NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

CROWDSOURCING ISR: A SYSTEMS THINKING APPROACH TO KNOWLEDGE DYNAMICS IN INTELLIGENCE OPERATIONS

by

John J. Hoffner

September 2013

Thesis Advisor:	Alexander Bordetsky
Thesis Co-Advisor:	Wayne Porter

Approved for public release; distribution is unlimited

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE | *Form Approved OMB No. 0704–0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** September 2013	**3. REPORT TYPE AND DATES COVERED** Master's Thesis

4. TITLE AND SUBTITLE CROWDSOURCING ISR: A SYSTEMS THINKING APPROACH TO KNOWLEDGE DYNAMICS IN INTELLIGENCE OPERATIONS

5. FUNDING NUMBERS

6. AUTHOR(S) John J. Hoffner

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943–5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.IRB Protocol number ______N/A______.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200words)

The Marine Corps Intelligence, Surveillance, and Reconnaissance Enterprise (MCISR-E) faces ever-increasing complexity in the conduct of expeditionary operations. This research seeks to explore computer-supported collaborative work of the MCISR-E. Properties of networks and complexity are explored through a systems thinking perspective on collective intelligence. Online social networking information technology is examined for demonstration of emergent knowledge creation for sensemaking in the computer-supported collaborative work of MCISR-E. This is provided through use cases of commercial off the shelf online social networking technology and crowdsourcing applications. Crowdsourcing through social networking technology as it benefits both collaborative information seeking and collaborative filters are suggested as possible fit to the MCISR-E. Use cases demonstrate this fit at the technical, organizational and individual levels. The MCISR-E is a complex adaptive system, designed to raise the collective intelligence of Marine Corps' units. Collective intelligence is defined as groups of people doing things intelligently. MCISR-E must effectively demonstrate sensemaking through knowledge creation to achieve this goal. MCISR-E processes must predict and react to events by group work capitalizing on current and new technology.

14. SUBJECT TERMS Marine Corps, ISR, MCISR-E, Intelligence, Crowdsourcing, Collaboration, Adaptation, Technology, Network-Centric Warfare, Complex Adaptive Systems, Open Systems, Systems Thinking, Systems Dynamics, Social Networks, Emergence, Autopoiesis, Self-organization, Knowledge Dynamics, Computer Supported Collaborative Work, Knowledge Networks

15. NUMBER OF PAGES 115

16. PRICE CODE

17.SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540–01–280–5500 | Standard Form 298 (Rev. 2–89) Prescribed by ANSI Std. 239–18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

CROWDSOURCING ISR: A SYSTEMS THINKING APPROACH TO INTELLIGENCE OPERATIONS THROUGH APPLICATION OF COLLABORATIVE FILTERS

John J. Hoffner
Major, United States Marine Corps
B.A., The Pennsylvania State University, 2002
B.A., The Pennsylvania State University, 2002

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
September2013

Author: John J. Hoffner

Approved by: Dr. Alexander Bordetsky
Thesis Advisor

CAPT Wayne Porter
Thesis Co-Advisor

Dr. Dan Boger
Chair, Department of Information Science

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

The Marine Corps Intelligence, Surveillance, and Reconnaissance Enterprise (MCISR-E) faces ever-increasing complexity in the conduct of expeditionary operations. This research seeks to explore computer-supported collaborative work of the MCISR-E. Properties of networks and complexity are explored through a systems thinking perspective on collective intelligence. Online social networking information technology is examined for demonstration of emergent knowledge creation for sensemaking in the computer-supported collaborative work of MCISR-E. This is provided through use cases of commercial off the shelf online social networking technology and crowdsourcing applications. Crowdsourcing through social networking technology as it benefits both collaborative information seeking and collaborative filters are suggested as possible fit to the MCISR-E. Use cases demonstrate this fit at the technical, organizational and individual levels. The MCISR-E is a complex adaptive system, designed to raise the collective intelligence of Marine Corps' units. Collective intelligence is defined as groups of people doing things intelligently. MCISR-E must effectively demonstrate sensemaking through knowledge creation to achieve this goal. MCISR-E processes must predict and react to events by group work capitalizing on current and new technology.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

3G	Third Generation Mobile Telephony Standard
4G	Fourth Generation Mobile Telephony Standard
ACE	Air Combat Element
AAR	After Action Report
BFT	Blue Force Tracker
C2	command and control
CE	command element
CI	counterintelligence
CIA	Central Intelligence Agency
CLIC	company-level intelligence cell
COIN	counterinsurgency
CONUS	Continental United States
COP	Common Operating Picture
COTS	Commercial Off-the-Shelf
DCI	Director of Central Intelligence
DIA	Defense Intelligence Agency
DIRINT	U.S. Marine Corps Director of Intelligence
DoD	U.S. Department of Defense
DOTMLPF	doctrine, organization, training, materiel, leadership and education, personnel, and facilities
EMW	expeditionary maneuver warfare
FY	fiscal year
G-2	derived from -2 for intelligence in the Napoleonic staffing system; the intelligence staff (see also S2)

GCE	Ground Combat Element
GEOINT	geospatial intelligence
GIG	Global Information Grid
GPS	Global Positioning System
HUMINT	human intelligence
IC	U.S. Intelligence Community
I-Dept	U.S. Marine Corps Intelligence Department
IID	U.S. Marine Corps Intelligence Integration Division
IM	Instant Messaging
IP	Internet Protocol
ISR	intelligence, surveillance, and reconnaissance
IT	information technology
JMIP	Joint Military Intelligence Program
LCE	Logistics Combat Element
MAGTF	Marine Air-Ground Task Force
MARFOR	U.S. Marine Corps Forces
MARFORCOM	U.S. Marine Corps Forces Command
MARSOC	U.S. Marine Corps Forces Special Operations Command
MASINT	measurement and signature intelligence
MCCDC	U.S. Marine Corps Combat Development Command
MCIA	U.S. Marine Corps Intelligence Activity
MCIS	U.S. Marine Corps Intelligence School
MCISR-E	U.S. Marine Corps Intelligence, Surveillance, and Reconnaissance Enterprise
MCSB	Marine Cryptologic Support Battalion

MCSC	U.S. Marine Corps Systems Command
MEB	Marine Expeditionary Brigade
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MI	military intelligence
MIC	MEF Intelligence Center
MIP	Military Intelligence Program
MOS	military occupational specialty
NCW	Network Centric Warfare
NDS	National Defense Strategy
NGA	National Geospatial-Intelligence Agency
NIP	National Intelligence Program
NMS	National Military Strategy
NPS	Naval Postgraduate School
NSA	National Security Agency
NSS	National Security Strategy
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
PIR	priority intelligence requirement
PM IDF&D	program manager, intelligence data fusion and dissemination
PM Intel	program manager, intelligence systems
RCT	regimental combat team
RSTA	reconnaissance, surveillance, and target acquisition
SA	Situational Awareness
SARC	Surveillance and reconnaissance cell

S2	derived from -2 for intelligence in the Napoleonic staffing system; the intelligence staff (see also G-2)
SIGINT	Signals intelligence
SME	Subject Matter Expert
SRIG	surveillance, reconnaissance, and intelligence group
T/O	Table of Organization
TECOM	U.S. Marine Corps Training and Education Command
TIARA	Tactical Intelligence and Related Activities
UAS	unmanned aircraft system
UAV	unmanned aerial vehicle
URL	Uniform Resource Locator
USMC	U.S. Marine Corps
VPN	Virtual Private Network
WiFi	Wireless Fidelity
WiMax	Worldwide Interoperability for Microwave Access

ACKNOWLEDGMENTS

Primarily, I would like to thank my wife, Tiffany Seoyoun Kang Hoffner, for her patience and her unwavering love during my time at Naval Postgraduate School. Every day I am thankful that you brought our son, Roarke, into this world. Because of the two of you my life holds purpose and meaning. Thank you for being there for me through this time. You are still and will forever be my sweetest. I look forward to tackling all life can throw at me because I have you. Tiffany, without your support, your smile, and your occasional kick in the pants I would not have completed this undertaking, nor would I be the man I am today.

To say that my Roarke changed my life would be the greatest of understatements. Roarke, Dad will not be spending so many long nights writing on campus anymore. As much as I wish that I could tell you that my work is done and all my time is now for you, I cannot. But I can say that all my work, indeed all my endeavors, are for you. You will always have my love, my attention, and you will always be my greatest achievement.

It also goes without saying that I owe a debt of gratitude to my thesis advisor, Dr. Alex Bordetsky, and co-advisor, CAPT Wayne Porter, for their mentorship and counsel along the way in this process. Additional thanks are also due to the Marine staff of NPS for their guidance and assistance in my time here.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A. BACKGROUND

In the past decade of constant warfare, there have been great technology advances in the number and accuracy of sensors, and greater speed and bandwidth in communication connections, in order to provide actionable military intelligence. U.S. military intelligence activities (both collection and analysis) need more than this. An evaluation of increased effectiveness necessitates a full examination of the people and interactions occurring in the workplace as technology advances. To bound the larger issue of U.S. military intelligence, this study focuses on the Marine Corps intelligence, surveillance and reconnaissance, enterprise (MCISR-E) as it is a defined system of systems that conducts intelligence activity in support of the Marine Air Ground Task Force (MAGTF). To combat the ever-increasing complexity and uncertainty of global expeditionary operations, the MCISR-E aims to seize competitive advantage through a networked structure as described in Network Centric Warfare (Alberts, Garstka & Stein, 1999). This thesis explores concepts from social networks, collective intelligence, and unbounded systems thinking in order to explore the possible effects of a mission capability module to provide an intelligence activity with competitive advantage from state of the art in crowdsourcing from commercial off the shelf (COTS) social network service (SNS) technology.

B. THE PROBLEM

Intelligence activities across all warfighting domains are presented with an excess amount of data due to the increases in sensor number and types as well as increases in the growth and speed of communications means. This excess of available data coupled with limitations on human cognition does not allow for properly planned, integrated and cross-cued intelligence collection operations through current standard operating procedures. Failure to address the effects of this increased availability of information that is exacerbated by a decrease in military and government manpower may lead to intelligence failures. Intelligence failures deny commanders the best utilization of manpower and resources in their least occurrence and can lead to operational disasters in their worst. Despite the many human and social aspects of these individual and institutional cognitive problems, much of the focus of attention in the intelligence community continues to revolve around the acquisition of more and better sensor and communications technology with little regard to the tools required to effectively synthesize the information into actionable intelligence.

C. THE PURPOSE

The purpose of this research is to examine how a collaborative task-based knowledge network (the MCISR-E) functioning to support decision-making in a military organization (the MAGTF) may increase their speed and effectiveness through social networking technology; to explore the possible effects of this technology on existing social structures; and, to suggest a model of the emergent effects of social networking technology on existent interactions of knowledge workers in this network. Acquisition of technology to improve the competitive advantage of intelligence activity is an on-going endeavor. Providing competitive advantage from the vast amount of data inherent in online social network services (SNS) is a growing field. Despite the body of knowledge available, when addressing the specific needs of the intelligence community and its use of technology there appears to be a lack of understanding of SNS and the possibilities of SNS technology insertion to facilitate the goal of increased collective intelligence through study of emergent behaviors.

This research will seek to fill this gap between intelligence needs and the SNS tools that might assist in addressing them by an examination of social media applications applied to military intelligence activity. Intelligence activity will be defined as knowledge workers engaged in three tasks- sense making, knowledge creation and influence - all with a goal of raising the collective intelligence of the group. Raising collective intelligence is evaluated as the key effort of military intelligence units (collaborative task-based knowledge networks) to support military decision-making. A common framework to categorize collective intelligence and capture emergent behaviors within intelligence units may lessen the negative effects of data saturation and its associated human factors as well as increase the ability of intelligence units to influence decision makers, raise awareness and understanding—hence achieving the goal of raising collective intelligence of the group in support of EMW through the tasks of knowledge creation, and sensemaking. This topic is both important and under-researched.

D. RESEARCH QUESTIONS:

1. Primary Question

How can online social networking applications (services offered by applications like Facebook, Twitter, and Foursquare) prove beneficial to increasing the collective intelligence of collaborative task-based knowledge networks engaged in the conduct of expeditionary military operations?

2. Secondary Questions

How can existing social networking software applications demonstrate properties of emergent knowledge creation within complex adaptive networks conducting military intelligence?

How can existing social networking software applications enable the work (collaborative information seeking and collaborative filtering) in task-based knowledge networks?

What possible effects can existing social networking software applications have on the influence intelligence knowledge workers have on the existing decision support structure within Marine Corps units?

E. METHODOLOGY

This is a qualitative research study, using qualitative methods to provide an examination of online social networking technologies in the setting of military units for their possible benefit. This examination will be done through the lens of systems thinking. A case study and examination of online collaborative filtering technologies and online social network software applications will be followed by a description of their possible utilization within and effects on the MAGTF and MCISR-E. The case study is focused on identifying the technical, organizational and personal levels that might benefit from crowdsourcing frameworks and technologies. Use cases will develop the stated issue as well as possible new problems and unintended consequences of proposed solutions.

F. ORGANIZATION OF THE THESIS

Chapter I of the thesis provides an introduction and overview of this work. This section consists of the background, problem statement, purpose statement, research questions, methodology, security classification issues and potential benefits of the thesis.

Chapter II consists of the literature review for the concepts brought to bear on this analysis. The literature review provides a brief review of selected topics from within Systems Thinking, Knowledge Networks, Information Networks, and Social Networks. The intent is to adequately set the stage for topics and concepts to be applied to the potential application for crowdsourcing from these technologies. Among the ideas addressed are complexity, holism, systems dynamics, emergence/self-organization, social networks, knowledge creation, and collective intelligence.

Chapter III will outline the methodology to be used in this analysis. The case study method, the concept of isomorphism as a framework, and the multiple perspectives method from unbounded systems theory are described.

Chapter IV contains the analysis and findings, beginning with a limited scope organizational analysis of the MAGTF and MCISR-E. Leavitt's diamond and the McCaskey model are used to highlight the organization's purpose and characteristics as a complex network. Subchapters will include use cases under examination. The ideas presented in Chapter II are discussed in relation to existing social networking software applications. These ideas will describe the case study of emergence of knowledge from online social networking technologies and increased collective intelligence through big data analytics.

Chapter V, conclusion and recommendations, describes the author's major conclusions and recommendations for future research in collective intelligence and social networking technology adoption in intelligence operations. Findings and recommendations are discussed as areas of future research and possible operational implementation.

G. SECURITY CLASSIFICATION

In the unclassified discussion of military intelligence there is a necessary obfuscation of detail required to maintain operational security (OPSEC). This thesis will characterize intelligence activity as well as good OPSEC that avoids specific mention of or allusion to specific targets, sources, or methods of intelligence. Specific details of classified targets, sources and methods are not necessary to develop the body of knowledge under discussion.

H. EXPECTED BENEFITS OF THESIS

On a theoretical level benefits of this research can support a better understanding of emergent knowledge dynamics in the use of social media. There are over seven billion people on Earth, many of whom are now adopting the use of social networking applications online, predominantly via mobile devices. Facebook had over 800 million user accounts at the end of 2012. Twitter users continue to grow with greater frequency across the Middle East, especially since the 2011 Arab Spring. And in China, there are over 400 million users of Baidu; a native Mandarin language-based social media site (Pew Internet, 2013). Due to the sheer number of users alone, there is great potential benefit to a greater understanding of the information resident on social media, as well as how it flows and emerges as new knowledge to users.

Potential operational benefits of this research for U.S. networks include optimization of the existing intelligence collections system of systems and improved design/acquisitions of future collections sensor networks and decision-support systems through increased understanding of the social sources and mechanisms of knowledge creation, sense making and influence at work in collaborative task-based knowledge networks. There also is the potential for research in counter-intelligence and operational security applications by understanding the dataset social media could show are associated with “bad actors” on an intelligence network, such as in the PVT Manning Wikileaks case. This could allow improved security in the design of future intelligence systems inclusive of automation from collaborative filtering and other knowledge derived from emergent properties in social networks. Recommendations could also include the proposal of new SOPs for intelligence analysis and collections as well as the redesign of intelligence personnel training and employment to take advantage of such technologies.

The application of commercially available social networking services has great potential to provide value through competitive advantage, as well as to save time and money. These potential savings could come from the formal acquisitions process, and the enhanced speed in training and employment of troops for intelligence operations due to their familiarity with commercially available and oftentimes free software. Application of social network technology to intelligence operations while not a novel approach is one that, once properly instituted, can harness the power of big data analytics to keep the Marine Corps, the Joint Force and the U.S. intelligence community in pace with cutting edge advances in technology. This effort can help keep the U.S. ahead of adversaries though innovative design, acquisitions, and employment of manpower and technology for intelligence operations. This research effort takes a holistic view of the USMC intelligence structure into account with a limited organizational analysis.

There are few existing frameworks that fully model adoption of online social networking technology within task-based knowledge networks, such as the Marine Corps ISR Enterprise. If an understanding of complexity and the emergent properties of networks can be demonstrated by the application of crowdsourcing from social media then it bears great theoretical potential for the Department of Defense and the extended U.S. intelligence community.

II. LITERATURE REVIEW

A. THE MULTIPLE PERSPECTIVES CONCEPT

In order to cover multiple aspects of the topic from various research paradigms this literature review will follow an adaptation of the Multiple Perspectives Concept (MSC) from Unbounded Systems Thinking (UST) (Mitroff & Linstone, 1993). UST contends that “everything connects to everything” in the inquiry into a problem, bringing all means to bear on solving those problems: “every one of the sciences and professions is considered fundamental; none is superior to or better than any other (Mitroff & Linstone, p. 91). This is seen as self-evident to Mitroff and Linstone since “every [inquiring system] presupposes some fundamental concept or process from each of the other [inquiring systems]. In this sense, all [inquiring systems] are interdependent or mutually dependent on one another” (Mitroff & Linstone, p. 92.)

The MSC employs three perspectives; the technical or “T” perspective, the organizational/societal or “O” perspective, and the personal/individual or “P” perspective. The technical perspective takes in all theories regarding physical observations and logical conclusions about the event or system in question that can be used in both analysis and agreement (Mitroff & Linstone, p. 85). The T perspective in these use cases will involve the aspects of the information network; both software and hardware technologies that can be observed or analyzed. The T perspective in not replaced, but augmented, by the Organizational/Societal and Personal/Individual. Their addition reflects the view of holism used to study the entirety of any system involving human actors working together and interacting with their environment (Deising, 1971). The O perspective shows a larger unit of analysis, “the group or organization,” either “formal or informal,” which can “range in size from the family to a global network (Mitroff & Linstone, 1993, p. 99), whereas the P perspective focus is on the individual.

As delineated in the table, complex problems involve facets covered by all three perspectives. Each perspective is more than a model/data coupling, rather it is a set of such couplings that all fall under a specific philosophical paradigm (Mitroff & Linstone, p. 97). “Each perspective reveals insights about a particular problem that are not obtainable in principle from the others (Mitroff & Linstone, p. 98).”By these three groupings UST ‘sweeps in’ all potential theories that could provide any potential to illuminate and aid in solving a problem by using MSC.

	Technical (T)	Organizational (O)	Personal (P)
World view	Science-Technology	Social entity, small to large, informal to formal	Individuation, the self
Goal	Problem solving, product	Action, stability, process	Power, influence, prestige
Mode of Inquiry	Sense-data, modeling, analysis	Consensual and adversary	Intuition, learning, experience
Ethical basis	Logic, rationality	Abstract concepts of justice	Individual values/morality
Planning	Far	Intermediate	Short, with exceptions
Other Characteristics	Looks for cause and effect Problem simplified, idealized Need for validation, replicability Claim of objectivity Optimization (seek best solution) Quantification Trade-offs Use of averages, probabilities Uncertainties noted (on one hand…)	Agenda (problem of the moment) Problem delegated and factored Political sensitivity, loyalties Reasonableness Satisficing (first acceptable solution) Incremental change Standard operating procedures Compromise and bargaining Make use of uncertainties	Challenge and response Hierarchy of individual needs Filter out inconsistent images Need for beliefs Cope only with a few alternatives Fear of change Leaders and followers Creativity and vision by the few Need for certainty
Communication	Technical report, briefing	Language differs for insiders	Personality important

Table 1. The Three Multiple Perspective Types and Their Paradigms (From Mitroff & Linstone, 1993)

B. SYSTEMS THINKING

A system is considers all the objects in a set and all relationships between them and their attributes (Hall & Faden, 1956). *Open systems* models recognize the environment, the inputs to the system, and the outputs of a system. *Closed systems* operate in isolation from their environment. Open systems are defined by boundaries between the processes and their environment but recognize that interaction is both vital to and a part of the processes. While recognizing there are sub-processes at work within the system the whole is considered not a reductionism that focuses on the parts (Heylighen, 1992).

