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ONE IN A MILLION: FINDING THE INNOVATIVE IDEA

by

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The increasing emphasis on innovation and the massive amounts of data that are collected and stored from innovative platforms provide for an opportunity to analyze innovative ideation data sets. However, the Department of the Navy does not currently have an effective way to analyze and visualize the innovative ideations posted on their idea-producing platforms. At present, big data analysis is conducted by humans who manually sift through each ideation posted and are virtually unable to fully depict and connect multiple and mutual ideas. This current process is very labor intensive and time consuming, and is subject to human error. This thesis assists in this endeavor by providing a proof of concept through use of Lexical Link Analysis (LLA) to analyze a large data set from an innovative ideation platform, the Massive Multiplayer Online War game Leveraging the Internet (MMOWGLI). LLA provides an automated methodology to depict pattern recognition, anomaly detection, and data fusion derived from this dataset. Through the use of LLA, MMOWGLI data are visually depicted, showing these ideas and how they interrelate as well as revealing emerging themes and patterns that can be more easily understood so that decision makers are presented with increasingly useful and accurate information.

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ONE IN A MILLION: FINDING THE INNOVATIVE IDEA

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The increasing emphasis on innovation and the massive amounts of data that are collected and stored from innovative platforms provide for an opportunity to analyze innovative ideation data sets. However, the Department of the Navy does not currently have an effective way to analyze and visualize the innovative ideations posted on their idea-producing platforms. At present, big data analysis is conducted by humans who manually sift through each ideation posted and are virtually unable to fully depict and connect multiple and mutual ideas. This current process is very labor intensive and time consuming, and is subject to human error. This thesis assists in this endeavor by providing a proof of concept through use of Lexical Link Analysis (LLA) to analyze a large data set from an innovative ideation platform, the Massive Multiplayer Online War game Leveraging the Internet (MMOWGLI). LLA provides an automated methodology to depict pattern recognition, anomaly detection, and data fusion derived from this dataset. Through the use of LLA, MMOWGLI data are visually depicted, showing these ideas and how they interrelate as well as revealing emerging themes and patterns that can be more easily understood so that decision makers are presented with increasingly useful and accurate information.

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LIST OF ACRONYMS AND ABBREVIATIONS

DARPA	Defense Advanced Research Projects Agency
DoD	Department of Defense
DoN	Department of the Navy
DIUx	Defense Innovation Unit - experimental
LLA	Lexical Link Analysis
MCWL	Marine Corps Warfighting Laboratory
MMOWGLI	Massive Multiplayer Online War-game Leveraging the Internet
MOVES	Modeling, Virtual Environments and Simulation
USMC	United States Marine Corps
XML	Extensible Markup Language

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I. INTRODUCTION

Recent improvements in the analysis of big data have allowed military leaders to make decisions based on very large sets of real-time data. To make real-time decisions, leaders need to be presented with the most useful, up-to-date information. This in turn can provide for more accurate, data-based decisions in wartime. Data sets have been collected from various platforms on various topics, but for the military, there has not been an effective method to filter or visually depict which data might be relevant and useful. Data that has been collected from almost every mission, training exercise or website that the Department of the Navy (DoN) can be especially cumbersome to understand due to its abundance.

The DoN is implementing new innovative ideation platforms. Using crowdsourcing techniques, the DoN is searching for new innovations that can be implemented so that there is an increase in efficiency, effectiveness and overall mission readiness, and to increase the innovative network. One ideation crowdsourcing platform being utilized at present is Massive Multiplayer Online Wargame Leveraging the Internet (MMOWGLI). MMOWGLI allows innovators to virtually submit and collaborate on ideas on how to improve a specific topic. The primary purpose of MMOWGLI is to develop and share innovative ideas through an online wargame that will ultimately lead to solutions for that problem set. Each individual game produces massive amounts of data. The problem is the abundance of data. At present, there is not an automatic method to analyze the MMOWGLI data sets to uncover innovative ideas. This problem exists because there are many relevant and creative ideations yet there is no efficient or automated way to filter or connect the ideations within the DoN.

Using Lexical Link Analysis (LLA) software, data can be visually depicted and consolidated so that themes and emerging patterns from large sets of data can be more easily understood and decision makers presented with increasingly useful and accurate information. This thesis seeks to apply LLA to a MMOWGLI data set to filter, identify and visualize the most relevant innovations and the most effective ideations. The findings from the MMOWGLI data set will then be analyzed to find patterns and themes in the innovative

ideations. We expect to determine which ideations derived from this crowdsourcing platform may become the most relevant and applicable for the DoN and to improve our understanding of how innovative ideas may become identified more efficiently and perhaps earlier in the process.

The purpose of this research is to visualize and analyze past data from a crowdsourcing innovative ideation platform for the DoN to determine how innovative ideas may be identified earlier. By applying LLA software to data from the MMOWGLI platform, this research can determine the efficiency of such methodologies. A secondary purpose is to explore how internal and external crowdsourcing may benefit collaborative interventions produced by this platform. This effort can also help inform leaders sooner of innovative ideas through the implementation of big data methodologies and analysis. This research may be extended to include how crowdsourcing might identify innovative ideas for other warfare-related problem spaces. It may also help us measure and determine ground truth of innovative ideas being presented from our data sets.

A. RESEARCH QUESTIONS

The following questions will be explored in this research:

- How can big data in the Department of the Navy be analyzed and visualized by LLA to identify innovative ideations from crowdsourcing platforms?
- What are the main innovative ideations derived from the MMOWGLI data set?

B. RESEARCH BENEFITS

This research is designed to specifically analyze and visualize data from the innovative ideation platform MMWOGLI using LLA software. The research may help determine the most effective way to analyze, collect and collaborate on innovative ideations for the DoN. This can ultimately provide a one-stop shop, easy to use platform as well as provide concrete data for decision makers to determine with which ideations

might be best to progress forward. This research may also help determine if internal and external crowdsourcing is the appropriate method to collect innovative ideations for the DoN.

C. RESEARCH METHODOLOGY

This research is a quantitative study and will rely on previously published literature, existing peer-reviewed studies, previously collected data, software literature, controlled software tests, and an analysis of current DoN policies. This may require changes and updates to existing software, Internet platforms and policies.

The first step in this research will be to collect data from the Naval Postgraduate School's MMOWGLI crowdsourcing platform. We will also apply the LLA software to the data set. The software will provide a visual of the various innovative ideations from MMOWGLI. This thesis will then explore the findings from the LLA output and we will determine which ideations are most relevant for the DoN.

The final step will be to map out a plan for the way ahead. Based on the LLA outputs, we will recommend ideation collection and analysis methods for the DoN to maximize the use of their crowdsourcing platform.

D. LIMITATIONS

The data set of this research may be a potentially limiting factor. Since the data is from an historical set, if there is a need for further research, more data might need to be collected. This is due to the scope of this thesis, only one data set will be analyzed. Ideally, multiple sets of data can be analyzed and compared against one another. When deciding what data set to use for this thesis, the data set with the most data was selected for a more robust analysis.

E. THESIS ORGANIZATION

Chapter II of this thesis provides the background on the full spectrum of innovation in both the corporate sectors and the DoD. This chapter discusses the definition of innovation, why there is such high motivation for innovation, and DoD specific

organizations that have been established with the mission of innovation. The chapter concludes with an overview of big data and big data analytics, including definitions of crowdsourcing and machine learning. Chapter III explores the crowdsourcing platform, MMOWGLI, in which the data set was collected for this research. This chapter also explains in detail the text-mining analytical software, Lexical Link Analysis (LLA), that is used to analyze the MMOWGLI data. Chapter IV focuses on the analytics and output from the LLA software. Chapter V is a summary of the output and also discusses the patterns and themes found in the data set. This chapter also discusses areas for potential future research.

II. BACKGROUND

This chapter provides information about innovation, both in the commercial industry and the Department of Defense (DoD), and also provides the background of crowdsourcing and big data. This thesis analyzes data from a crowdsourcing based innovative ideation platform, so it is important to understand many factors; what innovation is and how the DoD and commercial corporations are currently innovating and how they plan to innovate in the future. The software that is used to analyze the data leverages a text mining technique to filter and sift through the massive amounts of data. The software can also be applied to any data set from any commercial and DoD innovative agency to visualize and understand themes and trends.

This chapter offers a comprehensive overview of the key ideas that will be discussed throughout this thesis. Although all techniques and innovative processes are not analyzed in this thesis, this background information is significant in understanding the overall method and analysis of the Massive Multiplayer Online War-game Leveraging the Internet (MMOWGLI) data set.

A. WHAT IS INNOVATION?

Innovation is a term that is loosely defined and widely used across the private sector, as well as the DoD. Innovation has been linked to the success of a business and is thought to be a critical requirement for success. Many Chief Executive Officers (CEOs), including those from Ford Motor Co. and General Electric Co. have made statements regarding innovation and how it was tied to the future of their companies. William Ford Jr., chairman and CEO of Ford, stated in 2006 that "from this point onward, innovation will be the compass by which the company sets its direction and that Ford will adopt innovation as its core business strategy going forward" (Sawhney, Wolcott, & Arroniz, 2006, p. 75). Similarly, the CEO of General Electric, has stated that "innovation is central to the success of a company and the only reason to invest in its future" (Sawhney et al., 2006, p. 75). The DoD has also put innovation at the forefront of their missions. There are

quarterly innovation challenges in the Marine Corps as well as established agencies and commands with the mission to innovate.

But what does innovation mean? The term has come to stand for a new device or technology. When people think about innovation, they will perhaps point to the iPod, the iPhone or Google. People think about these big corporate companies that create new devices or ground-breaking search engines. It is important to understand that innovation is not just a new item. Innovation is much deeper than that. The MIT Sloan Management review from 2006 looks at business innovation in a different light. The review suggests that managers should look at innovation from a holistic view. The review also defines business innovation as "the creation of substantial new value for customers and the firm by creatively changing one or more dimensions of the business system" (Sawhney et al., 2006, p. 76). This review goes onto describe the 12 dimensions in which a business can innovate, including: offerings, platform, solutions, customers, customer experience, value capture, process, organization, supply chain, presence, networking, and brand.

Another view on innovation is from an author for the *Harvard Business Review*. In his article, Greg Satell (2017) describes four types of innovation. The four types of innovation that he describes are breakthrough innovation, sustaining innovation, basic research and disruptive innovation. These four types of innovation fit into a matrix that focus on two questions, as shown in Figure 1: "how well can we define the problem? and how well can we define the skill domain(s) needed to solve it?" (Satell, 2017, sec. "Introduction").

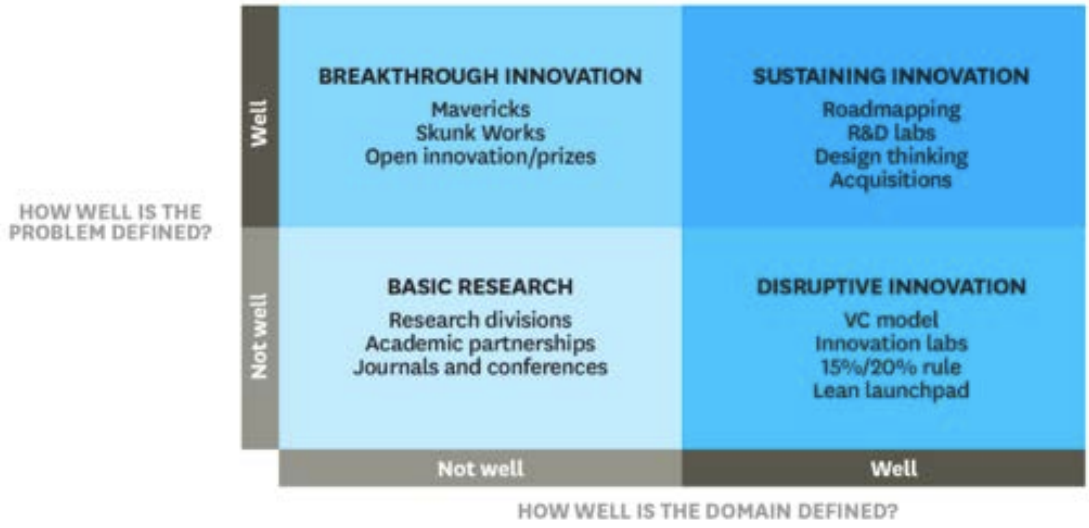

Figure 1. Satell's Four Types of Innovation. Source: Satell (2017).

