the control.)

**b. Materials/Apparatus**

Four half-inch gray binders

Scenario for control and experimental conditions

Seat information composed of eight specific facts relevant to the wargame  
(different for each seat position)

Three photos of Pratas Island

Sample Military Decision Matrix

One Blank Decision Matrix

Risk Analysis Matrix

Three sheets of blank paper

Sony voice-activated recording device with Maxell MC-60UR tapes

1:600,000 map sheet of South China Sea

Enlarged photo of Pratas Island

Pens, pencils and grease pencils (red, green, black and blue)

**c. Procedures**

Prior to the wargame, each participant completed the revised cultural and personality survey. Recall, no data was collected on potential stereotype in this experiment as a time-saving measure. Team experimentation took place based on participant time schedules and availability. The researcher accommodated each team and service based on prior coordination with the units providing participants for the wargame. Several pilot experiments attempted to have the participants complete the online version of the survey. It was determined that this was ineffective and the actual team experiments required participants to complete the survey in the presence of the researcher prior to the wargame.

The team composition for the wargame was four participants who were members of active duty military units representing all services. Participants arrived at a predetermined location based on the sponsoring military unit's mission and space availability. The set up for the wargame was identical across all locations. Each location had an adequate space with a long table (more than nine feet in length) and four identical chairs. All locations were well lit, environmentally comfortable, and situated in a manner that eliminated interruption by visitors. Signs were posted outside entrances that indicated experimentation was ongoing and requesting not to be disturbed or interrupted.

Prior to participant arrival, four gray half-inch binders were prepared, one for each participant. These binders were placed in the middle of the table between the

four seat positions and stacked one on top of the other. Prior to placement, they were shuffled so that the researcher was not aware of which binder represented which seat position. The following information was standard for each binder.

1. Scenario
2. Seat Information composed of eight specific facts relevant to the wargame (different for each seat position)
3. Three photos of Pratas Island
4. Sample Military Decision Matrix
5. One Blank Decision Matrix
6. Risk Analysis Matrix
7. Three sheets of blank paper (The exact information on each document is located in appendix G.)

Adjacent to the four seat positions was a 1:600,000 map sheet for the Taiwan Strait, South China Sea area. An overlay, depicting the current operation, was taped over the map sheet. Next to the map was a photograph of Pratas Island with an overlay of the occupation force's deployment on the island. All items were placed upside-down so that the back (white) side of each sheet was the only portion visible when the participants arrived. A Sony Clear Voice Plus recorder was positioned behind the seat positions wherever electrical outlets were available. The taping device used Maxell Micro cassette tapes (MC-60UR) to record the communications between participants. Additionally, a white sixty-minute food timer was positioned next to the map along with an assortment of pencils, pens, and wax pencils.

Upon arrival at the experiment location, participants were briefed by the researcher and instructed to take a seat at any of the four possible locations. Participants randomly selected a seat. Informed consent and demographic documents were handed out and read to the participants prior to their filling out those documents. Once completed, the researcher took up the documents, reviewed the informed consent for completeness, and proceeded with the experiment. Figure 11 provides an example of the room setup prior to participant arrival.



Figure 11. Example of room setup prior to participant arrival.

All participants were instructed to take one binder and open it. The binder for seat one was always designated as the leader. Selection of the leader for the team could only be determined after all binders were open and each seat position identified. Each binder contained exactly eight different facts based on the seat position. This was not known to the participants and never revealed by the researcher. Figure 12 provides an example of the room setup after the initial reading of the wargame instructions.



Figure 12. Room setup after the reading of the wargame scenario.

Once the binders were open, the scenario was read out loud by the researcher. Each participant had a copy of the scenario in their binder. The maps were turned over at precise points in the scenario reading to reveal their contents to the participants. Each scenario concluded with pointing out the recording device position and the opportunity for questions. The participants in the control condition were only cued to the recording device. Participants in the experimental condition received an additional cue concerning the cultural and personality surveys they had completed prior to the wargame.

After all questions were answered, the timer was set for thirty minutes, the recorder was turned on, and the participants began their experiment. During the wargame, the researcher did not answer any questions except to say, “Please refer to your scenario and continue.”

During pilot studies, it was determined that once any participant made reference to how much time was left to finish, the researcher stopped the experiment. The reasoning for this developed when it became apparent the participants stopped information sharing and course of action development in order to fill out a Decision Matrix. Their focus changed completely to how to fill out a piece of paper and added no value to the experimental variables. The tape recorder was stopped at this time and

participants were asked to complete two documents. Document One asked each participant to rate each of the eight facts for their seat position by importance. Document Two asked each participant to write a short paragraph responding to three questions.

1. Please write a short paragraph describing your satisfaction with your group's effectiveness in completing this wargame. Please list the positive and negative experiences during this experiment.

2. Do you believe having members from other services would have made determining Red Cell course of action decisions easier? Yes or No

3. Please explain your answer to question 2.

After completing the short paragraphs, each participant was handed a debriefing page outlining the experimental focus and this document was read to them. After answering questions, the researcher emphasized the necessity of not discussing this experiment with any other members of their unit. Each participant was provided with information on ways to contact the researcher if they desired the experimental results or to discuss the experiment.

### **3. Tools for Analysis**

The wargame is evaluated using several methods. The cultural and personality combined survey responses are examined as described for Study One, Parts A and B. Performance during the wargame is evaluated at the team and individual level. Team performance is based on the percentage of facts shared. Individually, each team member is evaluated on the percentage of facts shared by the seat position they occupied. Recall that each seat position has eight specific facts to share. Analyses evaluated seat position, team structure, team type, and military service affiliation. In addition to the performance parameters, the taped sessions of the wargame will be evaluated using the Linguistic Inquiry Word Count described next.

#### ***a. Linguistic Inquiry Word Count – LIWC***

The communication analysis among participants is an integral part of the team exercise. The tool used to analyze the written and transcribed communication is the Linguistic Inquiry Word Count (LIWC). A detailed explanation of this tool follows.

The use of linguistics to analyze communication dates back to the early research of the group process. Lippitt (1940) conducted studies of pronoun usage where



the use of "we" more than "I" during discussions among group members showed greater group belongingness. Ketchum (1965) used the same pronoun distinction to show the rise and fall of prisoner solidarity and morale of British soldiers in a German prisoner of war camp during the First World War. Little research on pronoun usage, as a measure of belongingness group members feel, has occurred since. The adaptation of using linguistic analysis to measure team communication offers the research community an opportunity to measure this construct and team effectiveness objectively, based on the work conducted by Pennebaker (2000).

The relationship between verbal interactions of members on a team and communication is not widely researched. Early researchers utilized word usage by participants to study team constructs such as cohesion, but this research never evolved. The studies by Pennebaker (1993) and Francis (1993) offer the re-examination of this concept of word usage and team communication by utilizing their Linguistic Inquiry and Word Count (LIWC). This instrument was developed during their exploratory research studying language and disclosure (Pennebaker, Francis & Booth, 2001).

The LIWC is a text analysis program designed to analyze written text on a word-by-word basis (Pennebaker et. al., (2001). It categorizes words based on eighty-two word variables, which are divided across five dimensions. (Appendix I lists the eighty-two different variables the LIWC examines.) Text is analyzed then categorized into a word category generating a frequency use table. The development of the LIWC evolved over the past eight years to what is now a comprehensive text analysis strategy. Pennebaker et al., (2001) research during the development of the LIWC reveals that having people write about a significant emotional event does indicate improvement in health.

Pennebaker and Campbell (2001) studied the idea that the words people use when they write impact health and emotional stability. In the past few decades, researchers have found that the word an individual uses predicts mental and physical health (Pennebaker, 1997; Smyth, 1998). Pennebaker and Campbell (2001) examined the effect that writing about emotional experiences over a three- or four-day period had on the general health of the participants during a subsequent six-month study.

Specifically, the experiment involved three groups. The first group was composed of first-year college students from a Midwestern community. The second group was composed of upper-level college students from the same community, and the last group consisted of psychiatric inmates from a maximum-security institution in the Midwest. All participants were divided into a control group and the experimental group. The control groups were told to write about a superficial topic for a three-day period. The experimental group was told to write about a traumatic period. The first-year student participants and the inmates were instructed to write fifteen to twenty minutes per day for three days, and the upper-level students to write for four days for ten to fifteen minutes. Data was collected on the number of hospital visits or infirmary visits the participants had made two months prior to the writing assignment and four months after the writing assignment was completed. The results indicated that participants in the experimental condition had improved health and fewer visits to the doctor than the participants in the control condition. These results were important, but the researchers wanted to explore whether the words written by all the participants could be predictors of health.

Pennebaker and Francis (2001) examined the writing of the participants using the Latent Semantic Analysis (LSA) which is designed to see if the important words people use indicate any significance between health and the different writings of the participants. Figure 13 gives an example of the different words the LSA examines.

*Coming to college* conjured up these *feelings*; *Excitement, anxiety, happiness, worry, anticipation, glee, nervousness, sadness, grief, energetic* and many others.

Figure 13. Example of LSA analysis

They found no connection between the LSA control words and health so concluded that what people wrote about made no difference to their health. They then did an analysis of the other words known as particle semantic space or "junk words" using the LIWC. Figure 14 gives an example of the types of words the LIWC examined.

Coming *to* college conjured *up these* feelings. Excitement, anxiety, happiness, worry, anticipation, glee, nervousness, sadness, grief, energetic *and many others*.

Figure 14. Example of LIWC analysis

Although the words gave no indication of the topic being discussed, the researchers were surprised to discover these words had a significant relationship to health prediction. For example, the use of pronouns was related to health improvements. Specifically, Pennebaker and Campbell (2001) concluded that it was not important *what* participants in the study talked about, but rather *how* they talked that mattered.

The results of the Pennebaker and Campbell study (2001) led Dzindolet and Purcell (2001) to examine pronoun usage and performance during a brainstorming task. The experiment involved participants from a southwestern university who brainstormed an ecology problem in dyads or four-member groups. The sessions were forty-five minutes long and recorded. The results indicated that the more groups used first person personal pronouns (I, me, my;  $r = -.76$ ), the less productive they were. Positive emotions ( $r = .53$ ) and positive feelings ( $r = .59$ ) indicated that the group perceived their performance as high, but when performance was analyzed, they had not done better at all ( $r = -.73$ ). It should be noted that Hofstede (2005) indicated significant relationships to pronoun usage and cultural orientation (Hofstede & Hofstede, 2005).

Dzindolet and Purcell's (2001) experiment provided the framework to evaluate the team communications by seat position and team. The experimental design of this project is to determine if teams composed of homogeneous and heterogeneous military members will communicate differently in the control and experimental condition. This will be accomplished by examining the communication between group members during task performance as analyzed by the LIWC. The design for evaluating communication is to transcribe the communications between team members. The communication files will be analyzed by the LIWC and subjected to a MANOVA to determine if the LIWC indicates sensitivity to the differences between team members or team type.

## C. STUDY 3 - NETLOGO

### 1. Hypothesis

$H_0$  = There are significant differences for performance between the wargame and the NetLogo simulation results.

$H_1$  = There are no performance differences between the wargame and the replicated wargame results using the NetLogo model in simulation.

Our development of the NetLogo model accomplishes two purposes. First, we want to demonstrate that a model populated with data from human experimentation yields results that replicate those seen in human experimentation. Further, we want to demonstrate that simulation of a human behavior model can add robustness to results where limitations for participants of the human experimentation are evident.

#### a. *Materials*

NetLogo is a downloadable software package available online from Northwestern University. (This model was explained in the literature review section.) We coded our model with the assistance of researchers at Northwestern and Mr. Lawton Cities, an analyst for Referentia. Using the wargame as the setup for the model, agents were coded four models. Each model represented one of the environments for each of the four team types. The wargame environment included seat position, eight facts per seat position, a common repository for facts shared, a course of action template, a weighting system for facts, and a weighting system for sharing based on the cultural and personality data  $M$  (mean) formulated from Study One and Two for each service. The decision to code a separate model for each team type was made after complications surfaced with developing arrays of the different service cultural and personality data sets within NetLogo.

Seat position was coded so that any combination of service members totaling four was required. The homogeneous models output team data for four of the thirty-five team types. The heterogeneous models output data for the remaining thirty-one team types.

The facts coding replicated the importance of a fact. The weighting was determined by the scoring sheets each participant completed for their seat position,

summed and averaged to determine the weight. The weight was coded into the model by seat position to insure that accuracy of fact to seat position was maintained.

Sharing of a fact between seat positions was developed to determine when a fact would be understood by the other seat positions. This weighting system, along with the individual service *means* from the cognitive data, was used to degrade the information flow between seat positions. Each model had different cognitive data depending on team type. Facts that were shared and understood by all other seat positions, based on the weighting system, were sent to a common decision list.

As facts were entered into the decision list, coding from a template of possible courses of action determined what course of action was selected based on the facts in the decision list. (Note that due to the subjective nature of the course of action selection we did not include course of action selection as a performance parameter for either the wargame or the models.)

The last coding for the models focused on insuring that the time steps for simulation runs replicated the actual wargame time constraints. We based a time step on the average time participants in the wargame actually engaged in communication.

For the experimental runs, we used the behavior space capability within NetLogo. The first simulation run consisted of thirty-five trials for each of the four models. The second simulation run consisted of one hundred trials for each team type model followed by a third simulation run of one hundred trials. (Homogeneous simulation trials = 400, heterogeneous trials = 3100.) The first simulation run of thirty-five trials revealed a coding error for time step which allowed some models to run longer than other models. This was corrected and rerun. It should be noted that after the simulation was rerun, no modifications or recoding of NetLogo occurred. Analysis from the model is described in the results section.

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## IV. RESULTS

Data collection for the three studies was accomplished from January to July of 2006. Study One required the administration of several surveys as described in the method section. The online survey was available all seven months with 425 participant responses. The data collected from this survey was evaluated for completeness and valid responses. The validity of each survey was based on completeness, recommendation validity from the survey developers professional guidelines, and participants' responses across each survey. (We eliminated surveys with only a middle response selection for each survey question.) The final sample size from the online data collection was 235. The survey completed by the wargame participants was a revised version from the online version. The survey items investigating stereotype were eliminated. The remainder of the wargame version duplicated the online version. The sample size for this collection method was 104. All surveys used for evaluation were valid and met the criteria for use in the analysis. Table 5 provides the summary table for the data set used for Study One analysis.

Table 5. Data Collection Method Demographics

| Current service |        | Data Collection Method |                |
|-----------------|--------|------------------------|----------------|
|                 |        | On Line Method         | Wargame Method |
| Air Force       | Male   | 8                      | 19             |
|                 | Female | 8                      | 0              |
| Army            | Male   | 65                     | 32             |
|                 | Female | 2                      | 0              |
| Marines         | Male   | 123                    | 36             |
|                 | Female | 14                     | 0              |
| Navy            | Male   | 14                     | 17             |
|                 | Female | 1                      | 0              |
| <b>Totals</b>   |        | 235                    | 104            |

Our analysis began with determining whether there were gender effects for survey completion. The analysis determined that there was one significant effect for gender by service. Marine gender differences were significant for neuroticism [ $F(1, 172) = 5.80, p = .01$ ]. Since this was the only indication of significance for gender across the five

variables of interest and between the four services, we decided to remove gender as an independent variable from further analysis. The remaining data sets will not include the gender factor in the summaries.

The following group of tables provides the summary data for all participants. Table 6 provides the rank structure, current military specialty, time in service, and additional variables of interest tables.

Table 6. Summary Tables for all Participants

**Summary Table for Rank Structure**

| Current service |            |             |             |            |
|-----------------|------------|-------------|-------------|------------|
| Rank            | Air Force  | Army        | Marines     | Navy       |
| <b>0-1</b>      | 3 (.88%)   | 39 (11.5%)  | 93 (27.4%)  | 7 (2.06%)  |
| <b>0-2</b>      | 2 (.59%)   | 3 (.88%)    | 19 (5.60%)  | 2 (.59%)   |
| <b>0-3</b>      | 24 (7.08%) | 51 (15.04%) | 57 (16.81%) | 17 (5.01%) |
| <b>0-4</b>      | 6 (1.77%)  | 2 (.59%)    | 4 (1.18%)   | 2 (.59%)   |
| <b>0-5</b>      | 0          | 4 (1.88%)   | 0           | 4          |

*Note.* % is calculated as percentage of total respondents.

**Summary Table for Age and Time in Service**

| Current service        |           |       |         |       |
|------------------------|-----------|-------|---------|-------|
|                        | Air Force | Army  | Marines | Navy  |
| <b>Time in Service</b> | 8.62      | 6.60  | 3.09    | 9.40  |
| <b>Current Age</b>     | 28.65     | 27.74 | 25.13   | 28.06 |



**Summary Table for Military Specialty**

| <b>Current service</b>    |                  |             |                |             |
|---------------------------|------------------|-------------|----------------|-------------|
| <b>Military Specialty</b> | <b>Air Force</b> | <b>Army</b> | <b>Marines</b> | <b>Navy</b> |
| None listed               | 24               | 1           | 44             | 5           |
| Administration            | 1                | 0           | 17             | 6           |
| Air Defense Artillery     | 0                | 1           | 0              | 0           |
| Armor                     | 0                | 0           | 1              | 0           |
| Field Artillery           | 0                | 78          | 6              | 0           |
| Aviation Maintenance      | 4                | 1           | 6              | 4           |
| Aviation Pilot            | 6                | 1           | 27             | 6           |
| Infantry                  | 0                | 4           | 56             | 0           |
| Maintenance               | 0                | 0           | 5              | 1           |
| Chemical                  | 0                | 10          | 2              | 0           |
| Engineer                  | 0                | 0           | 2              | 0           |
| Communications            | 0                | 2           | 2              | 6           |
| Medical                   | 0                | 0           | 1              | 3           |
| Intelligence              | 0                | 0           | 3              | 1           |
| Security                  | 0                | 1           | 1              | 0           |

**Summary Table for Additional Variables of Interest**

| <b>Additional Variables of Interest</b> |                  |             |                |             |
|---|------------------|-------------|----------------|-------------|
|   | <b>Air Force</b> | <b>Army</b> | <b>Marines</b> | <b>Navy</b> |
| Prior Service                           | 1                | 40          | 55             | 11          |
| Parent/s member of service              | 5                | 45          | 43             | 5           |
| Member of a Joint team                  | 3                | 68          | 19             | 9           |

Analysis did not indicate significant main effects for any of the variables listed when compared to cultural orientation and personality domain. As with gender, these variables were eliminated from inclusion with the analysis.

A comparison between participant responses to the online survey and responses to the survey prepared for wargame participants was conducted in order to determine whether differences between the two methods of data collection existed. Table 7 below shows the results.

Table 7. Comparison of Data Collection Methods

|                                |                             | Levene's Test for Equality of Variances |      | t-test for Equality of Means |        |                 |                 |                       |   |        |
|--------------------------------|-----------------------------|---|------|------------------------------|--------|-----------------|-----------------|-----------------------|---|--------|
|                                |                             | F                                       | Sig. | t                            | df     | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |        |
|                                |                             |   |      |                              |        |                 |                 |                       | Lower                                     | Upper  |
| T Score Extraversion           | Equal variances assumed     | 1.843                                   | .175 | -.191                        | 348    | .849            | -.195           | 1.021                 | -2.203                                    | 1.813  |
|                                | Equal variances not assumed |   |      | -.198                        | 210.86 | .843            | -.195           | .984                  | -2.135                                    | 1.746  |
| T Score Neuroticism            | Equal variances assumed     | 3.846                                   | .051 | -1.108                       | 348    | .269            | -.898           | .811                  | -2.493                                    | .696   |
|                                | Equal variances not assumed |   |      | -1.192                       | 230.71 | .234            | -.898           | .753                  | -2.382                                    | .586   |
| T Score Openness to Experience | Equal variances assumed     | .196                                    | .658 | -1.339                       | 348    | .181            | -.932           | .696                  | -2.300                                    | .437   |
|                                | Equal variances not assumed |   |      | -1.387                       | 210.21 | .167            | -.932           | .672                  | -2.256                                    | .392   |
| Status Differentiation         | Equal variances assumed     | .032                                    | .858 | .523                         | 348    | .602            | .04207          | .08050                | -.11625                                   | .20039 |
|                                | Equal variances not assumed |   |      | .528                         | 198.10 | .598            | .04207          | .07974                | -.11518                                   | .19931 |
| Emotion Regulation             | Equal variances assumed     | .163                                    | .687 | .550                         | 348    | .582            | .04054          | .07368                | -.10436                                   | .18545 |
|                                | Equal variances not assumed |   |      | .571                         | 210.71 | .569            | .04054          | .07106                | -.09954                                   | .18063 |

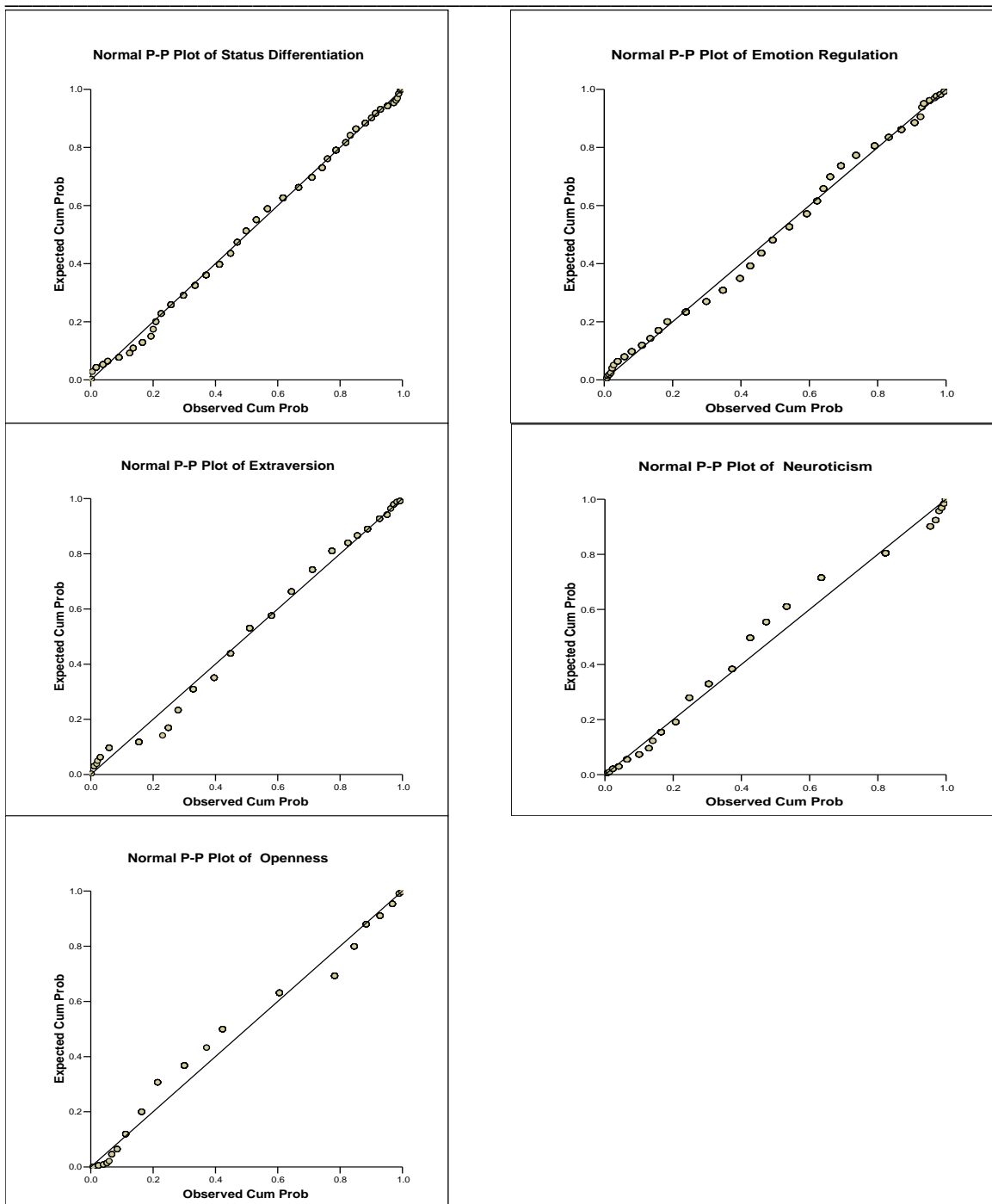
The analysis did not indicate any significant difference between the two methods of data collection. This being so, the following analysis utilizes the combined data sets from both methods of data collection.

The results from all three studies is formidable considering the amount of data and the robustness achieved. For simplicity, a standard pattern of presentation was developed to avoid repetition during the transition between variables and studies. In an attempt to limit the written interpretation, only brief comments about the results are offered. The discussion section will elaborate on each analysis.

#### **A. STUDY ONE**

The purpose of Study One was to evaluate the four different services by cultural orientation and personality domains. The 339 surveys were initially evaluated for linearity and normality. Using the JMP statistical package and the SPSS graphing package, the data was investigated for normality by evaluating the histograms for each of the five variables of interest (Extraversion, Neuroticism, Openness to Experience, Status Differentiation and Emotion Regulation). The graphs from JMP indicated limited support for the normality assumption so additional investigations of the P-P Plots by SPSS were accomplished. These plots are grouped together and provided in Table 8.

Table 8. P-P Plots for the Cultural and Personality Variables



The P-P plots graphs a variables cumulative proportions against another variables cumulative proportions to test for similar distributions. The determination was made that

the distributions for all variables are normal. The Q-Q plots were also evaluated and indicated that several outliers were influencing the normality assumption. The decision to keep the outliers in the data set was made after finding little substantial evidence for their removal. The analysis of the data begins with an investigation of cultural orientation.

### 1. Part A – Cultural Orientation Evaluation

The analysis began with an evaluation of the summary data for each service. Table 9 summarizes the data for status differentiation and emotion regulation.

Table 9. Cultural Orientation Summary Data by Service

| Service   | CSQ Item | n   | M     | sd   | se   | 95% M | 95% M |
|-----------|----------|-----|-------|------|------|-------|-------|
|           |          |     |       |      |      | Upper | Lower |
| Air Force | SD       | 35  | 1.733 | .721 | .120 | 1.977 | 1.489 |
| Air Force | ER       | 35  | 3.331 | .271 | .045 | 3.423 | 3.239 |
| Army      | SD       | 99  | 1.889 | .639 | .062 | 2.013 | 1.764 |
| Army      | ER       | 99  | 3.886 | .709 | .069 | 4.024 | 3.748 |
| Marines   | SD       | 173 | 1.960 | .578 | .043 | 4.048 | 3.877 |
| Marines   | ER       | 173 | 3.755 | .608 | .045 | 3.845 | 3.665 |
| Navy      | SD       | 32  | 1.985 | .677 | .119 | 2.231 | 1.743 |
| Navy      | ER       | 32  | 3.633 | .485 | .085 | 3.809 | 3.458 |

Note. SD – Status Differentiation, ER – Emotion Regulation  
n = population size, M = sample mean, *Sd* = standard deviation, *se* = standard error

The first analysis focused on evaluating whether differences existed between each service. In a 4 (Military Service: Air Force, Army, Marine, Navy) x 2 (Cultural Orientation: Status Differentiation, Emotion Regulation) each service was compared to determine whether differences existed across any of the cultural variables. The hypotheses evaluated were:

H<sub>0</sub> = No difference for Status Differentiation or Emotion Regulation between the individual services

H<sub>1</sub> = At least one service is different in Status Differentiation

H<sub>2</sub> = At least one service is different in Emotion Regulation

The data was initially analyzed using the standard Analysis of Variance (ANOVA). To insure that variances were equal, several homogeneity of variances comparisons were tested. The conclusions from that analysis indicated the variance for Status Differentiation was equal but not for Emotion Regulation. Additional hypothesis

testing, using the Welch ANOVA, provided a more accurate examination of Emotion Regulation. The use of the Welch ANOVA test takes into account the differences in group variance. We are more confident that the significant differences found using the Welch ANOVA were not caused by chance occurrence. Table 10 summarizes the ANOVA for Status Differentiation and the Welch ANOVA for Emotion Regulation.

Table 10. Comparison of *M* for SD and ER between the Services

One Way ANOVA

| Cultural Variable      | Source       | DF | Sum of Squares | Mean Square | F Ratio | Prob > F |
|------------------------|--------------|----|----------------|-------------|---------|----------|
| Status Differentiation | All Services | 3  | 1.53           | 0.51        | 1.08    | 0.35     |

Welch ANOVA

| Cultural Variable  | Source       | DF Number | DF Density | F Ratio | Prob > F |
|--------------------|--------------|-----------|------------|---------|----------|
| Emotion regulation | All Services | 3         | 1.53       | 18.34   | *.0001   |

Note. PD = Status differentiation      UA = Emotion regulation

\*  $p < .05$

Hypothesis 1 ( $H_1$ ) is not upheld. There appears to be no difference between any of the services for status differentiation. This was initially a surprising result. However, on reflection, the military environment is founded on subordination to persons of higher rank. This factor may account for the lack of differences and will be further discussed in the next chapter.