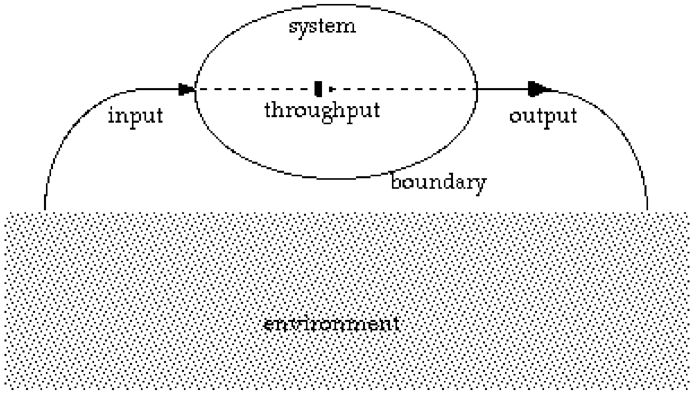

Figure 1. A system's interaction with its environment. (From Heylighen, 1998)

General Systems Theory (GST) refers to the work pioneered by Ludwig von Bertalanffy. A biologist, von Bertalanffy noted that all systems in nature are open to the influence of their environment (Bertalanffy, 1958). Systems thinking as we know it began in part with von Bertalanffy's work which allowed for great advances in scientific theory in psychology, management and design (Capra, 1996).

It is through an open systems perspective that this thesis proceeds with its analysis. Taking an open systems view allows us to observe the entirety of an activity or organization under analysis. This allows the study of the environment, inputs, outputs, processes and sub-processes as well as the interaction of all parts of an organization under the open systems model pioneered with general systems theory.

1. Complex Systems

The study of complexity is an area of great interest in modern scientific endeavors, noted to be one of the key characteristics of our world and the systems within it (Simon, 1996). Actions and systems demonstrate complexity when their "interactions [occur] in an unexpected sequence" (Perrow, 1984, p. 78). Complexity doesn't allow for simple cause and effect relationships because the many variables and their interdependencies in complex systems are nonlinear in nature (Smith, 2006). John Sterman noted that, most **complex behaviors usually arise from the interactions** (feedbacks) among the components of the system, **not from the complexity of the components** themselves (Sterman, 2000).

The line between something being complicated or complex is often blurred, especially in the application of technology. Looking at systems that exist in an environment involving human behavior the element of human agents within the system and their ability to take adaptive actions provide a high degree of complexity (ibid). Once a human element becomes involved even the complicated is assured to demonstrate complexity due to the addition of nonlinearity from human behavior (ibid).The actions of the agents within a system have unpredictable effects on the interdependencies and interactions of a complex system (Rosenau,1997).

Four general ideas of complexity theory were set forth as guidelines by Rosenau (1997). The first is that complex systems demonstrate self-organization, that is, the parts deal with change while preserving their purpose or process. Second, complexity allows adaptation to or coevolution with a changing surrounding environment. Next there is a propensity for small perturbations to throw complex systems into disequilibrium causing disproportionate reactions to the size of the stimulus. Finally, due to the many interdependencies in complex systems there is great potential for change from very small changes to initial conditions (Rosenau, 1997).

While understanding the difference between complex and complicated systems is a good starting point, it is necessary to understand the full implications of looking at a system in its environment holistically. According to Meadows, a system is an interconnected set of elements that is coherently organized in a way that achieves something (2008, p. 11). As such a system must have three parts to meet this definition; elements, interconnections and a function/purpose (Meadows, 2008).

Many sets of things meet this definition of a system: a zoo, a business, a country, a factory, a living organism. The example of the zoo allows an easy examination of the elements of a system. It is easy to see what makes up a zoo; the animals, cages, and yards, etc. Close examination even allows for classification and sub-classification of the animals (fish, birds, reptiles, etc.). But a catalogue of the animals, no matter how detailed, doesn’t describe the zoo fully. The interconnections of the zoo are the various arrangements we see the animals presented in, the arctic environment, a reptile house, or an African aviary, just to name a few. The interconnections are the relationships between the items in each set, which can either be physical or informational. What's more the zoo has a purpose, whether it is educational, a place of research, or entertainment that intends ultimately to generate profit. The elements may not give away the purpose or function of the system. Purposes and functions are seen by observing the behavior of the system—what it actually does—over time. The elements of the set are the easiest to take note of, but it is the interrelationships between the elements that will have greatest impact of behaviors and give the greatest insights into purpose/function (Meadows, 2008).

2. Systems Dynamics

The study of complex systems is best done through modeling and examination of the design of the system or organization (Forrester, 1961). This mode of study is known as *systems dynamics.* Systems dynamics functions under four guiding principles; that counter-intuitive behavior is driven by structure, that complexity involves non-linear relationships, that computer simulation is necessary to model and study behaviors of systems, and that the application of the first three premises allows one to improve the management and design of organizations (Forrester, 1961; Lane & Sterman, 2011). These rules have been applied to a wide variety of issues, from urban dynamics (Forrester, 1969) to social systems (1971).

3. Stock and Flow Diagrams

Systems dynamics allows you to understand the behavior of complex systems over time through by looking at stocks and flows within the system. Stocks are the things—materials or information—accumulated in the system over time. Stocks are elements that can be measured (Meadows, 2008). The changes to a stock over time are accomplished by a flow. Flows are movement, activity that brings elements into or out of a set (Meadows, 2008). Stocks can be said to be the "present memory of the history of changing flows within the system (Meadows, 2008 p. 18)." System dynamics seeks to endogenously model a problem by identifying its structure (stock, flow, and feedback mechanisms) and the behaviors that result. The systems thinking perspective, mapping the system in question through systems dynamics—the interactions of stocks, flows, and feedback—will provide a framework for understanding in this thesis.

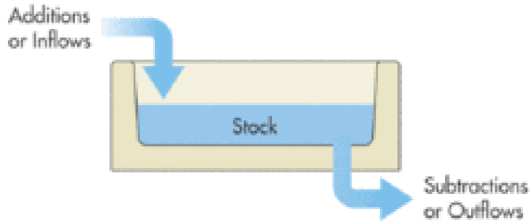

Figure 2. “Bathtub”-style diagram of stock and flows
(From http://ase.tufts.edu/gdae/, 2007)

In the figure the basic building blocks of systems dynamics are displayed as a bathtub. Water comes into the tub from somewhere on the left as a flow (additions or inflows) and leaves the tube through a drain on the right as a flow (subtractions of outflows). With the bathtub model in mind we can see the behavior of this system and make some predictions about how it will react over time (Meadows, 2008). Add water (flow) and the tub fills (stock). Stop the flow in and then open a drain (flow) and the tub will empty (also a stock, albeit a drained one). A systems diagram of the bathtub analogy gives us a simple visualization that can be built into grander scales and levels of complexity.

4. Feedback Loops

In addition to stock and flow diagrams, systems dynamics allows us to diagram a system’s structure and behavior through mechanisms called feedback loops. As explained by Capra a *feedback loop* is “a circular arrangement of causally connected elements, in which an initial cause propagates around the links of the loop, so that each element has an effect on the next, until the last “*feeds back*” the effect into the first element of the cycle (see figure). (1996, p. 56)”

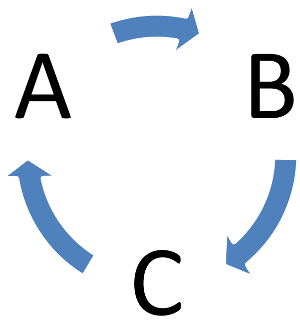

Figure 3. Circular causality of a feedback loop (After Capra, 1996)

The use of the term "feedback has come to mean the conveying of information about the outcome of any process or activity to its source". (Capra, 1996, p. 57) This previous sentence seems incomplete. These feedback loops can serve a system to either add to or counter the effect of the ongoing activity. Feedback loops then are either positive, in that the action of the feedback continues to add activity back into the loop or they are negative, in that the effect of the feedback is to reduce the amount of activity fed back into the loop (Meadows, 2008). Self-organization, *or* Emergence

In systems thinking several models for the self-organizing characteristic of systems have arisen. Ross Ashby was the first to use the term "self-organizing" to describe the spontaneous emergence of ordered patterns from random distributions (Capra, 1996). His ideas were limited in that the structures he believed could arise from a system were limited to those structures contained in the system. Heinz Foerster, in the late 1950s, developed a "qualitative model of self organization in living systems," coining the phrase "order from noise" to show that order isn't just introduced into the system, rather the system "integrates it into its own structure, and thereby increases its internal order (Capra, 1996, p. 84)."

From these two main ideas, many systems thinkers developed theories regarding the emergent property of self-organizing systems. Three main characteristics are common to the theories of self-organization/emergence in systems thinking. One is the "spontaneous emergence of new structures and new ways of behaving" (Capra, 1996, p. 85) through the self-organizing process at work in the system. A second is that systems that demonstrate these emergent patterns of behavior are “open systems operating far from equilibrium” (Capra, 1996, p. 85). The final characteristic common to self-organizing systems is that of “nonlinear interconnectedness of the system’s components. Physically this nonlinear pattern results in feedback loops; mathematically it is described in nonlinear equations” (Capra, 1996, p. 85).

The famous illustration of M.C. Escher below shows how self-organization occurs, figuratively of course. As one hand draws it creates the other hand and vice versa. From the elements of the systems adding to the system new patterns, (wrists, arms, etc.) emerge. It also shows how self-organization can be seen as a positive feedback loop.

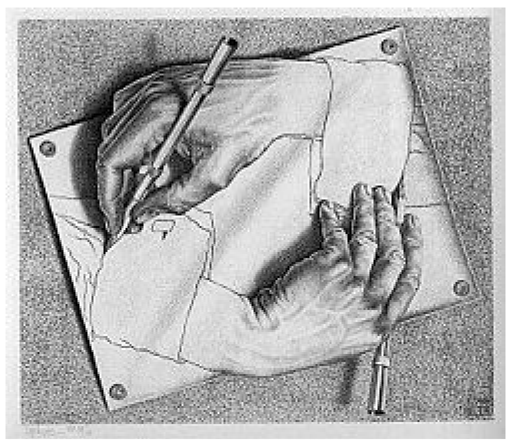

Figure 4. Drawing Hands, by M.C. Escher (From M.C. Escher, 1948)

C. KNOWLEDGE

1. Knowledge Hierarchy

There is a large and active body of literature on the relationships between, and the hierarchy of data, information, knowledge and wisdom. Data are defined as signals that allow one to reduce uncertainty about the environment or something in it, and data is required to produce information (Nissen, 2006). Davenport and Prusak called it a “set of discrete, objective facts about events” (2000, p. 2). As such, information is a construct from data, but it is more than a sum amount of data, it gives the data a context with which to inform its viewer and “provide meaning to a message” (Nissen, 2006, p. 16). The information one has may allow them to produce knowledge. Knowledge is also not an accumulation of data or information, rather "enables direct action" (Nissen, 2006, p. 16). Thus, knowledge "is a fluid mix of framed experience, values, contextual information, and expert insight" such that it "provides a framework" for evaluation and incorporation of new data and information (Davenport & Prusak, 2000 p. 4). Clearly set forth we see that data, information, and knowledge can be seen as a hierarchy in the figure below. The likelihood of knowledge and the alluded higher order functions increase the actionability increases while the likelihood of the subject being data increases with amount (Nissen, Kamel & Sengupta, 2000; Nissen 2002).

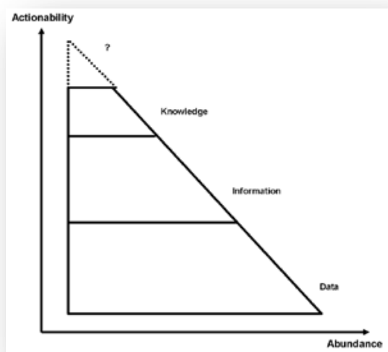

Figure 5. Knowledge hierarchy (From Nissen, Kamel & Sengupta, 2000)

Polyanyi (1966, p. 4) said that, "We can know more than we can tell." As such, he classified knowledge into two component parts, the tacit and the explicit (Polyanyi, 1966). *Tacit* knowledge, involving both technical and cognitive elements, gives us working, or "mental models" that humans use to make analogies within their minds for things in the world (Johnson-Laird, 1983). *Explicit* knowledge is that which can be expressed in numbers or words and which can be transferred or learned, in a codified systemic fashion (Polyanyi, 1966). Later Bateson (1973) referred to tacit knowledge being analogue; individuals share it in a process to build mutual understanding, whereas explicit knowledge is digital, discrete and captured in a form of record to be reassessed periodically (Nonaka, 1994).

2. Organizational Knowledge Creation and Management

From the ideas expressed in the knowledge hierarchy come the ideas of dynamic knowledge creation. In his model of dynamic organizational knowledge creation Nonaka (1994) posits that "organizational knowledge is created through a continuous dialogue between tacit and explicit knowledge" (Nonaka, 1994, p. 1). The main crux of his model was to show that the conversion of one type of knowledge to another was a dynamic interaction that resulted in the creation of knowledge.

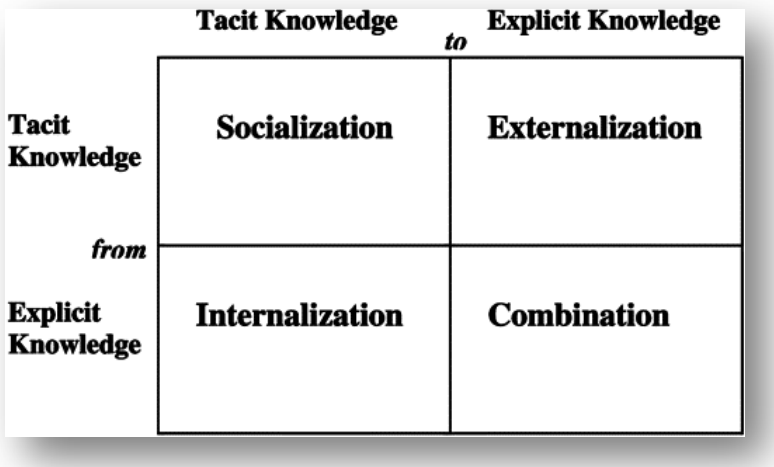

Figure 6. Modes of Knowledge Creation (From Nonaka, 1994)

The four ways of knowledge conversion, either from or to tacit or explicit knowledge, are *socialization, combination, internalization,* and *externalization* (Nonaka, 1994). New knowledge creation is "a process that 'organizationally' amplifies the knowledge created by individuals and crystallizes it as a part of the knowledge network of the organization" (Nonaka & Takeuchi 1995, p. 59). The key process of creating new knowledge is the interaction of those who possess the knowledge with others who possess like-knowledge or different types of knowledge. The interaction of people as they transfer knowledge is the heart of these processes. Thus, there is a social aspect as well to knowledge creation as well as a technological aspect. This is a key aspect which will be explored later in the literature review.

Choo (2003) explored the main perspectives of how organizations manage knowledge creation, showing that knowledge is generated in "informal, self-organizing networks over time" when people "share common interests, face common work problems, and are motivated to exchange their knowledge" (pp. 209–210). This is further developed by *knowledge flow theory*, a concept that borrows from known principles of basic physics to examine the complex patterns and interactions of the physical realm as they apply to knowledge networks (Nissen, 2006). The processes can be seen to work along a continuum below in Nonaka's spiral of organizational knowledge creation (1994). The spiral shows the creation or knowledge by depicting the knowledge flows between dimensions of knowledge from individuals, groups, and organizations and between organizations. The spiraling demonstrates properties of emergent behavior that occurs as the four processes of combination (explicit to explicit), socialization (tacit to tacit), externalization (tacit to explicit) and internalization (explicit to tacit) give rise to organizational knowledge.

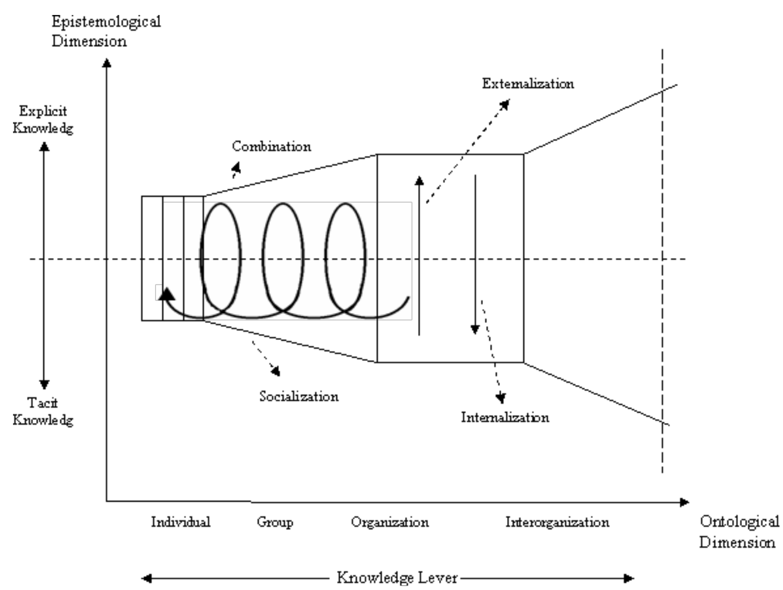

Figure 7. Spiral of Organizational Knowledge Creation (From Nonaka, 1994)

3. Knowledge Workers

First coined by Drucker (1959), *knowledge worker* refers to one who uses knowledge in the workplace, according to Davenport; one who thinks for a living, dealing in knowledge as their capital (2005). Nonaka (1991) showed that although knowledge workers can fuel innovation many managers fail to grasp this. Within the organization, Peter Drucker (1999) elaborated on the role of the knowledge worker in the 21stcentury by proposing six major factors characterizing their productivity in *knowledge work*, depicted in the table below. Knowledge work mainly entails producing, or consuming knowledge as well as brokering between individuals and groups for knowledge capital (Davenport & Prusak, 2000). Understanding Drucker's six factors could go a long way in ensuring the Marine Corps gets its 'bang for the buck' from Marines trained and equipped to act as knowledge workers across a myriad functions within MAGTF and sub-unit staffs.

The knowledge-worker's question is "What is the task?"
Knowledge-workers have to manage themselves and have autonomy.
Continuing innovation has to be part of the work, the task and the responsibility of knowledge workers.
Knowledge work requires continuous learning, and continuous teaching by the knowledge worker.
Productivity of the knowledge worker is not primarily a matter of quantity of output. Quality is at least as important.
Knowledge workers must be treated as "assets" rather than a "costs." They must prefer to work for the organization, over all other opportunities.

Table 2. Six factors of knowledge worker productivity in 21stcentury (From Drucker, 1999)

Many knowledge work roles have been described in research as the 'information economy' emerged in the latter half of the 20th century (Reinhardt, et al. 2011). The roles of *controller, helper, learner, linker, networker, organizer, retriever, sharer, solver,* and *tracker* are described along with common actions and source. Each of these roles would appropriately be followed with *"of knowledge.*" The term sensemaking provides a greater understanding of the activity which encompass these roles in an organization focused on knowledge as capital must be based on the context of the organization itself.

Role	Description	Typical knowledge actions (expected)	Existence of the role in literature
Controller	People who monitor the organizational performance based on raw information.	Analyze, dissemination, information organization, monitoring	(Moore and Rugullies, 2005) (Geisler, 2007)
Helper	People who transfer information to teach others, once they passed a problem.	Authoring, analyze, dissemination, feedback, information search, learning, networking	(Davenport and Prusak, 1998)
Learner	People use information and practices to improve personal skills and competence.	Acquisition, analyze, expert search, information search, learning, service search	
Linker	People who associate and mash up information from different sources to generate new information.	Analyze, dissemination, information search, information organization, networking	(Davenport and Prusak, 1998) (Nonaka and Takeushi, 1995) (Geisler, 2007)
Networker	People who create personal or project related connections with people involved in the same kind of work, to share information and support each other.	Analyze, dissemination, expert search, monitoring, networking, service search	(Davenport and Prusak, 1998) (Nonaka and Takeushi, 1995) (Geisler, 2007)
Organizer	People who are involved in personal or organizational planning of activities, e.g., to-do lists and scheduling.	Analyze, information organization, monitoring, networking	(Moore and Rugullies, 2005)
Retriever	People who search and collect information on a given topic.	Acquisition, analyze, expert search, information search, information organization, monitoring	(Snyder-Halpern *et al.*, 2001)
Sharer	People who disseminate information in a community.	Authoring, co-authoring, dissemination, networking	(Davenport and Prusak, 1998) (Brown *et al.*, 2002) (Geisler, 2007)
Solver	People who find or provide a way to deal with a problem.	Acquisition, analyze, dissemination, information search, learning, service search	(Davenport and Prusak, 1998) (Nonaka and Takeushi, 1995) (Moore and Rugullies, 2005)
Tracker	People who monitor and react on personal and organizational actions that may become problems.	Analyze, information search, monitoring, networking	(Moore and Rugullies, 2005)

Table 3. Typology of knowledge worker roles (From Reinhardt et al., 2011)

4. Computer Supported Cooperative Work and Collaborative Information Seeking

Military intelligence has been a topic of interest to the U.S. since the days of the founding fathers and the first Continental Congress. It can be viewed as the dedicated pursuit and acquisition of data, information, and knowledge for benefit of those with a role in national security. The dawn of the computing era didn't change that interest; it only made the processing of large data sets and the acquisition and processing of intelligence ever easier and faster by connecting the vast U.S. intelligence community through powerful information networks. When the U.S. government started these information networks by first linking computer nodes together through ARPANet it developed into the Internet as we know it today. The way we do work changed along with its development. The amount of data accessible anywhere continues to grow as the Internet grows in size. The large amounts of data require a distribution of labor to extract information to inform decision-makers such as the distribution of labor in the military intelligence community.