Satell (2017) goes on to discuss what each type of innovation means and the various problems that they solve. "Sustaining innovation" is the area in which the most innovation occurs; it includes road mapping and R&D labs. Basic research includes a new phenomenon that is a result of academic research and like fields. "Disruptive innovation" is the major changes in an industry and companies are required to change/innovate their business model. The last type of innovation, and in my opinion, the most important is "breakthrough innovation," also known as "transformative innovation." He describes breakthrough innovation as an "open innovation strategy" that "helps expose the problem to diverse skill domains" (Satell, 2017, sec. "Breakthrough innovation"). In his article, Satell also tells a story about the benefit of breakthrough/open innovation. He explains that "when you have a really tough problem, it often helps to expand skill domains beyond specialists in a single field" (sec. "Introduction") so that various points of view can be considered to find a truly transformative innovation.

A different view of innovation is discussed in the book *The Innovator's Way* by Dr. Peter Denning (2010) of the Naval Postgraduate School, in which he researches innovative successes. In his book, Denning defines innovation as a new practice adopted by a community. Denning's intention with this definition is to differentiate between innovation and invention. There are so many varieties of the definition of innovation that it is hard to

determine if the innovation is "the invention, the idea, the change, or the struggle" (p. 6). Instead, Denning poses a question, when does an innovation succeed?

> Innovation succeeds when an idea is put into practice. The process of accomplishing this is likely to include inventions, ideas, changes, and struggles- there is no innovation until a community of people adopts a new practice. Adoption is the key to success. That leads to the definition on which this book is based: *Innovation is the adoption of new practice in a community.*
>
> This definition is at the intersection of the notions of inventing, introducing ideas, making changes, and bucking traditions. It is rigorous and sets a strong criterion for innovation. If you want innovation to succeed, you focus on adoption. Furthermore, this definition makes a sharp distinction between innovation and invention. Invention becomes innovations only when they are adopted into practice. Innovation does not cause adoption; it is adoption. (p. 6)

Denning continues to describe and explain how an innovator can be successful in having their ideas and/or inventions adopted within their community. His process of innovation consists of eight practices, which include, sensing, envisioning, offering, adopting, sustaining, executing, leading, and embodying.

There are many different definitions of innovation. But overall what needs to be understood is that innovation is not only a new item or a new technological advance. It is a consant flow that can lead to restructuring an organization, change a process of how things are done, and adoption in a community. It is not particularily easy to innovate. Innovation takes time, it takes skilled individuals from different domains, it takes money, and it takes buy in from the community.

B. WHY INNOVATE?

Defining innovation is only the beginning of understanding what it is. To better understand innovation, it is important to understand why we innovate. The need for innovation has never been so high. In the past century, we have seen a steep influx of innovative technologies, products, services and even whole new industries. But why, in the last century, has there been such a huge increase in innovation? It is also important to understand the major drivers and reasons as to why a major corporation feels the need to

innovate. There are many reasons why a corporation is being pushed to constantly innovate. In her article "Top 10 Reasons Why We Need Innovation," Lorraine Cohen (n.d.) explains the ten most common reasons why corporate American is focusing on innovation. By gaining insight as to why corporate America is pushing innovation, there will be a better understanding as to why the DoD has been so focused on innovation.

The main reason for innovation that Cohen (n.d.) touches on is for economic growth. The maturation of both industries and products require innovation to meet market needs. Cohen (n.d.) explains that "innovation creates new businesses and is the fundamental source of growth in business and industry" (Cohen, n.d., p. 1). The need for economic growth ties into the next reason as to why corporation need to innovate. There is a need to innovate for the progression of human well-being. According to Cohen (n.d.), this is possibly the most important result of achieving innovation. The main reason for this is that innovation creates new businesses, which in turn creates new jobs and personal income, therefore creating human well-being. Not only does human well-being mean income, but it also means that it stimulates local economies to include higher standards of living.

Cohen (n.d.) also explains that another reason for innovation is for competitive advantage. There has been a trend of innovative companies over powering their competition with single innovations. The list of examples is long, but one example that Cohen (n.d.) discusses is the ATM. When the ATM was first introduced by Citibank, competitors looked old fashioned compared to the new technology that that ATM offered.

Innovation is also necessary because cost-cutting is not enough anymore. It is simply not enough to just reduce costs by downsizing. This practice will merely keep you in business, a business must grow and change with the times. Along the same lines as cost cutting, Cohen's (n.d.) next reason to innovate is the desire for higher business revenues. Cost cutting can only take a company so far. In turn, a company can increase sales using new marketing innovations, or offering new products and services. Another reason that Cohen (n.d.) explains, is to improve disappointing performance in the past two decades of U.S. firms. Cohen (n.d.) suggests that during the 1980s, the U.S. had a disappointing performance in regard to the technology intensive global market. An example of this is the

auto industry. The auto industries failure may have been due to a lack of innovation and a lack of product and processes improvement, compared to global competitors. Striving for innovation allows U.S. firms to stay competitive in the global market.

Cohen's (n.d.) next reason to innovate is to take advantage of opportunity. If an opportunity arises, a company must be flexible and able to innovate on a new idea, even if that is not where the company intended. As was stated earlier, innovation is a constant flow. Cohen's (n.d.) reason to innovate deals directly with that concept; for a more constant flow of innovation. By implementing a process that allows for an innovative pipeline and continuous flow of innovative ideas, managers can prevent slumps and surges of innovation. The second to last reason for innovation is for better return. Cohen (n.d.) explains that innovations yield far better return than ordinary business ventures, possibly because they break the mold and have never before been done.

Lastly, innovation in U.S. companies is simply for business survival. With rapid growth in industries and technologies, a company is required to innovate to stay with the times. A company that succeeded 20 or 30 years ago may not be the same company today, they may not offer the same products as they once did and mostly likely their processes have changed drastically.

Taking a closer look as to why companies innovate in the corporate sector allows for better understanding as to why the DoD needs to innovate. Although the reasons may be different for a corporate company than for the DoD, it is still important to understand these differences as well as understand that innovation occurs for various reasons.

C. INNOVATION IN THE DEPARTMENT OF DEFENSE

As with corporate America, rapidly growing technologies and changing environments are the main push for innovations within the DoD. There are many organizations, units and DoN challenges that encourage current Sailors, Marines and civilians to innovate. This section will discuss the various organizations, units and challenges that the DoD has put into place to be a more innovative organization.

This push for innovative is coming down from the top leaders. In a DoD News article about a briefing with Defense Secretary James Mattis on August 11, 2017, innovation within the DoD was the only topic (Pellerin, 2017, sec "Introduction"). The article goes into depth on the reasons for innovation that the Secretary of Defense spoke about. Defense Secretary James Mattis believes that the DoD must innovate to solve mission-critical problems facing warfighters. Mission critical innovation includes everything from technology, and operations, to talent management. Another reason for innovation is organizing for success. If the DoD wants to innovate to grow with technology and the changing war environment, there must be a change in the way our force is organized. Lastly, the DoD needs to innovate to enhance U.S. defenses. It is Mattis hope that innovations that are created and adopted in the civilian sector can be tailored for the DoD and will potentially help defend the nation.

1. Defense Innovation Unit – Experimental

The Defense Innovation Unit – Experimental (DIUx) was established in Mountain View, California with the goal of seeking commercial innovations that may solve the mission critical problems in the DoD. DIUx acts as a liaison between corporate companies that have innovative ideas or new products of interest to the DoD and DoD entities that have a problem. The agency speeds up innovation for national defense by connecting and implementing commercial innovation. DIUx is not bound by the Federal Acquisition Regulations so this agency has the ability to quickly implement new commercial systems within DoD entities. Pilot contracts within DIUx can be anything from hardware and software, to unique services.

The process at DIUx can work in one of two ways. First, a commercial company can pitch an innovative idea to DIUx. DIUx responds to the company within 30 days if there is any interest in the pitch. If there is a good match between the solution and DoD partners the company will then be invited to provide a full proposal. From the full proposal, a pilot can begin.

Secondly, a DoD entity can contact DIUx and present a mission-critical problem that a specific organization is facing. Along with DIUx, the mission-critical problem is

translated for commercial innovators. DIUx does the leg work to solicit commercial solutions. If there is any interested in the presented solutions, then the pilot can begin.

2. The Defense Advanced Research Projects Agency

The Defense Advanced Research Projects Agency (DARPA) was created by President Eisenhower in response to Sputnik and other early Soviet missile achievements in early 1958. According to the DARPA.mil website, DARPA was created to avoid a technological surprise from an adversary and also to create our own technological surprises (DARPA, n.d., sec. “History and Timeline”). In support of this overall mission, the agency encourages, funds, and manages research from various sources, to include the military, private industry, and academia. DARPA focuses on transformative innovation. As discussed in Section A of this chapter, transformative or breakthrough innovation is the agencies vision. Transformative innovation focuses on new technologies and ideas, it is not innovation on existing technologies.

DARPA has a long history of success; the agency’s main accolade is the development of the Internet. Walker (2016) describes that DARPA has also played a role in many other important developments to include stealth aircraft, miniaturized GPS technologies, unmanned aerial vehicles and in more recent years, brain-computer interface technology used to move artificial limbs with a person’s thoughts.

The agency has been able to maintain its success for many decades and according to a study by the Defense Technical Information Center “the most important factors that define the DARPA creative culture and explain its long and continuing history of innovation are limited tenure, a sense of mission, trust, and risk-taking and tolerance of failure” (Walker, 2016, p. 2). A facet that keeps the agency innovative is the short four or five-year tenure of the employees. It is a constant reminder that there is limited time to complete important work. According to office directors, “program managers who come to DARPA must be fired up to do exciting things, they must have their hair on fire, determined to achieve something new and important during their short time at the agency” (Walker, 2016, p. 2). It is not only the short tenure at DARPA that motivates its employees, it is also the sense of mission at DARPA. The agency’s “reason for being—’to prevent and create

technological surprises'—expresses its role in promoting the security of the United States and the safety and success of military personnel" (Walker, 2016, p. 4). This mission highly motivates the program managers as well as builds a common goal and community. Trust is also another key aspect in DARPA's continuing success. Trust in DARPA goes in both directions, up and down the chain of command. The creative freedom that the employees have breeds innovation, "the freedom to make decisions and take action without having to obtain the permission of managers or supervisors is critical to innovation…get the best people, then trust them" (Walker, 2016, p. 5). Risk-taking and tolerance of failure is the last key aspect of innovation at DARPA. The ambition and risk taking that comes hand in hand with innovation also has the possibility of failure. The culture at DARPA allows for far reaching ideas and creativity. If there was not a failure, then a project did not reach far enough.

The innovative work that is being done at DARPA is big picture, breakthrough innovation. The mission of DARPA states that finding the balance between an "employee's tenure, a sense of mission, trust and risk-taking and tolerance of failure" (Walker, 2016, p. 2) has allowed this agency to stay at the forefront of cutting-edge innovation.

3. Department of the Navy Innovation Vison

The Department of the Navy (DoN) prides itself in being an innovative and adaptable force but the current global changes and rate in which this change continues to occur has created a future full of uncertainty. In the DoN Innovation Vision, former U.S Secretary of the Navy Ray Mabus makes it very clear that "now is the time to remove barriers and foster a culture of innovation that unleashes the ingenuity intrinsic in our people" (DoN Strategy and Innovation, 2015, sec. "Introduction"). Mabus' goal is to have an entire fleet, from the highest-ranking member to the lowest ranking member, from candidates and recruits to civilians to concentration on ways to improve the organization. In the Navy's Innovation Vision, there is a push to develop capabilities and concepts that allow the DoN to be more agile and resilient for any future challenge. Everyone across the department needs to be open to new ideas and change and must not be afraid if they do not all succeed. The Navy and Marine Corps have always prided themselves on being

innovative and adaptable to any environment around the globe. But with increasing uncertainty, changing environments and minimal budgets, Mabus states that “now is the time to remove barriers” (DoN Strategy and Innovation, 2015, sec. “Introduction”) and create an environment that allows the DoN to be innovative while using the skills and experiences that our Sailors, Marines and civilians have.

Mabus also lays out five essential elements for innovation within the DoN. The first innovation element is to build the naval innovation network. There are many innovative and creative ideas from all over the fleet. The purpose behind this element is to create an ideation innovative platform that connects Sailors, Marine and civilians from all over. Their ideas would be directly visible to decision makers. The key objective of this element is leverage “crowdsourcing within the DoN and enable the ideation process, incentivize and assess innovation, support innovators locally, and create an environment that institutionalizes innovation” (DoN Strategy and Innovation, 2015, sec. “Innovation Element 1”).

The second innovation element is to manage the talent of the DoN workforce. There are a wide variety of skills and talents within the fleet. The DoN seeks to leverage those various skills within their workforce by moving to career paths of interest and professional development instead of simply filling vacancies. The DoN can only accomplish this by knowing what skills and training individuals have. By doing this, personnel can be matched to specific jobs or tasks based on their interests, training and skills.