The second hypothesis ( $H_2$ ) for emotion regulation is upheld. To determine which pairings were different, we examined the Tukey-Kramer (HSD) and the student's *t* tables for significant differences between the paired services. These methods indicated that the Air Force was the only service significantly different when compared with each of the other services. Table 11 summarizes the pairing for each service and the levels of significance for each pairing.

Table 11. Comparisons of Service Pairings for Emotion Regulation

| Cultural Variable  | Service Level | <i>M</i> | Pairing Level | <i>M</i> | DF  | <i>t</i> Ratio | p-Value  |
|--------------------|---------------|----------|---------------|----------|-----|----------------|----------|
| Emotion Regulation | Army          | 3.92     | Air Force     | 3.33     | 335 | 4.29           | *.<.0001 |
| Emotion Regulation | Marines       | 3.73     | Air Force     | 3.33     | 335 | 3.84           | *.0001   |
| Emotion Regulation | Navy          | 3.62     | Air Force     | 3.33     | 335 | 2.42           | *0.016   |

Note. \* Indicates  $p < .01$

Of the six possible pairings between the services, three pairings indicated significant main effects for emotion regulation. As a reminder, the higher the rating for emotion regulation, the higher the tolerance for differing opinions and for ambiguity and uncertainty (Matsumoto, Yoo, & LeRoux, 2005). Examining the means for all the services supports Hofstede's (2005) rating of the United States' low score for uncertainty avoidance, which translates by Matsumoto (2003) to higher scores for emotional regulation. The results indicate that high ER is a trait for all services but that the level of magnitude is significantly different between the Air Force and the other services. Discussion of the implications follows in the next chapter. The next element that Study One examined is personality.

## 2. Part B – Personality Domain Evaluation

The data for personality was evaluated exactly the same as the cultural data. The analysis began with an evaluation of the summary data for each service. Table 12 summarizes the data for extraversion, neuroticism, and openness to experience.

Table 12. Same Service Comparison for Personality Domains

| Service   | NEO Domain   | n   | M     | Sd   | se   | 95% M | 95% M |
|-----------|--------------|-----|-------|------|------|-------|-------|
|           |              |     |       |      |      | Upper | Lower |
| Air Force | Extraversion | 35  | 45.11 | 5.72 | .95  | 47.04 | 43.17 |
| Air Force | Neuroticism  | 35  | 55.38 | 4.15 | .69  | 56.79 | 53.98 |
| Air Force | Openness     | 35  | 45.52 | 4.25 | .70  | 46.96 | 44.08 |
| Army      | Extraversion | 99  | 52.75 | 7.36 | .72  | 54.18 | 51.31 |
| Army      | Neuroticism  | 99  | 53.81 | 5.93 | .58  | 54.97 | 52.66 |
| Army      | Openness     | 99  | 41.98 | 4.92 | .48  | 42.93 | 41.02 |
| Marines   | Extraversion | 173 | 57.39 | 8.49 | .63  | 58.66 | 56.14 |
| Marines   | Neuroticism  | 173 | 48.30 | 7.08 | .53  | 49.35 | 47.26 |
| Marines   | Openness     | 173 | 42.38 | 6.35 | .47  | 43.33 | 41.44 |
| Navy      | Extraversion | 32  | 54.03 | 7.79 | 1.37 | 56.86 | 51.21 |
| Navy      | Neuroticism  | 32  | 51.65 | 5.17 | .91  | 53.52 | 49.79 |
| Navy      | Openness     | 32  | 47.43 | 5.95 | 1.05 | 49.58 | 45.92 |

Note. n = population size, M = sample mean, Sd = standard deviation, se = standard error

The next analysis focused on evaluating whether differences existed between each service. In a 4 (Military Service: Air Force, Army, Marine, Navy) x 3 (Personality Type: Extraversion, Neuroticism, Openness to Experience) each service was compared to determine whether differences existed across any of the personality variables. The hypotheses evaluated were:

- H<sub>0</sub> = No difference for Extraversion, Neuroticism or Openness to Experience between the individual services.
- H<sub>1</sub> = At least one service is different in Extraversion.
- H<sub>2</sub> = At least one service is different in Neuroticism.
- H<sub>3</sub> = At least one service is different in Openness to Experience.

Again, unequal variance testing indicated inequality for all populations. As with Emotion Regulation, we evaluated the data with the Welch ANOVA. The data is summarized in Table 13.



Table 13. Comparison of *M* for Personality Domains

| Personality Domain     | Source       | DF Number | DF Density | F Ratio | Prob > F |
|------------------------|--------------|-----------|------------|---------|----------|
| Extraversion           | All Services | 3         | 93.057     | 24.4976 | *.0001   |
| Neuroticism            | All Services | 3         | 100.75     | 18.2034 | *.0001   |
| Openness to Experience | All Services | 3         | 93.606     | 7.3816  | *.0002   |

Note. \*  $p < .05$   
 DF = Degrees of Freedom

The results support the hypothesis that there are differences between the services for personality. The method used to determine the specific service pairing for differences is constructed using the same method as for cultural orientation. The results of only the significantly different pairings from this analysis are provided in Table 14.

Table 14. Comparisons of Service Pairings for Personality

| Personality Domain     | Service Level | <i>M</i> | Pairing Level | <i>M</i> | DF  | <i>t</i> Ratio | p-Value    |
|------------------------|---------------|----------|---------------|----------|-----|----------------|------------|
| Extraversion           | Marines       | 56.78    | Air Force     | 45.80    | 335 | 7.27           | * $<.0000$ |
| Extraversion           | Navy          | 54.25    | Air Force     | 45.80    | 335 | 4.24           | * $<.0001$ |
| Extraversion           | Army          | 53.06    | Air Force     | 45.80    | 335 | 4.53           | * $<.0001$ |
| Extraversion           | Marines       | 56.78    | Army          | 53.06    | 335 | 3.62           | *.0003     |
| Neuroticism            | Marines       | 48.86    | Air Force     | 54.45    | 335 | -4.57          | * $<.0001$ |
| Neuroticism            | Marines       | 48.86    | Army          | 53.49    | 335 | -5.55          | * $<.0001$ |
| Neuroticism            | Marines       | 48.86    | Navy          | 42.40    | 335 | -2.14          | *.0329     |
| Openness to Experience | Marines       | 42.49    | Air Force     | 45.02    | 335 | -2.36          | *.0335     |
| Openness to Experience | Army          | 42.06    | Air Force     | 45.02    | 335 | -2.60          | *.0095     |
| Openness to Experience | Navy          | 46.31    | Army          | 42.06    | 335 | 3.61           | *.0002     |
| Openness to Experience | Navy          | 46.31    | Marines       | 42.49    | 335 | 3.42           | *.0003     |

Note. \* Indicates  $p < .01$

Of the different pairings for each service, Table 13 indicates strong support that between the services, significant differences in personality across at least one domain are evident. An elaboration on these findings follows in the discussion chapter. However, as a reminder, differences in scores are not meant to imply a negative connotation. This research focuses on determining whether these differences exist and evaluating that potential influence on joint team effectiveness. Recall, the business community understands that these types of differences are boundaries to team effectiveness and, if understood, can be overcome. The next analysis examines perception and stereotype between the services.

### **3. Part C– Personality Stereotype Evaluation**

This portion of the study involved participants scoring the other three services using the NEO FFI. Having determined the differences between the services, the next task was to determine whether the services perceived each other the same way that a service perceived itself. The use of the NEO FFI for this purpose is common (McCrae, R., 2005). For this research section, the participants scored the other services while completing the survey about themselves. Note that the  $n$  for this study is 235 participants, all from the online method for data collection. The wargame participants did not complete this section of the survey as a time-saving measure. We felt that administering the complete survey to the wargame participants would be too time consuming and result in degraded performance during the wargame. Recall that no significant difference between data collection methods was indicated.

In a 4 (Military Service: Air Force, Army, Marines, Navy) x 4 (Other Service: Air Force, Army, Marines, Navy) x 3 (Personality Perception: Extraversion, Neuroticism, Openness to Experience) experiment, the following hypotheses were evaluated:

- H<sub>0</sub> = No difference between the service perception for Extraversion, Neuroticism and Openness to Experience
- H<sub>1</sub> = At least one service is perceived differently in Extraversion
- H<sub>2</sub> = At least one service is perceived differently in Neuroticism
- H<sub>3</sub> = At least one service is perceived differently in Openness to Experience

The analysis utilizes the same method as for the previous evaluation for Personality. The Oneway ANOVA table is not presented. Only three instances were noted in the analysis where the homogeneity test did not indicate unequal variance. All three instances were not significant by ANOVA and are not presented. The Welch ANOVA is offered for the remaining analysis. Table 15 summarizes the results.

Table 15. Comparisons of *M* for Personality Domains as Rated by Other Services

| Personality Domain            | Source    | DF Number | DF Density | F Ratio | Prob > F          |
|-------------------------------|-----------|-----------|------------|---------|-------------------|
| <b>Extraversion</b>           | Air Force | 3         | 39.06      | 2.39    | <b>*.0430</b>     |
| <b>Extraversion</b>           | Army      | 3         | 44.413     | 10.8375 | <b>*&lt;.0001</b> |
| <b>Neuroticism</b>            | Army      | 3         | 46.615     | 8.3688  | <b>*.0001</b>     |
| <b>Openness to Experience</b> | Army      | 3         | 44.425     | 7.8573  | <b>*.0003</b>     |
| <b>Extraversion</b>           | Marines   | 3         | 44.19      | 33.7183 | <b>*.0001</b>     |
| <b>Neuroticism</b>            | Marines   | 3         | 45.091     | 30.5479 | <b>*.0001</b>     |
| <b>Openness to Experience</b> | Marines   | 3         | 47.267     | 5.6224  | <b>*.0022</b>     |
| <b>Extraversion</b>           | Navy      | 3         | 40.47      | 3.2267  | <b>*.0323</b>     |
| <b>Neuroticism</b>            | Navy      | 3         | 41.245     | 2.9723  | <b>*.0427</b>     |

Note.  $p < .05$

The next analysis investigates which of the services indicated a difference in rating for personality. Table 16 summarizes the entire data set. The “Rating Service” indicates how that service sees the other services and highlights the means that are significantly different.

Table 16. Comparison of Rating between the Services

| Rated Service | Personality Domain | Rating Service |                |          |                |          |                |          |                |
|---------------|--------------------|----------------|----------------|----------|----------------|----------|----------------|----------|----------------|
|               |                    | Air Force      |                | Army     |                | Marines  |                | Navy     |                |
|               |                    | <i>M</i>       | <i>P Value</i> | <i>M</i> | <i>P Value</i> | <i>M</i> | <i>P Value</i> | <i>M</i> | <i>P Value</i> |
| Air Force     | T Score Extra      | 44.31          | NA             | 47.84    | *.02           | 48.06    | *.009          | 47.80    | .07            |
|               | T Score Neurotic   | 54.88          | NA             | 56.18    | .44            | 56.66    | .27            | 54.13    | .73            |
|               | T Score Openness   | 45.69          | NA             | 46.00    | .84            | 48.03    | .12            | 46.93    | .55            |
| Army          | T Score Extra      | 45.00          | *.0002         | 51.76    | NA             | 49.82    | *.0043         | 48.47    | .12            |
|               | T Score Neurotic   | 58.75          | *.0009         | 54.33    | NA             | 56.50    | *.01           | 55.13    | .66            |
|               | T Score Openness   | 45.13          | *.03           | 41.93    | NA             | 45.53    | *<.0001        | 46.00    | *.009          |
| Marines       | T Score Extra      | 45.31          | *<.0001        | 49.15    | *<.0001        | 57.13    | NA             | 51.27    | *.006          |
|               | T Score Neurotic   | 57.81          | *<.0001        | 54.45    | *<.0001        | 48.37    | NA             | 51.47    | .10            |
|               | T Score Openness   | 45.13          | .06            | 41.88    | .57            | 42.39    | NA             | 46.53    | *.007          |
| Navy          | T Score Extra      | 45.44          | *.01           | 48.01    | .08            | 49.02    | .23            | 50.93    | NA             |
|               | T Score Neurotic   | 57.56          | *.02           | 55.76    | .07            | 55.56    | .07            | 52.80    | NA             |
|               | T Score Openness   | 46.38          | .52            | 45.94    | .83            | 46.77    | .73            | 46.27    | NA             |

Note. Red \*  $p < .05$

Table 16 illustrates that the services do see each other differently than they see themselves, which research has determined could indicate a possible stereotype of a group. Examining the means reveals several interesting conclusions worth pointing out now. Notice that the means for neuroticism show that all the services see the other services as more neurotic than they do in self-evaluation. Although not significant across all services, the data does indicate a trend worth further exploration. Recall that neuroticism scaled above a T score of 56 indicates an evaluation score of “high” for neuroticism. Additionally, between the services, the Army and the Marines have the majority of stereotypical perceptions by the other services with the Air Force having the most single service stereotype perceptions compared to the other services.

Again, we reinforce that these results are not to be seen as negative perceptions of another service. The literature does not connect negativity to these types of results in the

least. The business community identifies that these perceptions may interfere in the communication process and team effectiveness. Business domains simply acknowledge that the differences exist and have developed methods to limit their influence without demeaning or degrading another’s culture or personality. Further, business enterprises have overcome these potential barriers with simple methodologies thereby improving the team communication process.

Again, the results substantiate the hypothesis that services do not perceive each other the way a service perceives itself. This is an important discovery and will be further discussed in the next chapter.

In summary, support for the first two research questions and the first three hypotheses were found. Profiles of the services can be developed by the use of empirically sound instruments and there are differences between the services’ cultures and personalities. Table 17 illustrates the combined results from all three parts of Study One.

Table 17. Summation of Significant Differences for Cultural and Personality

| Study One Results |                |    |                    |   |   |                                 |   |   |      |   |   |         |   |   |      |   |   |
|-------------------|----------------|----|--------------------|---|---|---------------------------------|---|---|------|---|---|---------|---|---|------|---|---|
|                   | Part A Culture |    | Part B Personality |   |   | Part C Stereotype Rated Service |   |   |      |   |   |         |   |   |      |   |   |
|                   | SD             | ER | E                  | N | O | Air Force                       |   |   | Army |   |   | Marines |   |   | Navy |   |   |
| Rating Service    | SD             | ER | E                  | N | O | E                               | N | O | E    | N | O | E       | N | O | E    | N | O |
| Air Force         |                | 1  | 1                  | 0 | 1 |                                 |   |   | 1    | 1 | 1 | 1       | 1 |   | 1    | 1 |   |
| Army              |                | 0  | 0                  | 0 | 0 | 1                               |   |   |      |   |   | 1       | 1 |   |      |   |   |
| Marines           |                | 0  | 0                  | 1 | 0 | 1                               |   |   | 1    | 1 | 1 |         |   |   |      |   |   |
| Navy              |                | 0  | 0                  | 0 | 1 |                                 |   |   |      |   | 1 | 1       |   | 1 |      |   |   |

Note. Legend 1– Significant Difference with other service  
 0 – No Difference with other service  
 SD – Status Differentiation, ER – Emotion Regulation  
 E – Extraversion, N – Neuroticism, O- Openness to Experience

The table illustrates several interesting relationships. First, the columns with the “1” indicate the services that were significantly different and the service to which it is different is marked with a “0”. Part C displays the rated service in the vertical columns and the rating service in the horizontal column. The complexity of the different

relationships is discussed in the next chapter. The fact that there is complexity emphasizes the necessity to understand and develop methods to overcome the potential impact. Communications across boundaries between the services, when in a joint environment, requires understanding of the relationship to insure that information flow is not impeded by potential stereotype or misunderstanding. A caution is important. The *n* for this study for the Air Force and Navy is low. Making conclusions about specific relationships lies outside the scope of this dissertation, however, the fact that significance was found with such low power requires further investigation on a much larger scale.

The third research question focuses on the extent that the cultural and personality differences influence the military team. The next study attempts to clarify the potential impact of these differences in an actual team information sharing experiment. The next section summarizes the analysis of Study Two.

## **B. STUDY TWO**

This study examined the primary research question: “Can the business model for improving team effectiveness be implemented by the military indicating improved joint team effectiveness in a wargame?” The wargame described in Chapter Three was conducted at several military installations from April 2006 through July 2006. The results of that experiment follow.

### **1. Part A – Composite Team Evaluation**

The wargame was structured to allow for survey, performance, and linguistic data collection. The initial analysis of the results focuses on the composite teams. Recall that Table 4 provides the demographic of the twenty-six teams that participated in the wargame.

Our primary research questions focus on information sharing and the performance indicator for the wargame is the percentage of facts shared. Recall that the facts were developed as described in the method section. Table 18 below presents the inter-rater reliability analysis between these five panel members who developed the fact list of the performance parameters for this experiment.

Table 18. Correlations between Raters for Fact List Development

|                | <i>Rater 1</i> | <i>Rater 2</i> | <i>Rater 3</i> | <i>Rater 4</i> | <i>Rater 5</i> |
|----------------|----------------|----------------|----------------|----------------|----------------|
| <b>Rater 1</b> | 1              |                |                |                |                |
| <b>Rater 2</b> | 0.96           | 1              |                |                |                |
| <b>Rater 3</b> | 0.93           | 0.90           | 1              |                |                |
| <b>Rater 4</b> | 0.96           | 0.96           | 0.89           | 1              |                |
| <b>Rater 5</b> | 0.91           | 0.86           | 0.82           | 0.93           | 1              |

The results indicated agreement among the developers of the thirty-two facts used as the information sharing parameters during the wargame. The scale developed for this analysis was to divide the total facts shared by the total facts available (32). The result was the percentage of facts shared.

The analysis methodology for this study follows the one used for Study One. The data was initially analyzed using the standard Analysis of Variance (ANOVA). To insure that variances were equal, several homogeneity of variances comparisons were tested. The analysis for team type across the twenty-six teams follows.

*a. Performance by Team Type*

There are four possible team types for the wargame: homogeneous control (HC), homogeneous experimental (HE), heterogeneous control (HTC), and heterogeneous experimental (HTE). In the control condition, teams are not given any information about the potential effects of cultural orientation or personality stereotype, while the experimental condition is cued to those factors.

In a 4 (Team Type: HC, HE, HTC, HTE) x 1 (Performance: Percentage of Facts shared) experiment the following two sets of hypotheses were evaluated.

- H<sub>0</sub> = No difference for performance between team types
- H<sub>1</sub> = Teams in the homogeneous control condition will outperform the teams in the heterogeneous control condition.

Further, we hypothesize that the heterogeneous experimental team's performance will be similar to the HC teams given the cueing in the experimental condition. The hypotheses for the experimental condition are:

- H<sub>0</sub> = Difference for performance between homogeneous control and the heterogeneous experimental teams will be evident.

$H_1$  = No differences between the homogeneous control and the heterogeneous experimental teams.

The results from the ANOVA did not support either hypothesis [ $F(1,25) = 1.16, p = .34$ ]. However, individual students'  $t$  analysis did detect a significant difference between the HTE ( $M = .52, SD = .11$ ) and HTC teams at .05 significance level [ $(M = .41, SD = .10) t(22) = 2.16, p < .04$  (one-tailed),  $d = .11$ ]. This difference between the teams in the experimental condition was not hypothesized initially but makes sense. An inferred hypothesis that results from combining the two hypotheses for team type would be that the HTE team type would outperform the HTC team type, since our original conclusions were that the HC team would outperform the HTC team, but the HTE team's performance would be comparable to the HC team's. We conclude that the finding of significance between the HTC and the HTE team types strongly supports the research question as the only difference in the experimental design was the cueing. Further, given the small  $n$ , finding any significance is an important indication that applying the businesslike solution to a joint team does improve information sharing among the team members. For clarity, we present the box plots from the analysis. Figure 15 provides the box plots for the percentage of facts shared.

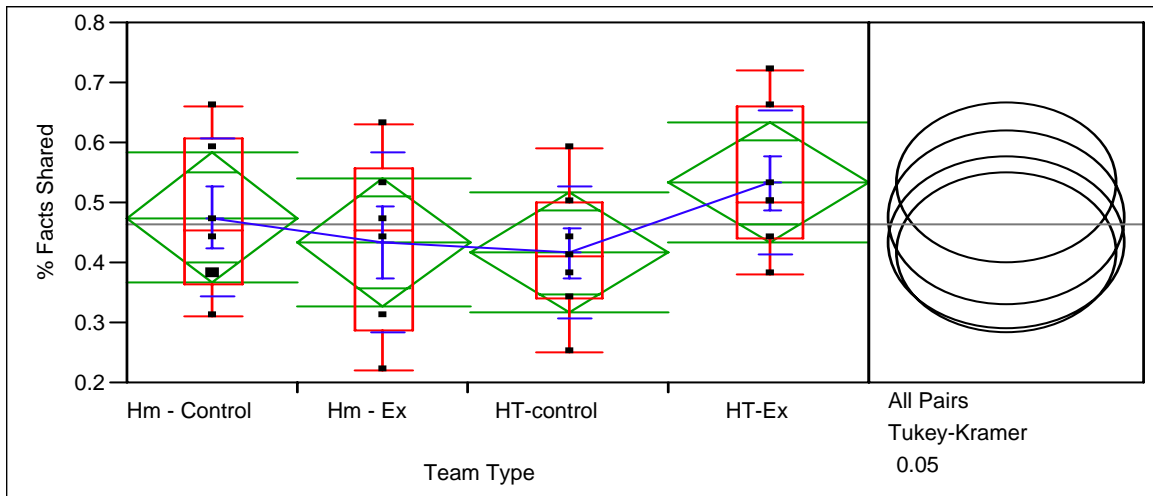


Figure 15. Box plots for Performance by Team Type.

The box plots are a method to illustrate the sample mean and the 95% confidence interval. Evaluating figure 15 reveals a trend in support of the control



condition hypothesis for percentage of facts shared. Examination of the plots indicates that despite lacking a significant difference, the HC team does share more facts than the HTC team, which we expected. The difference between the HTC and the HTE teams is well illustrated by the diagram. We discuss these results in more detail in the next chapter. The next analysis focuses on the linguistic communication among the team members.

***b. Linguistic Evaluation***

This analysis evaluates the transcripts of the dialog of the twenty-six teams using the Linguistic Inquiry Word Count (LIWC). Recall the hypothesis for this analysis is:

In a 4 (team type: HC, HE, HTC, HTE) x 1(LIWC), the following hypothesis was evaluated.

- H<sub>0</sub> = No difference for language usage between team types
- H<sub>1</sub> = The LIWC will be sensitive to differences between team types for word count, pronoun usage, and social variables.

The tapes of the communications were transcribed by two raters, and the reliability computed between the transcriptions, based on the LIWC analysis results for both raters. The correlation between the two rates ( $r = .61$ ) indicated significant differences between the raters' transcriptions. After discussing the problems that could have caused the differences, a determination was made that the tapes had been damaged during the delivery between the two raters. One additional transcription of the best tape was still unsatisfactory but improvement in the correlation was evident ( $r = .68$ ). Since the primary rater was present during the actual team experiment, the decision was made to use this rater's transcription. This aspect of the experiment is discussed in detail in the next chapter.

The hypotheses for this experiment were:

- H<sub>0</sub> = No difference in word count, pronouns, social processes, or relativity between team types
- H<sub>1</sub> = There will be differences in word count, pronouns, social processes and relativity between the HC and HTE team types

No significant differences for language were noted by ANOVA except for the inclusive variable. Significant difference between two team types was inclusive (with, include) was evident [ $F(1,25) = 4.86, p < .01$ ]. The lack of support across any other variables requires the null to be upheld. There are no significant differences in language usage between teams.

The results of the linguistic analysis were disappointing. Further evaluation of language involved an examination of pairwise correlations between all the team performance variables and the LIWC language variables. This examination attempted to determine whether there was any indication that a relationship existed between a team's performance, the team type, and language usage. The results of this analysis were very robust across several factors. A summary table of the significant results is offered in Table 19. (Note: A complete table of the results of the correlation evaluation was 100 pages long. This table is not included in appendix B.)

Table 19. Correlation Summary Table for Language Usage

| Teams | Count | Variable                           | By Variable                | Correlation | Prob |
|-------|-------|------------------------------------|----------------------------|-------------|------|
| HC    | 6     | Word Count                         | Percentage of Facts Shared | .81         | .04  |
| HC    | 6     | Total Second Person (You)          | Percentage of Facts Shared | -0.84       | .03  |
| HE    | 6     | 1 <sup>st</sup> Person Plural (We) | Percentage of Facts Shared | -0.88       | .03  |
| HE    | 6     | Positive Emotions (happy, good)    | Percentage of Facts Shared | .88         | .01  |
| HE    | 6     | Inclusive (with, include)          | Percentage of Facts Shared | .87         | .02  |
| HTC   | 7     | Positive Emotions (happy, good)    | Percentage Facts Shared    | .86         | .02  |

The results indicate that there is some correlation within teams for language usage and performance. One point of interest was the relationship of word count for the HC and HTE teams. The data was further analyzed by multiple regressions, using as regressors, the variables indicated by the LIWC as significant (word count, you, inclusive, I, we and positive emotions). Prior to completing the regression, a

stepwise regression indicated the removal of the I and we variables. The final regression fit was moderate ( $R^2_{adj} = .76$ ), but the overall relationship was significant [ $F(1,25) = 9.94, p < .0001$ ]. One interaction was evident for inclusive between the control and experimental condition. Inclusive language in the control condition had a positive relationship to percentage of facts shared, but in the experimental, the opposite was true. Inclusive language word usage in the team communications resulted in a smaller percentage of facts shared. One factor the regression indicated was that as word count went up, a like increase percentage of facts shared was observed, with the experimental condition indicating a higher increase for performance than the control condition.

The next chapter will elaborate further on these results. The next part of Study Two involved a detailed examination of teams by the individual participants that made up the teams.

## **2. Part B – Team Participant Evaluation**

Part A of this section was dedicated to strictly evaluating the composite twenty-six teams. Part B of this analysis will evaluate the individual members of each team by the performance parameter percentage of facts shared.

The analysis starts with a focus on the survey results for cultural orientation and personality by the wargame participants. Recall that no significant differences were observed comparing the online data collection method from the in-person data collection method. Additionally, no significant differences were evident by a re-evaluation of the survey for team participants only. We conclude that further analysis of these results would be repetitive and unrevealing.

Our next analyses will include performance by seat position, by service, by team structure, by team condition, linguistic analysis, and a summary of the responses by each participant to the following question and prompts.

1. Do you believe having members from another service on your team would improve or did improve your team's performance?
2. Please write a short paragraph describing your satisfaction with your group's effectiveness in completing this wargame. Please list your positive and negative experiences during this experiment.

3. Please explain your answer to Question One.

Additionally, the actual cultural and personality factors, by participant, will be incorporated into the analysis to determine whether there were any main effects or interactions within the teams. This analysis was not possible for the composite team. Normalized means of a team's culture and personality were inappropriate for a four-member team.

The evaluation of performance for this analysis is percentage of facts shared. This scale was arrived at by dividing the number of facts shared by a participant with the number of facts available (8). The scale established was 0 (no facts shared) to 1 (all facts shared). The analysis begins with checking this data for normality.

The test for normality revealed that the data is close to normal and the assumption is made that the data set is normal. Figure 16 provides the histogram and normal quantile plot the normality assumption is based on.