The field of study on *computer supported cooperative work* (CSCW) was a term first used by Greif and Cashman in a workshop to study individuals who rely on information technology to support and accomplish their work (Grudin, 1994). Grudin showed that from the inception of the term through its short history there has been contention as to what the focus of this research should be (ibid). Two main lines of thought separate CSWC on where to draw the boundary between people and technology. Carstensen exemplifies how on one side of this field CSCW examines both the collaborative activities going on and how their coordination can be supported through computer systems (1999). This is distinct from Wilson who sees CSCW as a generic term used to understand "the way people work in groups with the enabling technologies of computer networking and associated hardware, software, services and techniques (1991, p. 93)." This term accurately describes the extended intelligence community enterprise that is extended and enabled through technology from the U.S. intelligence agencies to the tactical level via satellites and mobile ad hoc networks.

Collaborative information seeking (CIS) is a field of research closely mirroring many of the non-analytic roles and work going on in military intelligence staffs. CIS recognizes first that the knowledge work going on in modern complex networks is collaborative by nature—not individual effort (Shah, 2010). Although many terms exist in the literature to describe CIS, such as collaborative information retrieval, social searching, concurrent search, collaborative exploratory search, co-browsing, collaborative information behavior, and collaborative information synthesis (Shah, 2010), Foster uses this; “the study of systems and practices that enable individuals to collaborate during the seeking, searching, and retrieval of information (2006, p. 329).”

5. Sensemaking as a Goal

The roles of a knowledge worker, in the table above from Reinhardt et al. (2011), could be grouped together under the heading of *sense making.* Karl Weick built upon general systems theory in his *Organizational Information Theory,* in which s*ensemaking* describes when organizations interpret information for which no frame of reference exists and for which they don’t have enough information for action (Weick, 1995).This is also part of a key point in the concepts of Network Centric Warfare (NCW) (Alberts, Garstka, & Stein, 2000). In the text *Information Age Transformation* sensemaking is defined as that activity which “encompasses the range of cognitive activities undertaken by individuals, teams, [and] organizations…to develop awareness and understanding and relate this understanding to a feasible action space. (Alberts, 1999)” Operational efforts are a main focus of MAGTF staff work and the intelligence activities which support it therefore it is important to note that both Weick and NCW finish their definition with either an explicit or implicit purpose of action.

Alberts and Hayes also discussed the phenomenon of sense making as raising understanding and awareness through the ability to synthesize various and disparate pieces of information using the expertise and experience of many (2006). Many MAGTF staff functions are focused on planning and execution phases of operations that require both interpersonal and staff section interaction. This generally agrees with the emphasis in Alberts and Hayes regarding shared experience and expertise of many in their exploration of sense making. MAGTF staff and commanders are consistently trained and evaluated for their bias for action. As such Marines acting as *knowledge workers* in the roles described by Reinhardt et al. are engaging in *sensemaking*.

6. Value of Knowledge

How should a military unit value its knowledge workers sensemaking activity? There is an established line of research that proposes a resource-based view to showing value. In this line of thought an organization's "competitive advantage" comes from its ability to maintain and control its resources (Nissen, 2006). Extending this line of reasoning the knowledge worker, or a knowledge network, maintains its "organizational knowledge as a resource with at least the same level of power and importance as traditional economic outputs (Nissen, 2006, p. 3)."

With agreement that knowledge provides competitive advantage it becomes imperative to provide measures of the efficiency and effectiveness of sensemaking in the organization. Waltz provided one such representative set of measurement, shown below.

Metric Category	Typical Data-Level Metrics	Description
Detection: ability to detect objects, events	Detection probability False alarm rate Miss probability	Probability of detection on single look False alarms per coverage Probability of fail to detect on single look
State estimation: ability to associate and estimate kinematic state	State accuracy Track accuracy Track persistence Correlation error probability	Accuracy of *x, y, z* and derivatives Accuracy of derivatives predictions Sustained estimation, dynamic target Probability of miscorrelation
Identification: ability to classify objects, events	Probability ID ID accuracy	Probability of correct ID Aggregate accuracy of ID decisions
Timeliness: time response of sensor/ processing	Observation rate Sensing delay Processing delay Decision rate	Rate of revisits to observe object Delay from observation to report Delay from sensor report to decision Rate of update of output decision updates

Table 4. Representative MOPs for a Military Command and Control System (From Waltz, 1998)

The success of military intelligence activity rests on the knowledge worker's capacity to sort the wheat from the chaff and produce what has come to be known as "actionable intelligence." Actionable military intelligence relates to what Nissen refers to as knowledge (2006): it is information that "enables direct action" (Nissen, 2006, p. 16), in this case that which enables successful military decision-making.

D. SOCIAL NETWORKS

A network, put simply, is a set of entities or objects (known mathematically as nodes), and a description (or map) of the relationships between them (Kadushin, 2012). Simple networks of pairs (dyads) and triads (sets of three) can be used to illustrate points and make observations about more complex networks and relationships (Kadushin, 2012). Social networks describe people and the relationships between them (ibid). Some networks neatly fit into structures, such as military platoons or children in grade school classrooms. However, other networks are 'open system networks' and do not easily fit into the structure defined clearly by any such boundary (Kadushin, 2012).

1. The Study of Social Networks

Today, the pervasiveness and fast growth of social network services allow for observation of and data collection from massive numbers of people. In 2012 CNET.com reported that the social network service Facebook was shown to have over one billion active individual user accounts worldwide (Whittaker, 2012). Bloomberg reported that Sina Weibo—a Mandarin language social network service used in mainland China—had 400 million individual users in 2012 (Cao, 2012). The study of networks has proven valuable to provide insight into the structure and behavior of systems. Through the study of social network services we can possibly observe and identify aspects of how the world's population propagates information, giving rise to the emergence of both tacit and explicit knowledge within and between groups and organizations.

The study of social networks has been ongoing in sociology for hundreds of years (Kadushin, 2012). According to research from several British universities published as "*The Italian Academies: 1525–1700*," the first intellectual networks of early modern Europe are believed to have existed as early as the Italian Renaissance and may be seen as a predecessor to social networking applications like Facebook and LinkedIn (Kelly, 2012). Since the renaissance and before various societies, guilds and groups have proven the benefits for traditional social networks. The study of social network theory is enjoying its own renaissance recently, as social sciences are gaining insight through rigorous analysis of social networks and the large data repositories the information age has created. Such analysis began with Leonhard Euler's use of mathematical graphs to solve the Koenig bridge problem in 1873 (Barabasi, 2002). Many aspects of the study of social networking and social media have been highly productive in various fields, but are outside the scope of interest to this research. A sample of those research areas, dominant themes, their definition and exemplars is provided in Table 5.

Research Area	**Theme**	**Definition**	**Exemplar studies**
Psychology	Management of Impressions	How users introduce themselves and the quality of relationships generated via SNS	Marwick 2005, Kumar, Novak & Tomkins 2006
	Reinforcing Relationships	SNS serve a need to reinforce our interpersonal connections	Ellison, Steinfeld & Lampe 2007
Politics	Dialogue & Participation	SNS as an avenue to influence election outcomes via social media campaign strategy	Harfoush 2009, Libert & Faulk 2009, Plouffe 2009
	Polarization	SNS visualization of the various divisions of expressed political opinions	
Education	Student/Faculty Interfaces	Student Reactions to Educators/Institutions as well as their influences on one another via SNS	Hewitt & Forte 2006, Mazer, Murphy & Simonds 2007,
	Challenges of SNS	Struggle for attention, SNS as a new landscape and resource for education	Kalamas, Mitchell and Lester 2009,
Marketing	Market Segmentation	Role of social media in different cultures, allowing for analysis of niche audiences	Geidner, Flock & Bell 2007, Gajjalla 2007 Fragoso 2006, Nyland & Near 2007
	Surveys	Users; both individuals and corporate entities, use SNS for survey data collection	Ricadela 2007, Lacy 2010
Sociology	Netnography	"Qualitative methodology that adapts traditional ethnography research techniques to the study of online cultures (Kozinets, 2006, p. 281)	Kozinets 2006,
	Privacy Paradox (Barnes, 2006)	Relationship between disconnect between protection of privacy with online SNS behavior within cultures	Barnes 2006, Stutzman 2006, Dwyer, Hiltz & Passerini 2007

Table 5. A Sample of Themes in the Social Media Research Literature (After Perez Latre, Portilla & Sanchez Blanco, 2011)

2. Looking Through a Social Network Lens

The following definitions provide a language to discuss and understand the interactions within and between individuals in a network. *Nodes* are objects within a set and *edges* represent the relationships between nodes (Barabasi, 2002). *Propinquity*, or co-presence, occurs when two or more nodes occur "in the same place at the same time (Kadushin, 2012, p. 18)." *Homophily* is the term used to describe the "birds of a feather" phenomenon, where people or groups are more likely to be connected the more they have in common, and will have more in common the more closely they are connected (Kadushin, 2012.) Density is the number of "direct actual connections [a node has] divided by the number of possible direct connections in a network (Kadushin, 2012, p. 29)." *Structural Holes* are areas where without presence of one node the network would fall apart (Kadushin, 2012.) From Granovetter (1982) *weak ties* are the nodes which do connect a network by bridging those structural holes. *Centrality,* or popularity in common terms, is "the sheer number of connections" a node has within the network—this is measured as "degree of centrality" (Kadushin, 2012). Distance between indirect connections is also important, as all nodes in a network are "eventually connected to one another through paths of various lengths (Kadushin, 2012, p. 32)."

"Human networks arise as a result of acts by individuals and organizations. The networks created by these acts in turn produce networks that have consequences for individuals and social organizations. Social networks evolve from individuals interacting with one another but produce extended structures that they had not imagined and in fact cannot see. (Kadushin, 2012, p. 11)" Through the examination of *nodes and edges* in sociograms we start to see these 'extended and invisible structures'. The examination leads to distributions of *propinquity*, *homophily*, *centrality*, *betweenness* and other measures. With them we can begin to explore social network theory. By looking at these properties we gain a set of tools with which we can dissect the complexity of the interdependencies across multiple levels of association and human interaction as well as an increased understanding of underlying network behaviors.

All these things can be evaluated through network concepts. They create clusters, reflecting properties of centrality, homophily and propinquity—all of which are characteristics to be explored to maximize their potential. Clustering, in terms of greater number of sensors (users) and communications bandwidth could lead to saturation of cognitive information processing in the individual (Denning, 2006); or, it could provide just the right dynamic between tacit and explicit knowledge to allow for successful knowledge creation (Nissen, 2006).

The structure and behavior of connections made in a social network service can be studied through social network theory as well as displayed through a stock and flow diagram such as Curry did in the below diagram (2011). People within a population (a stock) become users (a stock). There are flows where they go from the general population to the registered users stock, then the active users stock, where they contribute to the stock of information being distributed via their actions in the software application. The information added to that stock flows out of that system boundary, as it is added as a flow to the information that the registered users possess and use in interactions outside the social network application.

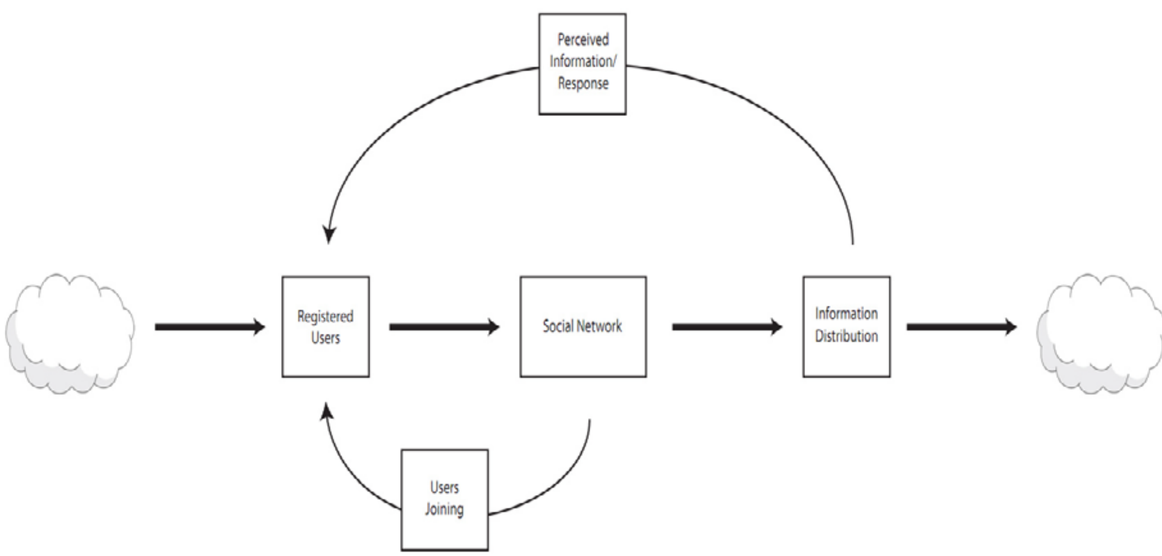

Figure 8. Systems Model of a Social Network (From Curry, 2011)

This is very simplified but as a systems model it serves the purpose to illustrate potential stocks, flows and causal loops in action within a social network. As members of the population register and enter the social networking application, they draw in more registered users with whom they have outside connections who seek to be connected with them in another dimension. As active use contributes to what members know about each other or a topic other registered users become more active to join in the discussion (Curry, 2011).

3. Mass Collaboration

Using mass collaboration, otherwise known as the wisdom of crowds, for competitive advantage is already heavily used in business applications (Surowiecki, 2004). At the heart of this pursuit is a term known as crowdsourcing, a form of outsourcing where the work is derived from the collective efforts of the group. Crowdsourcing is a means to put customers, workers, fans, or the public to work for the group. This is the act of outsourcing tasks to an undefined, distributed group of people—the public rather than a specific body. This can occur online or offline and serves as both a distributed problem solving model and a production model. In business, academia and even some sectors of government there is a groundswell of praise for the value of social media, social networks, and crowdsourcing.

4. Collective Intelligence

Mass collaboration is a manifestation of a phenomenon coming to be known as *collective intelligence* (CI). As it is an emerging field of study, CI has other popular working definitions. Pierre Levy claims CI is "a form of universal, distributed intelligence, which arises from the collaboration and competition of many individuals (Salminen, 2012, p. 1)" while Woolley et al. defined it as "the general ability of a group to perform at a wide variety of tasks (ibid, p. 1)." One of the main proponents of CI as a field of research is Dr. Thomas Malone of MIT, where he heads the Center for Collective Intelligence (CCI). The CCI has come to a working definition of CI as; "a) group(s) of individuals doing things collectively that seem intelligent b) groups addressing new or trying situations or c) groups applying knowledge to adapt to a changing environment

(MIT CI Handbook, 2010).” A research question of Malone’s, and a thread that links the much of the CCI research is this; “How can people and computers be connected so that collectively they act more intelligently than any individual, group, or computer has ever done before?”

a. Three Levels of Analysis

In order to focus the question of what the research community means by collective intelligence in humans, Salminen found that within a large sample of the existing research in CI the findings could be grouped by level of analysis; the micro-level, macro-level, and level of emergence (2012). The *micro-level* focuses on the individuals in the group, or system, and could be aligned with the P-perspective from Mitroff and Linstone’s MPC. An individual’s psychological, cognitive, and behavioral factors are the subject of CI research at this level (Salminen, 2012). The *macro-level* focuses on the outputs of the system as the effects of mass collaboration and focuses on the totality of factors of the group(s) under study (ibid). The *macro-level* could be aligned with MPC’s O-perspective. The *level of emergence* describes research whose foci are how the system behavior of the *macro level* emerges from the interactions between the individuals at the *micro-level* (Salminen, 2012). Many studies of CI which focus on the *level of emergence* use theories of complex systems, reviewed previously above. Many of the tools of research in *emergence* are technical in nature, as is the final perspective of MPC. As MPC is the making this very useful for the purpose of the research at hand.

The table below lists those themes identified by Salminen’s categorization that are relevant to the study at hand (2012). Humans are social animals, whose intelligence sets them apart from other species. Humans organize in communities which can be studied as complex adaptive systems. The self-organization and emergence demonstrated by complex systems should be understood in order to harness the power of mass collaboration for decision-making and other benefits for the group as a whole.

Level	Theme	Definition	Research Examplars
Micro	Humans as social animals	Viewing humans as social animals; immersion of self in the social network a typical human condition	Pentland 2006, Pentland 2007
	Intelligence	The intelligence of individual human beings, often measured with the g-factor	Woolley, et al., 2010
	Communities	Real and virtual communities, such as communities of practice and online social networks (Cachia et al. 2007) and brand communities (Brabham 2010)	Coe et al. 2001, Cachia et al. 2007, Chen 2007, Lykourentzou et al. 2010, Brabham 2010
Emergence	Complex adaptive systems	Systems that show adaptivity, self-organization and emergence (Ottino 2004)	Komninos 2004, Chen 2007, Luo et al. 2009, Schut 2010, Trianni et al. 2011
	Self-organization	The emergence of order at the system level without central control, solely due to local interactions of the system's components (Kauffman 1993)	Bonabeau and Meyer 2001, Franck 2002, Rasmussen et al. 2003, Wu and Aberer 2003, Luo et al. 2009, Krause et al. 2009, Schut 2010, Trianni et al. 2011
	Emergence	A rise of system level properties that are not present in its components; "the whole is more than the sum of its parts" (Damper 2000)	Rasmussen et al. 2003, Chen 2007, Cachia et al. 2007, Luo et al. 2009, Schut 2010, Lee and Chang 2010, Woolley et al. 2010, Trianni et al. 2011,
	Distributed Memory	The shared, often external, dynamic memory system that performs parts of agents ëtcdgniti 2006)	Bosse et al. 2006, Scarlat and Maries 2009, Gregg 2009, Luo et al. 2009, Levy 2010, Trianni et al. 2011
Macro	Wisdom of crowds	Under certain conditions, groups can be more intelligent than the smartest individuals in them; a collective estimate can be accurate, even if individual estimations are not (Surowiecki 2005)	Chen 2007, Pentland 2007, Nguyen 2008, Krause et al. 2009, Brabham 2009, Lykourentzou et al. 2010, Leimeister 2010, Lee and Chang 2010, Brabham 2010, Lorenz et al. 2011
	Decision making	The process of making decisions, both individually and in groups	Pentland 2006, Bonabeau 2009, Malone et al. 2010, Gregg 2010, Krause et al. 2011
	Aggregation	The combination of individual pieces of information to form a synthesis or collective estimation	Pentland 2007, Bothos et al. 2010, Krause et al. 2011

Table 6. A list of themes related to collective intelligence in humans categorized under three levels of abstraction (Adapted from Salminen, 2012)

5. Genome of Collective Intelligence

Many examples of collective intelligence from Internet based crowdsourcing have been catalogued and described at the MIT Center for Collective Intelligence. There Dr. Thomas Malone and colleagues began by examining hundreds of instances of idea proliferation and their rates of synthesis enabled by the Internet (2010). He showed we can gain value by knowing the "genes" of collective intelligence, how they combined into a "genome" and what collaborative tool best fits what use to raise the collective intelligence of the group (Malone et al., 2010). The crowd is constantly creating, revising, improving, expanding, retracting, and deleting crowdsourced material.

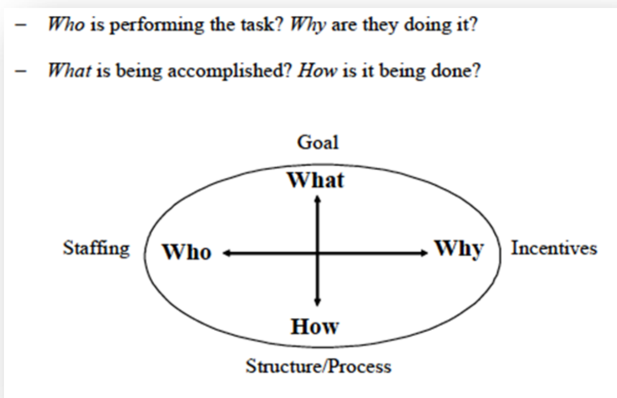

Figure 9. Mapping the Collective Intelligence Genome (From Malone, et al. 2010)

Just as in biology, the genes of collective intelligence string together in various sequences, resulting in many collective intelligence products (Malone, et al., 2010). The ability to classify the sources of input to your social network yields information with which to generate value from it or simply to improve it. Tracing the "genes" of collaborative media can apply to something as large as Facebook or as small as a survey posted on a blog. In simple terms knowing who is doing the work, why they did it, how they did it and what it does allow you to categorize and capitalize. Knowing why and how the source provides data can help understand and evaluate it. This knowledge of the network allows you to shape the use of online collaborative tools to enable collective intelligence that increases the value of the raw information.