Innovation element three discusses transforming how the DoN uses information. The DoN collects massive amounts of data every day, but the overall infrastructure lacks the aptitude to guarantee that the information is used to its full capacity. Many resources and lots of time are dedicated to turn the data into useful information. Once information is understood from the data, there is still a restriction as to how that information is shared, making it less valuable. This element of innovation focuses on analyzing data and sharing information across organizations and integrating new technology that will allow the DoN to better accomplish its mission.

The fourth innovation element of the DoN Innovation Vision is to accelerate new capabilities to the fleet. There is a difference in buying a new aircraft or ship and creating cyber/information technology. Therefore, the developmental process should be different. Using the traditional bureaucratic processes on "cyber/information technology, unmanned systems and advanced manufacturing hinders the building of operational capabilities and permits potential adversaries to gain a competitive advantage" (DoN Strategy and Innovation, 2015, sec. "Innovation Element 4"). This innovation element states that the DoN "must aggressively test and evaluate new capabilities in an operational environment and reform processes that are designed for legacy systems" (DoN Strategy and Innovation, 2015, sec. "Innovation Element 4").

The fifth and final innovation element is to develop game-changing warfighting concepts. The uncertainty of the current global environment cannot be matched with a single approach. No one approach is suited for the various scenarios that lay ahead. A variety of concepts must be developed to give the decision maker options during all phases of operations. An example of a new warfighting concept is unmanned swarming. This concept shows a promising way forward, but the concept of unmanned swarms is not yet included into military planning. The main focus in achieving this element is to "increase the frequency and breadth of DoN war-gaming and connect outcomes to the planning, programming, budgeting, and execution system" (DoN Strategy and Innovation, 2015, sec. "Innovation Element 5"). Wargaming can bridge the gap between a new technology and seamlessly integrating it into operational plans.

Figure 2 depicts the DoN innovation vision on how to make innovation a continuous process within the Navy.

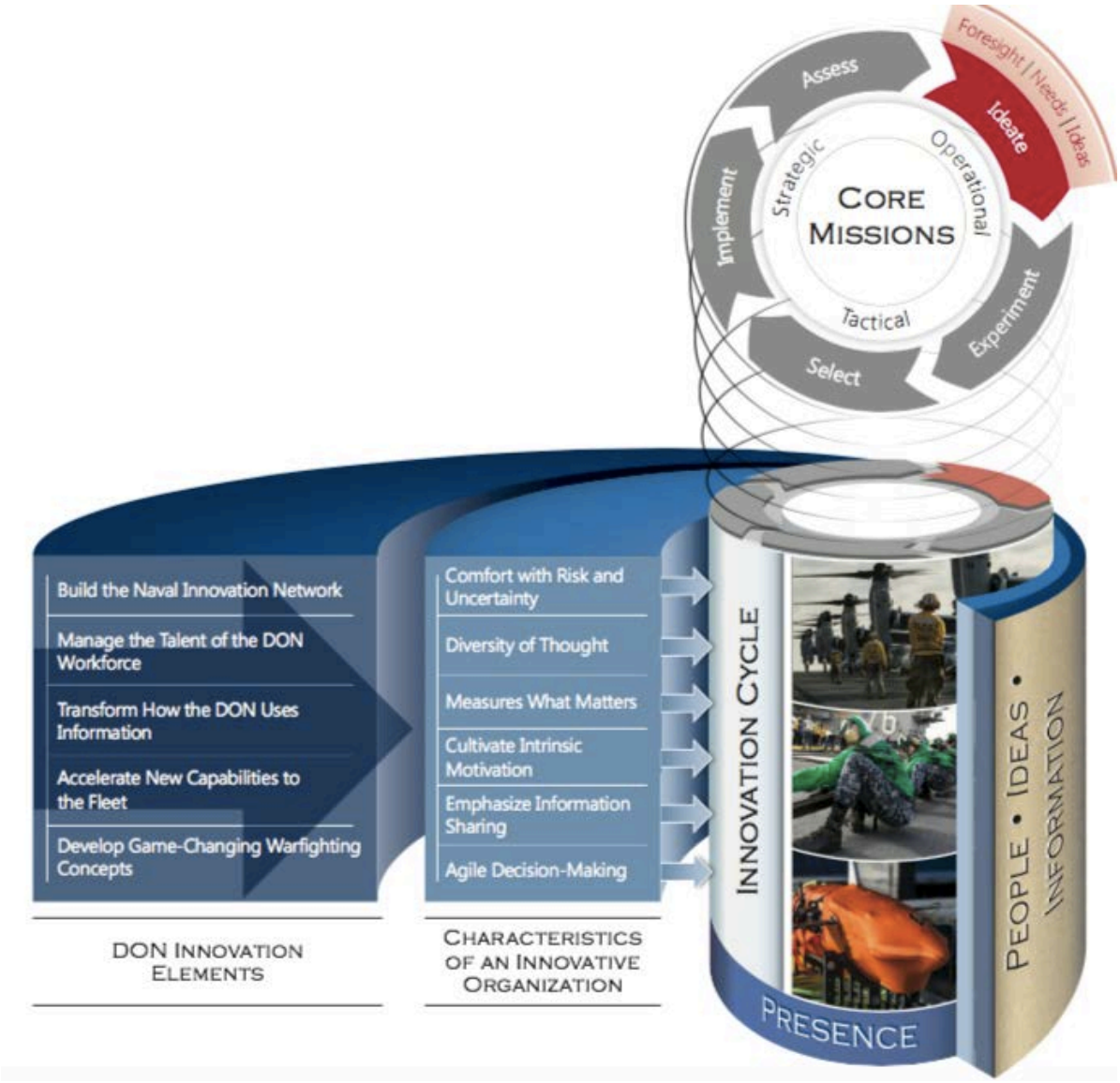

Figure 2. Innovation Vision. Source: DoN Strategy and Innovation (2015).

In the DoN Strategy and Innovation Vision (2015), Mabus states that "innovation is a means, or a process, not an end in itself, innovation within the DoN must be viewed as a continuous cycle." By focusing on the five innovation elements the DoN aims to maintain the ability to be an organization that continuously innovates.

4. United States Marine Corps Innovation

The DoN innovation vision has a huge impact in the way the United States Marine Corps (USMC) plans and operates. The push for innovation at all levels is evident in the USMC. There is a wide-ranging effort that includes all military occupational specialties and all ranks. The USMC is looking for change and innovation. There have been changes in the organizational structure, to include the creation of new commands that are focused on innovation and the USMC also began conducting quarterly crowdsourced innovation challenges. The 37th Commandant, Robert B. Neller, has put a great emphasis on innovation. His image of the future Marine Corps includes "unmanned aerial systems and robotics, artificial intelligence and autonomous technologies that would provide tactical and operational advantages" (The Warfighting Lab, n.d., sec. "The Commandant's Call"). It is unclear how the USMC will change in the future, but one thing is for sure, the Marine Corps will be researching, testing and evaluating new ideas and technologies that will make the force more capable and effective in the constantly changing environment.

a. Marine Corps Warfighting Laboratory

The Marine Corps Warfighting Laboratory (MCWL), originally called the Commandant's Warfighting Laboratory in Quantico, Virginia was created in October 1995. The unit is an environment of innovation. The mission of MCWL is to "identify future challenges and opportunities, develop warfighting concepts, and comprehensively explore options in order to inform that combat development process to meet the challenges of the future operating environment" (Marine Corps Warfighting Laboratory, n.d., sec. "Mission"). The efforts at MCWL allow the fleet Marine Corps to test and evaluate new technologies. Some of the current technologies that are being tested are 3D printed drones and quadruped prototype robots. General Robert Neller stated that "next year, my goal is that every deployed Marine Infantry Squad has their own quadcopter" (The Warfighting Lab, n.d., sec. "Testing Today's Technology"). By implementing new technologies into the hands of the individual warfighter, that warfighter is better informed to make decisions on the battlefield. These capabilities will also keep Marines safer and allow them to have more situational awareness.

MCWL also conducts annual war games. Through these war games, players are able to "explore issues vital to the future of the Marine Corps" (The Warfighting Lab, n.d., sec. "Battles won through wargames"). These war games have created developments in technology, energy and climate issues within the Marine Corps. The Warfighting Laboratory identifies trends and patterns in these war games. Focusing on the future environment, the war games give leaders the ability to identify which approach, technology or system is ready for testing.

MCWL not only focuses on innovating within the command but they also encourage innovation from all over the Marine Corps. In 2016 the Commandant of the Marine Corps initiated an innovative challenge, "the Warfighting Laboratory supported the Commandant's first Innovation Challenge—a month-long contest that is open to all Marines (active and reserve), Sailors and government civilians from across the Marine Corps" (The Warfighting Lab, n.d., sec. "The Commandant's Call"). Since 2016 the Warfighting Laboratory has sponsored a quarterly innovation challenge looking for innovative ideations from a wide range of expertise.

b. Commandant's Innovation Challenge

As stated above, since 2016 the Commandant of the Marine Corps has initiated a quarterly innovative challenge to the DoN, which includes, Marines, Sailors and government civilians. This challenge is sponsored by the MCWL and published in a quarterly Marine administrative message. The purpose of the Commandant's Innovation Challenge is to "identify missions that currently require Marines to accomplish and that could be replaced by an autonomous system. Additionally, submissions must identify systems or technologies that could make Marines more effective, efficient or safe" (The Warfighting Lab, n.d., sec. "The Commandant's Call").

The innovative challenge uses a crowdsourcing technique to solicit innovative ideations on specific topics. In fiscal year 2018, the topics include urban warfare, conduct information warfare, develop situational understanding, and protect the force. By using a crowdsourcing technique to solicit innovative ideations, the Marine Corps is pulling ideas from a wide range of experts, backgrounds and a wide range of ranks. Any Marines, Sailor

or civilian can submit innovative ideas that relate to the topic within a month and from that, a winner is announced. Winners of the quarterly challenge then have the opportunity to work with the MCWL to further develop their idea, this includes helping with prototyping, testing and possibly implementation into the fleet Marine Corps.

D. CROWDSOURCING

Both the Marine Corps and the Navy use crowdsourcing techniques to solicit innovative ideations, whether it is through a specific platform or in a Marine Administrative Message. In June 2016, Jeff Howe and Mark Robinson coined the phrase crowdsourcing. The word crowdsourcing comes from two words, crowd and outsourcing. As Brabham (2008) states, "the term crowdsourcing describes a web-based business model that harnesses the creative solutions of a distributed network of individuals through what amounts to an open call for proposals." Jeff Howe (2006) defines crowdsourcing as "the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call. This can take the form of peer-production (when the job is performed collaboratively) but is also often undertaken by sole individuals. The crucial prerequisite is the use of the open call format and the wide network of potential laborers" (Howe, 2006, p. 1). These two definitions both include outsourcing a task or job to a network of people in the form of an open call.

Using crowdsourcing is not only for the financial benefit, although it is much cheaper to solicit ideas from amateurs rather than hiring experts, but it is also a way to gain a different perspective on a topic from a wide range of people. For example, a t-shirt company called Threadless uses crowdsourcing as a way to submit and vote on new t-shirt designs. The company began in late 2000 and from the beginning anyone in the Threadless community or crowd can submit t-shirt design ideas. When a design idea is submitted it then goes to a vote where anyone from their crowd can vote on a scale of zero to five on whether they would buy the design or not. The design can be voted on for two weeks at the end of which, the Threadless staff select the most popular designs to be printed and sold.

By using crowdsourcing as a way to design and sell t-shirts the company is gaining valuable perspective as to what consumers will buy and wear.

Brabham (2008) also touches on the idea that crowdsourcing is successful because of crowd wisdom. Crowd wisdom is the idea that "groups are remarkably intelligent, and are often smarter than the smartest people in them" (Brabham, 2008, p.79). Crowdsourcing has the ability to combine millions of dissimilar independent ideas and it is a belief that crowd wisdom makes that possible.

Another definition of crowdsourcing comes from an article by Doan, Ramakrishnan and Halevy (2011) called Crowdsourcing Systems on the World-Wide Web. They have come to determine that a crowdsourcing system exists if it "enlists a crowd of humans to help solve a problem defined by the system owners, and if in doing so, it addresses the following four fundamental challenges: How to recruit and retain users? What contributions can users make? How to combine user contributions to solve the target problem? How to evaluate users and their contributions?" (sec. "Crowdsourcing systems"). This definition also includes the main challenges that the authors believe exist in crowdsourcing. The article mainly focuses on web-based systems due to their ability to recruit a large number of users and utilize software like email, wiki, discussion groups, blogging and tagging. The authors also state that "using the web, compared to the physical world, can dramatically improve existing crowdsourcing systems" (Doan et al., 2011, sec. "Crowdsourcing systems"). Digging deeper into their research on web-based crowdsourcing, they have come to conclude that the emerging field will grow rapidly, not only does web-based crowdsourcing allow for the recruitment of a large number of users, but it can also be applied to a wide variety of problems and the authors foresee that in the future crowdsourcing will be applied to more classes of applications.