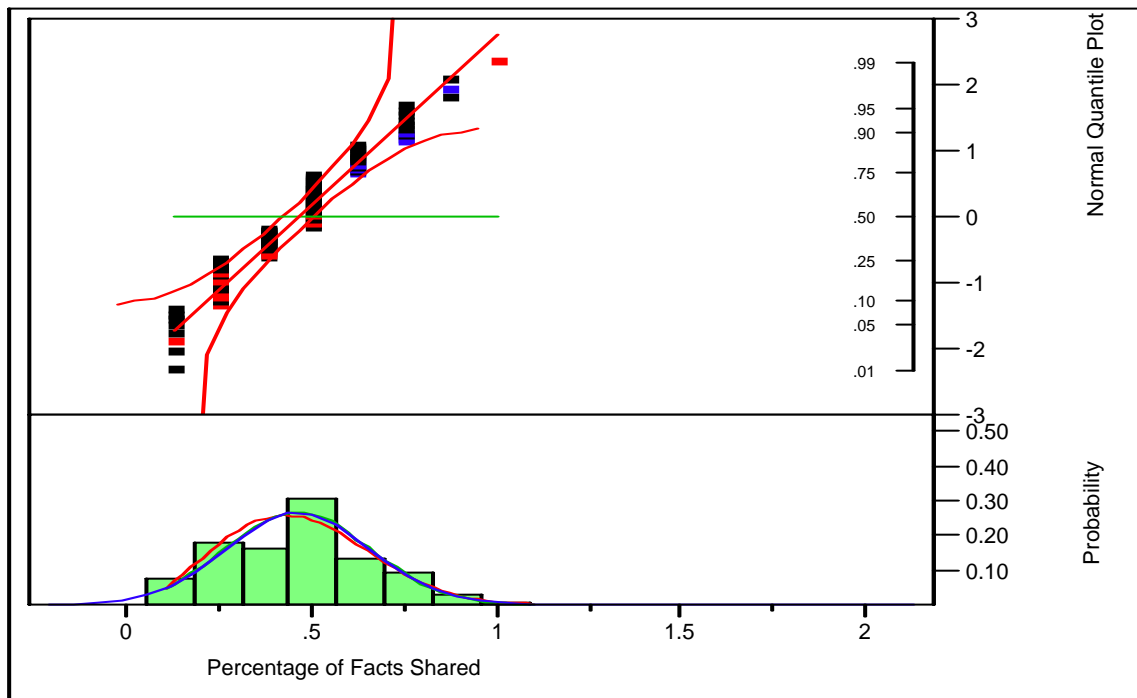


Figure 16. Histogram and Quantile Plots for Individual Performance Data

The analysis for this Part B is complex. We could refine the analysis since we had individual participant data for this evaluation with an  $n$  of 104. We are eliminating

the analysis for team structure, condition, and type, to percentage of facts shared, as it is a replication of the analysis for team composition. The analysis for service is next.

**a. Performance by Service**

In the 4 (Service: Air Force, Army, Navy, Marines) x 1 (Performance: percentage of facts shared), the following hypothesis was examined:

$H_0$  = No difference for performance between the services

$H_1$  = At least one service is significantly different for performance from another service.

The ANOVA concluded that there were no differences between the four services [ $F(1, 103) = 2.44, p < .06$ ]. However, individual students'  $t$  analyses did detect a significant difference between the Marines ( $M = .50, SD = .21$ ) and Army at .05 significance level [ $(M = .38, SD = .18) t(100) = 2.58, p < .01$  (two-tailed),  $d = .12$ ]. The box plot for this analysis in Figure 17 illustrates this difference.

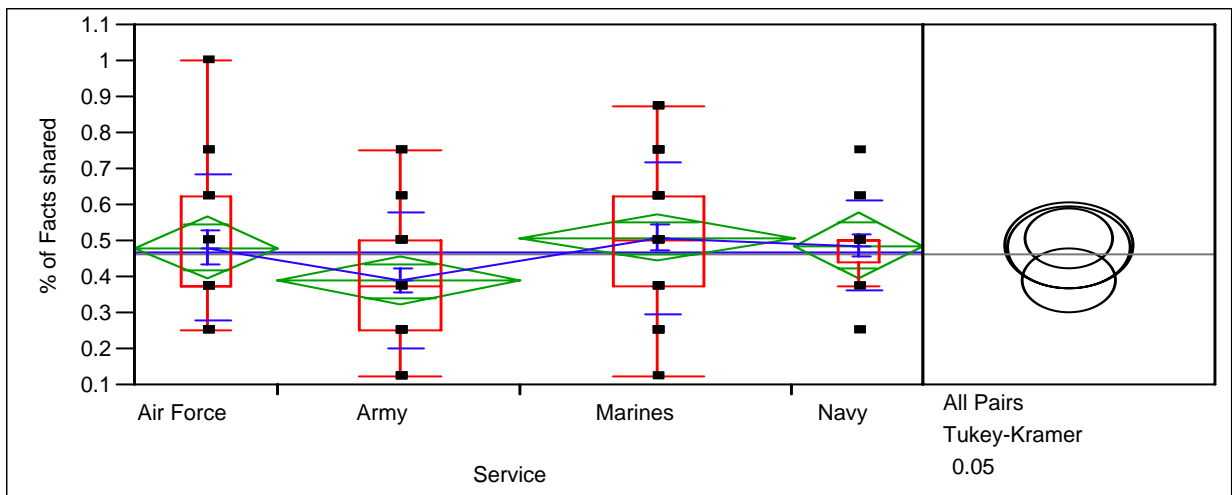


Figure 17. Box plots for Performance by Service.

Army participants shared fewer facts. The box plots illustrate the difference between the Army participants and the other service participants. Further analysis reveals the source of the difference. We now focus our evaluation on whether the difference between the services can be refined by seat position.

**b. Performance by Seat Position to Service**

In a 4 (seat position: seat 1, seat 2, seat 3, seat 4) x 4 (service: Air Force, Army, Marines, Navy) x 1 (Performance: percentage of facts shared) experiment, each

seat position was evaluated to determine whether a service performed differently based on the seat position occupied. The matrix in Figure 18 provides the number of times each service occupied each seat.

| Service by Seat | Participants by Seat Number |        |        |        |
|-----------------|-----------------------------|--------|--------|--------|
|                 | Seat 1                      | Seat 2 | Seat 3 | Seat 4 |
| Air Force       | 5                           | 5      | 4      | 5      |
| Army            | 6                           | 8      | 8      | 10     |
| Marines         | 11                          | 9      | 9      | 7      |
| Navy            | 4                           | 4      | 5      | 4      |

Figure 18. Participants' Seat Position by Service

Recall that seat one was always designated the leader of the team. The hypothesis for this experiment was:

Within Service Comparison

$H_0$  = No difference within a service for performance by seat position

$H_1$  = At least one service will differ significantly in performance by seat position.

A test for homogeneity across variance indicated no significant differences. Table 20 provides the ANOVA results from the data analysis.

Table 20. Shared Facts by Seat Position for each Service

| Seat Position | Source    | DF | Sum of Squares | Mean Square | F Ratio | Prob > F |
|---------------|-----------|----|----------------|-------------|---------|----------|
| All           | Air Force | 3  | 8.976          | 2.992       | 1.1348  | 0.3667   |
| All           | Army      | 3  | 21.410         | 7.1368      | 4.0527  | 0.0164   |
| All           | Marines   | 3  | 30.336         | 10.1121     | 4.6524  | 0.0083   |
| All           | Navy      | 3  | 1.214          | .04049      | .3618   | .7817    |

Note. \*  $p < .05$ .

Significant differences within services were observed for the Army and Marines. Comparing Army participants occupying seat one to Army participants occupying seats two, and three, the occupants of seat one share fewer facts. The finding that the Army participants shared a lower number of facts in the leadership position is worth further investigation. Between the Army participants there is a difference in fact

sharing. The same holds true for the Marines. Marines occupying seat four shared fewer facts when compared with Marines occupying seat one, two or three.

The next analysis compared whether there were differences between the services. In a 4 (service: Air Force, Army, Marines, Navy) x 4 (seat position: seat 1, seat 2, seat 3, seat 4) x 1 (Performance: percentage of facts shared) experiment, the following hypotheses were examined.

Between-Service Comparison

H<sub>0</sub> = No difference between the services for performance based on seat position.

H<sub>1</sub> = At least one service will differ significantly in performance between the other services based on seat position.

Figure 16 also gives the tabulated data for this analysis. Instead of reading across the table, which compares participants within the service, read down, which compares participants across the services. Table 21 summarizes the analysis for this experiment.

Table 21. Shared Facts by Service for each Seat Position

| Seat Position | Source          | DF | Sum of Squares | Mean Square | F Ratio | Prob > F |
|---------------|-----------------|----|----------------|-------------|---------|----------|
| Seat 1        | Service by Seat | 3  | 37.3740        | 12.4580     | 4.2817  | *0.0159  |
| Seat 2        | Service by Seat | 3  | 7.5899         | 2.5299      | 1.6103  | 0.2156   |
| Seat 3        | Service by Seat | 3  | .26623         | .08875      | .0497   | 0.9849   |
| Seat 4        | Service by Seat | 3  | 2.2703         | .7567       | .4741   | 0.7034   |

Note. \* p < .05.

The results indicated significant performance differences for the seat one position. We refined the evaluation for seat one and we determined the evaluation for unequal variance was significant so we present the Welch ANOVA results for this seat position in Table 22.

Table 22. Seat One Evaluation

| Service   | N  | M      | Abs (Dif) - LSD | p-Value |
|-----------|----|--------|-----------------|---------|
| Air Force | 5  | 4.6000 | .328            | *0.0252 |
| Army      | 6  | 1.6666 | -2.48           | 1.000   |
| Marines   | 11 | 4.5450 | .695            | *0.0084 |
| Navy      | 4  | 4.2500 | -0.19           | 0.0719  |

Note. \*  $p < .05$

Again, as with the within-service examination, the Army shared fewer facts when seated in the seat one position than the Marines and Air Force participants seated in that position. Examining the team structure, condition, and type did not reveal any reason for this result. The  $n$  is very low: normality for this specific evaluation is missing, however, non-parametric examination still indicates a significant difference [ $X^2(3, N = 104) = 10.54, p = .01$ ].

Adding to the dilemma, an analysis of the individual fact rating, by service, indicates no significant difference in how the service participants in seat one ranked the facts. The Army participants rated the eight facts equal to or higher than the other services. This can be interpreted as meaning the Army participants felt the facts were important but failed to share them at the same levels the other three services did. The possibility exists that in-service differences may be occurring. In the conclusion chapter, we expound on this possibility as a topic for future work. We continue the analysis examining team type by seat position.

**c. Performance by Seat to Team Type**

The last of the 4 x 4 x 1 designs evaluates the team type by seat. The design for the next two analyses is a 4 (team type: HC, HE, HTC, HTE) x 4 (seat position: seat 1, seat 2, seat 3, seat 4) x 1 (Performance: percentage of facts shared). The services are compared by participants within that service. The tabulated data in Figure 19 provides the matrix for this evaluation.



| Seat Number | Team type           |                          |                       |                            |
|-------------|---------------------|--------------------------|-----------------------|----------------------------|
|             | Homogeneous Control | Homogeneous Experimental | Heterogeneous Control | Heterogeneous Experimental |
| Seat 1      | 6                   | 6                        | 7                     | 7                          |
| Seat 2      | 6                   | 6                        | 7                     | 7                          |
| Seat 3      | 6                   | 6                        | 7                     | 7                          |
| Seat 4      | 6                   | 6                        | 7                     | 7                          |

Figure 19. Participants Seat Position by Team type

Evaluating both the designs resulted in no significant difference within the services for seat position based on team type or between the services. The final analysis compares the services for team type.

*d. Performance by Service to Team Type*

The design for this analysis is a 4 (service: Air Force, Army, Marines, Navy) x 4 (team type: HC, HE, HTC, HTE) x 1 (Performance: percentage of facts shared). The tabulated data in Figure 20 provides the matrix for this evaluation.

| Team Type                        | Participants by Service |      |         |      |
|----------------------------------|-------------------------|------|---------|------|
|                                  | Air Force               | Army | Marines | Navy |
| Homogeneous Control (HC)         | 8                       | 4    | 8       | 4    |
| Homogeneous Experimental (HE)    | 4                       | 8    | 4       | 8    |
| Heterogeneous Control (HTC)      | 3                       | 13   | 9       | 3    |
| Heterogeneous Experimental (HTE) | 4                       | 7    | 15      | 2    |

Figure 20. Participants' Service by Team Type

We first evaluated difference for team type within each service and determined there was a significant difference within each service for performance in the Homogeneous Control teams [ $F(1, 23) = 4.81, p < .01$ ]. Analysis indicated that within the service, the Army's performance for facts sharing was significantly different than the other three services. The box plots contained in Figure 21 illustrate the difference.

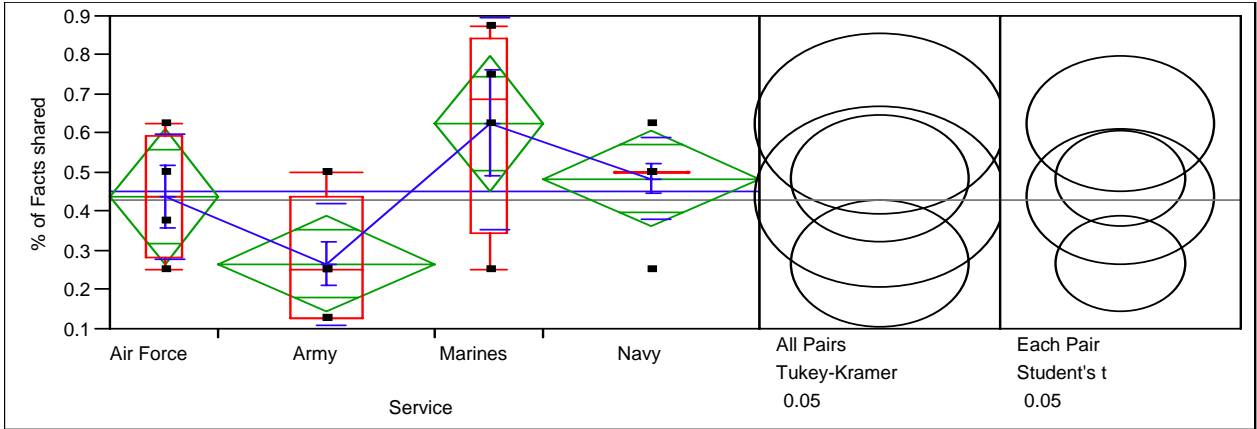


Figure 21. Box plots for Homogeneous Experimental Team Type by Service.

The box plots illustrate the differences between the services in the Homogeneous Experimental condition. This is an unexpected result and will be discussed further in the discussion chapter.

This concludes this portion of the analysis. Further comparison for team types is a repetition of the analysis for the composite team. The results for the participants can be further evaluated by correlation. The following section will provide the results from the correlation analysis.

*e. Correlation Analysis*

We began the correlation analysis by examining the following variables: time in service, extraversion, neuroticism, openness to experience, status differentiation, emotion regulation, and percentage of facts shared by team type. Our decision to add these variables was due to the added robustness. The results of this analysis are reviewed in table 24. The data indicated in red had a significant probability < .05.

Table 23. Correlations for Cultural and Personality Variables by Team Type

| HC (n = 24)       |      |               |               |              |       |        |                   |
|-------------------|------|---------------|---------------|--------------|-------|--------|-------------------|
|                   | TIS  | Extra T Score | Neuro T Score | Open T Score | SD    | ER     | % of Facts shared |
| TIS               | 1.00 | -0.36         | 0.25          | 0.26         | 0.10  | 0.08   | -0.36             |
| Extra T Score     |      | 1.00          | *-0.66        | -0.16        | 0.02  | *0.42  | 0.01              |
| Neuro T Score     |      |               | 1.00          | 0.07         | 0.10  | *-0.46 | -0.04             |
| Open T Score      |      |               |               | 1.00         | 0.29  | 0.16   | -0.09             |
| SD                |      |               |               |              | 1.00  | 0.02   | -0.15             |
| ER                |      |               |               |              |       | 1.00   | 0.19              |
| % of Facts shared |      |               |               |              |       |        | 1.00              |
| HE (n = 24)       |      |               |               |              |       |        |                   |
| TIS               | 1.00 | 0.19          | 0.05          | 0.30         | 0.29  | -0.04  | 0.37              |
| Extra T Score     |      | 1.00          | -0.40         | 0.06         | 0.29  | -0.04  | 0.05              |
| Neuro T Score     |      |               | 1.00          | 0.01         | -0.22 | 0.19   | -0.05             |
| Open T Score      |      |               |               | 1.00         | -0.02 | -0.32  | 0.02              |
| SD                |      |               |               |              | 1.00  | -0.11  | 0.21              |
| ER                |      |               |               |              |       | 1.00   | 0.11              |
| % of Facts shared |      |               |               |              |       |        | 1.00              |
| HTC (n = 28)      |      |               |               |              |       |        |                   |
| TIS               | 1.00 | 0.18          | -0.17         | -0.01        | -0.21 | 0.12   | -0.18             |
| Extra T Score     |      | 1.00          | *-0.54        | -0.15        | -0.02 | 0.23   | *-0.40            |
| Neuro T Score     |      |               | 1.00          | *0.44        | 0.11  | -0.33  | 0.07              |
| Open T Score      |      |               |               | 1.00         | *0.43 | *-0.55 | 0.23              |
| SD                |      |               |               |              | 1.00  | *-0.45 | 0.06              |
| ER                |      |               |               |              |       | 1.00   | -0.04             |
| % of Facts shared |      |               |               |              |       |        | 1.00              |
| HTE (n = 28)      |      |               |               |              |       |        |                   |
| TIS               | 1.00 | 0.13          | 0.17          | 0.17         | 0.29  | 0.15   | *0.39             |
| Extra T Score     |      | 1.00          | -0.36         | -0.13        | -0.16 | 0.03   | *0.41             |
| Neuro T Score     |      |               | 1.00          | 0.08         | 0.15  | -0.17  | 0.00              |
| Open T Score      |      |               |               | 1.00         | *0.42 | -0.35  | -0.27             |
| SD                |      |               |               |              | 1.00  | *-0.38 | -0.05             |
| ER                |      |               |               |              |       | 1.00   | 0.07              |
| % of Facts shared |      |               |               |              |       |        | 1.00              |

As hypothesized, the homogeneous teams had few relationships to the cultural and personality factors. However, in the heterogeneous condition, there are several interesting results worth noting now.

An Analysis of Variance (ANOVA) for the heterogeneous team types revealed main effects for extraversion between the heterogeneous control teams [  $F(1,$

26) = 4.93,  $p = .03$ ] with a correlation of ( $r = -.39$ ,  $p < .03$ ) and the heterogeneous experimental teams [ $F(1, 26) = 5.17$ ,  $p = .03$ ] with a correlation of ( $r = .41$ ,  $p = .03$ ). This is an interesting result. Notice that in the control condition, extraversion has a negative correlation to percentage of facts shared, yet in the experimental condition, the opposite is observed. Without the cue for culture and personality, extraversion has a negative relationship with information sharing, but with the cue, a positive relationship with information sharing is observed. Further discussion is contained in the next chapter. The analysis continues with the linguistic evaluation.

*f. Linguistic Analysis – LIWC*

The communications between the participants was analyzed exactly like the team transcription. The same problems described in that section hold true for this analysis. Low inter-rater reliability was determined to be caused by the same problems as the team transcription with one additional factor: the rater not present at the team exercises had greater difficulty determining who was speaking on the tape than the rater present during the wargame. The decision was made to only use the rater's transcription for the individual analysis without determining the reliability across several raters. This is discussed in detail in the next chapter. The analysis for the individual transcriptions is similar to the team transcriptions.

In a 4 (team type: HC, HE, HTC, HTE) x 1(LIWC), the following hypothesis was evaluated.

- $H_0$  = No difference for language usage between team types.
- $H_1$  = The LIWC will be sensitive to differences between team types for word count, pronoun usage, and social variables.

The LIWC data is evaluated in two ways. First we inspect the data by team type, and then by service. Table 25 provides the team type correlations results.

Table 24. LIWC Correlation Results by Team Type

| HC (n = 24)         |               |               |              |       |       |                   |
|---------------------|---------------|---------------|--------------|-------|-------|-------------------|
|                     | Extra T Score | Neuro T Score | Open T Score | SD    | ER    | % of Facts shared |
| Extra T Score       | 1.00          |               |              |       |       |                   |
| Neuro T Score       | -0.66         | 1.00          |              |       |       |                   |
| Open T Score        | -0.16         | 0.07          | 1.00         |       |       |                   |
| SD                  | 0.02          | 0.10          | 0.29         | 1.00  |       |                   |
| ER                  | 0.42          | -0.46         | 0.16         | 0.02  | 1.00  |                   |
| % of Facts shared   | 0.01          | -0.04         | -0.09        | -0.15 | 0.19  | 1.00              |
| Word Count          | -0.18         | 0.07          | -0.16        | 0.06  | 0.14  | 0.68              |
| Pronoun             | -0.60         | 0.52          | 0.08         | 0.20  | -0.40 | -0.25             |
| I                   | -0.33         | 0.03          | 0.23         | -0.04 | -0.08 | -0.11             |
| We                  | -0.43         | 0.55          | 0.15         | 0.26  | -0.25 | -0.15             |
| Self                | -0.59         | 0.47          | 0.29         | 0.18  | -0.26 | -0.20             |
| You                 | 0.00          | 0.11          | -0.26        | 0.21  | -0.01 | -0.43             |
| Negative Emotion    | 0.09          | -0.19         | -0.47        | -0.05 | -0.10 | 0.22              |
| Anxiety             | 0.43          | -0.28         | -0.51        | -0.02 | 0.21  | 0.40              |
| Past                | -0.22         | 0.24          | -0.58        | -0.35 | -0.12 | -0.03             |
| Future              | -0.55         | 0.47          | -0.17        | -0.22 | -0.20 | 0.16              |
| HE (n = 24)         |               |               |              |       |       |                   |
|                     | Extra T Score | Neuro T Score | Open T Score | SD    | ER    | % of Facts shared |
| Extra T Score       | 1.00          |               |              |       |       |                   |
| Neuro T Score       | -0.40         | 1.00          |              |       |       |                   |
| Open T Score        | 0.06          | 0.01          | 1.00         |       |       |                   |
| SD                  | 0.29          | -0.22         | -0.02        | 1.00  |       |                   |
| ER                  | -0.04         | 0.19          | -0.32        | -0.11 | 1.00  |                   |
| % of Facts shared   | 0.05          | -0.05         | 0.02         | 0.21  | 0.11  | 1.00              |
| You                 | -0.13         | 0.12          | 0.03         | -0.42 | 0.38  | -0.36             |
| Affect              | -0.41         | -0.16         | 0.16         | -0.10 | -0.18 | 0.40              |
| Positive Emotion    | -0.31         | -0.16         | 0.15         | 0.02  | -0.13 | 0.44              |
| Other references to | 0.13          | 0.21          | 0.10         | -0.18 | 0.17  | -0.42             |
| HTC (n = 28)        |               |               |              |       |       |                   |
|                     | Extra T Score | Neuro T Score | Open T Score | SD    | ER    | % of Facts shared |
| Extra T Score       | 1.00          |               |              |       |       |                   |
| Neuro T Score       | -0.54         | 1.00          |              |       |       |                   |
| Open T Score        | -0.15         | 0.44          | 1.00         |       |       |                   |
| SD                  | -0.02         | 0.11          | 0.43         | 1.00  |       |                   |
| ER                  | 0.23          | -0.33         | -0.55        | -0.45 | 1.00  |                   |
| % of Facts shared   | -0.40         | 0.07          | 0.23         | 0.06  | -0.04 | 1.00              |

|                                   |                      |                      |                     |             |             |                          |
|-----------------------------------|----------------------|----------------------|---------------------|-------------|-------------|--------------------------|
| <b>Word Count</b>                 | <b>-0.39</b>         | <b>0.38</b>          | 0.18                | -0.19       | 0.07        | 0.22                     |
| <b>I</b>                          | 0.22                 | -0.19                | <b>-0.45</b>        | -0.16       | 0.19        | -0.27                    |
| <b>Other</b>                      | 0.12                 | 0.06                 | -0.11               | 0.23        | -0.23       | <b>-0.41</b>             |
| <b>Affect</b>                     | -0.06                | 0.14                 | 0.35                | -0.12       | 0.12        | <b>0.58</b>              |
| <b>Positive Emotion</b>           | -0.11                | 0.17                 | 0.31                | -0.04       | 0.02        | <b>0.59</b>              |
| <b>Optimism</b>                   | -0.19                | 0.26                 | 0.16                | -0.02       | 0.07        | <b>0.47</b>              |
| <b>Communication</b>              | <b>-0.54</b>         | 0.00                 | -0.22               | -0.14       | 0.14        | 0.14                     |
| <b>Present</b>                    | <b>0.39</b>          | -0.19                | -0.22               | -0.02       | -0.01       | <b>-0.53</b>             |
| HTE (n = 28)                      |                      |                      |                     |             |             |                          |
|                                   | <b>Extra T Score</b> | <b>Neuro T Score</b> | <b>Open T Score</b> | <b>SD</b>   | <b>ER</b>   | <b>% of Facts shared</b> |
| <b>Extra T Score</b>              | 1.00                 |                      |                     |             |             |                          |
| <b>Neuro T Score</b>              | -0.36                | 1.00                 |                     |             |             |                          |
| <b>Open T Score</b>               | -0.13                | 0.08                 | 1.00                |             |             |                          |
| <b>SD</b>                         | -0.16                | 0.15                 | 0.42                | 1.00        |             |                          |
| <b>ER</b>                         | 0.03                 | -0.17                | -0.35               | -0.38       | 1.00        |                          |
| <b>% of Facts shared</b>          | <b>0.41</b>          | 0.00                 | -0.27               | -0.05       | 0.07        | 1.00                     |
| <b>Word Count</b>                 | 0.15                 | -0.05                | -0.27               | 0.13        | -0.05       | <b>0.54</b>              |
| <b>I</b>                          | <b>-0.42</b>         | 0.03                 | <b>0.43</b>         | 0.06        | -0.15       | -0.28                    |
| <b>Other</b>                      | -0.18                | 0.18                 | 0.13                | 0.29        | -0.13       | <b>-0.38</b>             |
| <b>Negate</b>                     | <b>-0.47</b>         | <b>0.40</b>          | <b>0.38</b>         | 0.36        | -0.18       | -0.27                    |
| <b>Positive Emotion</b>           | 0.25                 | 0.07                 | <b>-0.48</b>        | -0.34       | 0.31        | <b>0.40</b>              |
| <b>Anxiety</b>                    | -0.22                | -0.10                | 0.02                | 0.04        | 0.17        | <b>-0.39</b>             |
| <b>Social</b>                     | -0.18                | <b>0.42</b>          | -0.12               | 0.21        | -0.28       | -0.06                    |
| <b>Other references to people</b> | -0.15                | <b>0.40</b>          | -0.25               | 0.26        | -0.12       | -0.09                    |
| <b>Past</b>                       | -0.30                | 0.09                 | 0.17                | <b>0.48</b> | -0.24       | -0.25                    |
| <b>Present</b>                    | -0.27                | <b>0.61</b>          | 0.09                | 0.00        | -0.21       | -0.21                    |
| <b>Inclusive</b>                  | 0.25                 | -0.16                | -0.14               | -0.20       | <b>0.57</b> | -0.21                    |
| <b>Exclusive</b>                  | <b>-0.40</b>         | -0.08                | 0.16                | -0.01       | 0.28        | -0.29                    |

Note.  $p < .05$

The results of this analysis are discussed in the next chapter. The last LIWC analysis is by service. The results are presented in Table 26.

In a 4 (service: Air Force, Army, Marines, Navy) x 1 (LIWC), the following hypothesis was evaluated.

$H_0$  = No difference for language usage between the services

$H_1$  = The LIWC will be sensitive to differences between the services for word count, pronoun usage, and social variables.