E. SUMMARY

The intent of this literature review and thesis is to examine the opportunities to apply specific web technologies to gain actionable intelligence from human systems in a complex environment. Deising (1971) tells sociologists that the only way to study a "whole human system in its natural setting (p. 137)" is to do so from a holistic standpoint. Holism encourages research to treat human systems as complex adaptive systems that "consist…of myriad interweavings of themes and subsystems in a complex pattern. [With] complex interweavings of relationships… [Where] characteristics of a part are largely determined by the whole to which it belongs and by its particular location in the whole system (p. 138)."

Throughout the proceeding chapters, an effort was made to look holistically at human systems with all their attendant interdependencies and complexity. The next sections focus on the possible effects of social network services within the context of the MAGTF and MCISR-E.

THIS PAGE INTENTIONALLY LEFT BLANK

III. METHODOLOGY

A. CASE STUDIES FOR THE EXAMINATION OF SOCIAL NETWORKING SERVICES

Case study research is defined by Yin as “scholarly inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not clearly evident; and when multiple sources of evidence are used” (1994, p. 33). Cases studies can allow for greater understanding of complex issues (Dooley, 2002)—such as the many possible interactions and interdependencies within a social network reflected in the use of SNS or mobile technology—through strengthening and synthesizing the efforts of prior research. This is done by embracing multiple cases, both qualitative and quantitative data, as well as examining multiple research paradigms (ibid).

1. Basic Questions

Hannah’s insightful diagnostic questions (Hannah, 1988) were adapted to analyze the case study organization in its ‘as-is’ state and provide insights to the primary research question; How can online social networking applications (services offered by applications like Facebook, Twitter, and Foursquare) prove beneficial to increasing the collective intelligence of collaborative task-based knowledge networks engaged in the conduct of expeditionary military operations?. Not all the below questions will apply to the MAGTF or MCISR-E but an attempt was made to incorporate each of them in the following analysis.

- What is the purpose of these systems?
- What are the key outputs & outcomes?
- What key processes are used to achieve the purpose?
- What are the key inputs to those processes?
- Are there existent feedback mechanisms, either positive or negative, in the systems?

B. ORGANIZATIONAL DIAGNOSTIC METHOD

In the following chapter I will provide an organizational analysis of the basic deployable unit of the Marines, the Marine Air Ground Task Force (MAGTF) and the knowledge network (MICISR-E) that supports the commander and his staff in their decision making process, the Marine Corps Planning Process (MCPP). The commander of a MAGTF, his staff and the sub-components of a MAGTF rely on timely and accurate intelligence for successful operations. Marine Corps Intelligence is presented as a system of systems, the MCISR-E. The MCISR-E is a complex sub-system of systems from which every MAGTF integrates its Marine Corps intelligence personnel.

What follows is a limited organizational analysis – based on the *Multiple Perspectives Concept* - of a complex system of systems that provides intelligence support in the form of *knowledge workers* conducting *computer supported collaborative work* in support of MAGTF across the MCISR-E. Mapping these organizations, their information flows, and their knowledge dynamics will enable the examination of possible benefits to collective intelligence that may be derived from the emergent properties of social networking services used in a complex human environment

1. Leavitt's Diamond

Harold Leavitt's diamond model (Leavitt, 1965), as seen in Figure 1, provides an analytic framework for organizations that divides the organization into four main components; *technology, structure, people,* and *tasks.* Leavitt's diamond model sheds light on an organization's four main components and their interactions.

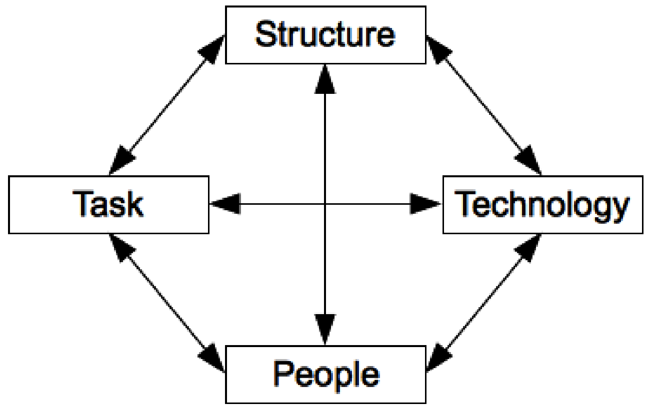

Figure 10. Leavitt’s Diamond Model.(From Leavitt, 1965)

Structure: This determines the placement of power and authority within the organization in question (Galbraith, et al., 2002). Galbraith highlights four main topics discussing the structure of the organization. First is the amount of *specialization* used to perform the work involved. The *shape* refers to the number of people in departments, indicating the span of control within each. *Distribution of power* shows whether the authority of a department of the organization to deal with things critical to their mission: Is it centralized or decentralized within the organization? Finally, *departmentization* covers how the organization forms at each level, which include functionally or by matrix, among others (Galbraith, et al., 2002).

Task: This relates to the organization’s true purpose as established by its mission. It does not include those acts carried out by the members of an organization in their day-to-day duties, which will be covered by the *technology* (Leavitt, 1965).

People: The people are those who carry out the tasks of the work (Burke, 2002). This is more than just a description of their characteristics or the stated organizational human resource policy. The people aspect of Leavitt’s model includes all aspects of recruiting, selection, rotation, training, and development for the human capital of the organization. These processes produce the talent required by the organization, which should be strategically aligned with all other aspects of the organization. Such alignment is shown to build capability within the organization (Galbraith, et al., 2002).

Technology: This includes all of those ‘things’ that the *people* use to accomplish the *tasks* of the organization’s mission. This can involve “tools, machinery, information technology/computers, etc., and structure implied sub-components such as workflow, decision-making authority, communications [means], etc.” (Sharma, 2007 p. 67).

2. The McCaskey Model, an Open Systems View

Although it is integrative of and descriptively covers the main components of the organization, Leavitt’s diamond model is not an open systems view. An open systems model of an organization would account for the input and output of the system, not just its inner transformative processes (Sharma, 2007). In order to have more of an open systems view and to cover the entirety of complex adaptive system of systems such as the MCISR-E, this analysis will attempt a more complete accounting of the organization using the McCaskey model. The McCaskey model focuses on what leaders and managers need to know about group performance, that is to say the focus of the model is on what factors of design, context, and culture that leadership can monitor and attempt to affect in order to produce successful outcomes (McCaskey, 1996).

Context: This can include the history, the physical landscape, the society (including other group, organizations, and competition), etc., in which the organization exists. This organization is first considered within its *context*, the sum of all the environmental conditions within which it must function. One of the primary considerations affecting the group is its purpose; this puts all other factors into a specific context (ibid).

Design: The *design* of a group, according to the McCaskey model, is Leavitt’s diamond. Tasks, people, structure and technology, as discussed above, remain a focus but are considered in total as the *design factors* of an organization. Leaders and designers should focus on building organization with “the strongest combination to increase the group’s chance of success (McCaskey, 1996, p. 5).”

Culture: Groups and organizations of all sizes are made up of people, therefore there’s no avoiding the psychological and sociological aspects of an organization. People’s presence and involvement in the group will result in an “emergence of patterns of thinking and behaving (McCaskey, 1996, p. 7)," which can be seen as a representation of the group's *culture*. This *culture* is built as the group starts "dividing the work, developing patterns of interacting, and establishing norms for behaving (McCaskey, 1996, p. 9)." The result of this emergent process is a schema that develops within the individuals' minds. As they "selectively perceive aspects of their world (McCaskey, 1996, p. 11),""group members tacitly and naturally evolve agreements for what is most important and what they cause and effect linkages are (McCaskey, 1996, p. 12)."

Outcomes: The outcomes of a group may not be intended or successful, but they can be observed. These observations are multi-dimensional, with three main groupings: "(1) productivity; (2) satisfaction; and (3) individual growth (McCaskey, 1996, p. 12)." The second and third outcomes may seem as beneficial to leaders and managers, but considering the importance of culture and the emergent behaviors that form culture, these observations provide the means to see *outcomes* which feedback into the *context*, *design*, and *culture* of an organization.

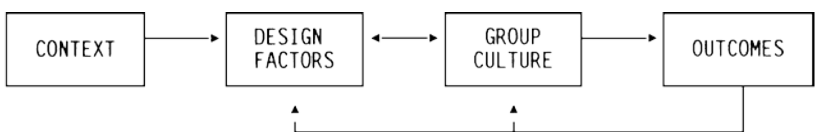

Figure 11. McCaskey model summary (From McCaskey 1996)

In summary, the context of an organization allows for a best fit of design factors (as in Leavitt's diamond) for a successful group, given what is known by leaders and designers. These design factors, along with the environmental context contribute to group culture, all of which results in outcomes. The outcomes of the group's design and culture provide feedback, and changes may or may not occur based on this feedback. The process is shown visually in Figure 15.

C. MULTIPLE PERSPECTIVES CONCEPT

Within the organizational analysis and use cases that follow different observations of the network, its technology and information flows will be added where appropriate. In keeping with the idea of MPC from Chapter II this will bring many different perspectives to bear on the analysis of the MAGTF, the MCISR-E, and the implementation of social network services for the emergence of knowledge. These observations will attempt to aid our insight of the personal, organizational, and technical aspects of the structure and behavior of this complex system—structure and behavior bounded by the McCaskey Model. In light of the scope of this study, it is recognized that the perspectives covered are not comprehensive. Additionally, a strong focus was placed on making this research relevant to the DoD, and even more so to the U.S. Marine Corps and its MCISR-E. This focus may affect the overall generalizability of the findings but fits the purpose and scope outlined for the study.

IV. ORGANIZATIONAL ANALYSIS

A. THE MARINE AIR GROUND TASK FORCE

1. The Marine Corps' Mission as Environment & Context

Hanna, (1988), defined the environment as everything—including all other systems and actors—outside the system's boundary. The Marine Corps has a global mission, to be America's expeditionary force in readiness. This is outlined under the U.S. National Security Act of 1947, amended in 1952, assigning the USMC to train, man and equip forces for the conduct of amphibious assault, to seize and defend advanced naval bases and to conduct such activities as the President may direct in the interest of the national security. This mission set makes the Marines America's global power projection force and its main organization, the MAGTF, the means of that power projection.

In the text Essentials of Organization Theory & Design, Daft defined a wide range of environmental sectors consisting of everything from the labor market, customers, suppliers, to local and federal government and all manner of entities in between (2003). The USMC faces political, financial and operational influences. These sectors of the USMC environment are acknowledged to have an influence that will not be developed fully for the purpose of this analysis. The environmental factors that the USMC addresses in organizational knowledge creation efforts are the range of military operations that the MAGTF faces in its conduct of expeditionary maneuver warfare, depicted in Figure 12 below.

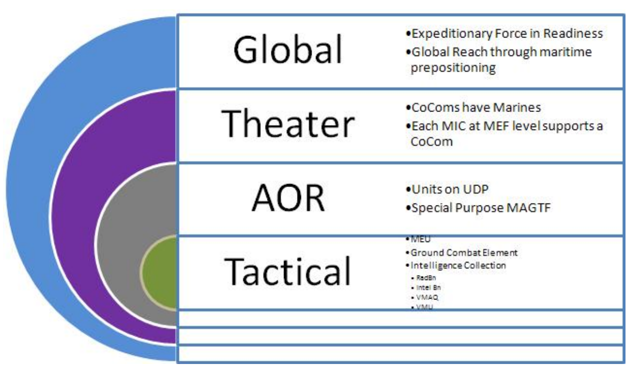

Figure 12. Global to Tactical (Author's image)

2. Design Factors: Leavitt's Diamond

a. The Marine Air-Ground Task Force as Structure

Structure can be examined solely as that within the MCISR-E organization's component parts or more fully by observing the MCISR-E as it relates to another organization, the Marine Air-Ground Task Force (MAGTF). The MAGTF is the mission-tailored, task organized deployable Marine Corps' unit. There are four main components and for standard sized MAGTF configurations.

Also depicted in the below figure, the MAGTF main components are:

Command element (CE): This is the commander and his support staff.

Ground combat element (GCE): This is the ground combat power made up of Marines in infantry, artillery, amphibious assault, tanks and like forces.

Aviation combat element (ACE): Full spectrum aviation support ranging from close air support of jet fighters to logistics resupply helicopters and sensor laden drones are all resident in the ACE as functions of Marine aviation.

Combat service support element (CSSE): The CSSE is the self-sustaining logistics capability of the MAGTF, providing engineers, embarkations, warehousing, maintenance and supply functions.

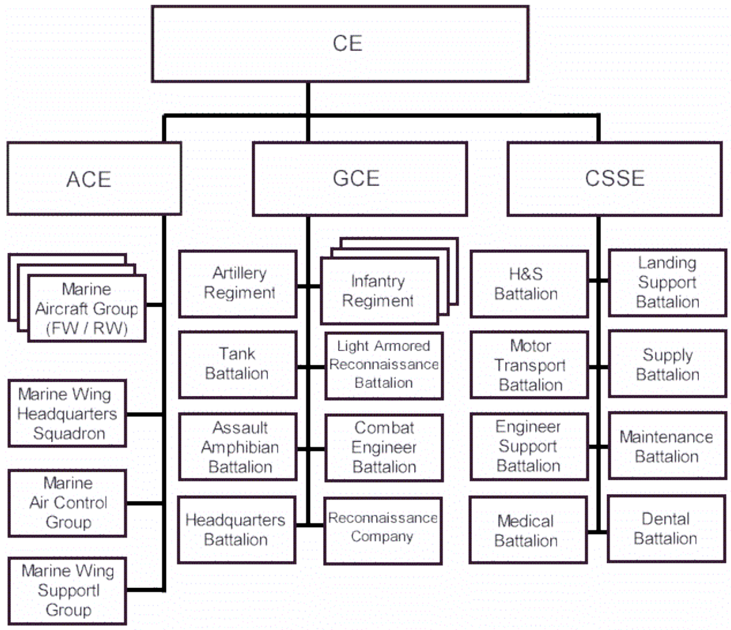

Figure 13. Elements of a MAGTF (From Marines.mil, 2013)

Standard MAGTF configurations of the MAGTF are determined by the size of the force needed to suit the mission. The ground combat element is the standard focal point of the MAGTF, but this can be altered for special missions. There are four standard sized MAGTFs:

Marine Expeditionary Force (MEF): The MEU is led by a two star general and his/her command element and made up of a Marine division (MarDiv), a Marine air wing (MAW), and a full Marine logistics group (MLG).

Marine Expeditionary Brigade (MEB): The MEB is led by a one star general and his/her command element and made up of a Marine regiment, a Marine air group (MAG), and a combat service support brigade (CSSB).

Marine Expeditionary Unit (MEU): The MEU is led by a colonel and his/her command element and made up of a Marine infantry battalion (Bn), a combined fixed/rotary wing squadron (Sqn) and a combat logistics battalion (CLB).

Special MAGTF (SPMAGTF): The SPMAGTF is task organized to meet the mission need, such as those that responded to riots in Lost Angeles in 1994, and disasters in Indonesia in 2003, New Orleans in 2005, Japan in 2010, and New York City in 2012.

b. *The Tasks and Technology of the MAGTF Staff: MCPP and Rapid Response Planning Process (R2P2)*

The tasks of the organization are the work it is organized to accomplish (Jansen, 2013). A MAGTF is a task-organized unit, tailored towards its specific mission set—'to be a forward-deployed force-in-readiness'. Technology is the totality of the means used to conduct the tasks of the organization (Jansen, 2013). The USMC has two planning processes that involve the participation of the commander and staff to execute. In sustained operations the Marine Corps Planning Process is used to create operations orders (OPORDs) for execution by the MAGTF and subordinate commands. In crisis situations, normally expeditionary operations such as those conducted by the MEU or SPMAGTF, the Rapid Response Planning Process (R2P2) emulates the key facets of MCPP but is designed for a maximum of six hours to pass from receipt of a mission to its execution.

Each step in this cycle involves work from intelligence Marines, and thus the involvement of the MCISR-E. The size of the network involved depends on the size MAGTF and their scale of operation. The abbreviated version of MCPP, R2P2, shortens timelines but still involves detailed work executed by Marines executing knowledge work for the purpose of sensemaking in the organization.

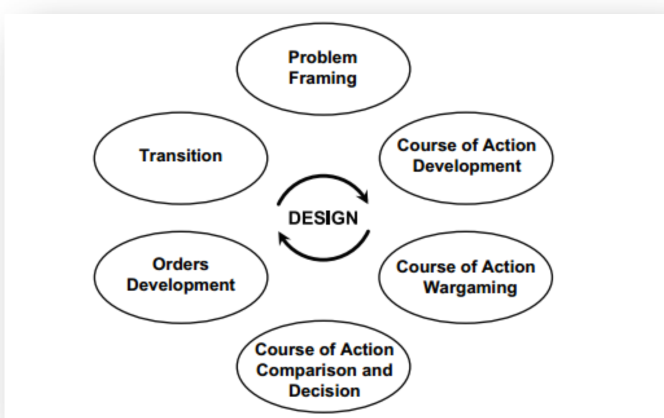

Figure 14. Marine Corps Planning Process overview (From Marines.mil, 2013)

Fulk, Schmitz & Steinfeld (1990) stated that the theories of technology use should be looked at through social influences. Others (Markus, 1990; Poole & DeSanctis, 1990; Markus & Robey, 1988) continued to suggest this; that best practices in information technology use are determined by both the technology itself and the social setting in which the technology is used. MAGTF staffs often rely on information and advice from both their own peer group and senior Marines within the same staff section. What did other Marines find useful to accomplish their mission? What lens did they use to view the problem? Are there technologies or tools should I learn about? What worked well and what worked poorly? Giddens (1990) suggests that we should view technology use in terms of *social construction*, moving past the determination of how technology should be used and instead putting it in the perspective of how use emerges as it occurs. Especially in more technical and technologically based staff sections, advances in useful information technology are rapid, so the ‘how’ of using tools to do things emerges through the social construction of fellow Marines. This drives home the importance of building and maintaining robust networks which will ensure the facilitation of information flow and knowledge dynamics.

c. Marines: the People Part of the Equation

One of the past Commandant’s of the Marine Corps, General Krulak, stated that the Marine Corps has two missions: one is winning America’s battles, the other—which supports the first—is making Marines. With a role to be America’s expeditionary force in readiness, and a history of hard-won amphibious landings going back to the revolutionary war, the U.S. Marine has a storied history. Another Commandant, General Jones, when asked what made the Marine Corps special, quoted Rudyard Kipling’s *Jungle Book* when he said, “The strength of the wolf is the pack, and the strength of the pack is the wolf.” Marines are trained differently than the other conventional U.S. military services. Marines are seen as riflemen first, able to capably fire their weapons, defend themselves in hand to hand combat, and execute basic infantry maneuvers and tactics. This warrior ethos applies to cooks, avionics technicians, and intelligence specialists alike. It is encapsulated in an arduous process of basic training that culminates for both officers and enlisted with the Crucible, a weeklong mental and physical regimen designed to challenge their mettle under simulated combat conditions. After graduation their transformation into a capable part of the Marine Corps is entrusted to the NCOs of the Marine Operating Forces and continues throughout their time in the Corps.

Marine Officers of every job specialty attend both officer candidate school (OCS) and the Basic School (TBS) in Quantico, VA. TBS is a commitment of six months out of an officer's initial four years in uniform. This highlights to outsiders the importance the Marine Corps places on its training. Officers live together in squads and platoons, learning what it means to be a leader of Marines. When it ends they all are basically trained platoon commanders, having demonstrated the ability to lead squads and platoons in day and night operations, call for fire from supporting artillery and aviation, and master the same individual weapons and Marine Corps martial arts as enlisted Marines.

Assignment policies for both officers and enlisted Marines rotate them among the Marine Operating Forces, the supporting establishment (like school houses and recruiting duty), and Joint commands (such as the Combatant Command HQs). General guidelines change Marines' duty assignments every 2–3 years. This manpower assignment flow and a continuous infusion of resident professional military education make an individual Marine a part of many social and professional networks. The traditional camaraderie felt by members of a Marine unit, past and present, is being augmented today by the availability of information network-enabled social networking services. Today a Marine has the potential to maintain contact with fellow Marines from across the entire Corps and utilize that network for mass collaboration in a manner unlike at any other time in history.

3. Culture

Norms and values can be both formal and informal. The culture of an organization like the MAGTF reflects the prevalent norms and values within it, resultant from the interaction of the design features (people, tasks, structure, and technology) (McCaskey 1996). One could say the culture of the Marine Corps is codified in writing, such as the

Marine Corps Manual, the *Guidebook for Marines*, and the *Marine Corps Officers' Handbook*. These manuals contain prescribed and required conduct; all the tasks and technology from the firing of a rifle, and the correct wearing of each uniform, to the standard way to maneuver a column of troops on the march.