In the scope of innovation in the DoN, crowdsourcing can be used to reach all members of the community using a web-based platform. Crowdsourcing can be used to gain perspective as to what Marines, Sailors and civilians want to see in the operating fleet, such as improved t-shirt designs. Pulling innovative ideations from all ranks and specialties may give the DoN an innovative ideation that had never before been thought of or tested before. By leveraging the World Wide Web, the challenges of crowdsourcing, as discussed

in the Doan et al. (2011) article can be minimized and possibly overcome. Overall the benefit of crowdsourcing using the World Wide Web can drastically benefit the outcome of crowdsourcing efforts.

E. BIG DATA

With technological advances, the use of crowdsourcing and the easy access that we now have to information, there is a lot more data and that amount is growing. Not only is data growing but also the types of data collected are changing making data sets even more complex. Big data is the large amounts of data sets that are varied and complex in structure. But these huge amounts of complex data sets result in complications of storing, analyzing and visualizing further processes or results. It seems as if every system we use is gathering data on something, whether it is buying and spending habits or weather patterns around the globe. Big data can be very useful if you know what is being collected and how to analyze those data sets.

1. What Is Big Data?

In the age where information is power, and data is collected on everything, it seems as if big data has taken over. There are many interpretations of big data and they have changed over the years. A more recent definition is from a McKinsey Global Institute (2011) study which defines big data as by the size of the content. They describe big data as "too large for standard database tools to capture, store, manage and analyze" (Manyika, Chui, Brown, Bughin, Dobbs, Roxburgh, & Byers, 2011, p. 1). Big data can also mean the variety of data, the time to process data as well as the creation of new streams of data. In a current big data course at the Naval Postgraduate School, big data is defined using a definition by Doug Laney. In 2001, Doug Laney described big data using a 3 V model (see Figure 3). The 3 V's that he talks about are volume, velocity and variety. Laney (2001) defines data volume as the size of the date, the mass amounts of data that is collected. The volume of data only seems to be getting bigger. Data velocity refers to the "pace data used to support interactions and generated by interactions" (Laney, 2001, sec. "Data Velocity"). Ultimately it is the pace at which data is generated to include the data collection and the analysis. Laney (2001) describes data variety as the diversity of sources and quality. This

can mean the diversity of data formats and structures, for example, video, text, images, social media and even health monitors.

Figure 3. Big Data 3 V's. Source: Soubra (2012).

This figure is a good visual of what Laney (2001) means by the 3 V's of big data and how big data can range depending on the scale. For example, the volume of big data can range from gigabytes to petabytes, there is not one defining amount that of data that determines if a data set can be considered big data.

In some more recent interpretations of Laney's (2001) 3 V model, there has been a fourth V that has been added, making it a 4 V model (see Figure 4). The fourth V in the model is veracity, meaning the uncertainty of data quality. It is important to take this into consideration seeing that data can practically be taken from anything, anywhere. There have also been recent trends of false information being used as a weapon. When it comes to analyze big data, it is important to know the source and quality of that data.

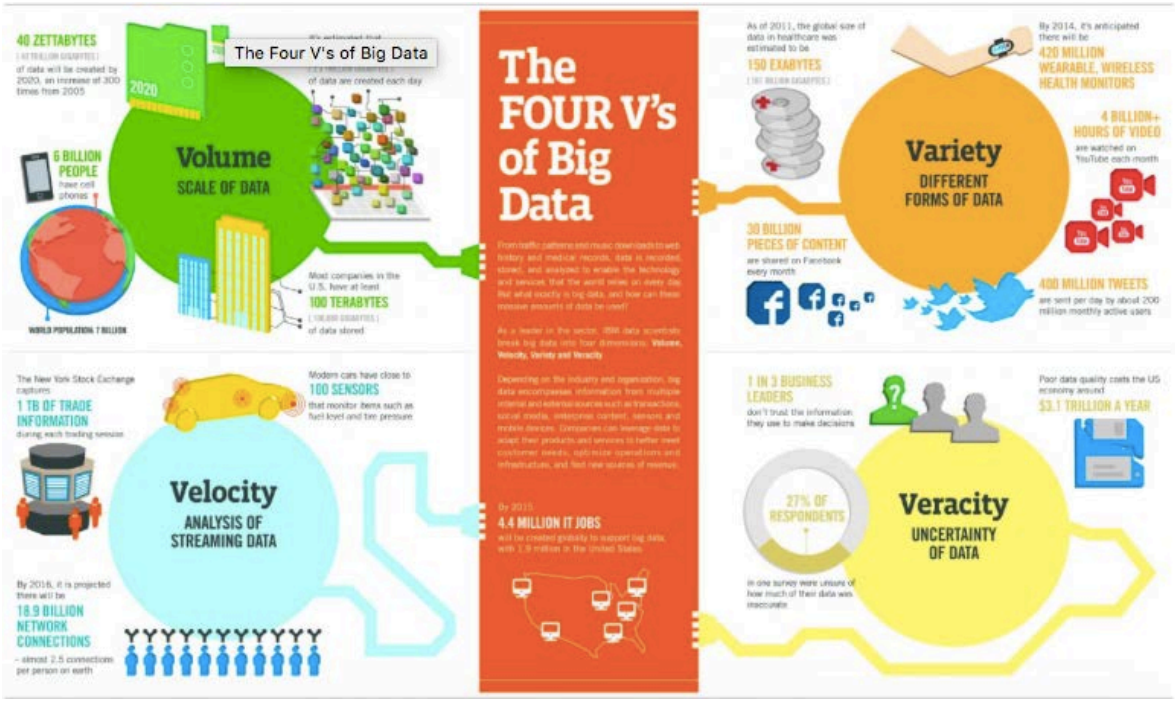

Figure 4. Big Data 4 V's. Source: IBM Big Data & Analytics Hub (n.d.).

The IBM interpretation of the 4 V's of big data is very busy with information, but this image a clear depiction of what the 4 V's of big data mean. The examples used in this image show how complex and large big data truly is.

2. The Value of Big Data

Big data is said to grow at a rate of 50 percent a year and it exists in every aspect of our culture and professions. The value of big data extends from business politics, sports, and advertising to public health. It has gone so far as to describe big data as a "new class of economic asset, like currency or gold" (Lohr, 2012, sec. "Introduction"). For example, political scientists collect data from blog postings, Congressional speeches, press releases and news articles (Lohr, 2012, sec. "Introduction"). It is the job of analysts "to look for insights into how political ideas are spread" (Lohr, 2012, sec. "Introduction"). In the business realm, data consultants study data from "web traffic, social network comments, software and sensors that monitor shipments, suppliers and customers to help guide decisions, trim costs and lift sales" (Lohr, 2012, sec. "Introduction"). The amount of data has grown so much and at such a rapid rate that a report by the McKinsey Global Institute

projected that “the United States needs 140,000 to 190,000 more workers with ‘deep analytical’ expertise and 1.5 million more data literate managers” (Lohr, 2012, sec. “Introduction”).

Big data is clearly being collected at a rapid rate, but the real value comes when big data can be properly analyzed in a timely manner. In a study done at the McKinsey Global Institute, “big data creates value in several ways” (Manyika et al., 2011, sec “Deep analytical talent”). The first way is by creating transparency. Many organizations have been able to reduce wasted effort and time of their employees by making data more readily available to the relevant stakeholders. This also includes sharing of big data, and improved R&D processes. The second way in which big data creates value is “as organizations create and store more transactional data in digital form, they can collect more accurate and detailed performance information on everything from product inventories to sick days, and therefore expose variability and boost performance” (Manyika et al., 2011, sec “Deep analytical talent”). Collecting and accessing large amounts of data has “enabled a very different way of making decisions that involves bringing science into management” (Manyika et al., 2011, sec “Deep analytical talent”). Managers have the ability to conduct scientific experiments based off of data and then analyze the quantitative results before making a decision. Ultimately, managers can use big data to be better informed to make decisions. The third way in which big data is of value is segmenting populations to customize actions. Based on demographics, customer purchase metrics and shopping attributes and behavior, consumer-based companies can target individuals for services and marketing. This is often used in insurance companies and credit card companies. The fourth reason that big data is valuable is because it replaces/supports human decision making with automated algorithms. Automated algorithms “improve decision making, minimize risks and unearth valuable insights that would otherwise remain hidden” (Manyika et.al., 2011, sec. “Deep analytical talent”). This is widely seen in retail, the changes in inventory and pricing are often done automatically based on real time sales. The fifth and final reason that big data is of value is that it is enabling the innovation of new business models, products and services. This does not mean solely coming up with new ideas, but also enhancing current products, processes and organization.

3. Unstructured versus Structured Data

Big data is an up and coming field and it offers an organization or an individual a lot of value, as long as the data is properly structured. Most of the data that exists today is not structured. In an article in the New York Times, the author Steve Lohr (2012) explains that the data today consists of data that is in the form of words, images and video on the Web and streams of sensor data. This is called unstructured data. Unstructured data is not very useful or processed by traditional databases. A huge amount of the data that is being collected in unstructured. But what does that mean? It is easier to describe structured data first. Structured data means that the data in the data sets has "a high degree of organization such that inclusion in a relational database is seamless and readily searchable by simple, straightforward search engine algorithms or other search operations; whereas unstructured data is essentially the opposite" (Brightplanet, 2012, sec "Introduction"). If data is unstructured, it makes it very time and energy consuming to compile the data in a meaningful way. Structured data is easy to handle using machine-language while unstructured is not.

An example of structured data is a spreadsheet. It is data that can be easily examined for material because it is organized and correctly organized. An example of unstructured data is an email. Emails can be arranged by date/time, size or sender, but it cannot be arranged by the exact content of the email. Other examples of unstructured data include "words, images and video on the Web and those streams of sensor data" (Lohr, 2012, para. 9). Although data is readily available and has a high value, it is very timely and costly to fully decipher data sets because so much of the data that exists is unstructured.

4. Analyzing Big Data

Without a doubt, big data is very useful to organizations across the board. There is now access to information that twenty years ago would not have been imaginable. That amount of information and access keeps growing and that information is only useful if it is properly analyzed. It is difficult to get accurate and meaningful information out of huge data sets. Many authors have compared analyzing big data to finding a needle in a hay stack. As Trevor Hastie, a professor at Stanford says, "the trouble with seeking a

meaningful needle in massive haystacks of data, is that many bits of straw look like needles" (Lohr, 2012, sec "Conclusion"). Data analytics is difficult to do properly but if it is done right, the information can be transforming. Due to data analytics, "we can measure and therefore manage more precisely than ever before. We can make better predictions and smarter decisions. We can target more-effective interventions and can do so in areas that so far have been dominated by gut intuition rather than by data and rigor" (McAfee & Brynjolfsson, 2012, sec "Introduction"). The analytics that are used today is much more powerful than any of the analytics that we have ever used before and as I stated earlier in this section, part 2, big data analytics is a growing profession. There is a need for professionals who have deep analytical skills because if data sets cannot be properly analyzed, the information is worthless.

To be able to convert data into useful and meaningful information, information technology specialists should control and analyze data using computer based and statistical methods. There are many technologies that play a role in making data into meaningful information and no single one technology can incorporate all of big data analytics. Multiple technologies can work together to pull the most valuable information. The main technologies used today in data analytics is data management, data mining, Hadoop, in-memory analytics, predictive analytics and text mining.

Data management is important to proper data analysis. The data that is flowing into an organization should be well managed and should be of a high quality so that the analysis of the data can be reliable. In an organization that has an enormous amount of data exchanges, it is critical to create standard operating procedures for data quality that can be easily repeatable. Once that process is ironed out and can be reliable upon, it is important to develop a management program for the entire enterprise's data.

Data mining can be used to discover patterns in large amount of data. This technology is also used to find trends in data so that better decision making can occur. Data mining software can be used to comb through all the chaos and repetition that occurs in data. This technology can detect what is pertinent. Data mining then use that data to calculate the possible results. This analysis allows for accelerated decision making.

Through the data mining software, raw data is taken and turned into data that can be visualized and interpreted.