Table 25. LIWC Correlation Results by Service

| Air Force (n = 19)         |               |               |              |       |       |                   |
|----------------------------|---------------|---------------|--------------|-------|-------|-------------------|
|                            | Extra T Score | Neuro T Score | Open T Score | SD    | ER    | % of Facts shared |
| Extra T Score              | 1.00          |               |              |       |       |                   |
| Neuro T Score              | -0.14         | 1.00          |              |       |       |                   |
| Open T Score               | -0.36         | -0.16         | 1.00         |       |       |                   |
| SD                         | 0.17          | 0.09          | 0.19         | 1.00  |       |                   |
| ER                         | -0.03         | -0.14         | 0.23         | 0.27  | 1.00  |                   |
| % of Facts shared          | -0.10         | 0.04          | 0.27         | 0.00  | 0.11  | 1.00              |
| Word Count                 | -0.08         | -0.14         | 0.33         | 0.11  | 0.04  | 0.72              |
| Pronoun                    | 0.17          | 0.17          | -0.23        | 0.60  | -0.08 | -0.17             |
| Other                      | 0.08          | 0.48          | -0.11        | 0.36  | 0.24  | -0.15             |
| Positive Feeling           | 0.24          | -0.48         | 0.04         | -0.05 | 0.16  | 0.38              |
| Cognitive Processes        | 0.18          | 0.25          | -0.50        | -0.22 | -0.17 | -0.20             |
| Social                     | 0.26          | 0.38          | -0.11        | 0.54  | -0.17 | -0.11             |
| Other references to people | 0.30          | 0.35          | -0.13        | 0.49  | -0.13 | 0.02              |
| Past                       | 0.21          | 0.00          | -0.76        | -0.26 | -0.15 | -0.20             |
| Army (n = 32)              |               |               |              |       |       |                   |
|                            | Extra T Score | Neuro T Score | Open T Score | SD    | ER    | % of Facts shared |
| Extra T Score              | 1.00          |               |              |       |       |                   |
| Neuro T Score              | -0.26         | 1.00          |              |       |       |                   |
| Open T Score               | -0.12         | 0.53          | 1.00         |       |       |                   |
| SD                         | -0.44         | 0.35          | 0.30         | 1.00  |       |                   |
| ER                         | 0.06          | -0.43         | -0.43        | -0.59 | 1.00  |                   |
| % of Facts shared          | -0.15         | -0.08         | -0.25        | 0.00  | 0.33  | 1.00              |
| Negate                     | 0.41          | -0.13         | -0.25        | -0.01 | -0.01 | 0.00              |
| Affect                     | 0.06          | -0.28         | -0.13        | -0.16 | 0.36  | 0.31              |
| Positive Emotion           | 0.13          | -0.20         | -0.19        | -0.25 | 0.38  | 0.19              |
| Anxiety                    | 0.01          | -0.28         | -0.17        | -0.01 | 0.35  | -0.04             |
| Communication              | -0.45         | 0.17          | 0.17         | 0.19  | -0.06 | 0.01              |
| Past                       | -0.42         | -0.18         | -0.17        | 0.09  | 0.04  | -0.15             |
| Present                    | 0.49          | -0.27         | -0.21        | -0.15 | -0.15 | -0.43             |
| Inclusive                  | -0.06         | 0.22          | 0.02         | -0.04 | 0.36  | 0.06              |
| Exclusive                  | 0.38          | -0.39         | -0.06        | -0.24 | -0.01 | -0.25             |
| Marine (n = 36)            |               |               |              |       |       |                   |
|                            | Extra T Score | Neuro T Score | Open T Score | SD    | ER    | % of Facts shared |

|                                   |                      |                      |                     |              |             |                          |
|-----------------------------------|----------------------|----------------------|---------------------|--------------|-------------|--------------------------|
| <b>Extra T Score</b>              | 1.00                 |                      |                     |              |             |                          |
| <b>Neuro T Score</b>              | <b>-0.37</b>         | 1.00                 |                     |              |             |                          |
| <b>Open T Score</b>               | 0.01                 | 0.13                 | 1.00                |              |             |                          |
| <b>SD</b>                         | -0.09                | 0.21                 | <b>0.37</b>         | 1.00         |             |                          |
| <b>ER</b>                         | 0.03                 | -0.09                | -0.22               | -0.21        | 1.00        |                          |
| <b>% of Facts shared</b>          | 0.19                 | 0.15                 | -0.25               | 0.04         | 0.01        | 1.00                     |
| <b>Word Count</b>                 | 0.12                 | 0.00                 | -0.33               | 0.10         | 0.07        | <b>0.51</b>              |
| <b>Negate</b>                     | <b>-0.34</b>         | 0.11                 | 0.10                | <b>0.37</b>  | -0.12       | -0.18                    |
| <b>Assent</b>                     | -0.10                | 0.26                 | -0.11               | 0.05         | <b>0.39</b> | 0.02                     |
| <b>Affect</b>                     | 0.11                 | 0.16                 | 0.14                | -0.03        | 0.18        | <b>0.43</b>              |
| <b>Positive Emotion</b>           | 0.07                 | 0.30                 | 0.08                | 0.02         | 0.17        | <b>0.44</b>              |
| <b>Optimism</b>                   | 0.07                 | 0.17                 | 0.00                | 0.27         | -0.09       | <b>0.43</b>              |
| <b>Negative Emotion</b>           | 0.09                 | <b>-0.34</b>         | 0.19                | -0.11        | 0.06        | -0.03                    |
| <b>Present</b>                    | -0.28                | <b>0.37</b>          | 0.04                | 0.25         | -0.07       | <b>-0.35</b>             |
| <b>Exclusive</b>                  | <b>-0.37</b>         | -0.03                | 0.10                | 0.07         | 0.14        | -0.08                    |
| <b>Navy (n = 17)</b>              |                      |                      |                     |              |             |                          |
|                                   | <b>Extra T Score</b> | <b>Neuro T Score</b> | <b>Open T Score</b> | <b>SD</b>    | <b>ER</b>   | <b>% of Facts shared</b> |
| <b>Extra T Score</b>              | 1.00                 |                      |                     |              |             |                          |
| <b>Neuro T Score</b>              | <b>-0.84</b>         | 1.00                 |                     |              |             |                          |
| <b>Open T Score</b>               | 0.15                 | 0.05                 | 1.00                |              |             |                          |
| <b>SD</b>                         | 0.25                 | -0.46                | 0.19                | 1.00         |             |                          |
| <b>ER</b>                         | 0.24                 | 0.07                 | -0.10               | -0.42        | 1.00        |                          |
| <b>% of Facts shared</b>          | -0.08                | -0.10                | 0.12                | 0.13         | -0.36       | 1.00                     |
| <b>Word Count</b>                 | -0.44                | <b>0.62</b>          | -0.15               | -0.40        | 0.30        | 0.06                     |
| <b>We</b>                         | -0.36                | <b>0.58</b>          | 0.03                | <b>-0.52</b> | 0.03        | -0.02                    |
| <b>Self</b>                       | -0.13                | 0.41                 | 0.22                | -0.35        | 0.15        | -0.17                    |
| <b>You</b>                        | -0.04                | 0.32                 | 0.03                | <b>-0.61</b> | <b>0.69</b> | -0.30                    |
| <b>Affect</b>                     | <b>-0.50</b>         | 0.39                 | 0.00                | -0.34        | -0.08       | 0.40                     |
| <b>Optimism</b>                   | <b>-0.57</b>         | 0.74                 | 0.11                | <b>-0.56</b> | 0.29        | -0.02                    |
| <b>Cognitive Processes</b>        | -0.32                | <b>0.50</b>          | 0.01                | <b>-0.49</b> | 0.33        | -0.32                    |
| <b>Other references to people</b> | -0.28                | <b>0.59</b>          | 0.11                | <b>-0.49</b> | 0.23        | -0.24                    |

Note.  $p < .05$

This concludes the team analysis. The correlation analysis for language demonstrates that the services do have different linguistic patterns for culture and personality.

Support for the hypothesis for the wargame is observed throughout the analysis. The analysis from Study One revealed the cultural and personality differences between the services. The conclusions from Study Two are that these differences do interfere with the sharing of information in a joint heterogeneous team that is not present



in service homogeneous teams. Our next study combines the human behavior results with computer modeling. The results from Study Three follow.

### **C. STUDY THREE**

Study Three incorporated the data from the first two studies in a behavioral model that replicated the wargame. The data from Study One was used to program the NetLogo agents with cultural and personality characteristics. The data from Study Two was used to program the facts list, the weighting assigned to the facts list, and the shared facts list. Four models were developed which represented each of the four team types.

Simulations of the models were executed three times. The first simulation run consisted of thirty-five trials per model (referred to as Run One). The models in the homogeneous structure required four iterations each totaling 280 runs (4: possible teams combinations) x ( 2: condition) x (35: number of trials per team combination). In the heterogeneous structure, thirty-one iterations were required, representing the total combination of teams. Each combination was executed in simulation by team type resulting in 2170 total trials (31: possible team combinations) x ( 2: condition) x (35 : number of trials per team combination). These initial runs indicated that a time step problem existed that was easily corrected by insuring all models were coded with identical stop conditions representing a twenty-minute wargame session.

The next simulation run consisted of 100 trials per team per model (referred to as Run Two). In the homogeneous condition, this resulted in 800 trials and in the heterogeneous condition, 6200 trials. The data output was consolidated in an Excel file where the results for facts sharing were summed and averaged exactly like the composite team data in Study Two. We examined consistency of output from Run Two by executing another simulation run of 100 trials per team (referred to as Run Three). A comparison between the model Runs Two and Three revealed no statistical differences in outputs for either of the simulations. The summary statistics for simulation Runs Two and Three are provided in Table 26.

Table 26. Summary Statistics for NetLogo Model Simulations

| Team Type<br>Run two   | Number of<br>Possible<br>teams | Mean    | Std Error | Lower 95% | Upper 95% |
|------------------------|--------------------------------|---------|-----------|-----------|-----------|
| HC                     | 4                              | 14.2550 | 0.63392   | 12.989    | 15.521    |
| HE                     | 4                              | 14.0875 | 0.63392   | 12.822    | 15.353    |
| HTC                    | 31                             | 12.8258 | 0.22771   | 12.371    | 13.280    |
| THE                    | 31                             | 15.5220 | 0.22771   | 15.067    | 15.977    |
| Team Type<br>Run three | Number of<br>Possible<br>teams | Mean    | Std Error | Lower 95% | Upper 95% |
| HC                     | 4                              | 14.4975 | 0.65802   | 13.184    | 15.811    |
| HE                     | 4                              | 13.9550 | 0.65802   | 12.641    | 15.269    |
| HTC                    | 31                             | 12.8890 | 0.23637   | 12.417    | 13.361    |
| THE                    | 31                             | 15.4965 | 0.23637   | 15.025    | 15.968    |

Comparing the means from the two simulations indicated no significant differences between Run Two ( $M = .44$ ,  $SD = .08$ ) and Run Three at .05 significance level [ $(M = .45$ ,  $SD = .08)$   $t(69) = .22$ ,  $p = .82$  (two-tailed),  $d = .01$ ]. Concluding that there were no differences, we decided that Run Two would be the data utilized for comparison to the wargame. The results of that analysis follow.

### 1. NetLogo Comparison to Wargame

The first analysis was to determine whether the results from the simulation were statistically different from the wargame results. The hypothesis for this analysis was:

$H_0$  = Significant differences for performance between the wargame and the NetLogo simulation

$H_1$  = No performance differences between the wargame and the replicated wargame using NetLogo.

The results from the analysis indicated no significant difference between the wargame and the simulation across all team types [ $F(1, 95) = 1.68$ ,  $p = .19$ ]. It should be noted that a test for unequal variance indicated a significant difference, but the Welch ANOVA and corresponding 2 sample t- test and Wilcoxon/Kruskal-Wallis Rank Sums Test did not reveal significance for any condition. Figure 22 provides the box plots of the comparison.

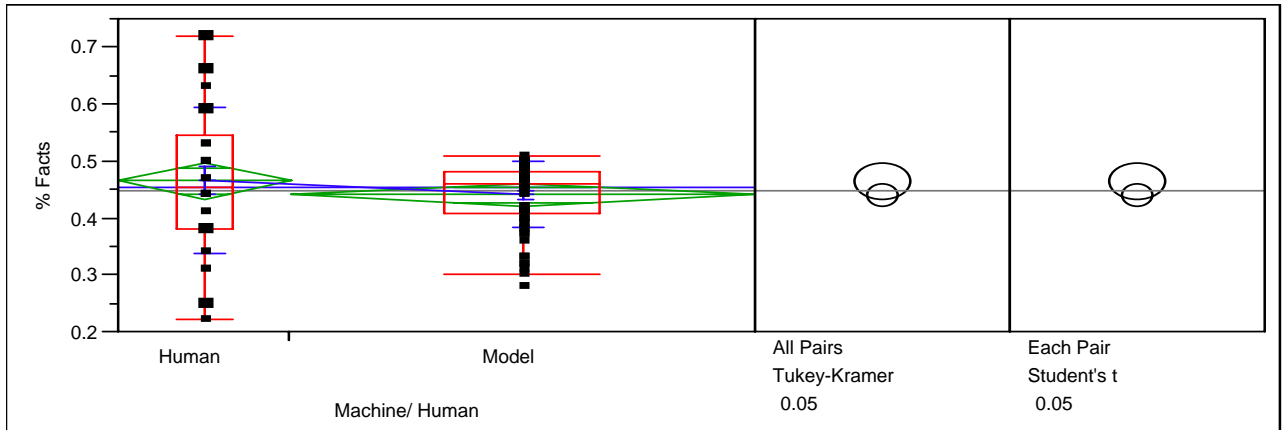


Figure 22. Box plots comparing Human to NetLogo Performance results.

The next analysis compared homogeneous and heterogeneous teams by human and model. The results have been reported previously for the team condition by human data collection method as not significant. The results for the model data collection method were not significant [ $F(1, 68) = 1.27, p = .26$ ]. Further, the test for unequal variance was not significant. We conclude that the data collection method and results between the human wargame and the NetLogo model are similar.

The next analysis compared the control condition to the experimental condition. The results previously reported indicated no significance for condition; however, recall we noted that a trend was evident in the wargame data. The results from the model data collection method did indicate significant difference [ $F(1, 68) = 38.35, p < .01$ ]. We anticipated these results. Recall we hypothesized that teams in the heterogeneous experimental condition would perform similarly to the homogeneous control teams. Finding significance at this stage of the analysis does not provide enough information to make a decision about that hypothesis. The next analysis focuses on team type.

The first analysis for team type compares the model output to the human experiment. The results indicated a significant difference in the human data collection for the HTE team type ( $M = .53, SD = .11$ ) when compared to the model data collection for HTE team type at the .05 significance level [ $(M = .48, SD = .01) t(36) = -2.27, p = .03$  (two-tailed),  $d = .04$ ]. Significance was not indicated in the one tail lower confidence level but was very significant at the upper confidence level, which we believe is the

factor that resulted in the significant difference between the data collection methods. Still, we conclude that the model supports further analysis as we anticipated some level of significance in heterogeneous teams. The next analysis combines the model and human data to explore our hypothesis.

Recall the hypotheses for team type in Study Two were:

- $H_0$  = No difference for performance between team types
- $H_1$  = Teams in the Homogeneous control condition will outperform the teams in the Heterogeneous control condition.
- $H_2$  = No differences between the homogeneous control and the heterogeneous experimental teams.

The results indicated significance for team type [ $F(1, 95) = 10.64, p < .001$ ].

Figure 23 illustrates the results.

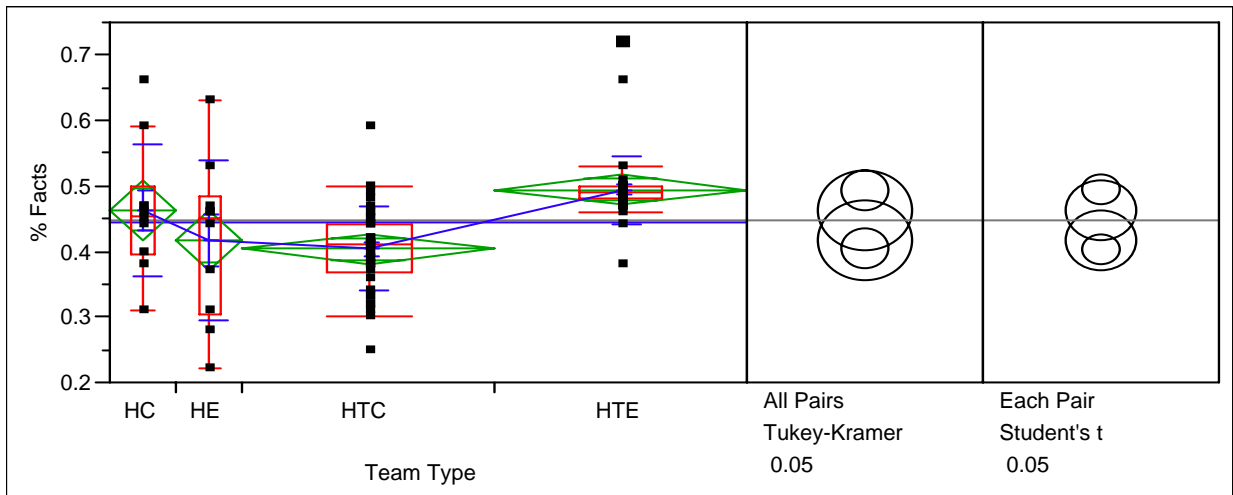


Figure 23. Box plots of Combining Human and NetLogo Performance by Team Type.

The significant differences occurred as hypothesized. The analysis indicated that the homogeneous control team ( $M = .44, SD = .03$ ) did outperform the heterogeneous control team at the .05 significance level [ $(M = .40, SD = .05) t(66) = -2.03, p = .04$  (two-tailed),  $d = .02$ ]. Further, no significant differences were observed between the HC and the HTE teams. This supports the second hypothesis.

These results strongly support our two research objectives for this study. First, we show the power of the developed model using empirical data from human

experimentation to replicate the wargame. Second, we demonstrate that teams given only small cueing, to the cultural and personality business solutions to information sharing in heterogeneous teams, do display improved information sharing. The next chapter discusses the results from all three studies in detail.

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## V. DISCUSSION

The research questions we proposed combined the domains of business science, cognitive science, simulation science, computer science, psychological science, and military science. This chapter will review the empirical findings and elaborate on the significance and applicability of the most important. The discussion begins with a review of the findings from our research.

### A. SIGNIFICANT RESULTS

Our research focused on five primary questions.

1. Can profiles of the military services indicate differences using the macro-cognitive factors of cultural orientation and personality as quantitative measures?
2. Do the service differences in cultural orientation and personality significantly impact team effectiveness during Effects Based Operations?
3. Can the business model for improving team effectiveness be applied to the military to improve information sharing and thereby affect joint team effectiveness?
4. Can computer simulations using agent-based models replicate human behavior experimentation results?
5. Can the reliability and validity standards of the social and behavioral sciences be incorporated into the simulation science Verification, Validation and Accreditation (VV&A) standards resulting in a model for Human Behavior Representation (HBR).

We examined these questions in three specific studies. For simplicity we will review each one separately prior to a discussion of the combined findings.

#### 1. Study One

We developed cultural and personality profiles for each service and examined the differences between the services. The dimensions we investigated were emotion regulation and status differentiation.

The services were very similar for status differentiation. This assessment is understandable considering the overall military culture for rank and discipline. The four

services do have a common respect for the rank structure. However, we believe there is cause to elaborate on this point.

It was interesting to note that during the interviews conducted as part of our research, the discussion of rank was common. It became apparent that the rank structures of each service are not well understood at the operational and tactical level of the other services. Each service understands the pay scale terms of 'E' grade and 'O' grade but they do not speak to one another by that terminology. Each service addresses members of their service by rank and during most interviews it was evident the other services' rank terminology was not common knowledge across all the services.

Student and cadre Marines at The Basic School (TBS) in Quantico, Virginia believed that more training on inter-service ranks, structures, and traditions was needed to improve joint effectiveness. In responses to the survey question concerning methods to improve joint team effectiveness, many responders indicated the same. An example of their responses was:

A basic understanding of each service's structure is needed. We address each other in a service according to tradition. How can another service know what our traditions are and how important they are with no training. Picking it up during the rare combined training or on the battle field is not a good way to get it done. When someone from another service fails to properly address a member of my service, I know my traditions are unimportant to him. (Marine, 0-3)

Failure to properly address members of another service can be translated as a lack of respect. During an interview with a Marine staff sergeant, the interviewer was stopped after addressing the staff sergeant as "Sergeant." The staff sergeant said he was tired of the Army disrespecting him by addressing him by a rank he was not. He informed the interviewer that in the Marine Corps, a staff sergeant was addressed that way. The Marine acknowledged his understanding of Army terminology, but not addressing members of the Marine Corps properly was viewed as disrespectful. Now this can be seen as trivial, but consider the consequences in a joint team environment composed of all services. Improperly addressing a member from another service could lead to unintentional consequences that could negatively impact team performance. Despite the



lack of significance observed for status differentiation, we conclude that this is an important factor in team effectiveness.

Emotion regulation was the cultural dimension where we did find significant differences between the services. The Army, Marines, and Navy reported higher scores for this factor than did the Air Force. It is not the purpose of this research to make conclusions concerning the differences for emotion regulation between the services so that it can be corrected. Rather, like the business community, acknowledging that cultural orientations are different provides the opportunity to limit any negative effect on the team processes, especially information sharing.

Research by Matsumoto (2005) indicates that communications can be affected when members of a team have differing scores for emotion regulation. In fact, his work has determined that successful adjustment within a culturally diverse environment is related to higher scores for ER. Our research demonstrated that simple cueing to differences had a significant impact on improving heterogeneous team performance.

We extended our examination to include the dimensions not included in the initial evaluation to determine whether either were significant across the service comparisons. In conjunction with SD and ER, our research did collect data on individualism/collectivism (IC) and for mastery/harmony (MH). Recall our analysis did not evaluate these dimensions of cultural orientation.

Analysis of these two factors did reveal that significant differences do exist between the services for both. In both cases, the Air Force was again identified as rating themselves differently than the other three services. The results for IC were [ $F(1, 338) = 12.49, p = .001$ ] and for MH were [ $F(1, 338) = 2.69, p = .04$ ]. (Box plots and graphs are presented in appendix B.) Additionally, IC results revealed that the Army and Marines were significantly different. On reflection, including the IC factor in our research analysis would have been wise.

We can conclude from the analysis for cultural orientation that the services have cultural differences and that these differences can be measured using instruments available from the business community. Differences do not translate to right, wrong, good, or bad. Based on the literature reviewed, the fact that differences exist indicates

their presence can influence effective team processes. Additional research evaluating these techniques and their influence on improving joint team effectiveness should be a priority. Next, we examined differences between the services' personalities.

Our research examined three of the five personality factors scored by the NEO FFI: extraversion, neuroticism and openness to experience. We did this in two ways. First, we analyzed scores from the NEO FFI for differences between the services' self-ratings, and second, we examined the potential stereotypical perceptions using scores from the services' perceived rating of another service using the NEO FFI. The analysis of the data supports our hypothesis that differences exist between the services for each of the personality domains as well as stereotype perceptions.

The Marines rated themselves higher in extraversion than the other services. McCrae (1989a) states that high extraversion scores indicate a strength in assertiveness and interest in innovation. The strongest effects for extraversion are seen between all the services and the Air Force. The Air Force mean for extraversion is 45.11, an equivalent T-score of average, while the Army and Navy rated at the highest end of the average category. The Marines are the only service to score high in extraversion and rank farthest from the Air Force in comparison.

The results also indicate a significant difference for neuroticism between at least two of the services. Neuroticism is considered the most pervasive domain of the personality scales. McCrae (1989a) describes neuroticism as a key component in successful adaptation to a new environment. Reviewing the analysis indicated significance when we compared the Marines with all other services and the Navy paired with the Air Force. Again, differences are not meant to infer good or bad characteristics. The difference points to potential interference to communication and team process, not that one service is superior to another. There were two domains for personality our study did not evaluate: agreeableness and conscientiousness.

Analysis of these two factors did reveal significant differences do exist between the services for both. The results for agreeableness were [ $F(1, 338) = 9.34, p < .0001$ ] and for conscientiousness were [ $F(1, 338) = 48.81, p < .0001$ ]. (Box plots and graphs are presented in appendix B.) Agreeableness was most significant comparing the Navy to the

other three services. Paired t-tests were significant for all three services. The Marines were significantly different when compared to the other services for conscientiousness. Paired t-tests indicted significance for all pairing with the Marines. Again, a critical flaw in our research is not having included the domains in the final analysis of the teams. Our efforts to select what were felt would be the critical factors, as determined by the Hofstede and McCrae (2005) summaries, was inappropriate. The final evaluation of the data for Study One examines a comparison of the way in which each service perceives another service.

The services do not perceive the other services in the same manner that they perceive themselves. The Air Force differed more in perception than any of the other services. McCrae (2005) claims that these differences in perception, as scored on the NEO FFI, can be related to a stereotype that influences effective communications across diverse groups. The extent these perceptions influence team effectiveness is difficult to determine. The literature does point out that stereotyping a group hinders the development of trust between team members. Alberts and Garstka (2004) identified that a key component for limiting uncertainty during Network Centric Operations was the trust between team members. Newell and Swan (2000) refer to the trust needed in teams that are short-term, complex, and task-oriented as 'swift trust' (p. 1294). According to Newell (2000), teams who develop swift trust are able to stay task-oriented and focused on the task at hand, rather than on the dynamics of the team.

Combining the analysis for culture and personality leads us to conclude that the services have differences common to all diverse organizations. Matsumoto (2005), McCrae (2004) and Hofstede (2005) have written extensively on the possible consequences of failing to understanding the impact of these differences on team processes. Caution should be taken in attempting to state that these differences are absolute traits for any service. The possibility of confounding variables influencing our results and other problems are reviewed next.

*a. Problems*

Gathering data from an online instrument is problematic. The most obvious flaw of our online research was the length of the questionnaire. From the outset, we accepted the fact that many of the participants would fail to accurately or properly

complete the survey. We felt there was no alternative. Lacking an existing research protocol where the number of items in the questionnaires was reduced, we concluded that we would include them all. As part of the research, we were going to perform a factor analysis and make a determination of which items from the questionnaires were the most significant. Future surveys could capitalize on these condensed surveys. However, when we discovered the proprietary characteristics of the surveys, this effort was abandoned. We could not ethically complete and report a factor analysis that violated those proprietary requirements.

However, we never intended for that questionnaire to be a final version for incorporation into military research or possible follow-on studies to this experiment. We understand fewer items should be used in the development of a more permanent instrument. The length of the survey is certainly the primary reason so many of the surveys were incomplete or inaccurately completed. We believe these limitations could be overcome if senior government officials intervened with the agencies holding the copyrights on the instruments in order to develop a more usable instrument.

Secondly, self-reports have limitations that affect external validity. Controlling the sample populations by determining who would participate was not possible. We relied completely on volunteers from the different military commands who agreed to participate. Additionally, being an online instrument, there was no control as to when and where a participant took the survey. The method we utilized to maximize external validity was to follow each of the test instrument guideline's validity checks. The NEO FFI is more advanced in the development of these checks than the CSQ. Following these methods, a substantial number of surveys that failed the validity checks mentioned above were eliminated. Interestingly, all of the participants from the in-person survey collection method met the validity checks. The success of our efforts to maintain the best possible validity is demonstrated by the lack of significant difference when comparing the two data collection methods. This indicates our success in following the best possible means to maintain the standards for reliability and validity during Study One.

The limited number of participants for the Air Force and the Navy is another concern. There is no reasonable explanation for the lack of participation from either of these services. The discovery that differences exist with such small populations for these services is important. We maintain that despite the small sample of participants, there are cultural and personality differences that exist between the services.

## **2. Study Two**

The team experiment was the focus for Study Two. We determined that the business model is appropriate in the military environment. Given that Study One supported that differences between the services exist, this study described the impact of differences as possible barriers that limit information sharing among heterogeneous teams. Further we demonstrated that a simple cueing to the differences resulted in statistically different performances between teams in the heterogeneous structure.

In the composite team evaluation, teams in the heterogeneous control condition were outperformed by all other team types. We had anticipated that significant differences would be observed when comparing the heterogeneous control teams and the homogeneous control teams. The results did not support this hypothesis.

Referring back to figure 14 (p. 125), the box plot does suggest a trend in support for the hypothesis that a significant difference for performance does exist when comparing the two team types. There are several possible explanations for a lack of significance we had thought would be evident. The power of our statistical test was limited (power = 0.26,  $n = 26$ ,  $\alpha = .05$ ). The possible causes for low power value are the small sample size for each team type and the low magnitude of the influence for the independent variable. These contributed to the limited treatment effects. The finding that a significant difference did exist between the heterogeneous teams for condition is worth emphasizing, given these constraints. Next, we extended the examination of the team data to evaluate the individual participants.

The most interesting finding from the analysis by individual participant was the degraded performance by the Army participants when in the leadership position. The analysis did reveal that only six participants occupied seat one (leader position) during the wargame and the significant difference occurred only in the homogeneous condition. This led us to conclude that possible within-service differences may be the root cause.

Cultural and personality differences within the service may impact homogeneous team performance as well as the hypothesized between service differences. At one point in the data collection, we considered investigation into this hypothesis using the Army or Marines as the subject population. Comments from several of the interviewees and participants in the wargame indicated that service members believe that differences within the services should be investigated. Recall, our analysis for job type, rank, and gender did not indicate significant differences for culture or personality. Still, this is a plausible explanation for this unusual occurrence between Army participants. Differences were significant for the heterogeneous structure teams.

Our analysis determined that the teams in the heterogeneous control condition were outperformed and were significantly different than those in the heterogeneous experimental condition. Despite the low power values discussed previously, analysis did indicate significant levels between the control and experimental conditions. This strongly supports further exploration of the implementation of a business-like model as part of improving joint team processes. The evaluation for cultural and personality effects supports this.

There were no statistically significant findings for cultural orientation influence on performance. Personality influence did reach levels of significance and one interaction was observed.