The Marine Corps however, cannot be encapsulated in said writings alone, and the norms and values of the Marines (the people and the structure) stem from their indoctrination and experience as Marines. Marines value esprit de corps, discipline, initiative, physical fitness and arguably by the very nature of their choosing the Marine Corps they eagerly seek out challenge. This is built on a foundation of Recruit Training, and Officer Candidate School then developed through their continuing transformation during service in the Operating Forces.

4. Outcomes (Versus Outputs)

The individual *output* that must occur for the success of a Marine unit is determined by the mission. For staff members, and specifically the intelligence Marines on the MAGTF staff, the outputs support either the MCPP or R2P2 (as required). An output can be counted and quantified by quantity, number of reports, number of PowerPoint slides, etc, which is different than an outcome. Good outcomes of MAGTF staff action result in improved effectiveness and efficiency of the commander's decision making process resulting in mission accomplishment.

Individual Marines are accountable for their execution of duties, and for their subordinates. Hence, due to reward structures and individual motivation to the individual Marine that means that the focus of tasks can wrongly shift to producing a quantity of outputs rather than on successful *outcomes* for the unit. Connection to the larger issues of the unit may enhance the individual Marine's, and separate staff sections', focus on the outcomes of the staff rather than making the individuals and sections focus on their own outputs. Information technology that enables constant contact among the networks a Marine establishes throughout his/her service can support the goal of improving unit outcomes.

B. THE MARINE CORPS INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE ENTERPRISE

This section will use the U.S. Marine Corps intelligence architecture as an example of a system of systems engaged in military intelligence activity. The system of systems in question, the *Marine Corps Intelligence, Surveillance, and Reconnaissance Enterprise* (MCISR-E), provides intelligence support to Marine Corps and Joint operations under the doctrine of *Expeditionary Maneuver Warfare* (EMW). MCISR-E is comprised of people, social and organizational structure, technology and tasks all designed to achieve an effect together. MCISR-E activities revolve around informing decision-makers and their staff of possible enemy, weather and environmental effects to friendly forces. This complex system of systems is what the Marine Corps utilizes to satisfy the need for predictive and analytic intelligence in EMW. To further set the stage for the use case and its implications, a partial organizational analysis of the MCISR-E follows.

1. History

The concept of MCISR-E evolved out of the DoD efforts to standardize and streamline military intelligence materiel acquisitions projects in one joint program, known as the Distributed Common Ground Station (DCGS). DCGS was solely prescriptive of standards and norms; it was neither directive nor effective, as it led to each service owning their own DCGS (in the Marines' case, DCGS-MC). DCGS-MC was a joint program under which all intelligence acquisitions programs were housed, while the actions of training, manning and equipping personnel for military intelligence support was known as the Marine Air-Ground Intelligence Systems (MAGIS). In 2005 the Marine Corps issued a directive, phased approach that combined DCGS-MC and the MAGIS into the MCISR-E.

Over years of U.S. conflict in Iraq and Afghanistan military intelligence has come under great scrutiny. Although this is not the focus of the organizational analysis, two points are presented. First, at the tactical level, successful intelligence activities have often been oversimplified into quantity of allocation and apportionment of both ISR sensors and communications bandwidth between units in the field (Flynn, 2009). Second and more directly applicable to MCISR-E as it was derived from the Marine Corps' Intelligence Directorate, is that the rapid fielding of hardware, software and codification of successful tactics, techniques and procedures has become a strategic goal for MCISR-E (Chudoba, 2009).

2. Overview

The MCISR-E delineates three types of nodes - fixed, garrison, and expeditionary – together this array of nodes may be viewed as a complex network. Fixed sites provide deep analytic support and reach back capabilities for both garrison and expeditionary nodes. One fixed node is the Marine Corps Intelligence Activity in Quantico, VA the service-level intelligence agency for the USMC. Another fixed node is the Marine Cryptologic Support Battalion, headquartered with the National Security Agency at Fort Meade, MD. Garrison nodes are the MEF-level intelligence centers (known as a MIC).Each MIC supports an established MEF, east coast & west coast in CONUS and forward deployed to Okinawa, Japan. Subordinate units from the MIC are expeditionary units and their intelligence sections; such as a division or air wing G-2, battalion or squadron S-2, and their organic collection capabilities, such as the radio battalion and intelligence battalion at each MEF and the UAS squadrons at each MAW.

In the MCISR-E view of EMW *every Marine is a sensor*. This is intended to emphasize that every set of eyes on the battlefield is a valuable part of the intelligence apparatus. Seeing the MCISR-E as a *living system* truly reflects that every individual Marine is also a node on the network. Therefore, inputs of every node need to be entered into the system for the benefits of mass collaboration. These inputs currently exist in after action reports, patrol debriefs and lessons learned reporting. However, these inputs are manually intensive and culled at several levels by the limitations of time, bandwidth and human cognitive biases and limitations. The following use cases illustrate where enabling individual nodes of the MCISR-E as a part of the greater network of support to the MAGTF will allow access to and utilization of the massive amount of data available from this living system.

3. Technology of MCISR-E Intelligence Activity

Technology is the totality of the means used to accomplish the tasks of the organization (Jansen, 2013). It is the 'how' that the people use to do the work. Giddens (1990) suggests that we should view technology use in terms of *social construction*, moving past the determination of how technology should be used and instead putting it in the perspective of how use emerges as it occurs. Along those lines, Poole and DeSanctis (1990) offer *Adaptive Structuration Theory,* which examines how the structure of a technology (in our case intelligence activities) and the social structure in which the technology is placed (the MCISR-E network) interact with one another. These studies occurred at the dawn of the information age, as corporations and government undertook great expenditures in IT acquisition. As the DoD struggles with fiscal constraint, it must ensure that it not only gets what it pay for, but that expenditures will be beneficial, and non-disruptive, to the existing intelligence community architecture (people, machines and processes).

Under established network centric warfare concepts, the MCISR-E seeks to capitalize on distributed operations and a knowledgeable, technologically enabled workforce to increase the capability of the enterprise beyond the sum capability of its combined nodes (Alberts, Garstka, & Stein, 1999). This is enabled by existing intelligence community projects such as TENCAP (Tactical Exploitation of National Capabilities) and the drive for National to Tactical integration found in practice across the greater intelligence community. In the MCISR-E, the heart of the intelligence activity is the intelligence cycle, an open system.

Figure 15. Intel Cycle as an open system (Author's image)

The above figure is based on McShane and Von Glinow's model of inputs, transformative processes and outputs, pictured below. Inputs come into the MCISR-E and the national, theater and tactical level and the intelligence cycle (a transformative process using various methods and means—HUMINT, SIGINT, IMINT, etc.) creates an output in the form of finished predictive intelligence for use in expeditionary operations. The outputs of the system are devised to create a specific outcome, increased sense-making on the part of commanders and staff.

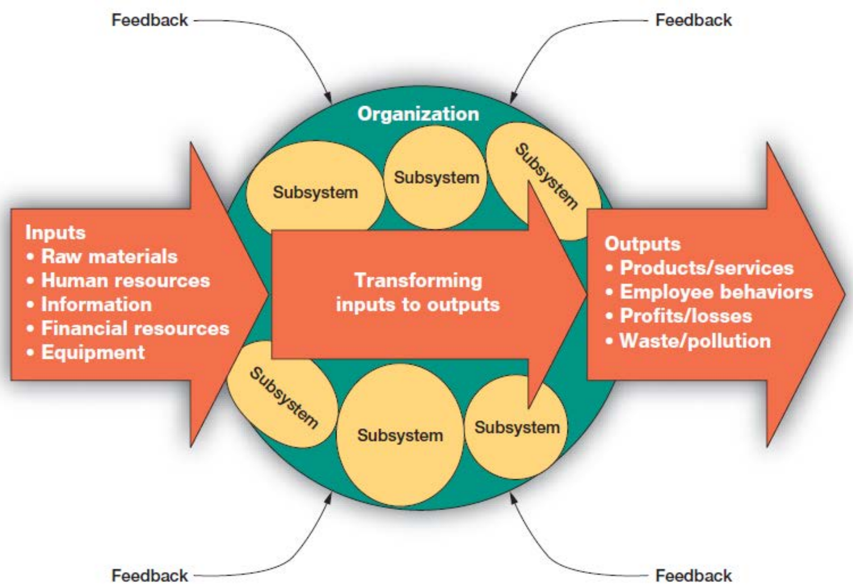

Figure 16. Inputs, transformative processes and outputs (From McShane & Von Glinow, n.d.)

a. A Note on Inputs

The inputs to the intelligence cycle are raw data from sensors and unanalyzed reports from human collectors and informants. The details of such inputs are often classified due to methods and means of collection. This protects them in order to retain their intelligence value for the U.S. national security. The raw material available to the MCISR-E includes the individual Marine trained to be a node in the enterprise.

b. A Transformative Process: the Intelligence Cycle

The intelligence cycle is an iterative process that aims to analyze information and create knowledge out of collected data. Each step of the process is aligned with work roles in the intelligence section, often separated into specialized military occupational specialties. This differentiation by work roles and MOSs is reflected in larger elements of MCISR-E (such as a MEF G-2) and in sub-elements that accomplish each task and overarching structures that fuse the work into finished intelligence. The basic work of each step is further elaborated with examples of role in a small node of MCISR-E (such as the MEU S-2 or infantry company level intelligence cell [CLIC]) and structure in a larger node such as the Intelligence Battalion at the MEF level in garrison.

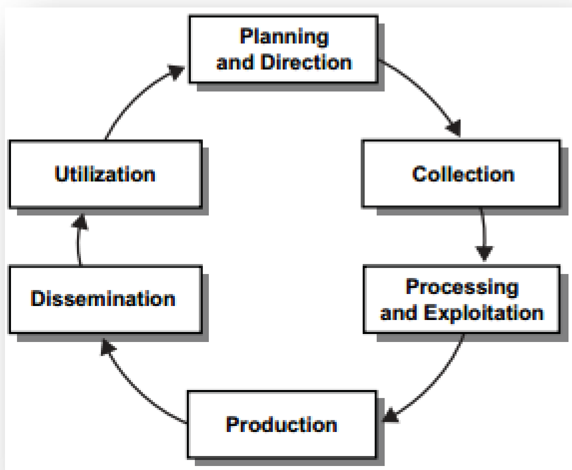

Figure 17. Marine Corps Intelligence Cycle (From marines.mil, date)

Planning and direction: Input of requests for information (RFIs) and prioritization of efforts both occur here. This is accomplished by a unit intelligence officer and intelligence chief at lower levels, or by a large Intel watch section providing 24 hour planning and direction at higher levels.

Collection: This involves many methods of acquiring unanalyzed intelligence, to include database checks, human sourced intelligence, and eavesdropping of various means. This may be done by Marines from the unit on patrol (a Marine-wide program known as “Every Marine a Sensor” stresses the importance of battlefield intelligence, National intelligence collection means, or by the MAGTF’s own organic collection assets.

Processing and exploitation: This is the conversion of raw data, such as patrols’ debrief reports, radar information or machine-to-machine signals, or whatever the case into interpretable intelligence for further analysis. One single trained Marine may provide the full exploitation capability to an operational unit or it may have a full complement of intelligence Marines with specialties ranging from Arabic Cryptologic Linguist to Geographic Intelligence Specialist and a wide variety of other skills.

Production: This can range from the creation of a single graphic depicting a visualization of the battle space to a full volume on the capabilities of a threat force and predictive analysis on their future courses of action. This varies, much like processing and exploitation, due to the wide range of actors doing the work.

Dissemination: Dissemination means getting intelligence products into the hands of decision-makers. “Product posted to a webpage isn’t product pushed.”

Utilization: This is the most difficult step in the process to measure. The outcomes of the intelligence process are dependent on utilization. This implies actual knowledge creation, not just possession of products. Trust, presence, influence and collaborative processes come into play. The message must be heard, received and synthesized into the decision-making cycle of a commander and his staff

4. Tasks of the MCISR-E as a Collaborative Task-Based Knowledge Network

The tasks of the organization represent the work it is organized to accomplish (Jansen, 2013). Intelligence work revolves around the process of informing the decision-maker and their staff of possible enemy, weather and environmental impacts on friendly forces (USMC, 1997). This must occur in a timely manner to keep the unit and commander ahead of enemy decision-makers, it must be accomplished in either peace or conflict and it must continue no matter what events unfold. This work cannot be accomplished alone; it requires inter-personal and inter-group collaborative efforts.

Support the commander’s estimate of the situation
Aid in situation development
Provide indications and warnings
Provide support to force protection
Support targeting
Support combat assessment

Table 7. The six functions of Marine Corps Intelligence (From marines.mil 2013)

The Marine Corps recognizes six functions of intelligence support to the organization at three levels of conflict (USMC, 2003). These function occur at all levels of conflict. The levels of conflict are strategic, operational and tactical and they align traditionally to the focus of the nodes of MCISR-E; fixed, garrison and expeditionary. Several distinctive processes and sub-process exist to execute these six functions, guided by doctrine and training, practiced through experience and improved with each deployment and exercise of the MAGTF for the betterment of the organization as a whole. The actual tasks and processes involving the work of the MCISR-E vary by individual, by unit, and by node.

C. AN INFORMATION-PROCESSING VIEW OF MCISR-E

1. Information-processing Organization

Going back to the reason to provide this analysis in the thesis, we asked what purpose the MCISR-E serves. After the limited organizational analysis the conclusion is that it exists to support the command and control of the MAGTF. To do this the MCISR-E “processes information in order to coordinate and control its activities. By processing information, it observes what is happening, analyzes and makes choices about what to do, and communicates the above to its members (Burton & Obel, 1995, p. 45).” According to Burton and Obel “*information- processing* is a way to view organizations and their designs (Burton & Obel, p.45)” which should take into account the information processing capacity of both IT systems and individuals.

Galbraith (1974) contends that to combat the limits of information processing across the system's elements an organization can either "reduce their need for information processing or increase their capacity to process information (Burton & Obel, 1995, p. 46)." The MCISR-E has acquired many IT solutions to increase that capacity, from sensors such as the Raven UAS to software such as Analysts' Notebook. They have also maintained many means of increasing information processing between groups that traditional organizational consultants would recognize, such as "direct contact, liaison roles, task forces, and permanent teams (Burton & Obel, p. 47)."

2. Pitfalls and Possibilities

Through all of its nodes and the processes it serves the MCISR-E is an information-processing organization, with great demands for communication and coordination between nodes. There are two pitfalls to these demands. First, a large amount of information must be shared; and second, a high degree of understanding and agreement must occur between groups and individuals with highly specialized tasks (Burton & Obel). The analysis of the following use cases suggests that these pitfalls may be mitigated or removed through the proper applications of information technology.

THIS PAGE INTENTIONALLY LEFT BLANK

V. INFORMATION PROCESSING TECHNOLOGY USE CASES

The following the uses cases will explore how social networking services technology; specifically the social web and big data analysis tools can provide competitive advantage from crowdsourcing to increase the information processing capacity of the intelligence community infrastructure. This will serve several purposes; to illustrate historical examples of big data analysis from SNS data streams, to demonstrate the creation of organizational knowledge from such big data analysis, and to illustrate the implications of emergence within knowledge flows in a military intelligence activity workforce using SNS. Additionally, case studies will be used to "foster the development of multiple perspectives" (Dooley, 2002 p. 337) of this topic for future research and operational application.

A. COMMERCIAL SOCIAL NETWORK SERVICES

The DoD released a 2010 memorandum on the responsible use of Internet capabilities which included the responsible and effective use of social network services, social media and several other aspects of web 2.0 technologies. The memorandum does not define those terms, although it does give examples of specific collaborative Internet based sites and applications under scrutiny; such as YouTube, Facebook, MySpace, Twitter and Google Apps (SecDef Memo, 2010). Since this research will attempt to show the utility of SNS for the military intelligence activity it is important to outline what specifically constitutes a SNS and to briefly cover the specific SNS that will be mentioned in the use cases.

Many definitions of social networking services, social media and the social web exist, but the unifying premise shown by Boyd and Ellison is multi-faceted, involving 1) a representation of each user by some sort of profile within a bounded system, 2) a means to make and articulate links between a list of other users, 3) a means to view the lists of connections and the connections and associations of their connections (2007). The entry for social network services within the collaborated SNS. Wikipedia loosely defines an SNS as a "platform to build social networks or social relationships among people(Wikipedia, 2013)" and adds an interesting catch-all provision that SNS provides "a variety of additional services (Wikipedia, 2013)." These additional services mainly revolve around sharing specific files/content across Internet connections (Wikipedia, 2013).

1. FaceBook

FaceBook (FB), an online networking service founded in 2004 by several college students, has become the giant of the SNS community worldwide. Users of FB register as individuals or create pages for companies, celebrities or organizations. Different types of users are subject to different use policies. The basic interface of FB is the user's *wall* and the accompanying *stream*. Once a user logs on FB shows the user the *stream,* a view screen which contains all posts from those users and pages the user has linked to. The user can shift their view to a user's *wall* where FB displays a cover picture, chosen by the user or page and seen only at the wall itself; a profile picture, seen on the user's wall and next to all comments the user makes in other walls and streams; and, all *posts* by the user or about the user by linked users and pages. FB allows users to post status updates, even prompting with questions like "how do you feel today," what's on your mind?," or "Write Something" in the space provided for the post.

Figure 18. Official NPS FaceBook Wall (From FaceBook.com, 2013)

Figure 19. A FaceBook Update Stream(From Facebook.com, 2013)

2. Twitter

Created in 2006, Twitter describes itself as a “real time information network (Twitter.com, 2013).” It provides both social networking and micro blogging services. Micro blogging is comparable to the status updates used in FB, a term to indicate a shortened form of blogging, or web logging—the act of keeping an online journal (Barbee, 2010). Twitter allows only 144 characters in each update—or tweet—from a user, a key feature of its brand identity (Thornton, 2009). Users post commentary, links, pictures, and follow other users’ activity. Twitter was one of the main proponents in the popularity of using hashtags in posts, which has since bled over to other social media such as FB and its subsidiary, Instagram. Hashtags are a way to mark content for easy search and retrieval by other users (i.e. #hashtags, #twitter, #search.) The hashtags make content easily accessible for searches by SNS users. Also, when a hashtag marks content users are then able to view content from users they are not otherwise connected.

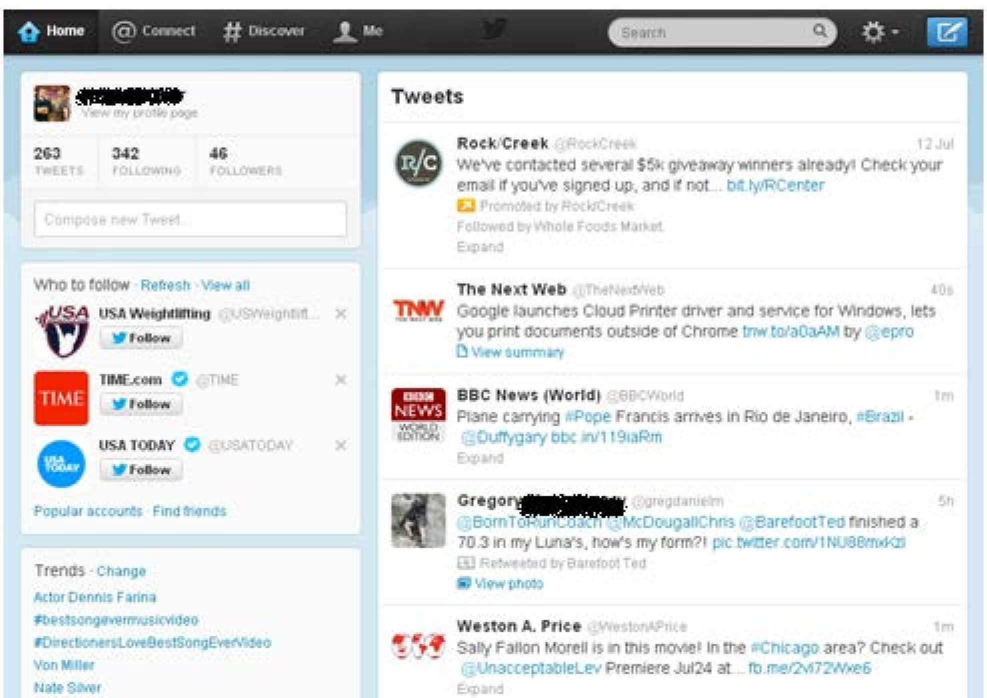

Figure 20. Twitter Home Screen (From Twitter.com, 2013)

3. FourSquare

FourSquare is a SNS that relies upon location-based services, the phenomenon of utilizing location—mostly from GPS data in a user’s mobile device—to provide functionality. FourSquare allows users to share where they are by a *check-in* at the location. Businesses can see who checks in at a location and offer rewards and incentives for their frequency of visits. In simplified terms this is a means to digitize and quantify word of mouth advertising.