Hadoop is a type open-source software that is run on a cluster of a collection of machines. Open source software means that the software is publicly accessible, so people can modify and share the software for free (in most cases). Cluster commodity hardware means that the software uses large numbers of computer components, that are already available. This allows Hadoop technologies to get great amounts of relevant computation at a much lower cost. This distributed computing model makes it possible to store large amounts of data and run applications, it also allows the Hadoop technology to process big data fast.

In-memory analytics utilizes data that is stored locally on a computer instead of querying data that is stored on hard drives. Using this technique, data is analyzed from stored memory, allowing for immediate insights and the ability to act on those insights fast. This is an easy way for an organization to quickly analyze data to make better decisions.

Predictive analytics focuses on future predictions. This process takes all of the data and algorithms to determine the probability of a future outcome. These predictions are based on historical and past data. This type of analytics allows for more confident future decision making because it is based on historical data. Some of the main uses of predictive analytics include operations, marketing, and fraud detection.

Text mining technology is the final technology that will be discussed. Text mining technology can sift through text documents, including emails, blogs, surveys etc., to analyze text data to discover important insights that may have not been noticed before (see Figure 5). Text mining uses machine learning technology to analyze text to help identify new relationships between words in the document.

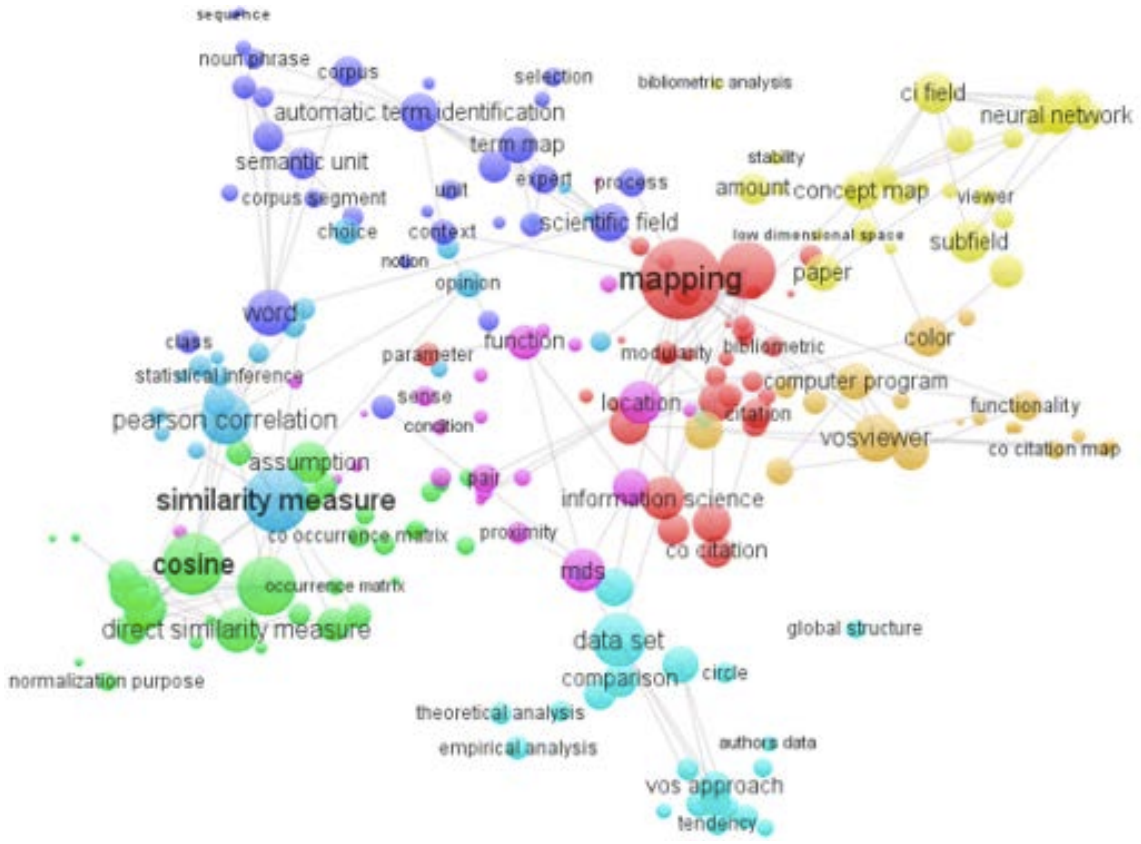

Figure 5. Text Mining Visual. Source: Van Eck and Waltman (2011).

5. Machine Learning

As stated in the above section, text mining technology uses machine-learning to identify word relationships in a content based (text) document. Arthur Samuel coined the term machine-learning in 1959. He was an expert in computer science fields, specifically in computer gaming and artificial intelligence. Machine learning has evolved from various sciences to include, pattern recognition and computational learning. This field has grown drastically in the past ten years due to the big data and the increase in content-based documents and the need to retrieve information from them. Today, machine learning is used for image, video and text recognition to help enhance security or optimize self-driving cars, for example.

In the scope of text mining, machine learning uses a “general inductive process which automatically builds a classifier learning, from a set of pre-classified documents”

(Sebastiani, 2002, sec. “Abstract”). Using algorithms, the machine does not need to be explicitly programmed, the machine can learn and make predictions on data. Machine learning allows text mining technology to find patterns and themes in content-based data that would not have otherwise been noticed.

Overall, this thesis will be analyzing a data set from an online war-game that uses crowdsourcing to generate ideas on a specific topic. The analytic technique being used to analyze this data will be text-mining, which uses machine learning to find patterns and themes within data sets. By conducting this research, we will be addressing specific Big data analytics that are relevant to the whole spectrum of innovation whether that may be in the corporate sector or in the DoD.

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III. MASSIVE MULTIPLAYER ONLINE WARGAME: LEVERAGING THE INTERNET ANALYSIS USING LEXICAL LINK ANALYSIS

As discussed in chapter II of this thesis, there are many platforms and organizations that focus on innovation in the Department of Defense (DoD). These platforms and organizations create a massive amount of data and that data is only beneficial if it can be properly structured and analyzed into useful information. The analysis that will be conducted for this thesis will be concentrated on one specific set of data from the crowdsourcing innovative ideation platform called the Massive Multiplayer Online Wargame Leveraging the Internet (MMOWGLI). The data set that will be analyzed is from the Singularity game. The data set from the Singularity game is analyzed using Lexical Link Analysis (LLA) in hopes of finding patterns and trends that will lead to the early identification of innovative ideations. Using LLA software, data from the Singularity Game can be visually depicted and consolidated so that themes and emerging patterns can be more easily understood, and decision makers can be presented with increasingly useful and accurate information

A. MASSIVE MULTIPLAYER ONLINE WARGAME LEVERAGING THE INTERNET

New innovative ideation platforms are being implemented into the Department of the Navy (DoN). The DoN uses crowdsourcing techniques to build an innovation network. Crowdsourcing is used as a way to collect and collaborate on innovative ideas that will improve the efficiency, effectiveness, and overall mission readiness. The DoN uses crowdsourcing as a way to generate new ideas about how to improve everyday problems using the online platform, MMOWGLI.

MMOWGLI is a web-based crowdsourcing platform that allows the Navy to host different games related to various topics, to encourage innovative thinking by many users. According to Kuo (2013, para. 6) “this platform puts the Navy in the unique position of being able to take unrefined new ideas, get subject matter expert evaluation and input, develop them through experimentation and pass the well-formed ideas to the organizations

who can put them on the path to implementation." On the MMOWGLI portal (n.d.) it states that the MMOWGLI games are "designed to support large numbers of distributed global players working together on idea generation and action planning, with an eye towards surfacing innovative outlier strategies." The specific MMOWGLI game that will be analyzed for this thesis is the Singularity game. By finding themes and patterns within the Singularity game data, we may be able to identify relevant innovative ideations that can be implemented into the DoN.

1. Singularity Game "Call to Action"

Each MMOWGLI game begins with a "Call to Action" video. The call to action is meant to set the scene for the game and give a brief explanation as to what topic will be explored and discussed throughout the process. The call to action gives an incomplete narrative that poses two questions, that are typically a yin and yang to each other. The questions can be opposites or complementary to one another. This is meant to get players to wrap their minds around a big idea question. The topic of each game is based off of some concern, question, problem etc., that the DoN is facing. The topic area of concern is then opened up in the crowdsourcing setting.

The Singularity games' call to action video first describes what singularity means. Singularity is compared to a black hole, it is compared to a "conversion of forces so profound and transformational that it creates an event which beyond nothing can escape" (Wheeler, 2017). The speaker in the video goes on to explain that singularity is the "emergence of greater than human intelligence from technological means" and that it is a world in which "intelligent machines would create its own kind of event horizon" (Wheeler, 2017). The speaker describes a world in which humans are left behind, where machines become so advanced that we can no longer compete. The speaker also uses visual depictions to drive home her point that a singularity environment is closer then we might think. The curve depicts the growth of computing power over time, starting with 1900 and the use of an analytical engine to the year 2040 where there is quantum computing and human machine integration. From the year 2000 to 2040, there is a steep incline of computing growth which is thought to lead to a singularity (see Figure 6).

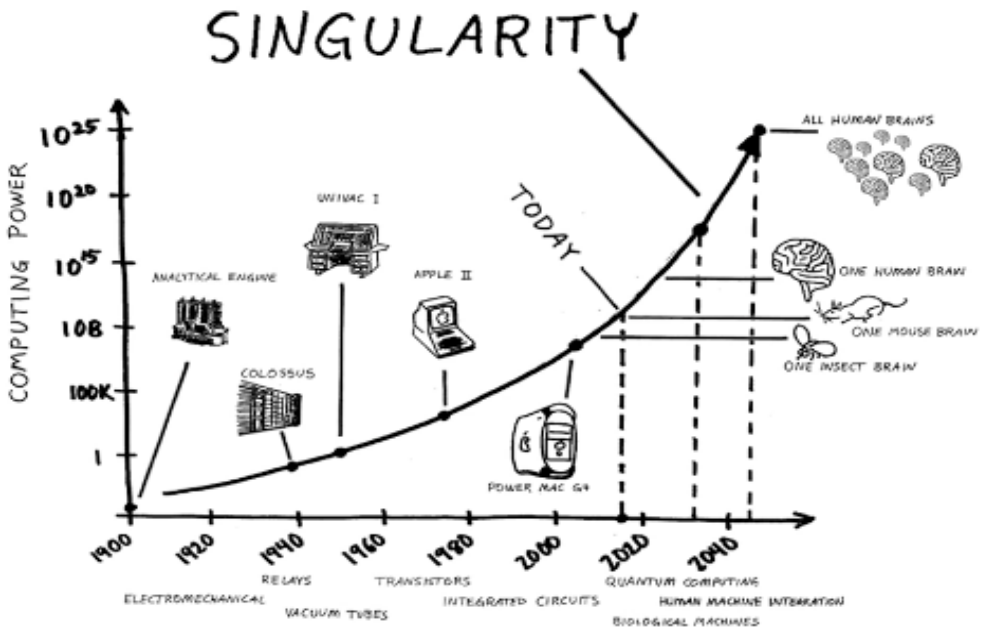

Figure 6. Singularity Curve #1. Source: Wheeler (2017).

A singularity environment is not unescapable. The speaker presents a metaphor of a chess game in which a chess master that is beaten by an IBM computer. This could have been seen as a singularity and the end of professional chess players as we know it, but it was not. Chess players began to play free style chess, and this version of the game introduced a human and computer team. This style of chess allowed professionals to integrate with computers to play the game. Instead of humans playing one another, there were now tournaments that allowed humans to team up with computers and play against other human computer teams as well as play against individual computers. The speaker uses an example of a chess tournament where grand master chess players along with advanced machines play against each other. The surprise is that it is not these grand masters that win the tournament. The winner is a pair of amateur chess players that had three modest computers working at the same time. These amateur chess players successfully teamed with machines to create a collective intelligence. This collective intelligence is smarter than the smartest human and better than the most advanced computer algorithm. The moral of this story is that humans and machines are better together than we are alone. Whether in the DoN or in civilization as a whole, there is a need to evolve the human machine team. If the Navy is going to be a necessity, Wheeler (2017) suggests that the Navy must "craft

ways to team with our machines, we need to blur the lines of where humans end and machines begin."

Machine intelligence is not the only factor in singularity, the speaker goes on to discuss a singularity curve #2 (see Figure 7) which involves civilization complexity and the current control structure. Along the vertical axis is complexity with our current control structure and along the horizontal axis is time. There is also a permanent horizontal line that represents the Maximum Individual Complexity. This curve has a strange resemblance to the singularity curve #1, showing that over time the complexity of our environment will exceed the maximum individual complexity given the current control structure.