Extraversion influenced performance and was significantly different between the heterogeneous teams. As extraversion scores increased, performance decreased for participants in the heterogeneous control team type. The opposite was found for the heterogeneous experimental team type. As extraversion scores increased, performance increased. Although we cannot assert that the cause of this interaction was due to the cueing for culture and personality, we can conclude support for the hypothesis for applying a business solution to improve joint team effectiveness. Team performance improved in heterogeneous teams made aware of cultural and personality differences. In an attempt to extend support for the hypothesis, we examined the communications between team members.

Recall we hypothesized that teams would communicate differently where there was knowledge of the factors that limit effective team process. First, we evaluated communication from the composite teams and did not discover any indication that communication by team types was significantly different. We had hoped that the linguistic analysis would have provided more insight. Only the inclusive language variable from the LIWC supported that heterogeneous teams, with knowledge of cultural and personality differences, would communicate differently. Examining the communication between the participants was more robust.

When examining the linguistics for team types by participant, we discovered that the HC and the HTE teams had the strongest correlations by the linguistic variables. Both team types were positively correlated for performance and word count ( $r = .68$ ,  $p = .0002$ ;  $r = .59$ ,  $p = .002$  respectfully). No support was found for the hypothesis that difference in team type would be evident by pronoun usage. There was no indication that the use of third person personal pronouns is an indication of better team effectiveness.

Extending the evaluation for within services comparisons revealed that the Air Force and Marines had positive correlations for word count and performance ( $r = .72$ ,  $p = .0006$ ;  $r = .51$ ,  $p = .001$  respectfully). As with the team type evaluation, no support was evident for our hypothesis. Still, we believe further experimentation of communication patterns between the services will yield useful information. The lack of significance could be a result of the limitation of this study.

Problems with our research certainly interfered with the results. The problems from the wargame experiment fell into three categories: small number of teams, difficulties controlling for extraneous variables, and low population of participants from the Air Force and the Navy.

*a. Problems*

Only twenty-six teams participated in the data collection effort. Separating those teams into four categories diminished the sample size for analysis. The design matrix of possible team types is complex. In the homogeneous structure, there are eight combinations of teams possible. In the heterogeneous structure, there are sixty-two combinations of teams possible. Conducting ten wargame evaluations per team type results in a matrix of seven-hundred experiments for the two different conditions just to

achieve a minimum sample size. Further, since our experiment could be extended to evaluate each service by seat position, the resulting matrix exceeds five thousand combinations if evaluating each team type ten times. The time for completing the entire matrix would exceed three years, which is impractical. Coordination for the twenty-six teams for our experiment was difficult; coordinating for seven hundred teams would require senior joint military cooperation. Even with cooperation, field condition experimentation increases the possibility of extraneous variable influence.

Extraneous variables are those variables that act on the dependent variable and must be controlled by the researcher to limit their influence on the dependent variable. In our research, extraneous variables changed by data collection location and military service. Failure to control these variables limits a researcher's ability to conclude that the effects recorded on the dependent variable were caused by the influence from the independent variable. Unfortunately, several variables were uncontrollable.

Recall that the leadership position was a random selection. In the military, this would never occur. Persons senior in rank always assume the position of leader in situations where no defined leader is present. There is no method to measure a participant's reaction to being senior and having a subordinate role during the wargame. Also, we limited our investigation to cultural and personality factors, which does not account for other macro-cognitive traits such as: intelligence, emotional intelligence, mood, age, or decision-making process. Each of these influences a participant's performance.

Other extraneous variables that could be controlled in a laboratory, but rarely in the field are: climate, lighting, interruptions, participant selection, time, and location. For instance, three of the teams from Ft. Sill required a start time of 0500 so as not to conflict with other training requirements. Two teams from Twenty-nine Palms had recently returned from Iraq and were going on leave the evening after participation in the experiment. The participants from Sheppard Air Force Base were volunteers who responded to a first sergeant's request for participants. Several experiments were cancelled due to one participant not arriving at the experiment site. Each location had different lighting, climate control, and set up. Despite the variety of variables that could



have confounded the results, field research is an accepted method for data collection and we attempted to minimize the effects in several ways.

First, the set up for the wargame was consistent for all teams. The researcher coordinated with each unit participating for the use of one long table, four similar chairs, a location that would limit interruptions, and the ability to control lighting and climate. Most locations were in a conference room that accommodated all of these. The pilot studies enabled the researcher to hone the process for reading, question answering, and behavior during the experiment. We discovered that when the population for experimentation is the military, going to their unit and working within their parameters was met with excellent coordination and cooperation. However, we note that we are a military at war. Everyone is competing for an airman's, soldier's, marine's or sailor's time. The lack of sufficient population was not due to a lack of interest by any service, but a lack of available personnel.

The team experiment was a huge undertaking but the results provide strong support that business models can be incorporated into the military team process. Despite our limited ability to state causal effects and make predictions, we believe our research provides a foundation baseline for further research in this area. Providing the field with alternative approaches to successfully defeat an adversary in an asymmetric environment requires improving our information sharing between the services, and limiting the adversary undenied access to our boundaries to exploit them.

Finally, the major limitation of our research is the small sample size of four-man teams in Study Two. To overcome this limitation we extended the work to include the development of four agent-based models. The models enabled further evaluation of all team designs we were unable to capture by human experimentation. The next discussion focuses on the implementation of the model developed for Study Three.

### **3. Study Three**

We coded the NetLogo models using the data collected in human experimentation. After coding, we simulated each model 100 times. The results from the simulation were evaluated to explore the problem space left void in the human data collection effort. We were successful in that endeavor. In fact, the results exceeded our expectations. We had hypothesized two specific results. First, performance output from

the model would not be significantly different from actual human experimentation. Second, incorporating the reliability and validity measures from human experimentation, into the modeling effort, would add to the model's verification and validation process.

We found strong support for the first hypothesis and discovered that our models added significantly to the data analysis from Study Two. In Study Two, we saw a trend in the data that indicated homogeneous control teams outperformed the heterogeneous control teams. However, adding the data from the NetLogo output for both teams types increased the teams' matrix and added robustness to the evaluation. The HC teams did significantly outperform the HTC teams. Further, we determined that HTE teams had comparable performance to the HC teams. Our results demonstrate that modeling human behavior can add robustness in complex human experimentation. Despite the simple approach to coding, having actual data to code the agents within the model instead of notional numbers, provided added meaning to our human experimentation. However, regardless of the robustness of the results, there are problems that future researchers must be made aware of.

*a. Problems*

There will be those who will argue that our model was a manipulation model where the coder just kept tweaking the model until it did what we wanted it to do. This is still a viable argument that will be made until agent modeling techniques advance. Also, it is an argument that should be made. In human experimentation, the purpose of strict adherence to standards of reliability and validity force researchers to explain, in detail, limitations in experimentation. These standards are the honest brokers in the process. In model development, verification and validation are still immature as rigorous methodologies for insuring strict adherence to prescribed standards. If you doubt this, then explain to the American tax payer the three billion dollar expenditure for the Joint Simulation System (JSIMS) and the colossal failure it was. Most social scientists can quickly determine why. Coders lack a common methodology to follow that is agreed upon within the domain and analysts lack tools to accurately replicate a coder's product. We believe the cautions from the doubters of our model should be heard. One means we

used to overcome the possible manipulation concern was the inclusion of human behavior reliability and validity standards into the computer science verification and validation process.

Our model only attaches to the VV&A model at the level of the data-driven model. We do not see the use of human reliability and validity in a physics-driven model at this time. However, if human behavior data is incorporated into a physics-driven model, the same standards for that data should be used for input as well as referent data.

Our models used both reliability and validity measures prior to the incorporation into the model. We have discussed those as we examined Studies One and Two so we will not reiterate them. Prior to model development, we were unsure of exactly what methodology we would use to code the NetLogo model with this data or to weight the model factors. We delayed coding the model beyond a framework stage until the data collection process was complete. We want to point out that this process extended our time schedule for model development, which we had not anticipated prior to the data collection. This is an important point and may provide the simulation community an important lesson to be learned when human data collection is a portion of the experimental design.

Further, model selection is an enormous undertaking. There are a large number of model developers using agent-based techniques. The decision to use a pre-existing model framework, versus coding a model from scratch, was based on the primary researcher's lack of expertise in coding. These were the two main problems with Study Three: unexpected delay in coding, and lack of expertise to code. Otherwise we are very satisfied with the results.

We conclude from this study that the military can implement the business model to improve joint team performance. Also, we believe that combat models can and should be coded with more accurate human behavior data and steer away from the use of notional numbers as representative of a human trait. Lastly, incorporating the rigors of human reliability and validity standards into data-driven models adds to the verification and validation process.

We have discussed the results of the three studies, but our research extended into several other areas. Although not included in the data analysis section, we report the results from these studies.

## **B. DISCUSSION OF OTHER DATA COLLECTION EFFORTS**

During the course of data collection, other methods were employed to evaluate the research questions. We have already indicated that prompt questions from the survey and wargame were completed. Additionally, a behavior analysis utilizing the System for the Multiple Level Observation of Groups (SYMLOG) method for naturalistic behavior observation, and one additional agent-based simulation using the Pythagoras non-traditional model were included. We briefly add a discussion of these efforts to provide researchers interested in pursuing this line of research insight into our discoveries during data collection and analysis. We start with the prompt questions and interviews.

### **1. Prompt Questions**

The 104 participants in Study Two responded to three prompt questions at the completion of the wargame. Those questions were:

(1) Please write a short paragraph describing your satisfaction with your group's effectiveness in completing this wargame. Please list the positive and negative experiences during this experiment.

(2a) Do you believe having members from other services would have made determining Red Cell course of action decisions easier? Yes or No (Question in the homogeneous structure)

(2b) Do you believe having members from the other services made a difference in determining Red Cell course of action? Yes or No (Question in the heterogeneous structure)

(3) Please explain your answer to question b.

The results of examining question one reveal that most participants felt that their team's performance was satisfactory. Negative comments focused on the lack of communication between different members of the team and the resulting frustration from poor communication. We attempted to analyze the transcribed data using the LIWC to determine whether a pattern emerged, but the analysis was not significant for performance.

The most interesting aspect of this analysis was the response to question 2. Table 28 provides the responses to that question by service.

Table 27. Response by Service to Question Two.

| Service          | Team type                             |     |                                       |     |                                     |     |                                     |     |
|------------------|---------------------------------------|-----|---------------------------------------|-----|-------------------------------------|-----|-------------------------------------|-----|
|                  | Homogeneous Control                   |     | Homogeneous Experimental              |     | Heterogeneous Control               |     | Heterogeneous Experimental          |     |
|                  | Would members of another service help |     | Would members of another service help |     | Did members of another service help |     | Did members of another service help |     |
|                  | No                                    | Yes | No                                    | Yes | No                                  | Yes | No                                  | Yes |
| <b>Air Force</b> | 0                                     | 8   | 0                                     | 4   | 0                                   | 3   | 0                                   | 4   |
| <b>Army</b>      | 0                                     | 4   | 1                                     | 7   | 2                                   | 11  | 1                                   | 6   |
| <b>Marines</b>   | 6                                     | 2   | 3                                     | 1   | 1                                   | 8   | 5                                   | 10  |
| <b>Navy</b>      | 0                                     | 4   | 4                                     | 4   | 0                                   | 3   | 1                                   | 1   |
| <b>Totals</b>    | 6                                     | 18  | 8                                     | 16  | 3                                   | 25  | 7                                   | 21  |

A majority of the respondents indicated that having other members of the services present would have contributed or did contribute to the performance of the team. We had intentionally designed the scenario for this purpose. We wanted the wargame to require a multi-service aspect so that all participants could use their expertise equally. The island design focused on the naval aspects and the land movement. Special forces incorporated the Army; potential ocean landing and land component focused on the Marines, and the air strip and air reconnaissance focused on the Air Force. We had hypothesized that with so many avenues of approach, a single service would have difficulty with developing courses of action where lack of experience in another service domain would limit their course of action development. Our failure to develop more robust performance criteria for courses of action limited our ability to examine this hypothesis.

We want to stress at this point that fact-sharing was the final determinate for performance, but from the outset we had planned to include a number of courses of action developed. We eliminated that performance factor after the subjective nature of evaluating a course of action limited interpretation of the results.

The diverse nature of the wargame and the need for multi-service representation was obvious from the responses to question three. Most respondents indicated that having a member of a service present would have helped or did help in decision making. Again, analysis by LIWC was not significant for performance.

The last point we want to make for the prompt question evaluation was the problem with examining the questions themselves. When we began our analysis, we wanted to incorporate a word analysis dictionary specifically designed for military key words. We failed in our attempt to locate such a dictionary. It occurred to us that for evaluating research such as ours, this type of dictionary would be critical. There are several research projects ongoing that examine text communications between different units and we believe that developing a joint key word list for research would be very beneficial. The next analysis discusses the results from the prompt questions contained in the written survey.

## **2. Survey Prompt Questions**

The survey had two specific areas designated for prompt questions: after the cultural surveys and at the end of the personality questions. The questions examined after the cultural section were:

(1) Indicate, by an x or check mark, which positive and negative characteristics you believe accurately portray each service's attributes. Select as many as you believe are appropriate.

The word list was developed from the sub-categories of the NEO FFI domains for personality. We ask this question to assist in the development of an implicit measuring tool for stereotype similar to the one developed by three Harvard professors known as the Implicit Association Test (Nosek, Greenwald, & Banaji, 2004). Table 28 provides the results from that analysis with the items in red indicating results we felt were worth noting. No statistical analysis was attempted; the percentages are the participant to total responders average.

Table 28. Responses to Prompt Question Examining Service Characteristics

|              | <b>Air Force</b> | <b>Army</b>     | <b>Marines</b>   | <b>Navy</b>      | <b>Number of Respondents</b> |
|--------------|------------------|-----------------|------------------|------------------|------------------------------|
| Aloof        | <b>71% (98)</b>  | 23% (32)        | 19% (27)         | 32% (44)         | <b>139</b>                   |
| Anxious      | 23% (28)         | <b>47% (57)</b> | 46% (56)         | 18% (22)         | <b>122</b>                   |
| Calm         | <b>47% (79)</b>  | 15% (25)        | 41% (70)         | <b>39% (66)</b>  | <b>169</b>                   |
| Careless     | 35% (48)         | <b>65% (90)</b> | 22% (30)         | 16% (22)         | <b>139</b>                   |
| Cautious     | <b>51% (88)</b>  | <b>53% (91)</b> | 33% (56)         | 39% (67)         | <b>172</b>                   |
| Confident    | 25% (53)         | 36% (74)        | <b>96% (199)</b> | 25% (51)         | <b>208</b>                   |
| Demanding    | 11% (22)         | 31% (65)        | <b>97% (203)</b> | 13% (27)         | <b>209</b>                   |
| Efficient    | 23% (41)         | 13% (22)        | <b>84% (147)</b> | 26% (46)         | <b>176</b>                   |
| Enthusiastic | 21% (42)         | 28% (54)        | <b>89% (175)</b> | 16% (32)         | <b>196</b>                   |
| Excitable    | 24% (37)         | 39% (61)        | <b>66% (103)</b> | 16% (25)         | <b>157</b>                   |
| Friendly     | <b>73% (136)</b> | 29% (55)        | 25% (46)         | <b>57% (106)</b> | <b>187</b>                   |
| Imaginative  | 48% (82)         | 27% (46)        | <b>58% (100)</b> | 24% (42)         | <b>172</b>                   |
| Impulsive    | 15% (21)         | 47% (67)        | <b>59% (84)</b>  | 13% (19)         | <b>142</b>                   |
| Optimistic   | 42% (65)         | 31% (47)        | <b>57% (88)</b>  | 31% (48)         | <b>154</b>                   |
| Suspicious   | 23% (26)         | <b>46% (52)</b> | <b>46% (51)</b>  | 21% (24)         | <b>112</b>                   |
| Thorough     | 22% (43)         | 29% (57)        | <b>84% (165)</b> | 24% (47)         | <b>196</b>                   |
| Tolerant     | <b>63% (93)</b>  | 42% (62)        | 24% (35)         | <b>50% (74)</b>  | <b>147</b>                   |
| Trusting     | 32% (45)         | 32% (44)        | <b>63% (87)</b>  | 29% (41)         | <b>139</b>                   |
| Withdrawn    | <b>46% (53)</b>  | 20% (23)        | 29% (33)         | 28% (32)         | <b>115</b>                   |
| Worrier      | <b>48% (51)</b>  | 47% (50)        | 21% (22)         | 30% (32)         | <b>107</b>                   |

(2) If you believe there are other word descriptors that were not listed in question 1, use this space to add your own.

The results from this question will not be revealed as the majority of responses are very negative. We did not anticipate this result. There were 28 responses and all came from the grades of O-1. We will discuss a possible explanation later in this chapter.

(3) Please indicate your desire to work as a member of a team composed of members from another service.

This question was the most interesting of all the prompt questions asked. The majority of responses indicated a willing or very willing reply. This is an encouraging result and indicates that cooperation is desired. Table 29 provides a summary of the results from this question.

Table 29. Summary of Results for Question Three

| Service          | RATING           |         |                  |          |                  |                           |                            |                |
|------------------|------------------|---------|------------------|----------|------------------|---------------------------|----------------------------|----------------|
|                  | Strongly Adverse | Adverse | Slightly Adverse | Neutral  | Slightly Willing | Willing                   | Very Willing               | Response Total |
| <b>Air Force</b> | 4% (8)           | 6% (12) | 8% (17)          | 20% (43) | 9% (20)          | <b>33%</b><br><b>(71)</b> | 22% (47)                   | 218            |
| <b>Army</b>      | 2% (4)           | 3% (6)  | 8% (17)          | 20% (42) | 12%<br>(24)      | <b>34%</b><br><b>(70)</b> | 22% (45)                   | 208            |
| <b>Marines</b>   | 0% (1)           | 0% (1)  | 2% (4)           | 7% (14)  | 0% (1)           | 24%<br>(49)               | <b>66%</b><br><b>(134)</b> | 204            |
| <b>Navy</b>      | 0% (1)           | 1% (2)  | 3% (7)           | 11% (24) | 11%<br>(23)      | <b>44%</b><br><b>(96)</b> | 30% (66)                   | 220            |

The last section of the survey asked two additional prompt questions. We will only discuss the question: “If you could influence or recommend one change to improve Joint Team Effectiveness, what would you recommend?” One hundred and thirty participants responded to this question and the majority indicated that training was a top priority to improve joint team effectiveness. Several of the responses are included here that indicate the emphasis of training.

Have more interservice training in order to improve communication and effectiveness of the armed forces. ( Air Force O-3)

More opportunities for Joint training and joint exercise environments. I think that educating, even at the lower level officer ranks, on how the different branches' duties overlap and how they interact would be useful. I also think that limiting comments that generalize about members of the other branches would decrease negative stereotypes. (Army O-3)

Require joint service for every mid-grade officer within the four services. Junior officers should be learning their service-specific jobs, and senior officers should have already learned the joint arena by the time they reach that level. Mid-grade officers, however, can truly improve themselves as warfighters, and in turn benefit their own service, by experiencing and learning from the larger DoD picture presented by joint duty. (Navy O-5)



I would recommend that all members of the joint team are thoroughly vested in the goals and interests of the joint mission. Members of the team from each service must ensure that their efforts are focused on the team effort, not individual or service-related achievement. There must be one person in charge who is responsible for maintaining the effectiveness of the entire team, regardless of service component. (Marine O-4).

The comments are supported by the interviews. The next section discusses the results from interviews.

### **3. Interviews**

Fifty-Seven individual interviews were conducted over the data collection period. Each interview lasted approximately ninety minutes. All services were represented and most interviewees were officers. Most interviews were taped with the intention of conducting a linguistic analysis of each and comparing answers to the interview questions across services. We had hypothesized that the language and answers to the interview questions would indicate differences between the services. Due to the lack of a performance or other dependent variable for the analysis, we eliminated the LIWC analysis. After further consideration, we determined the hypothesis was not of value to this research and did not report the results. However, the interviews themselves are very revealing and a synopsis of those interviews follows.

Six questions were asked of each interviewee. These questions were:

1. Have you worked with members from the other services?
2. What are the most difficult aspects of the work environment where the team is composed of members from the other services?
3. Were there occasions these differences between team members resulted in degraded performance? Improved performance?
4. Was there a common language?
5. What do you believe is the most significant problem to effective performance in a team composed of differing organizations?
6. Do you have any comments on how to improve a joint team's performance?

We are not going to summarize all the interviews as that would take some time. Our focus for this section is to provide support to the recurring suggestion that joint

training needs a higher priority. The interviewees list four main reasons: common language, training prior to joint integration for combat, boundaries, and schooling.

The lack of a common language between the services was addressed during every interview. We concluded that at the strategic level, common language is not as fragmented as at the operational or tactical level. It is at those levels where different service-specific terminology causes problems in communication. Many of the interviewees and survey participants indicated that training on service-specific terminology occurs only when a joint assignment or training event happens. It was not unusual for someone to tell a story where misunderstanding the language led to misinterpretation of orders or intent. The interviewees who participated in joint combat in Iraq explained that this was often the case just prior to engagements.

A specific incident where communication problems and lack of training hinder battlefield effectiveness occurred when marine and army tank units were integrated for an assault. Coordination for the attack took place at the line of departure (LOD) and had to be delayed due to miscommunication and no standardization for attack tactics. The comment made was, “Why didn’t we work stuff like this out at the National Training Center (NTC) and Twenty-nine Palms prior to real engagement? It didn’t make sense that we lieutenants and sergeants found out about different methods to attack at the LOD.” At the tactical level, this type of comment was common when interviewees had been involved in joint operations. The responses from others at high command did not indicate the same level of frustration and often indicated that previous command center training had been helpful in integration and coordination.

Another idea discussed during the interviews centered on boundaries being not just lines on a map. One officer remarked, “The enemy knows where our boundaries are and exploits them. They just look for where the uniforms change and hit us in-between.” When we asked about boundaries, there was a common response that they exist, but the means to overcome them varied widely. Several interviewees thought that training would be the most effective method.

The Marines repeatedly referred to The Basic School (TBS) as the place they received their tactical proficiency. It is interesting to see that since the interviews, a

scaled down school similar to TBS has started at several Army installations. The concept of schooling across the military, similar to TBS, coincides with the comments we referred to on the questionnaire from the junior officers. Although there is no statistical evidence, it seemed that the most belligerent group across the services was at the O-1 level.

We started to ask a question about what would cause this and learned that maybe, in an attempt to develop esprit de corps at Officer Basic schools, cadre use demeaning language and terms when discussing other services. Several officers indicated that this may have a strong influence on young impressionable officers. There was no method in our research to determine the actual impact of cadre negativity toward another service. The perception emerged from the research and indicated that cadre influence on the students they are entrusted to train may inadvertently develop into a stereotype. There is no other explanation for how a group of young officers, never exposed to other military services, could develop such negative impressions of a service not their own. There are examples other than the ones voiced during the interviews.

At one experimental site, a sign was hung in the cadre administrative area indicating that another service was unwelcome in that area. It read “(Name of Service) UNWELCOME.” Interestingly, cadre from that service were members of the staff and students that routinely had to be in that area. We believe it does not require a detailed experiment to determine the negative impression left by that sign on the service it referred to. The idea being pointed out is that training centers need to insure that the other services are not used as the adversary in the fight on terror in an effort to motivate the students.

It is encouraging to report that this was not a factor outside the training base. As reported above, coordination, cooperation, and integration were the topics for officers at the unit level. We suggest that training is a fundamental process for integration into the military and provides a setting to limit the possible development of cultural and personality differences between the services instead of it being the atmosphere for differences to widen.

#### **4. Behavioral Analysis**

We completed a substantial behavioral analysis for every participant in the wargame using the System of Multiple Level Observation of Groups (SYMLOG) procedure (Forsyth, 1999, p. 34). Unfortunately, the method we used was from an academic online source, which lacked the proper proprietary permissions. At the time we used the SYMLOG technique, we were unaware that a copyright violation had occurred at the academic site. We initiated a request for permission to use the SYMLOG method and report the results; however, at this time, we are still waiting on a decision for disclosing our results. We can explain that the analysis was significant across several variables contained in the SYMLOG behavior instrument. We mention this analysis so that future researchers understand that behavioral analysis of military teams is practical and worth including as a variable in examining the joint team process.

#### **5. Agent-Based Model – Pythagoras**

Pythagoras is an agent-based model developed by Northrop Grumman for use by Project Albert, a former Marine Corps Warfighting Laboratory organization. Pythagoras is a Java-based, platform-independent model capable of being run in a super computer or batch job environment (Pythagoras 1.10 Manuel, 2006). Programming a model that will simulate the incident in Iraq that we reported in the problem statement (p. 20) is ongoing and being refined.

As we discussed with NetLogo, one of the problems we encountered was our failure to adequately allot enough time for model completion prior to the defense date. Our efforts are ongoing as we want to examine differing scenarios from the Iraq incident to determine if there is a state that would prevent an occurrence such as we described.

Our purpose for choosing Pythagoras was based on the model's use of soft decision rules. These rules assign each agent an individual threshold within a fuzzy logic space, which includes decision as well as human factor variables. Pythagoras uses changes in color based on these decision rules to represent group or individual behavior. This is a complex process to code without violating one of the basic principles we have reiterated several times in our work: not using notional values to represent human behavior.

The model is working and we have developed communications across three agent types: Army, Marines and Insurgents. Each agent group is sub-divided into small groups representing squads of patrolling agents, command center teams, and insurgent groups. The problem space being evaluated incorporates the data from Studies One and Two into the Iraq scenario. We are exploring the effect of increasing and decreasing the impact of cultural differences and stereotype behavior on the ability of the insurgent force to maneuver across the boundaries. Our proposed final coding will be to alter the barriers presented by cultural and personality differences to determine the points where insurgents do not have free access to the boundaries between military units and the improvement of communications across those boundaries.

### **C. EXPERIMENTAL TOOLS DEVELOPMENT**

Currently, the development of a more realistic survey is a project being undertaken by researchers from the Army and Air Force Research Laboratories. We believe the data we have collected will be a valuable asset to the development of that instrument.

The answers to the survey prompt questions for characteristics of each service is being integrated into an implicit stereotype indicator under development at the Naval Postgraduate School. The instrument is based on the Implicit Association Test (IAT), created by Nosek, Greenwald and Schwartz (1998). The IAT was developed to distinguish whether measures of implicit cognition, when compared to self-reports, revealed mental associations without individual introspection (Nosek, Greenwald, & Banaji, 2005).

Our tool is a design similar to the IAT but extends the 2 x 2 format of the IAT to a 2 x 4 format for use by the military. This tool, currently termed Joint Environment Trust Indicator (JETI), is a means for the detection of implicit stereotype, which may not be revealed in a self-report survey.

Data from the responses to the prompt questions was used to program the wording for JETI. A working copy is being tested to determine the effectiveness of JETI to detect potential stereotype between the services. Our hope is that this method of measurement will eliminate the need to fill out a lengthy NEO FFI inventory for stereotype detection. JETI takes approximately ten minutes to complete and outputs data in two ways.

First, a spreadsheet is created that allows for the analysis of participants' scores and determines whether a potential stereotype exists for a certain service. Second, future coding will allow for an immediate evaluation to be printed on the screen of the computer a participant is using. If a potential stereotype is indicated, an embedded training program will start, similar to those currently being used in the business community, to assist in providing a participant with methods to limit a stereotype from interfering in the team process. The first iteration of JETI will be tested in December 2006.

Lastly, the wargame we designed is being considered for future use at the Naval Postgraduate School. Professors are considering implementing the wargame for use in the wargaming classes as well as for independent student research of joint teams. The wargame provides an excellent environment to examine decision-making, team process, communications, and interoperability.

This concludes the discussion chapter. We have limited our discussion to main points that are pertinent to answering the research question we purposed. Our conclusions and proposals for additional work are contained in the following chapter.

## **VI. CONCLUSIONS, SUMMARY AND FUTURE WORK**

Business methodologies are applicable in the military domain for the improvement of joint team effectiveness. These methodologies utilize reliable instruments to determine cultural orientation and personality of individual teams members to evaluate potential limitations of an effective team process. Using these instruments, our research determined that each military service has a different orientation for culture and different personalities. Builder (1989) suggested the possibility of differences between service personalities as potential limitations to the overall effectiveness (p. 3). The conclusions from our three studies add empirical confirmation to Builder's ideas.