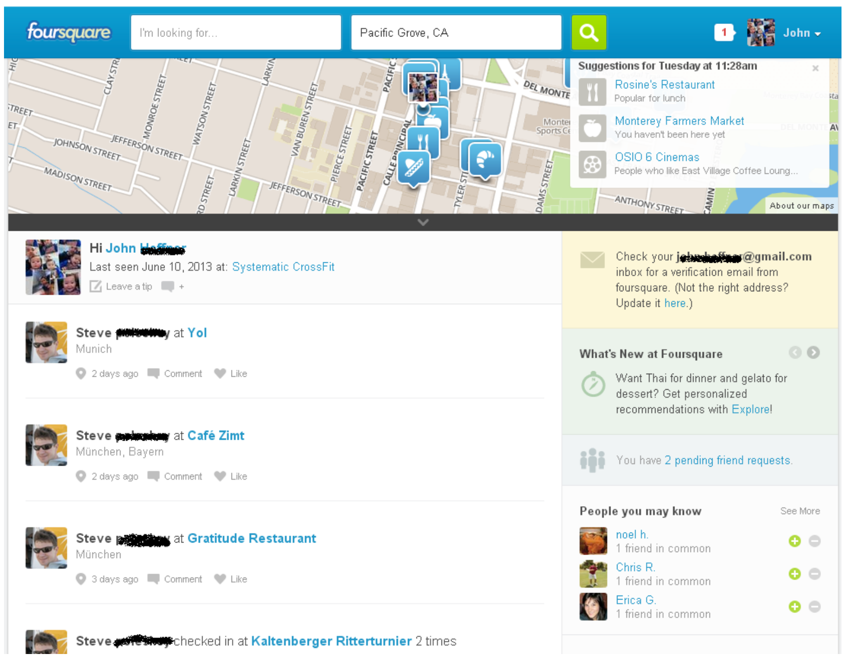

Figure 21. FourSquare Home Screen (From Foursquare.com, 2013)

4. SNS: Mobile and Ubiquitous

While information technology grows faster and more reliable, and Internet access diffuses across the world population via mobile devices, the use of social network services (SNS) continues to connect ever larger portions of the world’s population. Through SNS, such as these three examples, people worldwide are moving past rudimentary connection making and content sharing through networks and moving into crowdsourcing, which adds the collaborative benefit of collective intelligence to a network enhancing speed, accuracy and productivity for knowledge workers.

Users/purveyors of social media may discover new data, make sense of their environment, or have their opinion influenced—all based on their access to information flows and the knowledge created from their own personal and extended network through the use of social media services.

B. COLLABORATIVE FILTERING FOR COMPETITIVE ADVANTAGE

1. Recommender Systems

Recommendation is a nearly universal action across all societies in which one human communicates a preference to another human who faces a decision (Terveen & Hill, 2001). This process can be sought out by the decider or initiated by the recommender, but generally follows the model in Figure 22 (Terveen & Hill, 2001).

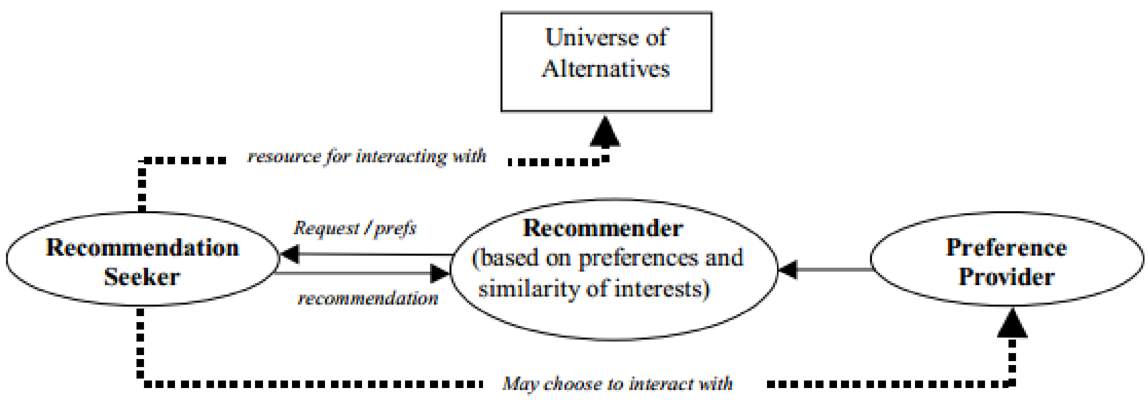

Figure 22. Model of Recommendation Process (From Terveen & Hill, 2001)

Social data mining is a process where the existing computational records of people—created as part of their normal activity—are mined for the useful information implicit in the record (Terveen & Hill, 2001). The term is an application of *data mining*—"extracting interesting patterns from raw data (Kleinberg, Papadimitriou, & Raghavan, 1998, p. 2)"—as it applies to social data. As a part of this area of research and tool development "useful information in these records is identified, computational techniques to harvest and aggregate the information are invented, and visualization techniques to present the results are designed (Kleinberg, Papadimitriou, & Raghavan, 1998, pp. 9–10)."

Recommender systems are part of an expansive field of research that has led to exciting technological developments. This research and development has occurred in the fields of computer science and mathematics, as the main research effort revolves around the complex algorithms used to fuel the complicated processes of matching those diverse users' data sets to equally diverse sets of recommendations. In a table below a sample of the existing computer science and mathematical research themes regarding recommendation algorithms are summarized. These fields are outside of the boundaries of this thesis, as this research focuses on the application of recommender technology as it could be applied to the military intelligence community.

Main Theme	**Definition**	**Research Exemplar(s)**
Data Mining	Extracting interesting patterns from raw data (Kleinberg, Papadimitiou & Raghavan, 1998) , bursty and hierarchical structure in data streams	Kleinberg, Papadimitiou & Raghavan 1998, Kleinberg 2002
Models of Collaborative Filtering	Aggregation of similarity in users behavior to make tailored recommendations	O'Mahony, Hurley, Kushmerick & Silvestre 2004, Kleinberg & Sandler 2004, Nisgav & Patt-Shamir 2011, Yang, Kim, Kim & Kim 2012
Prediction Algorithms	Correlation coefficients, vector-based similarity calculation, statistical Bayesian methods, Robust statistics	Breese, Heckerman & Kadie 1998, Drineas, Kerenidis & Raghavan 2002, Bar-Yossef 2002, Mehta, Hofman & Nejdl 2007

Table 8. Sampling of Recommender Systems Research

2. Commercial Collaborative Filters

Various SNS and other business technologies use tailored recommendations based on user preferences and network associations. These recommenders, known as collaborative filters, have been created to automate the benefits available from social aspects of the World Wide Web, commonly referred to as web 2.0. Collaborative filters need three things to work; “(1) many people must participate (making it likely that any given person will find others with similar preferences), (2) there must be an easy way for people to represent their interests to the system, and (3) algorithms must be able to match people with similar interests (Kleinberg, Papadimitriou, & Raghavan, 1998, p. 12).”

One would expect to get the most useful recommendations from a person with similar tastes, but it is not often easy to find that someone or get them to contribute recommendations (Kleinberg, Papadimitriou, & Raghavan, 1998).This is relatively the same issue with collaborative filters face; the sparsity of recommendations and the classification of preferences being expressed in recommendations (Kleinberg, Papadimitriou, & Raghavan, 1998). Despite these two problems, collaborative filters are a concept of web 2.0 that has been used to raise profit margins in business markets. This shows competitive advantage is provided by demonstrated, not just *potential*, power of the social web. Two examples follow, collaborative filters used by Amazon and iTunes. Both are examples of companies whose recommender systems successfully put automated crowdsourcing to work in customer decision support using predictive analytic power derived from a ‘collective intelligence’.

a. Amazon.com

One example of a highly profitable commercial recommender system, depicted in figure 23, is used by the online retailer Amazon. Amazon.com customers are offered additional purchase recommendations based on their own past purchases, views, user created wish lists, and the similar past activity of those who purchased or viewed the same or similar items in the customer’s shopping cart. This might be thought of as a tool for predictive intelligence.

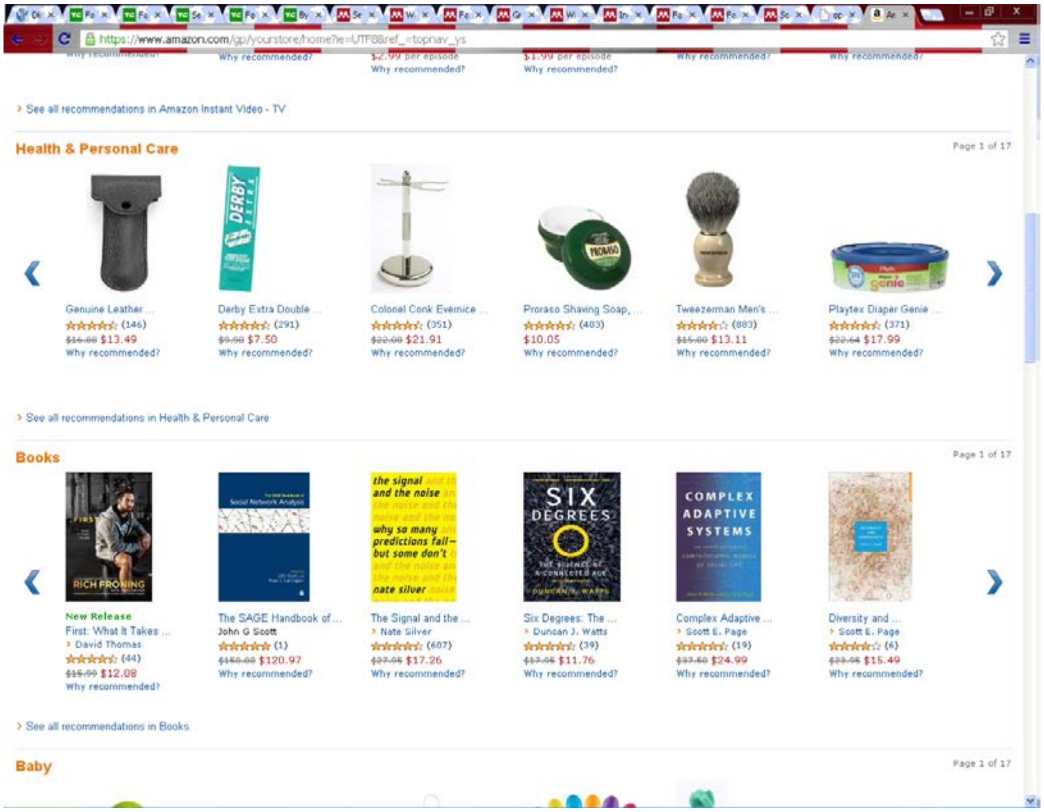

Figure 23. Recommendations of Products and Books to a User on Amazon.com (From Amazon.com, 2013)

b. Apple iTunes' Genius

Another familiar use of such automated predictive intelligence is used by Apple's online store iTunes for music purchases. Apple's "Genius" feature, shown in Figure 24, provides the user/shopper with a selection of music choices similar to the music choices previously purchased by the same shopper and those already in their iTunes library. Much like Amazon this is accomplished using the tastes of other iTunes users who displayed similar preferences. These suggestions are generated by an algorithm, which sorts massive amounts of captured data including mouse hovering duration, number of page views, and even geographic recognition based upon images gathered from facing cameras on mobile devices.

Figure 24. Apple iTunes' Genius Sidebar (From Appleinsider.com, 2013)

3. Benefit of Collaborative Filters

Easley and Kleinberg (2010) found that recommender systems overcome the "rich get richer effect" whereby things that are universally popular will show up ranked high in searches but may be uninteresting to the individuals searching. Instead the recommender system allows a commercial entity to "expose people to items that may not be generally popular, but which match user interests as inferred from their history of past purchases (Easley & Kleinberg, 2010, p. 555)" and if the data is available, then also from the past preferences of similar users and linked users.

C. USING BIG DATA ANALYSIS OF SNS FOR CROWDSOURCED OPERATIONAL INTELLIGENCE

1. Big Data Analysis and Splunk

The term "*big data*" is used to describe large unstructured data sets—on the magnitude of exabytes of data (1 EB = 1,000,000,000,000,000,000 B = 10^{18}bytes). Splunk is a company based in San Francisco, CA that operates in the realm of Big Data. Splunk is short for the word *spelunk;* the act of exploring caves underground. The original developers were allegedly told by clients that going through their own massive technology data files for useful information was like "being lost in the dark searching through the mud" and the name was conceived from there. Splunk is also the name of the company's main product, software that promises to unleash the power of machine data for operational intelligence and competitive business advantage. This "big data" analysis is a software toolset that will "collect, analyze and secure the massive streams of *machine data* generated by all your IT systems and technology infrastructure. (Splunk, 2013)" They simplify the by-products inherent in Internet and information technology with the term: *machine data*.

a. Machine Data

Splunk's product reference sheet maintains a laundry list of what machine data entails; application logs, business process logs, call detail records, clickstream data, configuration files, management and logging APIs, message queues, supervisory control and data acquisition data as is used in industrial systems, packet/flow data from ongoing transmission control protocol/information protocol routing, operating system metrics/status and diagnostic commands, sensor data, router, switch and network device syslogs, web access logs, web proxy logs and Windows events. These datasets can represent the treasure trove that fuels recommender systems and other forms of collective intelligence.

There are many cases where big data can provide increased collective intelligence. For example, take a geographically distributed group of analysts working for a company using SharePoint for a central collaboration point and hosting a website to receive customer requests using an Apache. Both applications generate log files that can be viewed through Splunk to examine incidents in the past (such as a deleted or corrupt file leading to a crashing website) or to view traffic to the website dynamically to determine bandwidth needs. This allows the IT section of the business to derive operational intelligence from machine data.

Machine data can be seen as the record of today's information technology; both mobile and fixed. It allows and precisely documents exactly how knowledge workers conduct computer supported cooperative work. What Splunk allows users to do is quickly to search and retrieve specific information—a set of discrete facts about events (Davenport & Prusak, 2000) that gives meaning to the message (Nissen, 2006)—from large, unstructured sets of machine data.

b. Search and Retrieval Using MapReduce

On the Splunk website it is possible to view many demonstrations of the software's capability, what follows is a brief explanation directly from their documentation of precisely how this software works. This is simply intended to allow the reader a working knowledge of the technology.

Splunk, as a software programming language, uses the MapReduce concept when running a search on one or more machines (Splunk, 2011). MapReduce is an elegant programming and implementation model that allows programmers to process and generate large data sets (Dean & Ghemawat, 2004). It was created by the software developers at Google to handle searches of Internet web pages. They did this after five years' work making single and "special-purpose computations that process large amounts of raw data" (Dean & Ghemawat, 2004, p. 1). They learned to increase the speed of such computations by distributing the processing over multiple machines; on the order of hundreds or thousands of machines.

Though this was a simple concept, there arose from this parallel processing a large amount of complexity in the software, obscuring the initial clarity desired from the software to begin with. The operations they applied to eliminate this complexity were to *map* and *reduce* the data set. A *map* operation is applied to each logical record in the input (the users' search terms) and a *reduce* operation is applied to all values that share the same key in possible key/value pairs (Dean & Ghemawat, 2004). This *map/reduce* function is the source of the name and the source of the ability to parallelize and distribute the processing of search and retrieval from large unstructured data sets like the machine data used by Splunk. MapReduce is used by Google's Sawzall, Yahoo!'s Pig and the open source Hadoop framework (Splunk, 2011); all of these programming languages are means to search and retrieve information from large unstructured data sets through distributed parallel processing.

2. Social Splunk Demo One at the 2012 South by SouthwestMusic and Technology Festival

How is this relevant to the emergence of knowledge from social network services? This section will describe the use of Social Splunk at the 2012 South by Southwestmusic and technology festival.

Splunk, priding itself on being a dynamic and disruptive company, demonstrated their capability at a recent technical conference called "Big Data for the Everyman." Their main premise was that the machine data generated from human activity on social networks can derive operational intelligence. Splunk's representative, Michael Wilde, provided an overview video of the talk. It is freely available on YouTube, here: [http://www.youtube.com/watch?v=ya65Leh7CSs].

a. Inputs

The video explanation begins with how social network service data streams are available through a service called GNIP. GNIP is a commercial service that provides the full "fire hose" of machine data streams from many social media services for a fee, making the full raw data available to analysis. These data streams are easily read and interpreted due to their common data format—JSON, or JavaScript Object Notification. While explaining the details of GNIP and JSON, the author then showed a list of the available machine data streams that he was ingesting into the Splunk software application. The GNIP-provided JSON streams that were ingested came from Twitter, FourSquare, YouTube, Google+ and others, as shown below. All were available from

Internet traffic in real time. He then showed how using the Splunk software, a MapReduce application, to index and search those streams he could find out who had executed a "check-in" using SNS FourSquare at South by Southwest(South by Southwest, 2012) (Figure 24.).

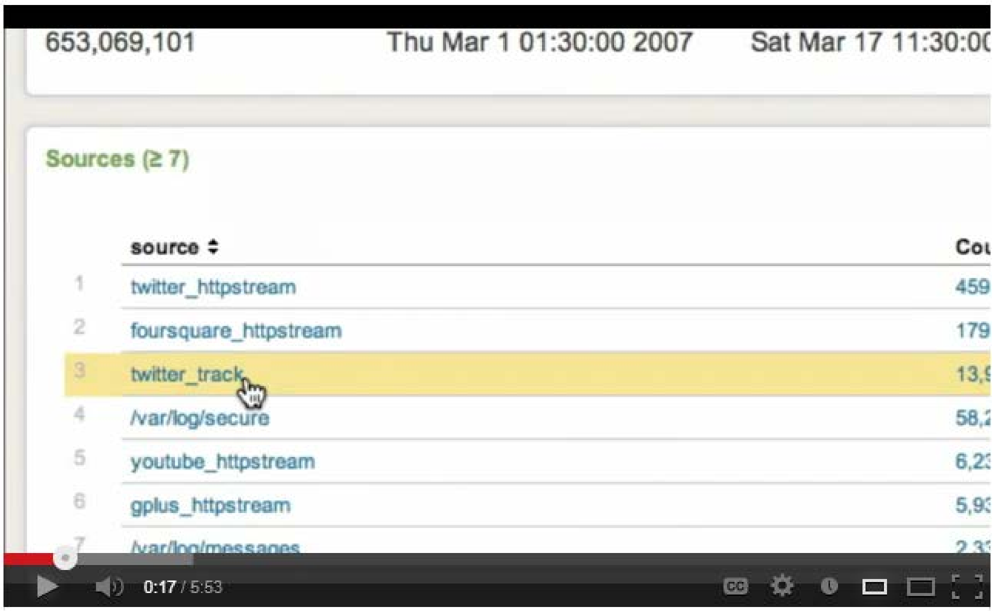

Figure 25. Splunk SOUTH BY SOUTHWEST Demo Machine Data Sources (From Wilde, 2012)

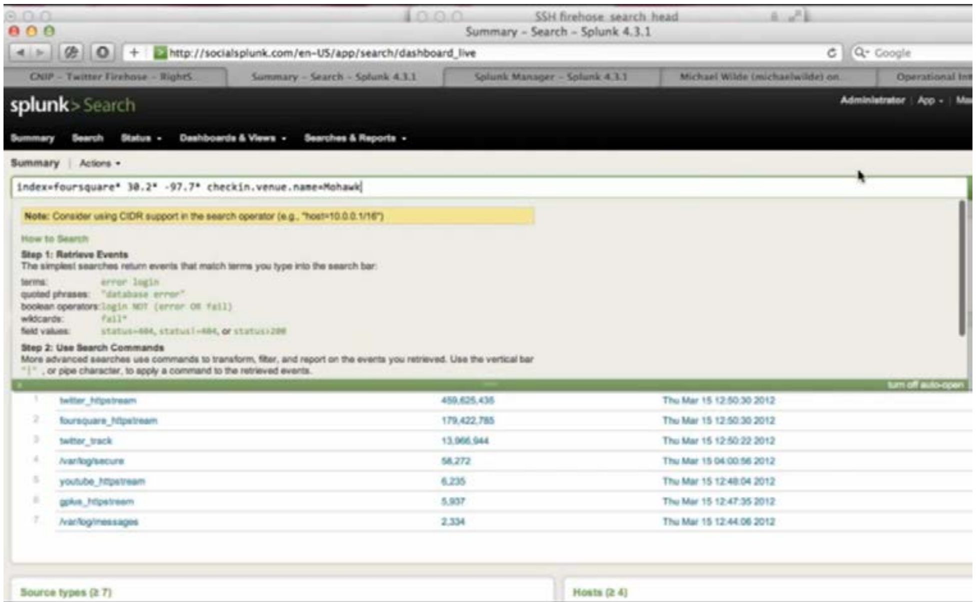

Figure 26. Splunk SOUTH BY SOUTHWEST Demo FourSquare Check-in Search (From Wilde, 2011)

b. Process One

Splunk allows each individual JSON data instance, as machine data, to be indexed temporally or by any other identifier (such as by hashtags). By quickly setting filters in Splunk Wilde then focused on a) the past 24 hours and b) a specific entertainment venue within the city of Austin: a nightclub known as the Mohawk, demonstrating a file based look up. The screen showed a dashboard view of who had checked in at the Mohawk in the past 24 hours. The output was a simple common separated (.csv) file and the search was set up so that it would execute repeatedly. To this search Wilde added what is called a mash-up, combining two related sets of data. In this mash-up Wilde combined the data available about the Mohawk nightclub from the SNS JSON data search to a data set of music entertainment band schedules available from another website, Sched.org a resource that helps people find out what bands are playing, along with accurate and up to date times for all the venues at SOUTH BY SOUTHWEST2012 (the website URL is www.sched.org).

c. Outcome One

Mashing these two SNS machine data sets together showed how many people were in attendance for each band at the Mohawk by time and by removing the specific bar name Wilde showed the most attended individual band performance across the festival and the most attended bar across the 24 hour span. This is a bit of useful operational intelligence from a business standpoint if one were a bar owner, a band, or a record label at South by Southwest looking for the next big thing from the independent bands playing the festival.