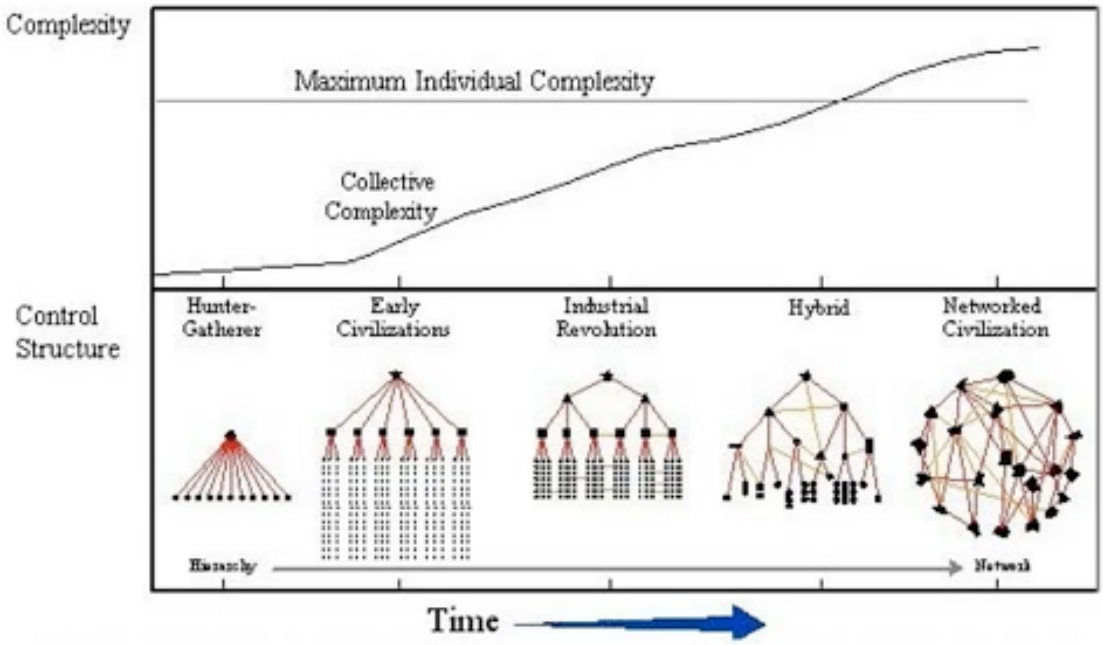

Figure 7. Singularity #2. Source: Wheeler (2017).

This is important to understand because the "complexity of our environment is overwhelming our ability to process it with our current organizational control structures" (Wheeler, 2017). With technology, the types of innovation are easy to see, but the complex mechanisms behind them are not so easy to see. The speaker has a fear that as long as complexity remains hidden from view, we won't see the singularity until it is too late.

Looking deeper into these two singularity curves, it is evident that our future is unclear. The speaker explains that her own vision is limited due to her own individual carrying capacity. Her vision is only the broad parameters for the Navy in the age of singularity. The parameters for singularity #1 is advanced human machine teaming, modeled after free style chess. For singularity #2, her parameters are the hive mind and true collective complexity. She explains that these are only broad parameters and she needs help filling in the details, that the "Navy needs help from people who are curious about the future and willing to put their imagination to work. She asks that people work with each other and continue the conversation on the MMOWGLI platform" (Wheeler, 2017). The Singularity game is then opened up for participation by porting the following announcement on the MMOWGLI platform:

> After much anticipation, Maritime Singularity MMOWGLI is beginning. As Dr. Lilly Wheeler explained in our inaugural MMOWGLI Talk, we must now collaborate together to imagine ideas about how the U.S. Navy might benefit from two distinct but related Singularities. In Singularity 1, we are interested how humans and computers can work better together so that the U.S. Navy might benefit from Singularity 1. Parallel to Singularity 1 is Singularity 2, an exponential increase in environmental complexity. Just as the U.S. Navy must harness the energy of Singularity 1, we must also embrace the complexity that will allow the U.S. Navy to excel in this complex environment. Specifically, what new organizational constructs might we need to consider to benefit from Singularity 2? (Wheeler, 2017)

This announcement includes the two major questions that players need to respond to throughout the game. Wheeler (2017) states that the two questions are: "What concepts for human machine teaming might we develop as we approach Singularity 1? As complexity rises all around us, what new organizational constructs should we consider?" These questions do not change throughout the entirety of the game.

2. Singularity Game Process

After the call to action is published, players can register to take part in the game. Players must create a player profile that consists of a user name, an affiliation (U.S. Navy, nonprofit, public, academia, etc.), a location and an expertise. The players from the Singularity game have a wide range of personnel that contributed to the play. Players were

located here in the United States, Canada, United Kingdom and players were even located as far away as Israel. Players also has a wide range of expertise, such as gaming and innovation solutions, Naval Intelligence and systems analysis. The diversity of the players was of great interest to us, even before we started analyzing the data sets.

There are game masters that monitor the direction and play of each MMOWGLI game. To start the Singularity game, the game masters post a new prompt (see Figure 8) that changes every day. The prompt is based off of the two main questions and creates card. Examples of the prompts are:

```
    <Type prompt="What concepts for human machine teaming might we develop as we approach
    Singularity 1?" round="1" title="Singularity 1"/>
  </InnovateType>
▼ <DefendType>
    <Type prompt="As complexity rises all around us, what new organizational constructs should we
    consider?" round="1" title="Singularity 2"/>
```

Figure 8. Prompt for the Singularity Game. Source: MMOWGLI Portal (n.d.).

These prompts are created for the purpose of getting a response from players. Each response is an idea card and each player can comment and create as many idea cards as they wish. Some cards are played or commented on more than others. Game masters also have the ability to draw the attention of the players to cards that they think are more interesting than others. Each idea card is also assigned a level. A level 1 idea card is a new idea and any response to that specific card is then given a level 2 identifier. If there is a direct response to a level 2 card, then that idea card is given a level 3, and so on. There are also different types of idea cards in response to a level 1 idea card. Players have the option to counter, expand, explore, or adapt to the idea card that they are responding to. These response options are explained further in the Table 1.

Table 1. Response Options for Level 1 Idea Cards

Response Options for Level 1 Idea Cards	
Counter	Speak in opposition to the idea
Expand	Give a fuller version or account of the idea
Explore	Inquire into or discuss the idea in detail
Adapt	Make the idea suitable for a new use or purpose

Cards are also given labels, such as "super interesting" based on how many players responded to that idea card or if the game masters deem the idea interesting. This back and forth prompting, idea card creation and idea card response can continue for anywhere from 48 hours to weeks to months. The length of the game depends on the size of the game and the number of excited players. The singularity game was shorter on purpose; the focus was to get big broad ideas from the public. Figure 9 is an example of idea card creation from the Singularity game.

Figure 9. Singularity Game Idea Card Chain. Source: MMOWGLI Portal (n.d.).

In the figure taken from the Singularity game portal, the first idea card is a level 1 which means that this is a new idea and it has a type of Singularity 1, which means it is related to the Singularity 1 question of the game. After that, players can respond to this card by exploring the idea further, expanding on it, countering against the idea or adapting the idea. The cards beneath the original, level 1 card are given their respective level number depending of what card they are responding to.

After some amount of time, determined by the game masters, the game gets away from the idea cards and turns into creating action plans. The action plans are created to go deeper into a specific idea, they are meant to "describe how to solve game challenges and achieve motivating goals" (MMOWGLI Portal, n.d. sec "About MMOWGLI"). Most of the time the action plans are created upon request of the players but sometimes, the action plans are created by the game masters based off the desired direction of the game. The action plans are multi-dimensional and cover the five w's, who, what, where, when, why and how. The creation of action plans is closed to specific users, but any player can give feedback. Basically, an approved user would create an action plan by giving the answers to the five w's and the how and then other users would give a peer review on the action plan. There is a 24–48-hour window in which action plans can be created and posted. The platform also offers a notes tab so that users can talk back and forth to mature an action plan prior to it being posted. Figure 10 is an example of an action plan that was posted to the Singularity game.

<ActionPlan creationDate="Monday, 27 March 2017 13:51:06-PDT" hidden="false" moveNumber="1" numVoters="30" roundRanking="1" sumThumbs="83" superInteresting="false" thumbs="2.77">
<Title>
Creating a framework for building and sustaining ethical AI
</Title>
<ID>4</ID>
<CardChainRoot ID="105" author="aurelius" date="Monday, 27 March 2017 06:23:13-PDT" type="Singularity 1">
Create ethical AIs: develop algorithms, training and testing methods that guarantee AI systems will do what we would have done (or better).
</CardChainRoot>
<WhoIsInvolved>
There are ongoing efforts by the IEEE to provide guidelines for ethical AI and autonomous systems. Other relevant organizations include the Partnership on AI, the Future of Life Institute (FLI), the Centre for Human Compatible AI (CHCAI), the Future of Humanity Institute (FHI), the Machine Intelligence Research Institute (MIRI) and the Leverhulme Centre for the Future of Intelligence (CFI). Standards and best practices will be implemented by developers, who may oppose them if too vague or restrictive.
</WhoIsInvolved>
<WhatIsIt>
Effective leaders are rated as having high Emotional Intelligence (EI). Teams with high EI perform more effectively. EI might be used as a measure of ethical action. AI should be employed in a manner that enhances the Emotional Intelligence of the team thus improving efficiency and enhancing outcomes. AI, whether independently or in collaboration with humans, will be tasked with recommending or performing actions. From image classifiers to in-situ support, AI should be prevented from causing harm.
</WhatIsIt>
<WhatWillItTake>
Technical and operational solutions that enhance meaningful human control, e.g. by providing the human supervisor a broader context, by allowing specification of forbidden policies in advance, by proactively evaluating consequences of actions, and by offering an interpretable and auditable explanation of recommendations and actions would increase trust in the systems, both by operators and by society and large, and will help avoid harmful accidents. Early interactions with AI will shape the public view. Wherever possible, initial contact with the singularity should result in overwhelmingly positive public assessment. By leveraging early impressions and positive outcomes it will be possible to shape future perception. How might (will?) mores & ethics change with AI?
</WhatWillItTake>
<HowWillItWork>
Research on value-aligned, interpretable and explainable AI is already ongoing, some of it supported by the DoD. Any systems designed and/or deployed by the Navy should follow the best practices developed by the research community, which would require resource and time investment. In addition, system operators and decision makers should be made aware of limitations of current and future systems, and the best way to guarantee meaningful human control given the level of autonomy of the system.
</HowWillItWork>
<HowWillItChangeThings>
Although aimed at S1, the experience gained in joint human-machine endeavours would assist in the development of effective restrictions on AI actions, thereby reducing its ability to cause harm and enhancing human control. Best practices learned through this process could then be applied to S2.
</HowWillItChangeThings>

Figure 10. Singularity Game Action Plan. Source: MMOWGLI Portal (n.d.).

The author of this action plan clearly stated the action plan idea, the idea card that was the chain root for this plan, who is involved, what it is, what will it take, how it will work and how it will change the *status quo*.

After all the action plans are submitted, the game masters will take a week off from working on the game. When the game masters return, they conduct the post-game data processing. This step of analyzing the data from the game is time consuming and labor intensive. There is also the possibility of human error when reading each of the post from the game. They combine threads into broader themes and document those ideas back to the sponsor of the game or the DoN.

B. LEXICAL LINK ANALYSIS

This thesis takes this same data from the Singularity game and instead of manually conducting data analysis with humans, we will apply LLA to find trends and patterns in the Singularity game. In a process that is currently done manually, we use a software to analyze the data from the Singularity game. LLA is applied to the Singularity data sets to filter, identify, and visualize the most relevant innovations and the most effective ideations. We expect to determine which ideations derived from this crowdsourcing platform may become the most relevant and applicable for the DoN and to improve our understanding of how innovative ideas may become identified earlier using this platform.

LLA is a "single agent installed in a single computer node that is capable of ingesting and analyzing data sources locally" (Zhao, Gallup, & MacKinnon, 2015, p. 6). LLA will provide pattern recognition, anomaly detection, and data fusion for the innovative ideations. This will be done by using bi-gram word pairs as groups or themes and placing them into three basic types, popular, emerging and anomalous. By using LLA, the MMOWGLI data can be visually depicted and consolidated so that themes and emerging patterns from large sets of data can be easily understood and decision makers are presented with useful accurate information

1. Pre-processing Data

For data to be properly analyzed using LLA the data must first be pre-processed. This is an important step that must occur prior to applying LLA software to the Singularity game data set. The gathering method used in the MMOWGLI game is very loosely controlled which may result in misleading data and the quality of the data is most important in the whole analysis process.