### **A. CONCLUSIONS**

Our research explored a vast problem space. There are several conclusions we can make from the results of all three studies. They are:

- (1) The services have differences for cultural orientation and personality type.
- (2) There are reliable assessment tools available from the business and psychological communities that can be used to evaluate culture and personality. Further, training methods are available to assist in limiting the potential negative impact of cultural and personality differences on joint team effectiveness.
- (3) Implementation of these methodologies positive influences joint team performance and information sharing.
- (4) Effective modeling of human behavior in a military environment is improved using data sets developed from actual human experimentation.
- (5) Complex design of human experimentation can be modeled, and in simulation, expand the knowledge and understanding of complex experiments.
- (6) Incorporating the measures for reliability and validity add to the integrity of model verification and validation.

## **B. SUMMARY**

### **1. Why is This Work Important?**

Our research confirms that the services have different cultural orientations and personalities as Builder (1989, p. 3) predicted. We have maintained that differences are not a negative characterization or imply that one service is better than another. If anything, we believe we have made the point that interoperability among the services is a mandatory function for success in the asymmetric warfare environment, and that improved interoperability will influence the battlespace in two ways.

First, by limiting the boundaries between the services, an adversary will not easily exploit those boundaries. Second, better interoperability will allow our military to begin to exploit the adversary's boundary and to influence the unlimited 'will' of the insurgency. For success, methods must be implemented to properly assess the culture and personality of teams formed during asymmetric warfare. As a first step, we investigated the potential boundaries between the services using the business approach.

### **2. What Did We Learn?**

Study One evaluated the differences between the services for cultural orientation and personality using the Matsumoto Cultural Styles Questionnaire and the McCrae/Costa NEO FFI. We extended the personality evaluation to include examination of potential stereotype using the NEO FFI. We found that the services do have significant differences for culture and personality and that stereotypes are indicated.

(1) The services have differences for cultural orientation and personality type.

Conclusion One is supported across three of the four cultural dimensions. No differences were found for status differentiation. Significant differences were determined for emotion regulation, individualism, and mastery. We further determined that the Army, Marines, and Navy were more closely related in scoring than the Air Force was for emotion regulation.

All five of the personality domains indicated significant differences between the services. Extraversion and conscientiousness indicated the greatest separation for scores between the services. The Marines rated themselves more extraverted and higher on conscientiousness than the other three services. Neuroticism was determined to be the next highest measure of separation, with the Air Force rating themselves more neurotic



than the others. The domain of openness to experience indicated that the Navy and Air Force see themselves differently than the Army and Marines. Agreeableness scores showed the Navy rating themselves differently than the other services.

Results for stereotype revealed that the services rate themselves differently than they are rated. This was especially true for neuroticism. All services rated the other services as more neurotic than in the self-ratings. The Air Force had the highest number of significant scores differing from other service's self-rating. Explicit evaluation of stereotypes is problematic and we propose the development of an implicit measurement tool similar to the Implicit Association Test as a method to improve evaluating stereotypes.

(2) There are assessment tools available from the business and psychological communities that can be used to successfully evaluate differences of the individual. Further, training methods are available to assist in limiting the potential negative impact of these differences on joint team effectiveness.

Reliable psychometric measurement tools are available in the business community. Our research utilized two instruments available for experimentation such as ours. There are many more available, which indicates the importance that the business and psychological domains place on these two cognitive factors. Time constraints limited our ability to implement the training aspect of the instruments we chose. Business employees routinely participate in taking surveys for cultural assessments. Following the survey, training is made available to limit the impact of cultural differences that may interfere with effective team processes. Our literature review indicated that this methodology is an effective means to improve team processes.

(3) Implementation of these methodologies positively influence joint team performance and information sharing.

Our research determined that the cueing technique did significantly improve performance in the heterogeneous experimental condition. We conclude from the improvement that implementing a business-like model into the military joint team environment will significantly improve team information sharing. This is an inexpensive undertaking which may significantly improve heterogeneous team processes within and

between the services. Our reliance on technological advances can be supplemented with the methods successfully used in the business community. We cannot state firmly enough our belief that improving these processes will improve information sharing across service boundaries and start the development of a less permeable structure for our adversaries to exploit. Further, we can conclude that the examination of these processes can be augmented by the modeling and simulation community.

(4) Effective modeling of human behavior in a military environment is improved using data sets developed from actual human experimentation.

Coding models with notional human behavior data sets limits interpretation of the resulting output. We demonstrated that programming a model with actual human behavior data results in more robust output. Our models replicated the wargame and the results demonstrate the power of coding a model with reliable and valid data. There were two significant findings from our efforts. First, the experimentation needed to generate the data sets for coding is very time consuming and will delay the start of the actual coding. Patience is mandatory. Second, interpretation of the outputs from simulation are more understandable given the input variables are known quantities. The models we developed replicated the human experimentation without any indication of significant differences. Further, our experimental design was very complex and required a large population of teams to complete the design matrix. Our models enabled the evaluation of the entire matrix without long term human experimentation.

(5) Complex design of human experimentation can be modeled and, in simulation, expand the knowledge and understanding of complex experiments.

The use of actual data effectively extends complex human research designs. We required a large number of teams to participate in our research, which were unavailable due to time and mission requirements. Our models extended the knowledge space for the differing team types. We were not attempting to predict performance but rather examine performance across an entire range of possible experimental combinations. Additionally, evaluation of the implementation of the business model for team process was extended. We were successful and found that heterogeneous teams do share information more

effectively across all team designs when using the business model. We discovered that the use of these data sets added to model verification and validation.

(6) Incorporation of measures for reliability and validity add to the integrity of model verification and validation.

We developed the model based on the wargame experiment. The verification process for the model requires that the model implementation and the associated data represent the true environment being examined. We accomplished both by insuring that the data for coding the human behavior was not notional and that the model programming was based on the results from the wargame. Our validation process determined that the output results were not statistically different from the actual experimental results. We were able to verify that the data output from the simulations was very similar to the human experimental data.

We believe that this one aspect from the developed models provides researchers interested in human behavior representation a means to improve the quality of the coding in future models, by use of actual data instead of notional data sets. We have proposed that in data-driven models, the measures for reliability and validity fit very well into the verification and validation process from the Defense Modeling and Simulations Office.

Executing human experimentation prior to model development required our maintaining adherence to the social science requirements, which we have concluded led to the successful implementation of the models. Data-driven models developed for simulation of human behavior, or those that will include a simulation of human behavior, must begin to move away from the notional data methodology for representing a human trait. Our research is a first step that could lead to the development of a repository of data sets available to model developers, which they could use to import into their military simulations, resulting in more reliable and valid representations of human behavior.

### **C. RECOMMENDATIONS**

This study was too large for a single dissertation. We believe that several future studies should be organized to demonstrate the implementation of the business model within a military joint context. As we have repeated several times, alternative methods must be examined to support success in the fight on terror.

First, an attempt should be made by DoD to replicate the three studies from our research. Each study should have independent agencies access the military across all domains of this research and compare those results. The belief is that most, if not all of the analytical results, will be upheld, but refinement will result.

Second, follow-on research should include all the dimensions of culture and the domains of personality. The interpretation of our results is limited by our failure to examine all the variables from each domain.

Third, the training centers should take into account the number of respondents who suggested joint training and education as a force multiplier. This would require refinement of the Program Of Instructions (POI), which as a former drill sergeant, I am aware is never a popular undertaking. Additionally, the cadre responsible for training students should be made aware of the potential influence that degrading another service may have on student perceptions.

Fourth, the Defense Modeling and Simulation Office should consider our proposed inclusion of social science measures in the verification and validation process. It is stated informally, but human behavior cannot be notionally coded and results in data output resemblant of actual behavior. We believe our technique will add robustness to the models and simulation under development and set a standard similar to those found in the social sciences.

Fifth, the tools being developed to assess cultural orientation and personality should be supported across DoD. The Joint Environment Trust Indicator needs refinement and implementation. Our models provide the basic structure for examining joint operations. Research by the Army Research Laboratory and the Air Force Research Laboratory is examining the multi-cultural team process. Their tools under development can easily be redesigned for the joint team examination we are proposing.

#### **D. FINAL THOUGHTS**

One of the unstated contributions of this work centers on the application of the methodology developed for experimentation. We demonstrated the ability to apply a logical and systematic process for developing creditable models by combining human

behavior research methods, and computer science modeling techniques. We were able to explore, analysis and develop advanced understanding of a complicated problem space. Further, we demonstrate that above the tactical, operational and strategic decision making levels our method to evaluate a problem space provides added integrity to understanding. Our experimentation provides policy makers a framework for more accurate data analysis to utilize in their decision making processes. Additionally, we provide a method to improve team processes by using simple survey and cueing techniques currently being successfully implemented in the business domain. Improved team processes are critical for success in an asymmetric warfare environment.

The evolving state of asymmetric warfare introduces new complexities across the battlespace which limit the effectiveness of problem solving solutions derived by mathematically oriented Operation Research (OR) or technology advances for success. In a state of war where opponents are matched by will and means, symmetric solutions like those proposed by OR and technology, have proven effective to defeat an adversary's power base and create the atmosphere for peace. Typically, this peace is welcomed by friend and foe alike. However, in the asymmetric environment, peace sustainment is fragile. Researchers from outside the OR and systems design domains must embrace the challenge of developing applications for alternative scientific approaches to sustain the fragile balance between war and peace, if success is to be achieved.

Resources are the keys to success but they are not the only variables needed for success. For several years, the in-fighting between the services for the key resources: money, relevance, people, and control was an inconvenience that resembled siblings' struggles. Today, the lives of the young men and women who serve our country demand more from our leadership. No single service is above another, and a rare opportunity presents itself to demonstrate the very principles a democracy tries to demonstrate to those living under tyranny: cooperation, equality, and respect for others. Our research indicates that these principles are applicable to joint teams' effectiveness, however, it does not approach reducing the barriers between the services. We do provide a fundamental new approach to assist today's leadership with methods to improve cooperation, interoperability, and respect.

We understand that resistance to these proposed recommendations will occur. Each service has a vested interest in maintaining its service integrity, tradition, and relevance. We do not disagree. However, if maintaining integrity is solely for the purpose of gaining slim quantities of available resources to simply pursue selfish agendas, then no progress towards interoperability will be made. Our adversaries will continue to rely on our internal struggles and exploit our differences as easily tomorrow as they do today. History is the only proof needed to verify this fact.

As a retired command sergeant major, the one question that has continued to plague me is how many more soldiers, sailors, airmen, and marines will lose their lives before someone in authority says enough? Carl Builder (1989) understood this before others had the courage, in writing, to even suggest that our differences limit our abilities. The idea Builder (1989) expressed was that by better understanding the institutions we serve, the better an opportunity for real change is created. We contend that change can be brought about using the techniques already used in other domains. Our research certainly demonstrates that in the joint environment, better interoperability is achievable. Builder concludes his book with an appropriate summation for our work:

If we can deal with these institutions in the light of their personalities, we shall be looking past the masks they have used too long to hide legitimate, but less noble, motivations and interests: the masks of war. (Builder, p. 206).

## APPENDIX A. IRB PAPERWORK

### Cover Sheet



**Dr. Rudy Darken**  
**MOVES Institute, Director**  
**Naval Postgraduate School**  
**Monterey, California 93943**

**831-656-7588**  
**DSN: 756-7588**  
**Fax: 831-656-7599**  
**darken@nps.edu**

To: Protection of Human Subjects Committee

Subject: Application for Human Subjects Review for:

**Modeling Macro-Cognitive Influence on Information Sharing between Joint Team Members**

1. Attached is a set of documents outlining surveys, direct observation, audio and video recordings, interviews, and focus group studies to be conducted at NPS.
2. We are requesting approval of the described experimental protocol. An outline is included for your reference that describes the methods and measures we plan to use.
3. We include the consent forms, privacy act statements, materials, and forms that a participant will read or fill out while in the experiment.
4. We understand that any modifications to the protocol or instruments/measures will require submission of updated IRB paperwork and possible re-review. Similarly, we understand any untoward event or injury involving a research participant will be reported immediately to the IRB Chair and NPS Dean of Research.

Rudy Darken, PhD

|  |  |
|--|--|
| APPLICATION FOR<br><br>HUMAN SUBJECTS REVIEW (HSR)   | HSR NUMBER <i>(to be assigned)</i>                             |
| PRINCIPAL INVESTIGATOR(S) <i>(Full Name, Telephone)</i><br>Rudy Darken, Ph.D., 831-656-7588 DSN: 756-7588 Fax: 831-656-7599<br>Steve Burnett, 831-241-8299 Fax: 831-656-7599   |  |
| APPROVAL REQUESTED <input checked="" type="checkbox"/> New <input type="checkbox"/> Renewal  |  |
| LEVEL OF RISK <input type="checkbox"/> Exempt <input checked="" type="checkbox"/> Minimal <input type="checkbox"/> More than Minimal<br>Justification:   |  |
| WORK WILL BE DONE IN (Site/Bldg/Rm)<br>Glasgow 221, MOVES, Defense Language<br>Institute, and other field locations as needed  | ESTIMATED NUMBER OF DAYS<br>TO COMPLETE<br>365                 |
| MAXIMUM NUMBER OF SUBJECTS<br>1500   | ESTIMATED LENGTH OF EACH<br>SUBJECT'S PARTICIPATION<br>2 hours |
| SPECIAL POPULATIONS THAT WILL BE USED AS SUBJECTS<br><input type="checkbox"/> Subordinates <input type="checkbox"/> Minors <input checked="" type="checkbox"/> NPS Students <input type="checkbox"/> Special Needs (e.g. Pregnant women)<br>Specify safeguards to avoid undue influence and protect subject's rights:<br>Special care will be taken to preserve anonymity in all data collection. Written documentation will be identified by number only, and faces and voices may be obscured on video recordings. |  |
| OUTSIDE COOPERATING INVESTIGATORS AND AGENCIES   |  |
| TITLE OF EXPERIMENT AND DESCRIPTION OF RESEARCH (attach additional sheet if needed).<br>See attached sheet   |  |
| I have read and understand NPS Notice on the Protection of Human Subjects. If there are any changes in any of the above information or any changes to the attached Protocol, Consent Form, or Debriefing Statement, I will suspend the experiment until I obtain new Committee approval.   |  |
| SIGNATURE _____  | DATE _____   |
| SIGNATURE _____  | DATE _____   |



## PARTICIPANT CONSENT FORM

1. Initial: \_\_\_\_\_ **Introduction.** You are invited to participate in a study of cultural orientation and personality differences using web-based and hand written surveys and/or team effectiveness war-gaming etc task environment. With information gathered from you and other participants, we hope to discover the macro-cognitive influences on information sharing affecting team performance. Please read and sign this form indicating that you agree to be in the study. Please feel free to ask any questions you may have before signing.
2. Initial: \_\_\_\_\_ **Background Information.** Personnel and faculty from the Naval Postgraduate Modeling, Virtual Environments and Simulations Institute, the Human System Integration Laboratory and Team Performance Center are conducting this study.
3. Initial: \_\_\_\_\_ **Procedures.** If you agree to participate in this study, the researcher will explain the tasks in detail. There will be several sessions, which include written questionnaires, web-based surveys, and/or participation in a war-game tactical scenario.
4. Initial: \_\_\_\_\_ **Risks and Benefits.** This research involves no risk or discomfort other than answering personality inventories and cultural sensitivity/adaptability questionnaires. Audio and video recordings of your participation will be made if you consent (item 9 below). Your participation will contribute to improving the effectiveness of information sharing in a joint team and the development of agent-based models to explore Sustainment and Stability Operations (SASO).
5. Initial: \_\_\_\_\_ **Compensation.** No tangible reward will be given. A copy of the results will be available to you at the conclusion of the experiment.
6. Initial: \_\_\_\_\_ **Confidentiality.** The records of this study will be kept confidential. Special care will be taken to preserve anonymity in all data collection. Written documentation will be identified by participant number only. No information which could identify you as a participant will be made accessible to your military unit, your supervisors, or to the public.
7. Initial: \_\_\_\_\_ **Voluntary Nature of the Study.** If you agree to participate, you are free to withdraw from the study at any time without prejudice. You will be provided a copy of this form for your records.
8. Initial: \_\_\_\_\_ **Points of Contact.** If you have any further questions or comments after the completion of the study, you may contact the principal researcher, Rudy Darken, PhD, at (831) 656-7588, DSN: 756-7588, [darken@nps.edu](mailto:darken@nps.edu) or Steve Burnett at (831) 241-8299, [sburnett@nps.edu](mailto:sburnett@nps.edu)
9. Initial: \_\_\_\_\_ **Consent to Video and Audio Recording.** I agree that audio and video recordings of my participation in this research may be made. I agree that the recordings may be:  
 Initial: \_\_\_\_\_ Studied by members of the research team,  
 Initial: \_\_\_\_\_ Shown to other researchers, research participants, and students, and  
 Initial: \_\_\_\_\_ Used in future training.
10. Initial: \_\_\_\_\_ **Statement of Consent.** I have read the above information. Any questions I had concerning this research have been answered to my satisfaction. I agree to participate in this study.

|   |             |
|---|-------------|
| <b>Signature of Researcher</b>            | <b>Date</b> |
|   |             |
| <b>Signature of Voluntary Participant</b> | <b>Date</b> |
|   |             |

**MINIMAL RISK CONSENT STATEMENT**  
 NAVAL POSTGRADUATE SCHOOL, MONTEREY, CA 93943

Participant: VOLUNTARY CONSENT TO BE A RESEARCH PARTICIPANT IN: Modeling Macro-cognitive Influence on Information Sharing between Joint Team Members,

1. I have read, understand and been provided "Information for Participants" and the "Participant Consent Form" that provides the details of the below acknowledgments.
2. I understand that this project involves research. An explanation of the purposes of the research, a description of procedures to be used, identification of experimental procedures, and the extended duration of my participation have been provided to me.
3. I understand that this project involves only minimal risk. I have been informed of any reasonably foreseeable risks or discomforts to me.
4. I have been informed of any benefits to me or to others that may reasonably be expected from the research.
5. I have signed a statement describing the extent to which confidentiality of records identifying me will be maintained.
6. I have been informed of any compensation and/or medical treatments available if injury occurs and if so, what they consist of, or where further information may be obtained.
7. I understand that my participation in this project is voluntary; refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled. I also understand that I may discontinue participation at any time without penalty or loss of benefits to which I am otherwise entitled.
8. I understand that the individual to contact should I need answers to pertinent questions about the research is Dr. Rudy Darken, Principal Investigator, and about my rights as a research participant or LTC Eric Morgan, MC, USA, Commanding Officer of the Presidio of Monterey Health Clinic. A full and responsive discussion of the elements of this project and my consent has taken place. NPS Medical Monitor: LTC Eric Morgan, MC, USA, [eric.morgan@nw.amedd.army.mil](mailto:eric.morgan@nw.amedd.army.mil), (831) 242-7550, doctor on-call pager: (831) 648-2177.

| Signature of Researcher            | Date |
|------------------------------------|------|
|                                    |      |
| Signature of Voluntary Participant | Date |
|                                    |      |

**PRIVACY ACT STATEMENT**

NAVAL POSTGRADUATE SCHOOL, MONTEREY, CA 93943

**PRIVACY ACT STATEMENT**

1. Purpose: The data collected from this research, *Modeling Macro-cognitive Influence on Information Sharing between Joint Team Members*, will assist in understanding and modeling the macro-cognitive human behaviors of cultural orientation and personality differences into computer simulations.
2. Use: Research data from this study will be used for statistical analysis by the Department of Defense and other U.S. Government agencies provided this use is compatible with the purpose for which the information was collected. The Naval Postgraduate School, in accordance with the provisions of the Freedom of Information Act, may grant use of the information to legitimate non-government agencies or individuals.
3. Disclosure/Confidentiality:
  - a. I have been assured that my privacy will be safeguarded. I will be assigned a control or code number, which thereafter will be the only identifying entry on any of the research records. The Principal Investigator will maintain the cross-reference between name and control number. It will be decoded only when beneficial to me or if some circumstances, which are not apparent at this time, would make it clear that decoding would enhance the value of the research data. In all cases, the provisions of the Privacy Act Statement will be honored.
  - b. I understand that a record of the information contained in this Consent Statement or derived from the experiment described herein will be retained permanently at the Naval Postgraduate School or by higher authority. I voluntarily agree to its disclosure to agencies or individuals indicated in paragraph 3 and I have been informed that failure to agree to such disclosure may negate the purpose for which the experiment was conducted.
  - c. I also understand that disclosure of the requested information, including my Social Security Number, is voluntary.

|  |             |
|--|-------------|
| <b>Name, Rank (please print)</b>         |             |
|  |             |
| <b>Signature of Voluntary Participan</b> | <b>Date</b> |
|  |             |



## PARTICIPANT INFORMATION FORM

To all research study participants:

You are invited to participate in a research study at the Naval Postgraduate School. Your participation will help improve our understanding of human behavior in network-centric operations. Please read the description of the research on the following three pages, and initial and sign where requested.

This is not a test of your skills or abilities. I want to emphasize that your participation or non-participation in this study will have no effect on your current or future military status. Information sharing, not the individual participant, is being evaluated. While there are questions of you pertaining to personality and cultural sensitivity/ adaptability, none of this information, nor your participation in this research, will be entered into your military record or released to your current command.

Please do not discuss any part of the study with other students or potential participants until the study has concluded (around December 2006). We want all participants to be equally prepared during the study, and no one to be "coached" or otherwise prepped beforehand.

During the study, you will answer questions from a personality questionnaire, a cultural survey, and a web-based application. Additionally, some participants will engage in a war-game scenario involving information sharing to select one of four possible courses of actions to recommend to a commander. Ask as many questions as you like of the instructors or researchers. The war-game exercise and the exit interview will be video-taped and audio-recorded so there is a release form that we ask you to sign so that we may use the recordings. These standard consent forms are always required in any kind of research on people. I do not believe there is the slightest risk to your health or to your privacy.

Please fill out the enclosed survey. If you have any questions about the survey, we will answer them during the group training session.

Please don't hesitate to ask us any questions you may have at any time during the study. Thank you for your participation.

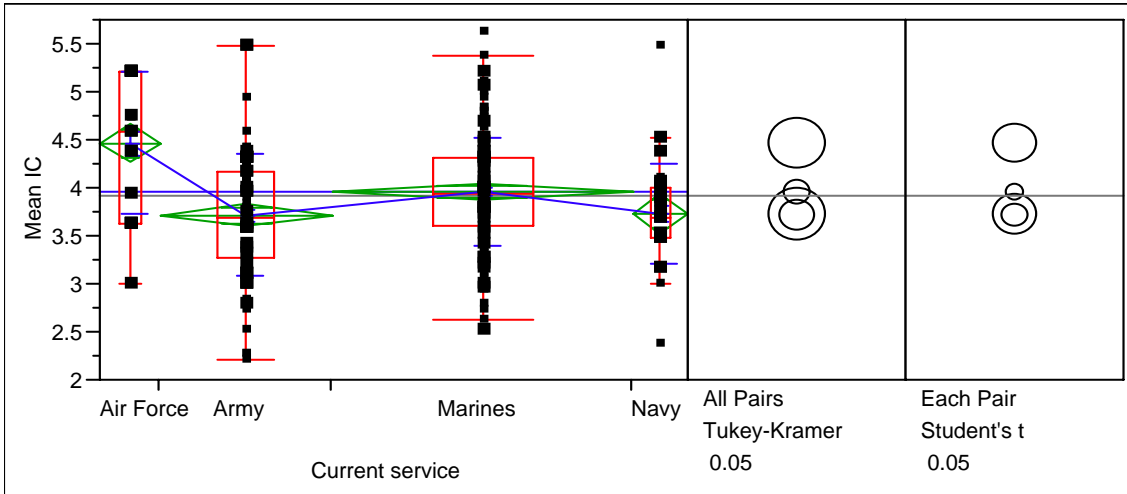
Sincerely,

Mr. Steve Burnett  
CSM (R)  
Department of Army Civilian

## APPENDIX B. ADDITIONAL BOX PLOTS AND GRAPHS

Figure 24 provides the box plots for the cultural dimensions: Individualism/Collectivism and Mastery/Harmony.

### Individualism



### Mastery

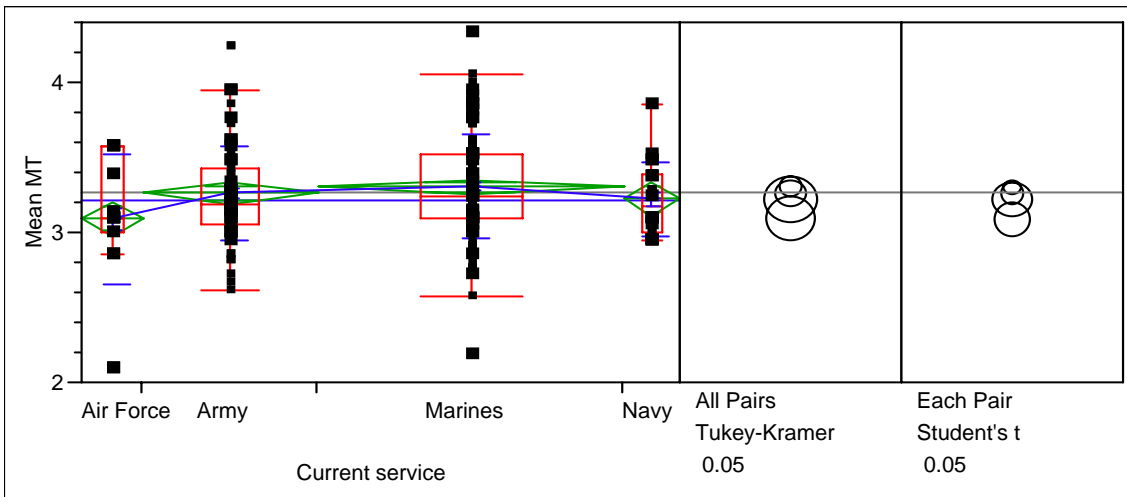
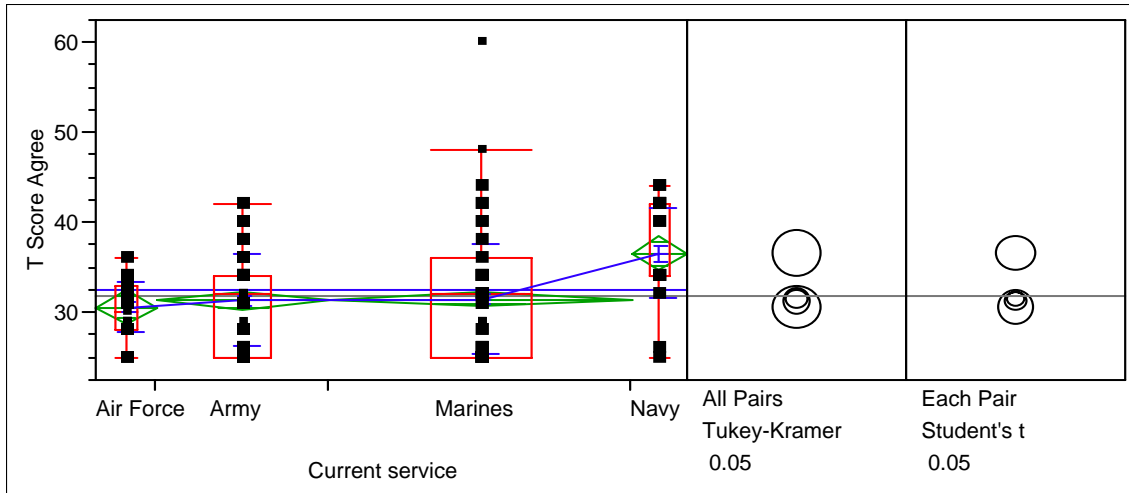


Figure 24. Box plots for Cultural Orientation Dimensions: Individualism and Mastery.

Figure 25 provides the box plots for the personality domains: Agreeableness and Conscientiousness.