3. Social Splunk Demo One at the 2012 South by South West Music and Technology Festival

The second example is also a description of real world Social Splunk use at the 2012 South by Southwest music and technology festival. Having demonstrated an interesting but relevant operational intelligence functions of Splunk the company representative proceeded with a second demonstration showing how the machine data generated from human activity on social networks can derive operational intelligence in real time. Splunk's representative, Michael Wilde, again provided an overview video of the talk. Also freely available on YouTube, it can be found here:

[http://www.youtube.com/watch?v=Z6Xo6V-fjhw]

a. Inputs

The focus of the second demonstration begins by using Splunk to find the JSON data stream of those Twitter users who have used the hashtags #SouthbySouthwest or any like variant of hashtags to indicate that the "tweet" has something to do with the South by Southwest festival. The presenter then conducts another mash-up by combining the first search result to more GNIP available JSON data from SNS FourSquare to see real time location check-ins from users, noting venue names and gender of users. Again all of this is accomplished using the data openly available to Splunk from GNIP's fire hose of user-provided streaming JSON data from the SNS users' messages and activity on the Internet.

b. Process Two

Using the mashup results, Splunk's Michael Wilde converts them into a visually appealing and understandable dashboard layout using Splunk to display the data in a manner that quickly conveys meaningful information to the viewer; a) a speedometer showing how frequently the hashtags are used on twitter, and b) the most popular nightclubs by check-in data (seen in Figure 27). The dashboard's utility is shown as it can be manipulated to highlight specific hashtags, pairs, and using the GPS data from users' tweets and check-ins all the data can be plotted in real time on a map display (seen in Figure 28).

Figure 27. Dashboard view of real time social Splunk data (From Splunk, 2012)

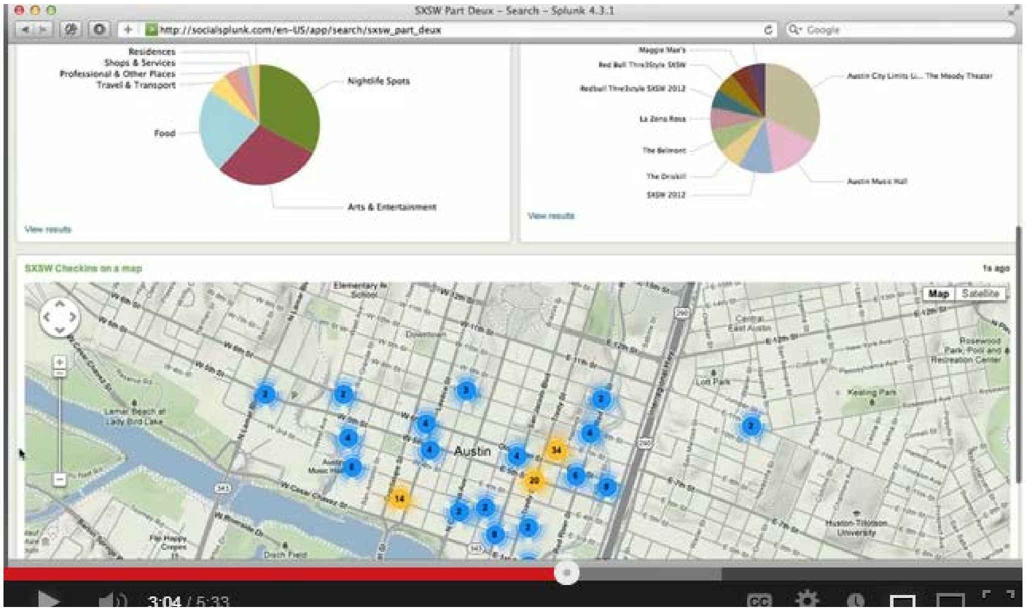

Figure 28. Map View of real time Splunk Data (From Splunk, 2012)

The process was made more useful and detailed by sorting the check-ins by category, then drilling down to the times individual people arrive at an exact bar. Picking the bar Maggie May's the display showed who checked in at that bar. Focusing then on the times of interest for a category, *night life*, the display separated the distribution of check-ins to indicate whether they are male or female. Another data stream was added, from the website *sched.org*, which is a real time crowdsourced guide to when and where music events happen during South by Southwest 2012.

c. Outcome Two

This real time mash-up of freely available information from SNS JSON data allowed a user to see where bars were crowded, to see which gender was more prevalent, and to see where music they liked was available. To further demonstrate the capability of Splunk the map view of real time data was brought up again at a bar of interest, Betsy's, and with a click the text data from the JSON stream was shown to indicate that their schedule was already behind by 45 minutes (figure 29).

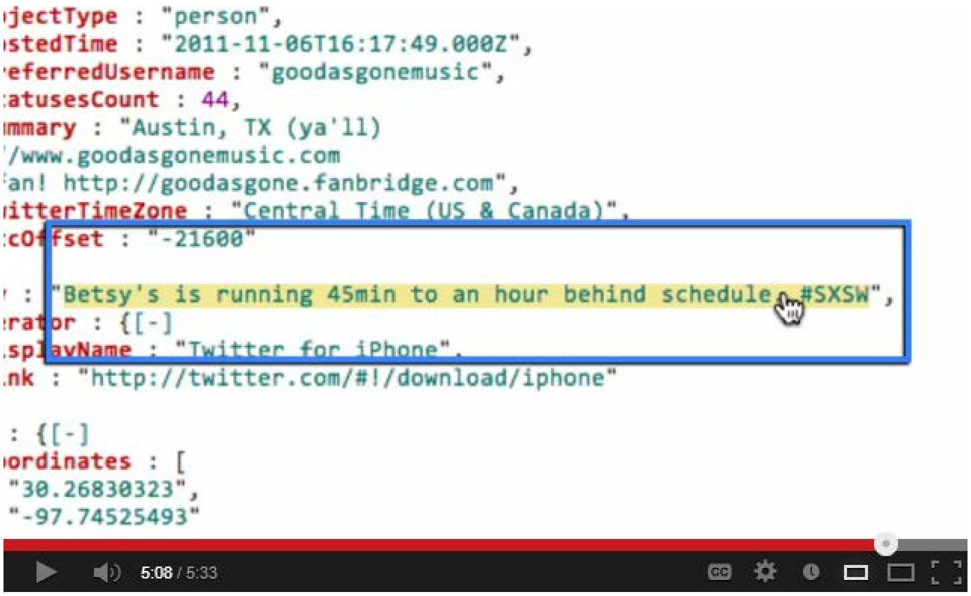

Figure 29. Real time twitter content from JSON data (From Splunk, 2012)

4. Splunk Demonstrations Summary

These demonstrations showed real time search and machine data capture using MapReduce and the mash-up and pivot of big data using Splunk as an interface to openly source SNS data traveling on the Internet. These two demonstrations also show the emergence of knowledge, as “information that enables direct action” (Nissen, 2006), from the use of Splunk as it “amplifies the knowledge created by individuals and crystallizes it as a part of the knowledge network” (Nonaka & Takeuchi 1995, p. 59). This represents the act of *new knowledge creation* according to Nonaka and Takeuchi. The correspondence between Nonaka’s spiral of organizational knowledge creation (1994) is displayed in the table below. Of note, the transfer of knowledge studied in organizational knowledge creation involves intentional interpersonal interactions, the use of SNS and Splunk extracts the information from a virtual pool—hence the conclusion that knowledge creation can emerge from the use SNS independent of whether the users of the SNS know one another or directly interact.

Stage of Nonaka's Spiral	Exchange of Knowledge	Activities within Demonstration	Enabling Technology
socialization	*tacit to tacit,* between SNS users	Sharing of messages regarding music venues and bands	SNS, JSON
combination	*explicit to explicit,* Splunk Operator to Audience	Mash-up of users' gender information to geographically located check-in information gleaned from SNS data streams	SNS, JSON, MapReduce, Splunk
internalization	*explicit to tacit,* map of mash-ups and live tweets/check-ins	Geolocation data allows verification of message data	GPS, SNS, JSON, Splunk
externalization	tacit to explicit, SNS users to Splunk Operator/Audience	Internal message from real time capture regarding late bands at venue "Betsy's" from SNS data stream	SNS, JSON, MapReduce, Splunk

Table 9. Correspondence between Nonaka's Spiral and Splunk Demonstrations

D. IMPLIED USES OF SNS FOR INFORMATION PROCESSING IN MILITARY INTELLIGENCE ACTIVITIES

Participants in a military intelligence activity are knowledge workers conducting collaborative information seeking and sensemaking. They are a social network, connected to various information networks at both fixed and mobile locations worldwide. As parts of local and extended formal and informal networks they have many relationships and many interests. They gather and transmit data. They have likes, preferences, experiences, and individual and role-based backgrounds.

1. Commercial SNS

Traditionally military and business professionals do not turn to the crowd for input, much less answers to their research or operational questions. Some even struggle to recognize what benefit social networking services like Twitter or Facebook could possibly provide beyond obvious personal entertainment and diversion from the real work of the organization. In most military and intelligence organizations social networking services—even those that could provide advantage from crowdsourcing—tend to be treated as security risks, access to which must be restricted within the workplace.

Adding a COTS SNS capability would capture the ‘corporate memory’ from service members, enabling sharing across the intelligence community and, where possible, with our allies. Such a corporate memory would provide information discovery assistance to military units and individuals on rotational deployments by connectingas the breadth of intelligence activities being conducted by the Marine Corps ISR- Enterprise (MCISR-E). This can be done over the course of a deployment, an assignment or over entire careers. By adding commercially available SNS technology to standard software loads of mobile and desktop computing assets across the military community we would enable individuals and military units to share and record the explicit and tacit knowledge possessed by each for the benefit of all.

2. Recommender Systems/Collaborative Filters

Recommender systems using social data mining from the aforementioned COTS SNS could contribute to a crowdsourced collective intelligence advantage for the Marine Corps and DoD. This would envision widespread adoption and use of such software to along with similar collaborative filter applications to gain the same competitive advantage achieved by the suggestion and reference actions of the online entities Amazon, iTunes and others to support warfighting activities.

Incorporating a mission module in DoD enclaves that derives operational intelligence from machine data could glean valued information from the intelligence worker’s role, their unit, the unit’s mission, the assets available, and the user’s defined information requirements. This would be done by careful analysis of how they search for information, what references they access, and the databases they use. Users could actively engage in their day to day operations while such capability modules would run ubiquitously in the background alongside current software, analyzing the user’s unique preferences and actions alongside large datasets of users with similar roles and similar activity. Capturing the preferences of individual users and those in like roles allows *social data mining* for recommendations to improve the performance of many individuals via collaborative filters.

3. Big Data Analysis Through Social Splunk

Splunk, and other machine data software, use meta-data to see how information is stored, accessed, shared, routed and viewed as well as to insights into the profile of users. Click by click the information network users of the DoD, and as part of it the MAGTF, populate the same type of large, unstructured machine data set used by Splunk in the various computer network enclaves (public and classified), making it ripe for exploitation to enhance competitive advantage. These large unstructured data sets allow exploration of how individuals or units create the tacit and explicit knowledge that is essential for successful decision-making. Big data analysis may provide DoD the ability to answer requests for information (RFIs), answer priority intelligence requirements (PIRs) and shape commanders critical information requirements (CCIRs) by the same means that enable commercial success for Amazon and Apple.

VI. FINDINGS AND CONCLUSION

A. POSSIBLE ISOMORPHISM IN THE EMERGENT BEHAVIOR OF SYSTEMS USING SOCIAL NETWORK SERVICES

Systems thinking research often relies on the use of isomorphism. Mathematically an isomorphism indicates where two sets are structurally the same, in essence indicating that the results of an operation on elements in one set would correspond to the results of an analogous operation on the isomorphic set (Merriam-Webster, 2013). One to one correspondence, also known as bijection, is displayed below, and is a key to showing isomorphism graphically (Weisstein, 2013). The analysis of these use cases suggests an isomorphism for further examination.

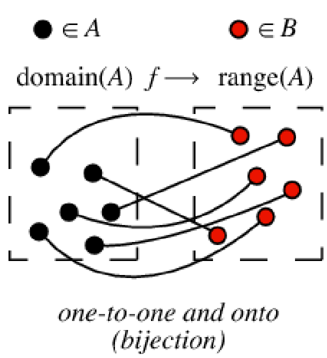

Figure 30. Bijection (From Weisstein, 2013)

Properties of emergence, as seen in both biology (Barabasi, 2002), could be compared to the emergence of knowledge within social networking applications. There are many theories of self-organization in complex systems, also referred to as emergence of order from chaos (Capra, 1996). From biology one example of emergence is known as the *hyper-cycle*. Hypercycles have been suggested as one of the possible activities that led to the creation of life. This activity occurs when a specific set of preconditions exist, followed by the activity of a catalyst that makes the system act or react in a manner that allows order to emerge from chaos. As one of the possible interpretations of the main question under examination; *In what manner can online social networking applications (services offered by applications like Facebook, Twitter, Foursquare, and Pinterest)* *prove beneficial to increasing the collective intelligence of collaborative task-based knowledge networks engaged in the conduct of expeditionary military operations?*

As described briefly in the preceding review of the literature a defining characteristic of complex systems is that they demonstrate self-organizing behavior. Self organization is defined by three elements; it is the emergence of new structures and ways of thinking, it occurs in open systems operating far from equilibrium, and nonlinear interconnection between system elements is expressed by feedback loops (Capra, 1996).

As a result of this research a hypothesis arose; that the pervasiveness and ubiquity of the technology of social networking services (SNS) and mobile technology in society have progressed to a point where their interactions may be isomorphically compared to the self-organizing behavior displayed in the hypercycle. In this case the complex systems contain the preconditions and SNS may act as that catalyst. In order to demonstrate this isomorphic relationship it must be shown that new structures or ways of behaving emerge from the complex interactions of people in.

B. MAJOR CONCLUSIONS FROM RESEARCH

1. Extended Networks Have Great Potential to Raise a Group's Collective Intelligence

The increasing processor speed, storage capability and processing power available via technological advances in computing is compounded by the addition of mobile devices and their proliferation around the world. The exponential growth in interconnectedness of all human networks contributes to the possibilities for data discovery. In light of the continuous improvements in mobile computing technology and connectivity the study of the social aspects and properties of networks can provide an avenue to improve collective intelligence.

2. Crowdsourcing Can Provide Competitive Advantage

Increasingly, social media applications are becoming intuitive interfaces to modern users of technology, ubiquitous across global society. The application of crowd-sourcing could highlight to the individual intelligence Marines, and to the MCISR-E, new capabilities and possibilities, thereby increasing individual performance and unit effectiveness. Crowdsourcing does not remove the active engagement of the human mind from intelligence analysis, rather it uses best known solutions and provides guidance and choices to the intelligence worker similar to lessons learned and after action reports but in a dynamic fashion. The demonstrations of Splunk software to catalyze the emergence of knowledge from the information available in SNS machine data show the possibilities of dynamic knowledge creation.

3. Big Data Analysis Can extract Knowledge from Otherwise Unconnected Information

Analysis of extremely large (exabytes), unstructured data sets may show emergence of knowledge beneficial to intelligence activities. Competitive advantage and performance enhancement may be quite readily captured from the emergent properties in those knowledge networks. Currently, potential competitive advantages of the network are being missed.

A second aspect of this crowdsourced competitive advantage would allow for knowledge management and knowledge creation for the organization as a whole. When an individual knowledge worker gains insight from a particular full motion video feed or analytic blog or other data source, then the analysis of other knowledge workers could benefit from suggested feeds or blogs that are similar. This applies to all the members of an intelligence section; if an individual in a specific role gains insight or benefit from a sensor or source of collection, it goes to follow that knowledge workers in their unit and other units with similar roles would all benefit to know about it as well as sources and works that explore similar topics.

C. AREAS FOR FURTHER RESEARCH

1. Further Discovery and Limited Demonstrations

Prior to insertion of social networking services or recommender systems into the information systems used by deploying units a study based on field exercises could give us an ability to imitate this insertion of automation technology. Discovery level experiments would be appropriate to combine with events like Marine Corps' own

MAGTF Staff Training Program’s MEFEX or one of the MEF level Special Operations Training Group’s TRUEX/CAPEX for a deploying Marine Expeditionary Unit.

Use of SNS, recommender systems and social data mining in further discovery experiments conducted during military exercises would allow us to estimate the value of introducing and testing social networking tools in follow-on hypothesis testing experiments in the field. Further analysis and discovery level experiments could enhance collective intelligence in Marine Corps units by modeling the effect of the insertion of new technology into existing collaborative task-based knowledge networks with a goal of sensemaking.

LIST OF REFERENCES

Ackoff, R. L. (1974). *Redesigning the future: A systems approach to societal problems*. New York, NY: Wiley.

Alberts, D. S., Garstka, J., & Stein, F. P. (1999). *Network centric warfare: Developing and leveraging information superiority*. Washington, DC: National Defense University Press.

Alberts, D. S., & Hayes, R. E. (2003). *Power to the edge: Command, control in the information age*. Washington, DC: CCRP.

Alberts, D. S., & Hayes, R. E. (2006). *Understanding command and control*. Washington, DC: CCRP.

, A. (2003). *Linked: How everything is connected to everything else and what it means for business, science, and everyday life*. New York, NY: Plume.

Barbee, J. (n.d.). "What the hell is a microblog?" . [Blog post]. Retrieved August 26, 2013, from http:// dotcomconfessions.com/dotcom-diva-unplugged/what-the-hell-is-a-microblog

Bennet, A., & Bennet, D. (2008). The decision-making process for complex situations in a complex environment. In F. Burstein & C. Holsapple (Eds.), *Handbook on decision support systems*. Retrieved from http://www.carlisle.army.mil/proteus/docs/bennet-the-decision-making.pdf

Bernoff, J., & Li, C. (2008). Harnessing the power of the oh-so-social Web. *MIT Sloan Management Review*, *49(*3), 36–42.

Bloom, S. (2000). Chaos, complexity, self-organization and us. *Psychotherapy Review, 2*(8).

Brogan, C., & Smith, J. (2009). *Trust agents: using the web to build influence, improve reputation, and earn trust*. Hoboken, NJ: John Wiley & Sons.

Brown, J. S., & Duguid, P. (2000). *The social life of information*. Boston: Harvard Business School Press.

Burke, M., Marlow, C., & Lento, T. (2009, April). In D Olsen (Chair). Feed me: Motivating newcomer contribution in social network sites. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Boston (pp. 945–954). doi: 10.1145/1518701.1518847

Burke, W. W. (2002). *Organization change: theory and practice.* Thousand Oaks, CA: Sage Publications.

Cao, B. (2012). Sinaweibo’s outlook buoys Internet stock gains: China overnight. Retrieved June 1, 2013, from http://www.bloomberg.com/news/2012–02–28/ sina-s-weibo-outlook-buoys-Internet-stock-gains-in-n-y-china-overnight.html

Capra, F. (1996). *The web of life: A new scientific understanding of living systems*. New York, NY: Anchor Books.

Carafano, J. (2009). Social networking and national security: How to harness web 2.0 to protect the country, *Backgrounder*, 2273, http://s3.amazonaws.com/thf_media/2009/pdf/bg2273.pdf

Carrington, P. J., Scott, J., & Wasserman, S. (2005). *Models and methods in social network analysis*. Cambridge, MA: Cambridge University Press.

Carstensen, P. H. (1999). *Computer supported cooperative work: New challenges to systems design*. Lyngby: Center for Tele-Information, Danmarks Tekniske Universitet.

Choo, C. W. (2003). Perspectives on managing knowledge in organizations. *Cataloging & Classification Quarterly, 37*(1/2), 205–220.

Christakis, N. A., & Fowler, J. H. (2009).Connected: the surprising power of our social networks and how they shape our lives. New York, NY: Little, Brown..