The first step in pre-processing the data so that it can be analyzed using LLA is that the data must be stored in a Microsoft Excel or text file format. The original format of the Singularity game data was in extensible markup language or XML. Unfortunately, this format cannot be read by the LLA software. It was then necessary to process the data into another format, the format that the data was processed into was Excel using a custom script. The data was then separated into two separate files, one of metadata and another with the card contents.

The second step in the pre-processing of the Singularity game data is that there was much irrelevant and redundant information. Once the data was in the appropriate Excel file format, we then had to clean up the file so that there was not unnecessary data.

For example, when the data was first exported into an Excel format, there were multiple rows that had the date, author and there was even a column with the title of text color. We were able to narrow down the data to only relevant information that we were interested in researching. We took information from the idea cards, the action plan cards and the player profiles to link all the data to gain a full portrait of all the relevant information for the Singularity game. Table 2 shows what data was available in each file so that we can link all of the data that was relevant to the game.

Table 2. Relevant Data Available in Each File

Idea Card	Action Plan Cards	Player Profile
- Author - Date - Card ID - Level - Type (Singularity 1 or 2)	- Date - Super Interesting - Thumbs - Card ID - Author - Type	- Author/ Player User Name - Affiliation - Location - Expertise

The information on the data that was kept was author, date, card id, level, type, super interesting, text, thumbs, affiliation, location, and expertise. Figure 11 is a screenshot of the Excel spreadsheet with the consolidated Singularity Game data.

type	superInteresting	text	Affilication	Location	Expertise
Singularity 1	FALSE	Reflecting on the player experience: How might we improve Card play?			
Counter	FALSE	Would be nice to be able to edit cards after played for typos or expansion. Some expansions sever	Non-profit/N	Maryland	US Navy R&D
Explore	FALSE	Provide for better linking between cards to reduce redundancy.	Public	MS - US	IT profession
Expand	FALSE	Strolling thru long list takes significant time for list to show up on screen. Some way to move to a	Non-profit/N	Maryland	US Navy R&D
Expand	FALSE	To encourage direct contact rather than polite chat in cards, put a PM (mail) button on each card (S	Non-profit/N	California	I do MMOW(
Counter	FALSE	The discussion should be kept public as much as possible. I like the idea, but it seems to go against	International	Royal Militar	Twelve years
Adapt	FALSE	Force the player creating a new card to go through some categorization (aligns with other cards or	Academia	Nebraska	Military back
Explore	FALSE	Provide immediate vetting for redundancy based on simple word and phrase searches. "It seems lil	Public	MS - US	IT profession

Figure 11. Excel Spreadsheet of Singularity Game Data

The final step of the data pre-processing was to then write scripts to combine data fields into extra information that we wanted to know. For example, if an idea card was generated, how many other idea cards were played in response to that one main idea. We were able to do this by counting the number of cards that were posted under that main idea card. This will help us get a better idea as to what idea cards sparked the most interest and the most responses in the game. This could potentially help us identify interesting topics or main themes that occurred throughout the game.

2. Bi-gram Word Pairs

The method that LLA uses to analyze the Excel file containing the Singularity game data is through text mining. The idea is that "word pairs or bi-grams as lexical terms and features can be extracted and learned from a document repository. LLA automatically discovers word pairs or bi-grams and displays them as a network from data. In a text data set, words form the nodes and pairs of words or bi-gram word pairs form the links between nodes" (Zhao, MacKinnon, Gallup, & Billingsley, 2016, p. 3). This process creates a tree of words that are connected to one another. This allows for a visual depiction of common trends and patterns within the data set. Figure 12 shows the connection between common words and trends in a data set. Some of the bi-gram word pairs that were discovered in this particular data set is "middle_east policy," "intelligence analyst," and "political analyst."

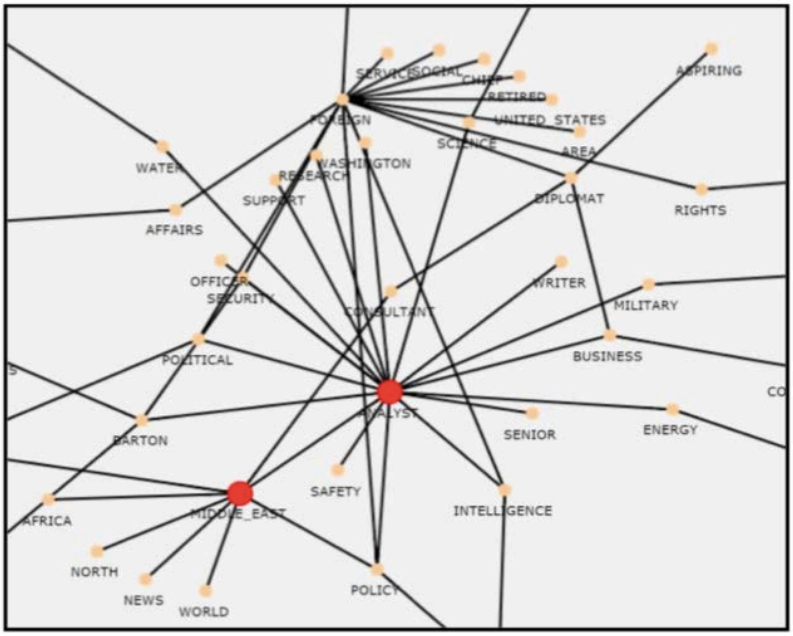

Figure 12. Bi-gram Word Pair Example. Source: Zhao et al. (2016).

LLA uses multiple steps to process a data set using the text mining method. The first step is to filter out “pre-defined stop words,” which includes words like “a,” “the,” “this” and “that.” These words can be filtered out because they do not convey meaning in English. The second step is to apply an algorithm that can be used to find a social network community. An example of this is the Newman community detection method to separate the data into themes, “a theme includes a cluster or community of word pairs that are connected to each other” (Zhao et al., 2016, p. 4). The Newman algorithm is used to detect communities and relationships in complex systems. The third step is to “compute an importance measure to each theme” (Zhao et al., 2016, p. 4), meaning that there is a way to compute how important the theme is within the data. The final step is to “sort theme importance measured by time or other sequential parameters and study the distributions of the discovered themes” (Zhao et al., 2016, p. 4). Figure 13 is a depiction of a theme in a set of data. This example uses a six-word theme that are “Care, Practice, Staff, Patient, Ward, and Home” These are the “top six words with the highest total degree of centrality” (Zhao et al., 2016, p. 4).

By using LLA to analyze the Singularity game data set, we are able to visually depict bi-gram word pairs as well as show themes of central words, like in Figure 12 and Figure 13.

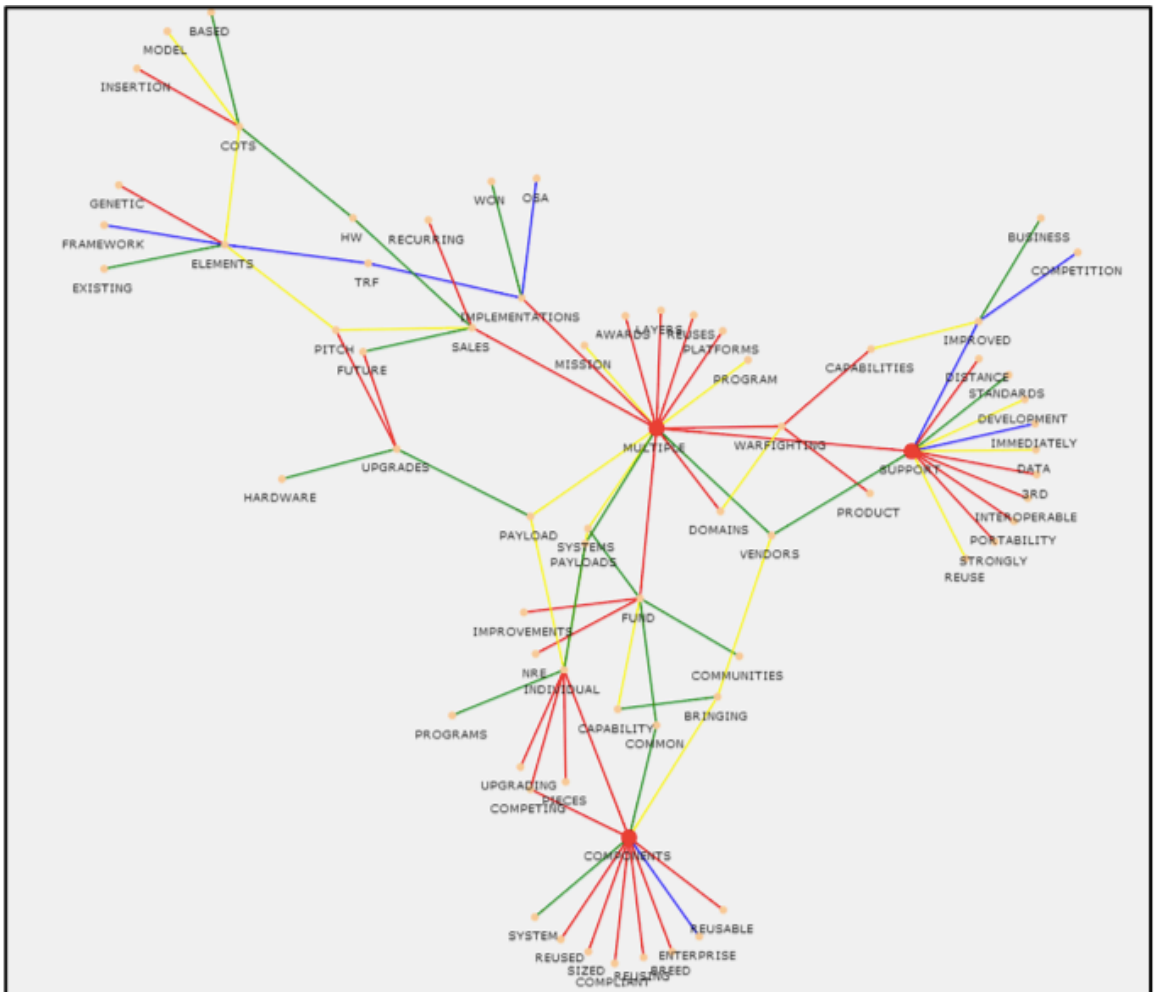

Figure 13. Depiction of a Theme. Source: Zhao, Brutzman, and MacKinnon (2013).

Using LLA to analyze this data set may be more efficient and effective then using humans, as it is currently done. We also hope to find emerging themes sooner in the MMOWGLI game process instead of waiting till the end to compile themes and patterns.

IV. ANALYSIS

We obtained the Singularity Game data from the Modeling, Virtual Environments and Simulation (MOVES) Institute server at the Naval Postgraduate School in Monterey, California. This required a request for access from the Massive Multiplayer Online Wargame Leveraging the Internet (MMOWGLI). The historical data from the Singularity game is stored in this server and is saved as multiple files. The files include the action plan list, game design, idea card chain and the player profiles. As explained in Chapter III of this thesis, the data from all of these files needed to be properly structured and were combined into one file of relevant and usable information so that the data could be easily analyzed using the Lexical Link Analysis (LLA) tool.

As discussed in Section B of Chapter III of this thesis, LLA automatically selects and groups the MMOWGLI ideas into one of three categories. Zhao, Gallup and MacKinnon explain the differences between the three categories in their journal article from 2015 titled "Big Data and Deep Learning for Understanding DoD Data":

- *Popular (P):* They are the main themes in the data. These themes could be less interesting because they are already in the public consensus and awareness. They represent the patterns in the data.
- *Emerging (E):* Themes may grow to be popular over time
- *Anomalous (A):* These themes may be off-topic themes that are interesting for further investigation. (Zhao et al., 2015, p. 5)

This analysis will focus on the emerging category to find the unique, less popular and innovative ideations. The popular ideas are themes that everyone talks about and may be too common. We might not be able to find a unique idea from popular themes. The anomalous ideas may be too abnormal and may not actually be directly related to the Singularity game.

When conducting our analysis, we had to keep in mind the two prompt questions for the Singularity game. The two questions that Wheeler (2017) created are as follows verbatim:

> What concepts for human machine teaming might we develop as we approach Singularity 1?
>
> As complexity rises all around us, what new organizational constructs should we consider? (sec. “Video Introduction”)

The first step in our analysis was to separate the Singularity idea cards from those that were turned into action plans. This was completed on an Excel spreadsheet. An idea was only turned into an action plan if it was thought to be an interesting idea. By sorting the data by action plans and all the other idea cards or non-action plans, we were able to determine what the gamemaster’s thought were innovative ideas.

Once the text files were uploaded to the LLA tool, we were able to visually depict what LLA categorized as emerging. The word pairs are assigned the category of emerging by the LLA tool’s algorithm.