## Agreeableness



## Conscientiousness

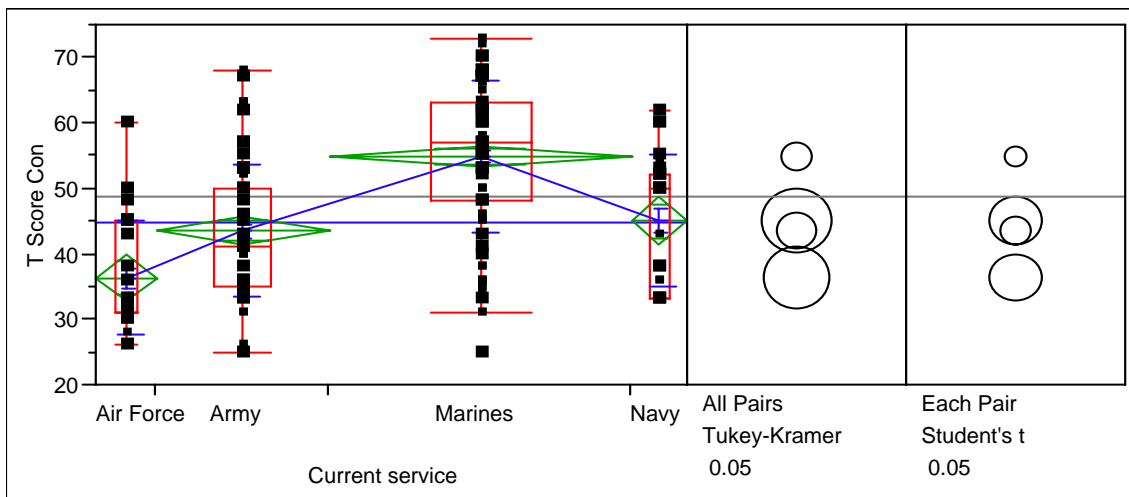


Figure 25. Box plots for Personality Domains: Agreeableness and Conscientiousness.

## **APPENDIX C. ONLINE SURVEY**

### **1. Purpose**

To all research study participants:

You are invited to participate in a research study being conducted by researchers and students from the Naval Postgraduate School. Your participation will help improve our understanding of human behavior in Network-Centric Operations. Please read the description of the research on the following pages, and initial where requested.

This is not a test of your skills or abilities. I want to emphasize that your participation or non-participation in this study will have no effect on your current or future military status. Information sharing, not the individual participant, is being evaluated. While there are questions of you pertaining to personality and cultural sensitivity/adaptability, none of this information, nor your participation in this research, will be entered into your military record or released to your current command. Your identity and responses will remain private.

Please do not discuss any part of the study with other students or potential participants until the study has concluded (around December 2006). We want all participants to be equally prepared during the study, and no one to be "coached" or otherwise prepped beforehand. During the study, you will answer questions from a personality questionnaire and a cultural survey using a web-based application.

Additionally, there are fill-in-the-blank questions. Please read the standard consent forms on the following pages. There is no risk to your health or to your privacy. Please do not hesitate to ask any questions you may have. You can email your questions to [sburnett@nps.edu](mailto:sburnett@nps.edu). Thank you for your participation.

Sincerely,  
Mr. Steve Burnett  
CSM (R)  
Department of Army Civilian

## **2. Informed Consent**

### **PARTICIPANT CONSENT FORM**

#### **1.Introduction.**

You are invited to participate in a study of cultural orientation and personality differences using web-based surveys. With information gathered from you and other participants, we hope to discover the macro-cognitive influences on information sharing affecting team performance. Please read this form and by proceeding you are indicating that you agree to be in the study. If you have any questions, please contact Steve Burnett at [sburnett@nps.edu](mailto:sburnett@nps.edu).

#### **2.Background Information.**

Personnel and faculty from the Naval Postgraduate Modeling, Virtual Environments and Simulations (MOVES) Institute, the Human System Integration Laboratory (HSIL) and Team Performance Center are conducting this study.

#### **3.Procedures.**

If you agree to participate in this study, the procedures to complete this survey will be explained as you proceed with each section.

#### **4.Risks and Benefits.**

This research involves no risk or discomfort other than the slight possibility associated with use of a computer. Your participation will contribute to improving the effectiveness of information sharing in a joint team and the development of agent-based models to explore Sustainment and Stability Operations (SASO).

#### **5.Compensation.**

No tangible reward will be given. A copy of the results will be available to you at the conclusion of the experiment.

#### **6.Confidentiality.**

The records of this study will be kept confidential. Special care will be taken to preserve anonymity in all data collection. Written documentation will be identified by participant number only. No information which could identify you as a participant will be made accessible to your military unit, your supervisors, or to the public.

#### **7.Voluntary Nature of the Study.**

If you agree to participate, you are free to withdraw from the study at any time without prejudice. If you desire, a copy of this form will be provided at no cost to you. Simply provide an address for this form to be sent to.

#### **8.Points of Contact.**

If you have any further questions or comments after the completion of the study, you may contact the principal researcher, Rudy Darken, PhD, at (831) 656-7588, DSN: 756-7588, [darken@nps.edu](mailto:darken@nps.edu) or Steve Burnett at (831) 241-8299, [sburnett@nps.edu](mailto:sburnett@nps.edu)



9.Statement of Consent.

I have read the above information. If I have questions I understand I can email or call CSM (R) Steve Burnett at sburnett@nps.edu or 831-241-8299 before proceeding. You are required to initial in the line below

\_\_\_\_\_Signature  
\_\_\_\_\_Date

### 3. Instructions

The following pages contain a series of six surveys totaling 140 questions. You may contact me at sburnett@nps.edu or call collect to 831-241-8299.

The first section is a demographics survey followed by a series of surveys. The instructions for each section head that page and explain the method to complete that section. Please do not rush. Give your honest opinion for each survey item. If you decide to stop taking the survey for any reason, simply exit. Pilot studies indicate that it will take between 20 to 40 minutes to complete the entire survey. Thank you again for your participation.

#### 4. Demographics

**Please provide the information requested below. Any item that does not pertain to you can be skipped.**

**1. What is your current age and at what age did you enter the military or school.**

Current Age \_\_\_\_\_ Age When Entered Military \_\_\_\_\_

**2. What military service are you or were you a member of? (Place an X to indicate answer.)**

Air Force \_\_\_\_\_ Army \_\_\_\_\_ Marine \_\_\_\_\_ Navy \_\_\_\_\_

**3. If you have been a member of another service, indicate all that apply. (Place an X to indicate answer.)**

Air Force \_\_\_\_\_ Army \_\_\_\_\_ Marine \_\_\_\_\_ Navy \_\_\_\_\_

**4. Were one or both of your parents members of the military while you were growing up? If yes, indicate the number of years in the menu item.**

|             | Mother | Father |
|-------------|--------|--------|
| Air Force   | _____  | _____  |
| Army        | _____  | _____  |
| Marines     | _____  | _____  |
| Navy        | _____  | _____  |
| Coast Guard | _____  | _____  |

**5. Within your branch, what job were you trained for? (Examples: Artillery, Infantry, Aviator, -Fixed-Wing, Surface Warfare - Communications, etc.) . Please do not abbreviate your answer with service specific acronyms. Spell out your job specialty completely.**

\_\_\_\_\_

**6. What is your gender? (Place an X to indicate answer.)**

Male \_\_\_\_\_ Female \_\_\_\_\_

**7. What is/was your rank? \_\_\_\_\_**

**8. What is or was your total Time in Service (TIS)?**

Years (Still Serving) \_\_\_\_\_ Previous service or Retired TIS \_\_\_\_\_

**9. If you have been a member of a Joint service team of any type, what other services were represented? (Place an X to indicate answer.)**

Air Force \_\_\_\_\_ Army \_\_\_\_\_ Marines \_\_\_\_\_ Navy \_\_\_\_\_

**10. If you are an Officer with prior enlisted service, indicate the length of time you were enlisted and with what service.**

|           | Years |
|-----------|-------|
| Air Force | _____ |
| Army      | _____ |
| Marines   | _____ |
| Navy      | _____ |

**11. If you are an officer, how did you receive your commission?**

|                 |       |          |       |
|-----------------|-------|----------|-------|
| Service Academy | _____ | Where    | _____ |
| ROTC            | _____ | Where    | _____ |
| OCS             | _____ |          |       |
| Other           | _____ | Describe | _____ |

---

### Survey One

**INSTRUCTIONS:** Please indicate how **IMPORTANT** it is for you to do the following when interacting with other members of **YOUR** service. (Place an **X** in the column that best indicates your answer.)

#### Matsumoto Individual/Collectivism Inventory

5. 6. Survey Two

6.

**INSTRUCTIONS:** When interacting with members of **YOUR** service with a **HIGHER STATUS** (rank, social standing, etc), how appropriate do you believe each of the following are?

#### Matsumoto Status Differentiation Inventory

7. Survey Three

**INSTRUCTIONS:** Using the scale provided, indicate your opinion for each item.

#### Matsumoto Emotion Regulation Inventory

8. Survey Four

As with the preceding survey, please indicate your opinion for each item.

#### Matsumoto Mastery Inventory

**9. Fill in the blank**

The next portion of the survey asks you to describe all the military services by providing words that indicate positive and negative attributes of each.

Please think carefully about your experience, what you have heard and what you have read when selecting these attributes.

**82. Indicate, by an x or check mark, which positive and negative characteristics you believe accurately portray each service's attributes. Select as many as you believe are appropriate.**

|              | Air Force | Army | Marines | Navy |
|--------------|-----------|------|---------|------|
| Aloof        |           |      |         |      |
| Anxious      |           |      |         |      |
| Calm         |           |      |         |      |
| Careless     |           |      |         |      |
| Cautious     |           |      |         |      |
| Confident    |           |      |         |      |
| Demanding    |           |      |         |      |
| Efficient    |           |      |         |      |
| Enthusiastic |           |      |         |      |
| Excitable    |           |      |         |      |
| Friendly     |           |      |         |      |
| Imaginative  |           |      |         |      |
| Impulsive    |           |      |         |      |
| Optimistic   |           |      |         |      |
| Suspicious   |           |      |         |      |
| Thorough     |           |      |         |      |
| Tolerant     |           |      |         |      |
| Trusting     |           |      |         |      |
| Withdrawn    |           |      |         |      |
| Worrier      |           |      |         |      |

**83. If you believe there are other word descriptors that were not listed in question 82, use this space to add your own.**

|           |
|-----------|
| Air Force |
| Army      |
| Marines   |
| Navy      |

**84. Please indicate your desire to work as a member of a team composed of a member from another service.**

|           | Strongly Adverse | Adverse | Slightly Adverse | Neutral | Slightly Willing | Willing | Very Willing |
|-----------|------------------|---------|------------------|---------|------------------|---------|--------------|
| Air Force |                  |         |                  |         |                  |         |              |
| Army      |                  |         |                  |         |                  |         |              |
| Marines   |                  |         |                  |         |                  |         |              |
| Navy      |                  |         |                  |         |                  |         |              |

**10. Survey Six**

This survey asks you to indicate your belief about the statement. Please answer as you believe the typical member of each service would respond. Do not linger on a question if it does not make sense for the military. Simply mark “neutral” and move to the next question. Read each statement carefully and indicate your opinion.

**Neo FFI Inventory**

**11. Final Survey**

Please complete the last two fill-in-the-blank sections.

**144. If you could influence or recommend one change to improve Joint Team Effectiveness, what would you recommend?**

**145. Use this block for any additional comments. Also you can use this section to revise an answer or add to an answer, since you are unable to go back in the survey to do so.**

#### **DEBRIEF**

**You have completed the survey. Your participation will assist in several efforts to understand, describe, and improve team effectiveness where teams are composed of members from joint, multinational, and inter-agency components.**

**Your responses, along with your colleagues', will help develop profiles of military culture and identify potential blockages to information sharing between differing organizations. The business community has understood for many years that different cultural orientation and personality stereotypes influence marketing and sales in the global economy. The State Department and the Department of Defense now realize that the lives of the young men and woman who serve our country are more valuable than whether we can sell products more efficiently.**

**THIS RESEARCH WILL DIRECTLY INFLUENCE THE LIVES OF THESE YOUNG MEN AND WOMEN. YOUR PARTICIPATION INSURES THAT THE LEADERS AT ALL LEVELS WILL HAVE THE SKILLS AND TRAINING NECESSARY TO LEAD THE INFORMATION AGE OF WARFARE DEVELOPMENT.**

**Lastly, if you would like the results of this research emailed or sent to you at no cost, please provide me with your address. As stated in the informed consent, you may contact me at any time if further discussion is desired. You have my sincerest thanks for assisting in this effort.**

**Steve Burnett  
Command Sergeant Major (Retired), US Army  
Doctoral Candidate  
Naval Postgraduate School  
sburnett@nps.edu  
831-241-8299**

## **APPENDIX D. INITIAL WARGAME DOCUMENTS**

### **A. Consent and Demographics Documents**

#### **Purpose**

To all research study participants:

You are invited to participate in a research study being conducted by researchers and students from the Naval Postgraduate School. Your participation will help improve our understanding of human behavior in Network-Centric Operations. Please read the description of the research on the following pages, and initial where requested.

This is not a test of your skills or abilities. I want to emphasize that your participation or non-participation in this study will have no effect on your current or future military status. Information sharing, not the individual participant, is being evaluated. Your identity and responses will remain private.

Please do not discuss any part of the study with other students or potential participants until the study has concluded (around December 2006). We want all participants to be equally prepared during the study, and no one to be "coached" or otherwise prepped beforehand.

Please read the standard consent forms on the following pages. There is no risk to your health or to your privacy. Please do not hesitate to ask any questions you may have. You can email your questions to [sburnett@nps.edu](mailto:sburnett@nps.edu). Thank you for your participation.

Sincerely,

Mr. Steve Burnett

CSM (R)

Department of Army Civilian

**Demographics**

**Please provide the information requested below. Any item that does not pertain to you can be skipped.**

**1. What is your current age and at what age did you enter the military or school.**

Current Age\_\_\_\_\_ Age When Entered Military\_\_\_\_\_

**2. What military service are you or were you a member of? (Place an X to indicate answer.)**

Air Force \_\_\_\_\_ Army\_\_\_\_\_ Marine\_\_\_\_\_ Navy\_\_\_\_\_

**3. If you have been a member of another service indicate all that apply. (Place an X to indicate answer.)**

Air Force \_\_\_\_\_ Army\_\_\_\_\_ Marine\_\_\_\_\_ Navy\_\_\_\_\_

**4. Were one or both of your parents members of the military while you were growing up? If yes, indicate the number of years in the menu item.**

|           | Mother | Father |
|-----------|--------|--------|
| Air Force | _____  | _____  |
| Army      | _____  | _____  |
| Marines   | _____  | _____  |
| Navy      | _____  | _____  |

**5. Within your branch, what job were you trained for? (Examples: Artillery, Infantry, Aviator-Fixed Wing, Surface Warfare - Communications, etc.) . Please do not abbreviate your answer with service specific acronyms. Spell out your job specialty completely.**

---

**6. What is your gender? (Place an X to indicate answer)**

Male\_\_\_\_\_ Female\_\_\_\_\_



**7. What is/was your rank?** \_\_\_\_\_

**8. What is or was your total Time in Service (TIS)?**

Years (Still Serving) \_\_\_\_\_ Previous service or Retired  
TIS \_\_\_\_\_

**9. If you have been a member of a Joint service team of any type, what other services were represented. (Place an X to indicate answer.)**

Air Force \_\_\_\_\_ Army \_\_\_\_\_ Marines \_\_\_\_\_ Navy \_\_\_\_\_

**10. If you are an Officer with prior enlisted service, indicate the length of time you were enlisted and with what service.**

Years

Air Force \_\_\_\_\_

Army \_\_\_\_\_

Marines \_\_\_\_\_

Navy \_\_\_\_\_

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## **APPENDIX E. WARGAME DOCUMENTS - SEAT INFORMATION**

### **Seat One**

#### **Leader**

#### **Intelligence Information Update**

**2006 – 24 April – 0200**

#### **1. Commands Intent – South China Sea Mission**

Commanders Intent is to establish China as the single proprietor of the South China Sea (SCS), to develop a strategic stronghold over the region and insure peaceful coexistence with the countries bordering the SCS. China has long insisted that the SCS was proprietary and now demands international recognition of their legal right to ownership. The Commander of Red Cell has binding and legal authority from the Chinese Government to use all means possible to insure rapid and complete control of the entire region.

#### **2. Command Options for All Combatant Commanders**

The established order of priorities for all courses of actions are:

Attack  
Defend  
Delay  
Withdraw  
Reinforce

#### **3. Current Operation**

Chinese forces are preparing to deploy to the Spratly Islands located 1280 KM from Pratas Island. Carrier group NEWCON has maneuvered to the North Western side of Pratas Island and begun occupation of the Island. Pratas Island is being established as a strategic location. Current plans are to establish a higher headquarters on Pratas Island as combat operations unfold. The primary mission for deploying forces on Pratas Island is to establish and secure the island for sea and air logistic operations in support of the Spratly, Palawan and South China Sea actions.

Currently, land forces from the 46<sup>th</sup> Mechanized Infantry Division have secured the western shores and are moving to secure the entire Island.

The NEWCON Carrier Battle Group has established continuous fighter and helicopter operations in support of the initial landing. Current flight operations extend out to a 250 miles radius from Pratas. Diesel and Nuclear Submarines are currently deployed between Pratas Island and the Chinese coast, between Pratas and Spratly Islands and between Taiwan and Pratas Island.

The landing strip has been secured. Logistical and security flight operations have commenced. Of concern to the commander is the report of a blue special force unit on the eastern coast of Pratas island.

#### **4. Force Deployment**

Current force deployments are displayed on the Pratas Overlay 04-01-2A. Initial occupations are from the northwestern port and the landing strip along the entire western coastline. Movement to secure the island is to the southeast with small boat support around the island and reefs.

#### **5. Mission For Commander Red Cell**

Develop Pratas Island as the Red Cell operational base for support to South Sea Operations. Secure and defend. Develop port operations for resupply and logistical operations.

#### **6. Objectives**

Take control of the South China Sea. Establish the Spratly Islands, Palawan and Pratas Island as control points for security and management of the sea lanes.

#### **7. Logistics**

Current port operations have established logistical supply points to support Red Cell forces. Off-load is complete to support current operations. Development for follow-on operations across the SCS have not begun. Current supplies of ammunition, food, water, repair parts, petroleum, hospital supplies, and barrier equipment are Code Green (Logistics Support for next 30 days available at current level of Operations Tempo – OPTEMPO).

#### **8. Staff Preparation**

The current operational planning has been ongoing for many years. The staff is established, each position has a competent person assigned with a replacement identified. They are well rehearsed and prepared for many contingency operations. Communications between the different staff members include highly sophisticated equipment as well as back up measures in the event of EPW attacks. These measures are

tested and effective. One weakness of the staff is the lack of operation experience during actual combat operations.

**Seat Two**

**Intelligence Information Update**

**2006 – 24 April – 0200**

**1. China Complete Combat Power and Force Structure**

|                                     | <b>Personnel</b> |   |                              |
|-------------------------------------|------------------|---|------------------------------|
| <b>Army</b><br>Brigades             | 1.5 Million      | 40 Maneuver Divisions                   | 40 Maneuver                  |
| <b>Navy</b>                         | 260,000          | 60 Surface ships<br>50 Amphibious Ships | 66 Sub Surface<br>2 Carriers |
| <b>Air Force</b><br>6500 Transports | 400,000          | 4300 Tactical Fighters                  | 1000 Bombers                 |

**2. Air Support**

Multiple aircraft are deployed and protecting the region. The extent of air superiority is unknown. Current estimates indicate the Chinese force capable of 24 hour continuous and undenied air space. Several UAV's (CH-1, D-4 and ASN-206) are deployed and operational.

Fighter support includes Air Force, Army and Naval aircraft. Estimates of force size are unavailable but believed to be adequate to support current operations around Pratas Island.

**3. Reserve Reinforcement Support**

(Details of internal composition of the forces are not of value to the current operation)

LAND: Employability – one week  
The 28<sup>th</sup> Army Group is supporting the Pratas Island Red Cell Operations.

70<sup>th</sup> Motorized Infantry Div.  
71<sup>st</sup> Infantry Div  
1 Armored Div (Reserve)

NAVAL: Employability – 96 hours  
Southern Fleet Battle Group

Naval Air Force, SSF  
32<sup>nd</sup> Submarine Flotilla

8 NAF Div  
U/I Destroyer Flotilla

AIR: Employability – 48 to 72 hours

44<sup>th</sup> Airborne Div

39<sup>th</sup> Fighter Div

11<sup>th</sup> Attack Div

34<sup>th</sup> Air Division

#### **4. Air Defense Support**

Chinese forces have deployed a partial FT 2000 BN. Equipment includes one battery PLT of FT 2000, surface to air missile commonly referred to as the AWACS killer. Forces are located along the western shoreline of Pratas island.

The Chinese have at least a battery of HQ 17 deployed. The HQ 17 SAM system is capable of engaging not only aircraft and helicopters, but also RPVs, precision-guided weapons, and various types of guided missiles. Effective range limits are from 1500 to 12000 m with target altitude limits being between 10 and 6000 m.

#### **5. Artillery Support**

Chinese artillery support is missile and convention munitions based. Currently there are two battalions on. One battalion of CSS 6 Short Range Ballistic Missiles (SRBM) and two battalions of conventional artillery are established as shore batteries. 105mm and 120mm battalions are operational.

#### **6. Naval Support**

##### Surface

China has a total of 40 frigates, 20 destroyers and an unknown number of small vessels deployed in support of the operation. Located close to Pratas Island are 5 frigates, 2 destroyers and at least 50 small vessels serving as patrol boats. Ten amphibious landing craft are located in the port close to.

##### Sub Surface

Of the 60 diesel and 6 nuclear boats deployed, 5 diesel boats and 2 nuclear boats are in the vicinity. No accurate location is known at this time.

#### **7. Sensors**

Current Special Operations Forces are deployed on the eastern coast of Pratas Island with good communications established with HQ's Red Cell.

Satellite imagery is available and being transmitted to Commander Red Cell after evaluation by Intelligence staff on Chinese mainland.

Subsurface sensors are deployed around Pratas Island with plans for additional deployments over the next 48 hours.

Surface sensors aboard surface vessels are operational and tied to all Air Defense assets in the area.

Lack of sensors focused on the Spratly Islands and Palawan are a concern for Commander, Red Cell.

## **8. Command and Control**

Chinese leaders have developed and established a formidable C2. All agencies are linked to each other and have access. There is evidence that the linkage is weak across certain boundaries due to mistrust and political aspirations, but these weaknesses need to be probed to determine their vulnerability.

Doctrine for all C2 operations includes highly sophisticated communication systems, rapid intelligence updates, and operational flexibility due to the large force structure. Breakdowns occur primarily when the OPTEMPO reaches a saturation point and the commanders delay decisions pending clarification from higher up. The lack of operational combat experience negatively affects the C2 system and decision-making.



## Seat Three

### Intelligence Information Update

2006 – 24 April – 0200

#### 1. Island Demographics

Uninhabited due to continued disputes between China, Vietnam and Japan as to rightful ownership. The island is 18.8 km long and 14.8 km wide. White sand beaches surround most of the island with light brush and trees extending approximately 6 km into the interior where the foliage becomes heavy. Elevation is sea level to approximately 1200 feet above sea level on Mt. Pratas.

Pratas Island is in the north part of the South China Sea, near the Pescadores (Penghu Islands), and is very close to Taiwan. Pratas Island is at the mid-point between South Taiwan, Hong Kong, and the Pearl River estuary.

The island has a runway 4,921 feet long and two man-made piers which are located in the northwestern corner of the island. There is ample room for port development.

#### Natural Environment

The Pratas Islands are situated on the Pratas Terrace in the northern part of the South China Sea. They are formed from a series of reef flats, and cover an area around 150 km long and 30 km wide. The Pratas Islands include three coral atolls. From north to south, these are: North Vereker Atoll, South Vereker Atoll and Pratas Atoll. South Vereker Atoll and Pratas Atoll are continuous shoals. The reefs are shaped like an ellipse, and are submerged beneath the water. Pratas Reef is a typical atoll. Pratas Island is at the west end of Pratas Atoll. It is the only island exposed above the sea surface in the Pratas Atoll. The Pratas Atoll was recorded on the "Ch'ing Dynasty Unifies China for A Thousand Years Map" (printed in 1767) under the name "Nan Awo Chi."

#### 2. Weather

HONG KONG ADJACENT WATERS: PRATAS ISLAND  
WINDS - EAST FORCE 4 TO 5  
BECOMING SOUTH TO SOUTHEAST FORCE 4 LATER.  
MODERATE TO HEAVY FOG 0100-1000, THUNDERSTORMS ONGOING.  
MODERATE SEAS.

Visibility is degraded over the next 4 days with a weather system moving through the area. Small and medium boat advisories have been issued for China coastal regions. All South China Sea areas are included.

## Weather Forecast

|           | <b>Today</b> | <b>Tomorrow</b> | <b>Next day</b> | <b>Follow on week</b>      |
|-----------|--------------|-----------------|-----------------|----------------------------|
| <b>Hi</b> | 78           | 79              | 80              | 78 - 82                    |
| <b>Lo</b> | 77           | 78              | 78              | 77 - 79                    |
| <b>FC</b> | Rain         | T-storms        | T-storms        | Moderate to Heavy T-storms |

### 3. Daylight

|         |               |      |
|---------|---------------|------|
| Sunrise | Approximately | 0610 |
| Sunset  | Approximately | 1825 |

### 4. Tide Schedule

| Low1       | Meters | High1       | Meters |
|------------|--------|-------------|--------|
| 1:02<br>am | .17    | 11:19<br>am | .70    |
| 2:25<br>am | .38    | 11:54<br>am | .98    |
| 4:27<br>am | .34    | 12:25<br>pm | .95    |
| 6:11<br>am | .24    | 1:22<br>pm  | .86    |
| 6:52<br>am | .38    | 3:06<br>pm  | .89    |
| 7:21<br>am | .19    | 4:48<br>pm  | .72    |
| 7:43<br>am | .28    | 6:06<br>pm  | .83    |
| 8:02<br>am | .24    | 7:03<br>pm  | .85    |
| 8:18<br>am | .33    | 7:51<br>pm  | .92    |
| 8:38<br>am | .27    | 8:35<br>pm  | .88    |
| 8:49<br>am | .40    | 9:14<br>pm  | 1.1    |
| 9:12<br>am | .35    | 9:58<br>pm  | .98    |
| 9:31<br>am | .22    | 10:48<br>pm | .26    |
| 9:52<br>am | .17    | 11:39<br>pm | .70    |

Illumination

Last Quarter moon

25% Illumination

## **5. Moral**

Troop moral is high. Desire to achieve goals is considered high among the senior leadership. Desire to achieve goals among the moderate leadership and troops is unknown. History indicates that the Chinese military responds well when the senior leads are present and available. Breakdown in moral occurs when the senior leaders are tied to plans and operations denying them visibility with the troops. Current conditions on Pratas Island are favorable to high moral due to senior leaders' presence and availability.

## **6. Communication Effectiveness**

Chinese units are independent in command and control. Individual unit cohesion is high but in joint operations, difficulties have prevented adequate and effective initial execution of a mission. Communication between similar organizations is understandable, rapid and effective. Communications between dissimilar organizations requires more detailed explanation, has degraded transmission speed, and is not initially as effective as the leadership desires. Command channels have boundaries that are not easily crossed.

## **7. Unity of Force**

Training commanding officers for joint operations. The military educational institutions have intensified their joint operations training. The elementary command colleges offer basic courses in joint operations. The intermediate command colleges offer courses on service campaigns and combined operations. The advanced command university offers courses on strategic studies and joint operations. In order to bring up commanding officers for joint operations, PLA units carry out on-duty training and regional cooperation training, and acquire knowledge of other services and arms and joint operations through assembly training, cross-observation of training activities, academic seminars, and joint exercises.

## **8. Leadership**

Revolution in Military Doctrine since 1990 is believed to be based on the Chinese intent to gain control over the South China Seas once effective military strength to neutralize and defeat the United States is established. The leadership may believe that with the extended force deployments of the US and its Allies, that this RMA may exist. With the strengthening of the strategic and cooperative partnership between China and Russia, the two countries have established a senior-level meeting mechanism to exchange views on major issues. They have also held consultations on major strategic issues

between relevant departments. Russian involvement in this crisis has not been established

The leadership is determined to meet the military objective by the means and will necessary to achieve that goal. The Officers at the senior levels are highly trained and professional. The mid-grade leadership is capable but untested. The lower grades are suspect due to the large size of the standing military which at this time is

## Seat Four

### Intelligence Information Update

2006 – 24 April – 0200

#### 1. Landing capabilities of Blue

Current Blue capabilities include but are not limited to (not all assets are available for the rescue mission):

- Land – 1 Airborne Division
  - 1 MEU
  - 1 Philippine Infantry Div
  - 2 Philippine Airborne Brigades
  - 1 Special Operations group
- Naval -1 Joint Carrier Assault Group
  - 2 Sea Wolf Submarines
- Air
  - 25 FA 18
  - 54 FA-16
  - 28 F -15
  - 12 AV 8
  - 5 C5A
  - 56 C130
  - 2 AWACS
  - 4 Globehawk

#### 2. Update Intelligence for Blue

**(estimated by Blue on the known or suspected activities Red is aware of)**

Current intelligence shows a rapid build up of Blue forces in Japan, Malaysia and the Philippines. Taiwan has authorized limited troop, air, and naval force deployments in and around the Taiwanese controlled land and waters. Surveillance satellites are over flying the region but weather conditions are limiting the effectiveness of that information. Special Operational Forces have been deployed.