Churchman, C. W. (1971). The design of inquiring systems: basic concepts of systems and organization, New York, NY: Basic Books.

CIO Council, ISIMC NISSC Web 2.0 Security Working Group. (2009). Guidelines for secure use of social media by federal departments and agencies. Retrieved from CIO Council https://cio.gov/wp-content/uploads/downloads/2012/09 /Guidelines_for_Secure_Use_Social_Media_v01–0.pdf

Clark, H. H., & Brennan, S. E. (1991). Grounding in communication. In L. Resnick, J. Levine & J. Levine (Eds.), *Perspectives on socially shared cognition* (pp. 127–149). Washington, DC: American Psychological Association.

Clark, H.H., & Wilkes-Gibbs, D. (1986). Referring as s collaborative process.*Cognition*, *22*(1), pp1–39. Please follow my lead on journals, websites, state abbreviations.

Clausewitz, C. v., & Graham, J. J. (1873). *On war*. Champaign, Ill.: Project Gutenberg.

Collins, P., Ryan, L., & Matusik, S. (1999). Programmable automation and the locus of decision-making power. *Journal of Management, 31*(3), 512–543.

Coming, P. A. (2007). Synergy goes to war: A bioeconomic theory of violence. *Journal of Bioeconomics, 9* (22), Retrieved October 19, 2012, from http://www.complexsystems.org/publications/warfare.html

Curry, M. (2001, October 04). [Web log message]. Retrieved from http://mec3yh.wordpress.com/category/systems/page/2/

Daft, R. L. (2003). *Organization theory and design* (8th ed.). Mason, Ohio: South-Western/Thomson.

Davenport, T. H. (2005). *Thinking for a living: how to get better performance and results from knowledge workers*. Boston: Harvard Business School Press.

Davenport, T.H. & Prusak, L. (1998). *Working knowledge*. Boston: Harvard Business School Press.

Davis III, C. H. F., Deil-Amen, R., Rios-Aguilar, C., & González Canché, M. S. (2002). Social media and higher education: A literature review and research directions. Report printed by the University of Arizona and Claremont Graduate University.

DeSanctis, G., & Poole, M. S. (1994). Capturing the complexity in advanced technology use: Adaptive structuration theory. *Organization Science, 5*(2), 132.

Delaney, J. E. (2009). Managing communications with experts in geographically distributed collaborative networks. (Master's thesis, Naval Postgraduate School) Retrieved from http://edocs.nps.edu/npspubs/scholarly/theses/2009/Mar/09Mar_Delaney.pdf

Deluga, R. J. (1995). The relation between trust in the supervisor and subordinate organizational citizenship behavior. *Military Psychology, 7*(1*),* 1–16. Retrieved February 9, 2010, from http://www.informaworld.com/10.1207/s15327876mp0701_1

Denning, P. J. (2006). Infoglut. *Communications of the ACM, 49*(7), 15–19.

Naval Operations for Information Dominance, (2010). *The U.S. Navy's vision for information dominance*. Washington DC: The Department of the Navy.

Deputy Secretary of Defense. Department of Defense, (2010). Directive-Type Memorandum (DTM)09–026 - responsible and effective use of Internet-based capabilities. Retrieved August 23, 2010 from http://www.dtic.mil/whs/directives/corres/pdf/DTM-09–026.pdf

Diesing, P. (1971). *Patterns of discovery in the social sciences.* Chicago: Aldine·Atherton.

Dooley, L. M. (2002). Case study research and theory building. *Advances in Developing Human Resources*, 4(3), 335–354.

Drapeau, M., & Wells, II, L. (2009). Social software and national security: An initial net assessment. (Center for Technology and National Security, National Defense University) Retrieved August 10, 2009, from http://www.ndu.edu/CTNSP/docUploaded/ DTP61_SocialSoftwareandNationalSecurity.pdf

Drezner, D.W., & Farrell, H. (2004, Nov. 1). Web of influence. *Foreign Policy*.

Drucker, P. F. (1999). *Management challenges for the 21st century*. New York, NY: HarperBusiness.

Dukemorales. (2009, August 2). Social network services. Retrieved December 1, 2012, from http://forum.wareseeker.com/socialnetwork-service-t1934.html

Eilenber, D. (2007, Mar/Apr). Intellipedia shows revolutionary promise. *National Geospatial Intelligence Agency Pathfinder, 5*(2). Retrieved from http://www1.nga.mil/NGASiteContent/StaticFiles/pathfinder/marapr07.pdf

Eoyang, G. (2004). Complex adaptive systems (CAS). Retrieved from Actrix Users Home Pages website: http:users.actrix.co.nz/bobwill/CASmaterial.pdf

Easley, D., & Kleinberg, J. (2010).Networks, crowds, and markets reasoning about a highly connected world. New York, NY: Cambridge University Press.

Facebook.(2013). User statistics. Retrieved March 1, 2013, from http://www.facebook.com/press/info.php?statistics

Freeman, L. C. (2004). The development of social network analysis: a study in the sociology of science. Vancouver, BC: Empirical Press, Book Surge.

Fulk, J., Schmitz, J., & Steinfield, C. W. (1990). A social influence model of technology use. In J. Fulk & C. Steinfield (Eds.), *Organizations and communication technology.* Newbury Park, CA: Sage Publications.

Galbraith, J. R. (2002). *Designing organizations: an executive guide to strategy, structure, and process* (New and rev. ed.). San Francisco: Jossey-Bass.

Getha-Taylor. (2008). Identifying collaborative competencies. *Review of Public Personnel Administration*; *28*(2); 103.

Giddens, A. (1990). The consequences of modernity. Stanford, CA: Stanford University Press.

Gladwell, M. (2002). *The Tipping Point: How Little Things Make a Big Difference*. New York, NY: Little Brown.

Goldsmith, S., & Kettl, D. F. (2009).Unlocking the power of networks keys to high-performance government. Cambridge, MA: Ash Institute for Democratic Governance and Innovation .

Granovetter, M. (1983). The strength of weak ties: A network theory revisited. *Sociological* Theory, 1, 201–233.

Grimes, J. (2007). Department of defense information sharing strategy. Retrieved from Office of the Department of Defense Chief Information Officer website: http://cionii.defense.gov/docs/InfoSharingStrategy.pdf

Grudin, J. (1994). Computer-supported cooperative work: History and focus. *Computer, 27*(5*)*, 19–26.

Grudin, J. (1988). *Why CSCW applications fail: problems in the design and evaluation of organization of organizational interfaces*. In Grief, I. (Eds.), *Proceedings of the 1988 ACM Conference on computer-supported cooperative work* (pp. 85–93). New York: ACM Press.

Hanna, D. P. (1988). *Designing organizations for high performance.* Reading, MA: Addison-Wesley.

Hendrix, S. A. (2001). Network centric operations and naval officers of the future: A first order analysis of desired knowledge, skills, abilities, and personality traits. (Master's thesis, Naval Postgraduate School) Retrieved September 23, 2009 from http://edocs.nps.edu/npspubs/scholarly/theses/2001/Sep/01Sep_Hendrix.pdf

Heussner, K. (2008, September 2). Social media proves itself as emergency tool. *ABC News*. Retrieved September 5, 2008 from http://abcnews.go.com/Technology/SmartHome/ story?id=5703281&page=1

Heylighen, F., & Joslyn, C. (1992, November 1). What is systems theory. Retrieved from Principia Cybernetica Web: http://pespmc1.vub.ac.be/SYSTHEOR.html

isomorphism. (nd.). In *Merriam-Webster.com.* Retrieved 10 June 2013, from http://www.merriam-webster.com/dictionary/isomorphism

Jansen, E. (2013). Winter Quarter. Organizational design for special operations. Lecture conducted from Naval Postgraduate School, Monterey, CA

Janssen, E. (2008, July 29). Why are social networks popular?. Retrieved September 15, 2010, from http://biznik.com/articles/why-are-social-networks-popular

Johnson-Laird, P. N. (1983). Mental models: Toward a cognitive science of language. Boston: Harvard Univeristy Press.

Kadushin, C. (2012). Understanding social networks: theories, concepts, and findings. New York, NY: Oxford University Press.

Kelly, T. (2012, June 28). Social networking concept may have emerged during renaissance, researchers say. Huffington Post. Retrieved June 1, 2013, from http://www.huffingtonpost.com/2012/06/28/social-networking-concept-italian-academies_n_1631595.html?utm_hp_ref=social-networking

Kingsley, C. (2010). Making the most of social media: 7 lessons from successful cities. Philadelphia, PA: Fels Institute of Government, University of Pennsylvania. Retrieved from https://www.fels.upenn.edu/sites/www.fels.upenn.edu/files/ PP3_SocialMedia.pdf

Kinniburgh, J. B. (2004). Who networks? : The social psychology of virtual communities. (Master's thesis) Retrieved from http://edocs.nps.edu/npspubs/scholarly/theses/2004/Jun/ 04Jun_Kinniburgh.pdf

Leavitt, H. J. (1965). Applied organization change in industry: Structural, technological and humanistic approaches. In J. March (Ed.), *Handbook of organizations* Chicago: Rand McNally.

Liebowitz, J. (2007). Social networking: the essence of innovation. Lanham, Md.: Scarecrow Press.

Losey, S. (2008, May 11). The race to collect knowledge. *Federal Times*. Retrieved May 21, 2008, from http://www.federaltimes.com/index.php?S=3521664

Markus, M. L. (1990). Toward a 'critical mass' theory of interactive media. In J. Fulk & C. Steinfield (Eds.),*Organizations and communication technology*(pp. 194–218). Newbury Park, CA: Sage Publications.

Markus, M. L., & Robey, D. (1988). Information technology and organizational change: Causal structure in theory and research. *Management Science*, 1, 583–598.

McCaskey, M. B. (1997). Framework for analyzing work groups. Boston: Harvard Business School Press.

McCulloh, L., Webb, M., & Graham , J. (2008). Change detection in social networks. (Technical Report No. 1235). Arlington, VA: United States Army Research Institute for the Behavioral Social Sciences. Retrieved from http://handle.dtic.mil/100.2/ADA484611

Miller, J. (2007, September 6). CIA works to break info-sharing barriers. Retrieved September 1, 2008, from http://www.fcw.com/online/news/103692–1.html

Miller, J. (2008, March 3). Intelligence analysts establish trust in an online community of their own making. Retrieved March 3, 2008, from http://www.fcw.com/print/22_5/ features/151790–1.html

Meadows, D. H., & Wright, D. (2008). *Thinking in systems: A primer.* White River Junction, VT: Chelsea Green.

Mitroff, I. I., & Linstone, H. A. (1993). *The unbounded mind: breaking the chains of traditional business thinking*. New York, NY: Oxford University Press.

Nielson Online. (2009, March). March 2009 global faces and networked places: A Nielsen report on social networking's new global footprint. Retrieved from http://blog.nielsen.com/ nielsenwire/wp-content/uploads/2009/03/nielsen_globalfaces_mar09.pdf

New Way Media. (2008). Social media. Retrieved September 15, 2010, from http://newwaymedia.com/web/social-media/

Nissen, M. E. (2006). Harnessing knowledge dynamics. Hershey PA: IRM Press.

Nissen, M.E. (2002). An extended model of knowledge-flow dynamics. *Communications of the Association for Information Systems. 8*, 251–266.

Nissen, M. E., Kamel, M. N., & Sengupta, K. C. (2000). Integrated analysis and design of knowledge systems and processes. *Information Resources Management Journal*, *13(1)*, 24–43.

Nonaka, I. (1991). The knowledge creating company. *Harvard Business Review, 69(6)*, 96–104.

Nonaka, I. (1994). A dynamic theory of organization knowledge creation. *Organization Science*, *5(1)*, 14–37. Retrieved October 16, 2009, from http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=7098440&site=ehost-live&scope=site.

Nonaka, I. & Hirotaka, T. (1995). The knowledge-creating company: How Japanese companies create the dynamics of innovation. New York: Oxford University Press.

Odden, L. (2009, February 12). Best and worst practices:Social media marketing. Retrieved October 28, 2010 from http://www.toprankblog.com/2009/02/ best-worst-practices-social-mediamarketing/

O'Reilly, T. (2010). Opening the doors of government to innovation. Retrieved August 7, 2010, from http://radar.oreilly.com/2010/08/opening-doors-governmentinnovation.html

Pavlou, P. A., & Stewart, D. W. (2000). Measuring the effects and effectiveness of interactive advertising: A research agenda. *Journal of Interactive Advertising*, 1(*1)*, 65.

Plutsky, G. (2010 February, 12). 6 tips for connecting with social media content. Retrieved on October 22, 2010, from http://www.imediaconnection.com/content/25860.asp

Pérez Latre, F., Portilla, I., & Sánchez Blanco, C. (2011). Social networks, media and audiences: A literature review. *Communication and Society/Comunicación y Sociedad. 24(1)*, 63–74.

Pierce, D. (2010). Pentagon’s social network becomes hub for Haiti relief. Retrieved on March 4, 2010, from http://www.wired.com/dangerroom/2010/01/pentagons-social-network-becomes-hub-for-haiti-relief

Polanyi, M. (1966). *The tacit dimension*. London: Routledge & Kegan Paul.

Poole, M.S., & DeSanctis,G. (1990). Understanding the use of group decision support systems: The theory of adaptive structuration. In J. Fulk & C. Steinfield (Eds.),*Organizations and communication technology*(pp. 173–193). Newbury Park, CA: Sage Publications.

Prigogine, I. (1967). *Introduction to thermodynamics of irreversible processes (*3rd ed.). New York, NY: Interscience.

Qualman, E. (2009). Socialnomics: How social media transforms the way we live and do business. Hoboken, NJ: Wiley.

Radick, S. (2010). How social media is changing the way government does business. Retrieved July 16, 2010, from http://mashable.com/2010/07/02/social-media-government-business/

Rasmussen, C. (n.d.) ‘The Intellipedians’:The social software movement within the U.S. Intelligence Community. [Audio briefing]. Retrieved August 1, 2012, from http://fcw.com/blogs/insider/2008/07/fcw-insider-fcwfederal-news-radio-show-with-intellipedias-chris-rasmussen.aspx /

Reinhardt, W., Schmidt, B., Sloep, P., & Drachsler, L. (2011). Knowledge worker roles and actions-results of two empirical studies. *Knowledge and Process Managemen*t, 18(3), 160.

Richards, C. (n.d.). Briefings - Colonel John R Boyd, USAF. Retrieved August 26, 2013, from http://www.ausairpower.net/APA-Boyd-Papers.html

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Rubin, H. J., & Rubin, I. (1995). *Qualitative interviewing: the art of hearing data*. Thousand Oaks, CA: Sage Publications.

, J. (2009). *The coding manual for qualitative researchers*. London: Sage.

Schmidtchen, D. (2006). The rise of the strategic private: technology, control and change in a network-enabled military. Duntroon, ACT-Australia: Land Warfare Studies Centre.

Seele, R. (2001). Towards a model of self-organized transformation in teams and organizations. Retrieved 1 August 2012, from http://www.newparadigm.co.uk/Self-Org%Change.htm

Shah, C. (2012). *Collaborative information seeking the art and science of making the whole greater than the sum of all*. Berlin: Springer.

Sharma, R. R. (2007). *Change management: Concepts and applications*. New Delhi: Tata McGraw-Hill.

Smith, J. (2009, July 2). Inside Facebook tracking:Facebook and the Facebook platform for development and marketers. Retrieved October 27, 2011, from http://www.insidefacebook.com/2009/07/02/facebook-now-growing-by-over-700000-users-a-day-updated-engagement-stats

Smith, T., & Stevens, G. (1994). Emergence, self-organization and social interaction:Arousal-dependent structure in social systems. University of Rochester. Retrieved from Santa Fe Institute website: http://www.santafe.edu/media/ workingpapers/94–08–046.pdf

Solomonoff, R., & Rapaport, A. (2006). Connectivity of randomnets. In M.E.J. Newman, A. Barabási& D. J. Watts (Eds.), *The structure and dynamics of networks* (pp. 27–37). Princeton, NJ: Princeton University Press.

Sullivan, J. (2009). Harnessing open source intelligence: Social media and the CIA. Retrieved December 8, 2011, from http://www.findingdulcinea.com/news/Americas/2009/October/Harnessing-Open-Source-Intelligence--Social-Media-and-the-CIA.html

Surowiecki, J. (2004). *The wisdom of crowds: why the many are smarter than the few, and how collective wisdom shapes business, economies, societies, and nations.* New York: Random House.

Tapscott, D., & Williams, A. D. (2006).*Wikinomics: how mass collaboration changes everything.* New York, NY: Portfolio.

Thompson, C. (2006, December 3). Open-source spying. *New York Times*. Retrieved October 16, 2008, from http://www.nytimes.com/2006/12/03/magazine/03intelligence.html

Thornton, S. (n.d.) Twitter versus Facebook: Should you choose one? Retrieved December 7, 2012, from http://www.twitip.com/twitter-versus-facebook/

Travers, J., & Milgram, S. (2006). An experimental study of the small world problem.In M. E. J. Newman, A. Barabási & D. J. Watts (Eds.*), The structure and dynamics of networks* (pp. 130–148). Princeton, NJ: Princeton University Press.

Trevino, L. K., Daft, R. L., &Lengel, R. H. (1990). Understanding managers' media choices: A symbolic interactionist perspective. In J. Fulk& C. Steinfield (Eds.), *Organizations and communication technolog*y (pp. 71–94). Newbury Park, CA: Sage Publications.

Trist, E. L., & Bamforth, K. W. (1951). Some social and psychological consequences of the longwall method of coal getting. In *Human Relations 4*(3), 3–38. Retrieved from http://www.uv.es/gonzalev/PSI ORG 06–07/ARTICULOS RRHH SOCIOTEC/Trist Long Wall Method HR 1951.pdf

United States Marine Corps. (1997). Marine Corps doctrinal publication 2: Intelligence. Retrieved from: http://www.marines.mil/Portals/59/Publications/MCDP 2 Intelligence.pdf

United States Marine Corps. (2003). Marine Corps war fighting publication 2–1: Intelligence operations. Retrieved from: http://community.marines.mil/news/publications/Documents/MCWP%202–1%20Intelligence%20Operations.pdf

United States Marine Corps. (2008). Marine Corps vision and strategy 2025. Retrieved from http://www.onr.navy.mil/~/media/Files/About%20ONR/usmc_vision_strategy_2025_0809.ashx

United States Marine Corps. (2013). Marine Corps concepts and programs 2013. Retrieved from http://www.hqmc.marines.mil/pandr/ConceptsandPrograms/ConceptsandPrograms2013.aspx

Ushahidi Haiti. (2010). Retrieved on 25 July 2012, from http://haiti.ushahidi.com/main

Vieweg, S., Palen, L., Liu, S., Hughes, A., & Sutton, J. (2008, May). In S French (Chair). *Collective intelligence in disaster: Examination of the phenomenon in the aftermath of the 2007 Virginia Tech shooting*. Paper presented at International ISCRAM Conference, Washington, D.C., Retrieved from http://www.iscramlive.org/dmdocuments/ISCRAM2008/papers/ISCRAM2008_Vieweg_etal.pdf

VonBertalanffy, L. (1972) The history and status of general systems theory. *The Academy of Management Journal*, *15(4)*, 407–426. Retrieved 27 August 2013, from http://www.jstor.org/stable/pdfplus/255139.pdf?acceptTC=true

Waltz, E. (1998). *Information warfare principles and operations*. Boston: Artech House.

Watts, D. J. (1999). *Small worlds: the dynamics of networks between order and randomness*. Princeton, N.J.: Princeton University Press.

Weisstein, E. W. Bijection. MathWorld- Wolfram Web resource Retrieved July 3, 2012 from http://mathworld.wolfram.com/Bijection.html

Weick, K. E. (1995). *Sensemaking in organizations*. Thousand Oaks, CA: Sage Publications.

Werner, A. R. (2008). The potential transformation impact of Web 2.0 technology on the intelligence community. (Master's Thesis, Naval Postgraduate School) Retrieved from http://edocs.nps.edu/npspubs/scholarly/theses/2008/Dec/08Dec_Werner.pdf

White, T. (2012). *Hadoop: The definitive guide* (3rd ed.). Farnham: O'Reilly.

Whittaker, Z. (2012, October 4). Facebook hits 1 billion active user milestone. CNET. Retrieved December 20, 2012, from http://news.cnet.com/8301–1023_3-57525797–93/facebook-hits-1-billion-active-user-milestone/

Wilshusen, G. C. Government Accountability Office, (2010). Information management: Challenges in federal agencies' use of web 2.0 technologies (GAO-10–872T). Washington, D.C.

Woodcock, J. (2009). Leveraging social media to engage the public in homeland security. (Master's Thesis, Naval Postgraduate School) Retrieved from http://edocs.nps.edu/npspubs/scholarly/theses/2009/Sep/09Sep_Woodcock.pdf

Yin, R. K. (1994). *Case study research: Design and methods* (2nd ed.). Thousand Oaks, CA: Sage Publications.

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California