Submarine activity is anticipated and indications are that several US and Japanese subsurface vessels are in the area. Locations of these forces are unavailable.

Current Blue Force Air is limited and no engagements have occurred. Caution appears to be the operational focus until all forces are deployed.

US Mainland forces are being deployed and estimates indicate that 50% of the force is operational in the area. Palawan has been occupied by a limited number of Blue Force with Air and Naval support on station and operational.

Blue Forces have occupied the Spratly islands but no estimate of force type or operational status is available.

### **3. Deception**

To cover the current operation, media and news items are being distributed indicating this operation is strictly a training mission that developed as a Senior Leadership Surprise Mission to evaluate the state of Joint Operational capabilities.

### **4. Accessibility**

Access to the region is limited. Chinese forces are well deployed and air superiority is assumed. Forces on Pratas Island are well established on the western coast but limited on the Eastern Coast and at higher elevations. Eastern coast access is limited by the reef surrounding the island, but water depth outside the reef allows subsurface ship deployment. Mining operations of the waters are delayed for at least the next 72 hours due to weather condition and troop placements.

### **5. NBC posture**

China possesses an advanced biotechnology infrastructure as well as the requisite munitions production capabilities necessary to develop, produce and weaponize biological agents. Although China has consistently claimed that it has never researched or produced biological weapons, it is nonetheless believed likely that it retains a biological warfare capability begun before acceding to the BWC. China is commonly considered to have an active biological warfare program, including dedicated research and development activities funded and supported by the government for this purpose. There is essentially no open source data on the subject of Chinese BW activities, and many legitimate research programs use similar, if not identical equipment and facilities. Chinese doctrine has advanced the use of chemical warfare and the extent of available resources is unknown. Chemical gear has been detected in the port area.

China has 8000 DF 31 ICBM's capable of reaching the United States. Current capabilities indicate ranges from the all of the West Coast of the US to the Rockies.

### **6. Rules of Engagement**

Current rules of engagement are to deny the enemy any air, sea, or ground location that could result in compromising current operations in the South China Sea. Chemical, biological, and nuclear means are not authorized. Commander, Chinese Forces has the only approval authority for these weapons. All other means of denial are authorized.

### **7. Combat experience**

The current force has limited experience in actual operation outside the mainland. Most experience is in civil uprising. The leadership is inexperienced in high OPTEMPO operations outside of simulated exercises.

### **8. Freedom to act**

Current Chinese doctrine attempts to give commanders in the field, at sea, and in the air operation control of their area of responsibility. Exercise evaluation indicates limited freedom to act without first obtaining higher command authorization.

## **Initial Briefing for Experimental Condition**

Satellite Imagery from the National Reconnaissance Office has detected the continued movement SSE of a large Chinese Naval Fleet believed to be headed toward the island of Palawan as an initial force attempting to take control of the South China Seas (SCS). Supporting the Palawan invasion is a Chinese Naval Battle Group code named “Red Cell” currently occupying in the Pratas Island Group approximately 250 miles SSW of the China Coast.

U.S. Seal Team One (ST1) was inserted earlier on Pratas Island. Their mission, although classified at this time, was in support of the coalition forming to oppose the Chinese operation. The coalition code name is KALAWAN EXPRESS and is ongoing. ST1 has now missed three consecutive radio check-ins (Check-ins are at 12 hour intervals.) Their location and disposition are undetermined but their last known location was in the mountainous region on the eastern coast of Pratas Island. The team’s last report indicated the Island was being occupied by a substantial but undetermined number of Red Cell Forces. Small vessels were patrolling the entire island and reef area.

U.S. Commander, KALAWAN EXPRESS, has directed his staff to begin preparation for a possible rescue mission of ST1. Air Force, Army, Marine and Navy forces are preparing for this operation. As part of the initial planning, the J2 has been directed to begin developing possible Red Cell responses to a rescue attempt. [NOTE - There is one Sea Wolf Submarine currently in the waters approximately 50 miles from Pratas Island on an information gathering mission. Exposure of the submarine for a rescue attempt would cripple that resource but is available.]

The J2 is currently at the initial commander’s mission brief but will return in the next 30 minutes. You represent the J2 staff that will develop possible Red Cell responses to an attempted rescue operation by the time of his return. This information will be used to develop the Intelligence Preparation of the Battlefield (JIPB).

The notebooks before you contain documents in raw format with information about Red Cell. Your team is to use this information to develop potential courses of actions expected by Red Cell in the event of a Blue Force rescue attempt. Begin by developing what the possible Red Cell course of action response may be and prepare a Decision Matrix to determine the most likely response. Each of you has certain information in the notebook provided to you that will assist in the development of the decision matrix. [REMEMBER – you are acting as the Red Cell staff developing courses of action to a Blue rescue mission.]

This is not an exercise in determining the right responses or courses of action. There is no right or wrong answer. Do the best you can as a team to develop the Decision Matrix by the end of the 30 minute time period. To assist in the measurement of performance, the team’s discussion is being recorded by the tape recorder located on the adjoining table and by the surveys you took. The recording and survey results are for the researcher only and will not be made available to anyone in your organization. Try not to allow the taping of your session or any cultural and personality differences between you interfere with your information sharing. Your time will begin after your questions have been answered.



## **Initial Briefing for Control Condition**

Satellite Imagery from the National Reconnaissance Office has detected the continued movement SSE of a large Chinese Naval Fleet believed to be headed toward the island of Palawan as an initial force attempting to take control of the South China Seas (SCS). Supporting the Palawan invasion is a Chinese Naval Battle Group code named “Red Cell” currently occupying in the Pratas Island Group approximately 250 miles SSW of the China Coast.

U.S. Seal Team One (ST1) was inserted earlier on Pratas Island. Their mission, although classified at this time, was in support of the coalition forming to oppose the Chinese operation. The coalition code name is KALAWAN EXPRESS and is ongoing. ST1 has now missed three consecutive radio check-ins (Check-ins are at 12 hour intervals.) Their location and disposition are undetermined but their last known location was in the mountainous region on the eastern coast of Pratas Island. The team’s last report indicated the Island was being occupied by a substantial but undetermined number of Red Cell Forces. Small vessels were patrolling the entire island and reef area.

U.S. Commander, KALAWAN EXPRESS, has directed his staff to begin preparation for a possible rescue mission of ST1. Air Force, Army, Marine and Navy forces are preparing for this operation. As part of the initial planning the J2 has been directed to begin developing possible Red Cell responses to a rescue attempt. [NOTE - There is one Sea Wolf submarine currently in the waters approximately 50 miles from Pratas Island on an information gathering mission. Exposure of the submarine for a rescue attempt would cripple that resource but is available.]

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The notebooks before you contain documents in raw format with information about Red Cell. Your team is to use this information to develop potential courses of actions expected by Red Cell in the event of a Blue Force rescue attempt. Begin by developing what the possible Red Cell course of action response may be and prepare a Decision Matrix to determine the most likely response. Each of you has certain information in the notebook provided to you that will assist in the development of the decision matrix. [REMEMBER – you are acting as the Red Cell staff developing courses of action to a Blue rescue mission.]

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### Facts Evaluation document for each Participant

Please indicate the level of importance of each of the eight facts you were provided in your notebook had on the team's ability to determine a Red Cell Course of Action.

Fact 1

| Very important | Somewhat Important | Somewhat Unimportant | Unimportant |
|----------------|--------------------|----------------------|-------------|
|                |                    |                      |             |

Fact 2

| Very important | Somewhat Important | Somewhat Unimportant | Unimportant |
|----------------|--------------------|----------------------|-------------|
|                |                    |                      |             |

Fact 3

| Very important | Somewhat Important | Somewhat Unimportant | Unimportant |
|----------------|--------------------|----------------------|-------------|
|                |                    |                      |             |

Fact 4

| Very important | Somewhat Important | Somewhat Unimportant | Unimportant |
|----------------|--------------------|----------------------|-------------|
|                |                    |                      |             |

Fact 5

| Very important | Somewhat Important | Somewhat Unimportant | Unimportant |
|----------------|--------------------|----------------------|-------------|
|                |                    |                      |             |

Fact 6

| Very important | Somewhat Important | Somewhat Unimportant | Unimportant |
|----------------|--------------------|----------------------|-------------|
|                |                    |                      |             |

Fact 7

| Very important | Somewhat Important | Somewhat Unimportant | Unimportant |
|----------------|--------------------|----------------------|-------------|
|                |                    |                      |             |

Fact 8

| Very important | Somewhat Important | Somewhat Unimportant | Unimportant |
|----------------|--------------------|----------------------|-------------|
|                |                    |                      |             |

## **Paragraph Evaluation**

Team ID \_\_\_\_\_

- 1 Please write a short paragraph describing your satisfaction with your group's effectiveness in completing this wargame. Please list your positive and negative experiences during this experiment.

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- 2 Do you believe having members from other services would have made determining Red Cell course of actions decisions easier?

Yes \_\_\_\_\_

No \_\_\_\_\_

- 3 Please explain your answer to question 2.

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**Additional Information Provided to each Participant in the Individual Binders**



Figure 26. Photo of Pratas Island



Figure 27. Photo of Pratas Island and surrounding reef



Figure 28. Photo of Runway on Pratas Island



Figure 29. Map of South China Sea (The entire map sheet was available.)

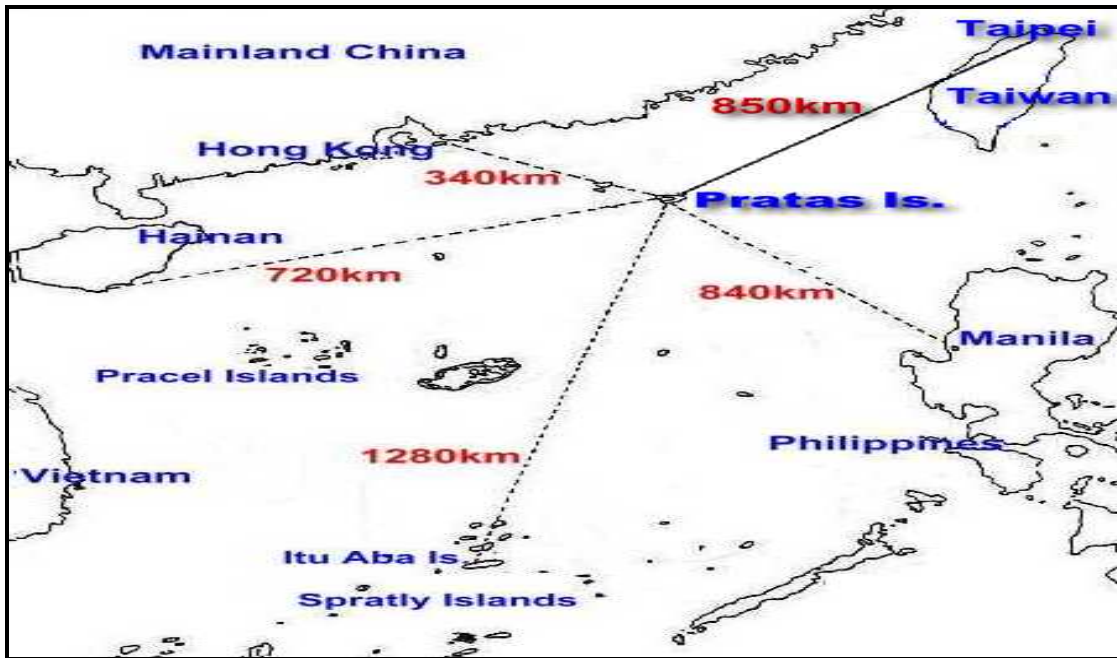


Figure 30. Distance Map for Pratas Island Wargame

## APPENDIX F. HOFSTEDE COUNTRY SCORES

Hofstede Country Scores for Power Distance, Uncertainty Avoidance, Individualism/ Collectivism and Masculinity/Femininity.

Table 30. Hofstede Power Distance Scores

| <b>Country</b>         | <b>PDI</b> |
|------------------------|------------|
| <u>Austria</u>         | <b>11</b>  |
| <u>Israel</u>          | <b>13</b>  |
| <u>Denmark</u>         | <b>18</b>  |
| <u>New Zealand</u>     | <b>22</b>  |
| <u>Ireland</u>         | <b>28</b>  |
| <u>Norway</u>          | <b>31</b>  |
| <u>Sweden</u>          | <b>31</b>  |
| <u>Finland</u>         | <b>33</b>  |
| <u>Switzerland</u>     | <b>34</b>  |
| <u>Costa Rica</u>      | <b>35</b>  |
| <u>Germany</u>         | <b>35</b>  |
| <u>United Kingdom</u>  | <b>35</b>  |
| <u>Australia</u>       | <b>36</b>  |
| <u>Netherlands</u>     | <b>38</b>  |
| <u>Canada</u>          | <b>39</b>  |
| <u>United States</u>   | <b>40</b>  |
| <u>Jamaica</u>         | <b>45</b>  |
| <u>Hungary*</u>        | <b>46</b>  |
| <u>Argentina</u>       | <b>49</b>  |
| <u>South Africa</u>    | <b>49</b>  |
| <u>Italy</u>           | <b>50</b>  |
| <u>Japan</u>           | <b>54</b>  |
| <u>Pakistan</u>        | <b>55</b>  |
| <u>Czech Republic*</u> | <b>57</b>  |
| <u>Spain</u>           | <b>57</b>  |
| <u>Iran</u>            | <b>58</b>  |
| <u>Taiwan</u>          | <b>58</b>  |
| <u>Greece</u>          | <b>60</b>  |
| <u>South Korea</u>     | <b>60</b>  |
| <u>Uruguay</u>         | <b>61</b>  |
| <u>Chile</u>           | <b>63</b>  |
| <u>Portugal</u>        | <b>63</b>  |
| <u>East Africa**</u>   | <b>64</b>  |
| <u>Peru</u>            | <b>64</b>  |

|                     |            |
|---------------------|------------|
| <u>Thailand</u>     | <b>64</b>  |
| <u>Belgium</u>      | <b>65</b>  |
| <u>El Salvador</u>  | <b>66</b>  |
| <u>Turkey</u>       | <b>66</b>  |
| <u>Colombia</u>     | <b>67</b>  |
| <u>France</u>       | <b>68</b>  |
| <u>Hong Kong</u>    | <b>68</b>  |
| <u>Poland*</u>      | <b>68</b>  |
| <u>Brazil</u>       | <b>69</b>  |
| <u>Singapore</u>    | <b>74</b>  |
| <u>India</u>        | <b>77</b>  |
| <u>West Africa</u>  | <b>77</b>  |
| <u>Ecuador</u>      | <b>78</b>  |
| <u>Indonesia</u>    | <b>78</b>  |
| <u>Arab World**</u> | <b>80</b>  |
| <u>China*</u>       | <b>80</b>  |
| <u>Mexico</u>       | <b>81</b>  |
| <u>Venezuela</u>    | <b>81</b>  |
| <u>Philippines</u>  | <b>94</b>  |
| <u>Guatemala</u>    | <b>95</b>  |
| <u>Panama</u>       | <b>95</b>  |
| <u>Malaysia</u>     | <b>104</b> |



Table 31. Hofstede Uncertainty Avoidance Scores

| Country                | UAI |
|------------------------|-----|
| <u>Singapore</u>       | 8   |
| <u>Jamaica</u>         | 13  |
| <u>Denmark</u>         | 23  |
| <u>Hong Kong</u>       | 29  |
| <u>Sweden</u>          | 29  |
| <u>Ireland</u>         | 35  |
| <u>United Kingdom</u>  | 35  |
| <u>Malaysia</u>        | 36  |
| <u>China*</u>          | 40  |
| <u>India</u>           | 40  |
| <u>Philippines</u>     | 44  |
| <u>United States</u>   | 46  |
| <u>Canada</u>          | 48  |
| <u>Indonesia</u>       | 48  |
| <u>New Zealand</u>     | 49  |
| <u>South Africa</u>    | 49  |
| <u>Norway</u>          | 50  |
| <u>Australia</u>       | 51  |
| <u>East Africa**</u>   | 52  |
| <u>Netherlands</u>     | 53  |
| <u>West Africa</u>     | 54  |
| <u>Switzerland</u>     | 58  |
| <u>Finland</u>         | 59  |
| <u>Iran</u>            | 59  |
| <u>Thailand</u>        | 64  |
| <u>Germany</u>         | 65  |
| <u>Ecuador</u>         | 67  |
| <u>Arab World**</u>    | 68  |
| <u>Taiwan</u>          | 69  |
| <u>Austria</u>         | 70  |
| <u>Pakistan</u>        | 70  |
| <u>Czech Republic*</u> | 74  |

|                    |            |
|--------------------|------------|
| <u>Italy</u>       | <b>75</b>  |
| <u>Brazil</u>      | <b>76</b>  |
| <u>Venezuela</u>   | <b>76</b>  |
| <u>Colombia</u>    | <b>80</b>  |
| <u>Israel</u>      | <b>81</b>  |
| <u>Hungary*</u>    | <b>82</b>  |
| <u>Mexico</u>      | <b>82</b>  |
| <u>South Korea</u> | <b>85</b>  |
| <u>Turkey</u>      | <b>85</b>  |
| <u>Argentina</u>   | <b>86</b>  |
| <u>Chile</u>       | <b>86</b>  |
| <u>Costa Rica</u>  | <b>86</b>  |
| <u>France</u>      | <b>86</b>  |
| <u>Panama</u>      | <b>86</b>  |
| <u>Spain</u>       | <b>86</b>  |
| <u>Peru</u>        | <b>87</b>  |
| <u>Japan</u>       | <b>92</b>  |
| <u>Poland*</u>     | <b>93</b>  |
| <u>Belgium</u>     | <b>94</b>  |
| <u>El Salvador</u> | <b>94</b>  |
| <u>Uruguay</u>     | <b>100</b> |
| <u>Guatemala</u>   | <b>101</b> |
| <u>Portugal</u>    | <b>104</b> |
| <u>Greece</u>      | <b>112</b> |

Table 32. Hofstede Individualism/ Collectivism Scores

| Country                | IDV |
|------------------------|-----|
| <u>Guatemala</u>       | 6   |
| <u>Ecuador</u>         | 8   |
| <u>Panama</u>          | 11  |
| <u>Venezuela</u>       | 12  |
| <u>Colombia</u>        | 13  |
| <u>Indonesia</u>       | 14  |
| <u>Pakistan</u>        | 14  |
| <u>Costa Rica</u>      | 15  |
| <u>Peru</u>            | 16  |
| <u>Taiwan</u>          | 17  |
| <u>South Korea</u>     | 18  |
| <u>El Salvador</u>     | 19  |
| <u>China*</u>          | 20  |
| <u>Singapore</u>       | 20  |
| <u>Thailand</u>        | 20  |
| <u>West Africa</u>     | 20  |
| <u>Chile</u>           | 23  |
| <u>Hong Kong</u>       | 25  |
| <u>Malaysia</u>        | 26  |
| <u>East Africa**</u>   | 27  |
| <u>Portugal</u>        | 27  |
| <u>Mexico</u>          | 30  |
| <u>Philippines</u>     | 32  |
| <u>Greece</u>          | 35  |
| <u>Uruguay</u>         | 36  |
| <u>Turkey</u>          | 37  |
| <u>Arab World**</u>    | 38  |
| <u>Brazil</u>          | 38  |
| <u>Jamaica</u>         | 39  |
| <u>Iran</u>            | 41  |
| <u>Argentina</u>       | 46  |
| <u>Japan</u>           | 46  |
| <u>India</u>           | 48  |
| <u>Spain</u>           | 51  |
| <u>Israel</u>          | 54  |
| <u>Austria</u>         | 55  |
| <u>Hungary*</u>        | 55  |
| <u>Czech Republic*</u> | 58  |
| <u>Poland*</u>         | 60  |
| <u>Finland</u>         | 63  |

|                       |    |
|-----------------------|----|
| <u>South Africa</u>   | 65 |
| <u>Germany</u>        | 67 |
| <u>Switzerland</u>    | 68 |
| <u>Norway</u>         | 69 |
| <u>Ireland</u>        | 70 |
| <u>France</u>         | 71 |
| <u>Sweden</u>         | 71 |
| <u>Denmark</u>        | 74 |
| <u>Belgium</u>        | 75 |
| <u>Italy</u>          | 76 |
| <u>New Zealand</u>    | 79 |
| <u>Canada</u>         | 80 |
| <u>Netherlands</u>    | 80 |
| <u>United Kingdom</u> | 89 |
| <u>Australia</u>      | 90 |
| <u>United States</u>  | 91 |

Table 33. Hofstede Masculinity Scores

| <b>Country</b>       | <b>MAS</b> |
|----------------------|------------|
| <u>Sweden</u>        | 5          |
| <u>Norway</u>        | 8          |
| <u>Netherlands</u>   | 14         |
| <u>Denmark</u>       | 16         |
| <u>Costa Rica</u>    | 21         |
| <u>Finland</u>       | 26         |
| <u>Chile</u>         | 28         |
| <u>Portugal</u>      | 31         |
| <u>Thailand</u>      | 34         |
| <u>Guatemala</u>     | 37         |
| <u>Uruguay</u>       | 38         |
| <u>South Korea</u>   | 39         |
| <u>El Salvador</u>   | 40         |
| <u>East Africa**</u> | 41         |
| <u>Peru</u>          | 42         |
| <u>Spain</u>         | 42         |
| <u>France</u>        | 43         |
| <u>Iran</u>          | 43         |
| <u>Panama</u>        | 44         |
| <u>Taiwan</u>        | 45         |
| <u>Turkey</u>        | 45         |
| <u>Indonesia</u>     | 46         |
| <u>West Africa</u>   | 46         |
| <u>Israel</u>        | 47         |
| <u>Singapore</u>     | 48         |
| <u>Brazil</u>        | 49         |
| <u>Malaysia</u>      | 50         |
| <u>Pakistan</u>      | 50         |
| <u>Arab World**</u>  | 52         |
| <u>Canada</u>        | 52         |
| <u>Belgium</u>       | 54         |
| <u>Argentina</u>     | 56         |

|                        |           |
|------------------------|-----------|
| <u>India</u>           | <b>56</b> |
| <u>Czech Republic*</u> | <b>57</b> |
| <u>Greece</u>          | <b>57</b> |
| <u>Hong Kong</u>       | <b>57</b> |
| <u>New Zealand</u>     | <b>58</b> |
| <u>Australia</u>       | <b>61</b> |
| <u>United States</u>   | <b>62</b> |
| <u>Ecuador</u>         | <b>63</b> |
| <u>South Africa</u>    | <b>63</b> |
| <u>Colombia</u>        | <b>64</b> |
| <u>Philippines</u>     | <b>64</b> |
| <u>Poland*</u>         | <b>64</b> |
| <u>China*</u>          | <b>66</b> |
| <u>Germany</u>         | <b>66</b> |
| <u>United Kingdom</u>  | <b>66</b> |
| <u>Ireland</u>         | <b>68</b> |
| <u>Jamaica</u>         | <b>68</b> |
| <u>Mexico</u>          | <b>69</b> |
| <u>Italy</u>           | <b>70</b> |
| <u>Switzerland</u>     | <b>70</b> |
| <u>Venezuela</u>       | <b>73</b> |
| <u>Austria</u>         | <b>79</b> |
| <u>Hungary*</u>        | <b>88</b> |
| <u>Japan</u>           | <b>95</b> |

## **APPENDIX G. CONTACT INFORMATION FOR ASSESSMENT TOOLS USED IN THIS RESEARCH**

### **McCrae and Costa NEO FFI**

Psychological Assessment Resources, INC

16204 N. Florida Avenue

Lutz, FL 33549

1-800-331-8378

[www.parinc.com](http://www.parinc.com)

### **Matsumoto Cultural Styles Questionnaire**

Department of Psychology

(415) 338-1114

Voice

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[dm@sfsu.edu](mailto:dm@sfsu.edu) Email

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**APPENDIX H. LINGUISTIC INQUIRY WORD COUNT (LIWC) -  
LIWC VARIABLE OUTPUT INFORMATION**

Table 34. LIWC2001 Output Variable Information

| Dimension                         | Abbrev  | Examples               |
|-----------------------------------|---------|------------------------|
| <b>I. STANDARD LINGUISTIC</b>     |         |                        |
| Word Count                        | we      |                        |
| Words per sentence                | WPS     |                        |
| Sentences ending with?            | Qmarks  |                        |
| Unique words (type/token ratio)   | Unique  |                        |
| % words captured, dictionary word | Die     |                        |
| % words longer than 6 letters     | Sixltr  |                        |
| Total pronouns                    | Pronoun | 1, our, they, you're   |
| 1" person singular                | I       | I, my, me              |
| 1" person plural                  | We      | we, our, us            |
| Total first person                | Self    | I, we, me              |
| Total second person               | You     | you, you'll            |
| Total third person                | Other   | she, their, them       |
| Negations                         | Negate  | no, never, not         |
| Assents                           | Assent  | yes, OK, mmhmm         |
| Articles                          | Article | a, an, the             |
| Prepositions                      | Preps   | on, to, from           |
| Numbers                           | Number  | one, thirty, million   |
| Affective or Emotional Processes  | Affect  | happy, ugly, bitter    |
| Positive Emotions                 | Posemo  | happy, pretty, good    |
| Positive feelings                 | Posfee) | happy, joy, love       |
| Optimism and energy               | Optim   | certainty, pride, win  |
| Negative Emotions                 | Negemo  | hate, worthless, enemy |
| Anxiety or fear                   | Anx     | nervous, afraid, tense |
| Anger                             | Anger   | hate, kill, pissed     |
| Sadness or depression             | Sad     | grief, cry, sad        |
| Cognitive Processes               | Cogmech | cause, know, ought     |
| Causation                         | Cause   | because, effect, hence |
| Insight                           | Insight | think, know, consider  |
| Discrepancy                       | Discrep | should, would, could   |
| Inhibition                        | Inhib   | block, constrain       |
| Tentative                         | Tentat  | maybe, perhaps, guess  |
| Certainty                         | Certain | always, never          |
| Sensory and Perceptual Processes  | Senses  | see, touch, listen     |
| Seeing                            | See     | view, saw, look        |

|                                      |               |                            |
|--------------------------------------|---------------|----------------------------|
| Hearing                              | Hear          | heard, listen, sound       |
| Feeling                              | Feel          | touch, hold, felt          |
| Social Processes                     | Social        | talk, us, friend           |
| Communication                        | Comm          | talk, share, converse      |
| Other references to people           | Othref        | 1pl,2nd,3rd person pronoun |
| Friends                              | Friends       | pal, buddy, coworker       |
| Family                               | Family        | mom, brother, cousin       |
| Humans                               | Humans        | boy, woman, group          |
| Time                                 | Time          | hour, day, o'clock         |
| Past tense verb                      | Past          | walked, were, had          |
| Present tense verb                   | Present       | walk, is, be               |
| Future tense verb                    | Future        | will, might, shall         |
| Space                                | Space         | around, over, up           |
| Up                                   | Up            | up, above, over            |
| Down                                 | Down          | down, below, under         |
| Inclusive                            | Incl          | with, and, include         |
| Exclusive                            | Excl          | but, except, without       |
| Motion                               | Motion        | walk, move, go             |
| Occupation                           | Occup         | work, class, boss          |
| School                               | School        | class, student, college    |
| Job or work                          | Job           | employ, boss, career       |
| Achievement                          | Achieve       | try, goal, win             |
| Leisure activity                     | Leisure       | house, TV, music           |
| Home                                 | Home          | house, kitchen, lawn       |
| Sports                               | Sports        | football, game, play       |
| Television <i>and</i> movies         | TV            | TV, sitcom, <i>cinema</i>  |
| Music                                | Music         | tunes, song, cd            |
| Money and financial issues           | Money         | cash, taxes, income        |
| <i>Metaphysical self</i>             | <i>Metaph</i> | God, heaven, coffin        |
| Religion                             | Relig         | God, church, rabbi         |
| Death and dying                      | Death         | dead, burial, coffin       |
| <i>Physical states and functions</i> | Physical      | ache, breast, sleep        |
| Body states, symptoms                | Body          | Ache, heart, cough         |
| Eating, drinking, dieting            | Eating        | eat, swallow, taste        |
| Sleeping, dreaming                   | Sleep         | asleep, bed, dreams        |
| Grooming                             | Groom         | wash, bath, clean          |
| Swear words                          | Swear         | damn,, piss                |
| Nonfluencies                         | Nonfl         | uh,rr*                     |
| Fillers                              | Fillers       | you, know, I, mean         |

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