By comparing the action plans, which were hand selected by the gamemasters, with the emerging themes, which categorized by LLA, we were able to determine if LLA had selected the same ideations as humans. On the contrary, we were also able to determine if the gamemasters overlooked a relevant ideation that may have been brought to light by LLA. If LLA can be used on all MMOWGLI games then this process can be drastically cut down in time and in manpower, allowing for a quicker turnaround between idea cards and action plans. Ultimately, LLA can expedite the process so that leaders in the Department of the Navy (DoN) are receiving innovative ideas sooner. The sooner that leaders receive innovative ideas, the quicker they can be implemented into the DoN.

A. MMOWGLI ACTION PLANS

During the data pre-processing step, discussed in Chapter III, Section B, Paragraph 1, we decided that the information that we found relevant for the analysis of this data was the idea card identification (ID) number, the level, the author, affiliation of the author, location of the author, expertise of the author, the type (counter, explore or adapt), text, highest badge, total badges, cards played, and thumbs. The ID number is a number given by the game so that each idea card has a unique identifying number. The level determines if it is the first idea card or if it is a response to another idea card. Level one means it is a

new idea, level two means that it is a response to a level one card and so on. The author information, which also includes their affiliation, location and expertise is information about the person that is making a post. The type can fall into one of three categories which are explained in Chapter III, Section A, Paragraph 2 of this thesis. The text is the actual text that was written and posted by an author. The game masters give out badges for various accolades, for example responding to a certain amount of level one posts, and the highest badge is the highest that the particular author received, and the total badges is the total amount of badges that an author receives. "Cards played: refers to the total amount of cards that an author has played. Thumbs are given to action plans when a player likes another player's idea. This process resembles Facebook's "like" feature in which a user can "like" another user's post by clicking a thumbs-up button. We were able to filter the action plans from the idea cards because only action plans received thumbs.

These categories were used to filter the MMOWGLI data on an Excel spreadsheet. On the Excel spreadsheet, as shown below in Figure 14 and Figure 15, the action plans are also sorted from largest to smallest number of thumbs.

date	id	level	author	type	text
3/27/2017	105	1	aurelius	Singularity	Create ethical AIs: develop algorithms, training and testing methods that guarantee AI systems will do what we would have done (or better).
3/27/2017	3329	1	Gardener	Singularity	Complex Adaptive Systems (CAS) http:__bit.ly_1dkW5cu are at the root of this ecosystem. We must understand those as we move forward
3/27/2017	3443	1	Sedgeheel	Singularity	Engage public in developing autonomous AI with commercial games, as with ACTUV and Dangerous Waters, emphasizing human_AI cooperative play
7/6/2015	1	1	SeedCard	Singularity	Reflecting on the player experience: How might we improve Card play_
3/27/2017	27	1	Quinn	Singularity	Need to train the humans to understand how machines "thinks" and train the machine how the humans thinks, to building understanding for both
3/28/2017	5104	1	Ironman42	Singularity	New Navy ships should have a modular design to allow for plug in and go as new AI develops. This will increase mission capability
3/28/2017	5336	1	NavyAnalys	Singularity	Could we incorporate AI into armor_ Could it help detect internal injuries_
3/30/2017	8201	2	cas1992	Expand	Machines can run simulations to help analyze future possible migration consequences of Global Warming. (duplicate for new AP)
3/27/2017	2822	1	Ironman42	Singularity	The Electromagnetic Pulse will become the most important weapon in the 21st century.
3/27/2017	24	1	OgreMkV	Singularity	Like this game, massively distributed stock market for ideas related to strategic concepts. People pay to play, but get rewards on ideas.
3/27/2017	20	1	undaunted	Singularity	Create a swarm system that a single person can control multiple single task machines
3/27/2017	3059	1	Athon	Singularity	There are a many discussions about the morality of AI. Anyone have some strategy to share in this naval simulation So that we might win_
3/28/2017	5192	1	Travis42	Singularity	Real time (accurate) translation services are an AI powered tool the Navy could use in the near future.
3/27/2017	542	1	hezel	Singularity	Assimilate concepts of computer programming into human (natural) language. Doing so will improve clarity of ideas shared among people.
3/27/2017	9	1	JFeatherstc	Singularity	Should there be any areas where AI_Machine Learning should be prohibited, regardless of whether we get "better results."
3/31/2017	8980	5	Astrosploy	Explore	Despite years and millions its still mostly in a university or government lab exploration phase.
3/27/2017	3266	1	Travis42	Singularity	Send developers to sailor work sites, interview them, create tailor made apps that form a network with similar apps. Repeat.
3/28/2017	6675	1	Renkin	Singularity	Modify Boston Dynamics' LS3 or BigDog into an Autonomous Stretcher Bearer _Casualty Evacuation (CASEVAC) asset.
3/27/2017	601	1	radial	Singularity	Push decision making to Swarms (highly decentralized yet still structured and aligned groups). See Swarmwise by Rickard Falkvinge
3/27/2017	10	1	ninjamonk	Singularity	95% of all work with computers will be vocal, we'll talk to computers and they will talk back to us.
3/27/2017	11	1	undaunted	Singularity	Similar to military working dogs, create an interface that can grow with the user throughout their service time.
3/27/2017	2142	1	isomer	Singularity	Why is carrying capacity horizontal_ Don't better education networks produce better leaders_ Hive education has more complexity handling_
3/27/2017	1504	2	Charrelle	Expand	Perhaps humans and machines_technology will become interchangeable in the future creating a new interface between the two.
3/28/2017	6189	1	Ddrizzle	Singularity	Human machine integration spans from individual_machine to community_network. Scalability
3/27/2017	327	1	Athon	Singularity	Anti-AI Defence, ala Battle Star Galactica's disconnected network.
3/27/2017	79	1	Brasidas	Singularity	What is the role of the Nation-State in an era of technological acceleration_ Still relevant, irrelevant or more required than ever_
3/28/2017	5695	1	Travis42	Singularity	Train ML algo to recognize FMV figures carrying guns, vice shovels, bags, etc. AI team w operators can better ID hostiles, reduce mistakes.
3/27/2017	671	1	BlackFox	Singularity	Applied transhumanism: integrated intelligent tech(suits_) that not only upgrade the individual but interface with a collective intelligence
3/27/2017	477	1	Miraboreas	Singularity	As a developer, I like to think that organizational constructs should look like the Agile Methodology proccess. An SCRUM_KANBAN adaptation.
3/27/2017	1854	1	MotokoSus	Singularity	once autonomous how do you force a AI to obey do you threaten it with shut down and if you shut it down would that be murder
3/27/2017	3272	1	SnowdenA	Singularity	Obsolete hierarchical institutions will be replaced by peer-level organic cooperation. Government by encrypted direct democracy.
3/27/2017	2283	1	Ironman42	Singularity	How do we develop a naval approach to take advantage to of machine and human teaming_
3/28/2017	4893	1	FunTzu	Singularity	Protocols to leverage on AI speed and coordination to shorten seek_destroy cycle and automate "counterbattery" attacks.
3/30/2017	8104	3	Astrosploy	Adapt	Think more ordinance on demand. With present printing and fab trends it wont be long before this is possible in field.
3/27/2017	345	2	Athon	Expand	Opponent AI will compromise network. Must have a means to protect internal ship network by disconnecting from allied communication.

Figure 14. Excel Spreadsheet Output of Action Plans

Affilication	Location	Expertise	Highest Badge Number	Total Badges	CardsPlayed	thumbs
Academia	Cambridge, UK	Academic researcher of the future of artificial intelligence	7	6	7	2.77
Non-profit/Non-Governme	California	I do MMOWGLI	7	7	509	2.75
Student	Canada	Amateur historian and wargamer	7	7	231	2.7
						2.64
Department of the Navy	None	Technologist for US Navy	7	5	33	2.62
U.S. Navy	Rhode Island, USA	Naval Intelligence Naval Aviation	7	7	470	2.57
Industry	VA	Manage $10M budget for three programs	7	6	22	2.57
Student	Blacksburg, Virginia	Statistics and Computational Modeling	7	5	29	2.56
U.S. Navy	Rhode Island, USA	Naval Intelligence Naval Aviation	7	7	470	2.5
Public	Central Texas	Science and Technology Writer and Dreamer	7	6	106	2.5
U.S. Army	Pentagon	Gaming and innovative solutions	7	7	94	2.45
Industry	San Diego	Long time strategic gammer. Work with AI in RL.	7	6	347	2.44
None	None	None	7	6	49	2.43
Industry Software	Israel	System analysis, data flow and critical thinking	7	6	63	2.43
Industry	Chicago	None	7	7	169	2.4
Public	USA Rockies	None	7	6	585	2.4
None	None	None	7	6	49	2.38
None	None	None	7	5	94	2.38
None	None	None	7	4	9	2.38
None	East Coast USA	I love bacon.	7	6	64	2.33
U.S. Army	Pentagon	Gaming and innovative solutions	7	7	94	2.33
None	None	computing, popular technology trends	7	4	22	2.33
Department of the Navy	Patuxent River	Mathematics, Computer Programming, Graphic Design	7	6	80	2.26
None	Dc	Working engineer, physics masters student	7	5	13	2.22
Industry	San Diego	Long time strategic gammer. Work with AI in RL.	7	6	347	2.22
Department of the Navy	New England	Naval War Gaming SME	7	7	206	2.17
None	None	None	7	6	49	2.14
None	USA	Robotics, programming, design, research, theoretical innovation.	7	5	31	2.12
Non-profit/Non-Governme	Madrid, Spain	I have a computer science degree and I've been working 3 years progr	7	6	10	2.12
U.S. Army	None	been mmo gaminging to nearly 20 years	7	4	8	2.11
Academia	Cascadia	See NSA dossier	7	7	80	2.05
U.S. Navy	Rhode Island, USA	Naval Intelligence Naval Aviation	7	7	470	2
Public	None	Writer; long time defense, foreign politics and economy enthusiast	7	6	138	2
Public	USA Rockies	None	7	6	585	2
Industry	San Diego	Long time strategic gammer. Work with AI in RL.	7	6	347	2

Figure 15. Excel Spreadsheet Output of Action Plans, Showing Thumbs

There were approximately 8000 idea cards, 42 of which were turned into action plans. The 8000 idea cards were sifted through and the action plans were hand-picked by the gamemasters to be considered as an innovative ideation that needed more attention. As shown in Figure 14, some examples of the action plans are to create ethical artificial intelligence, use complex adaptive systems, organizational constructs looking like the agile methodology process, engage the public in developing autonomous artificial intelligence with commercial games, updating Navy ships to allow for plug in and go as new artificial intelligence develops.

To show this significance, statistical analysis was conducted on the action plans and all the other idea cards or non-action plans (see Figure 16)—i.e., for each idea, count the number of emerging concepts computed by LLA for the two populations (Column A and Column B). Column A is the action plans and column B is the non-action plans. The statistical t-test is to test if the means of the number of emerging concepts are different in the two populations.

Data Summary

	A	B	Total
n	42	7656	7698
$\sum X$	268	33995	34263
$\sum X^2$	2138	219073	221211
SS	427.9048	68124.7209	68709.9388
mean	6.381	4.4403	4.4509

Results

$Mean_a - Mean_b$	t	df	P		
1.9406	+4.2	7696		one-tailed	<.0001
				two-tailed	<.0001

Figure 16. T-Test for Statistical Significance

The mean is the number of emerging concepts in the two populations (Column A and Column B). The ideas that were turned into action plans have a statistically significantly higher average (6.38) of emerging concepts than the non-action plan ideas (4.44). Since Column A has a higher mean that indicates that it has more emerging concepts than Column B (non-action plans). Based off of the p-value of <.0001 in Figure 16, these two populations are statistically very different. This indicates that the emerging concepts identified by LLA are correlated with innovative ideas (i.e., the ideas turned into action plans).

Another statistical test was conducted to try to explain how the gamemasters selected the action plans (see Figure 17). The t-test included multiple variables in the game: the highest badge, total badges, number authored and number of ideas below that idea card. The variables are each of the Columns and Row A is the action plans while Row non-A is the non-action plans.

Metrics	Categories in Data			
	Highest	*Total*	*# Authored*	*# of Ideas Below*
A	6.9	5.9	9.5	12.26
Non-A	6.5	4.8	7.7	0.86
p-value	0.0734933	0.001333	0.149908	< .0001

Figure 17. Statistical Test. Source: Zhao, Zhou, and Bellonio (2018).

The first column in Figure 17 shows the users with the highest score, action plan (A) vs. non-action plans (non-A). The p-value in this column means that there is not much difference in the users that had action plans vs. non-action plans. The "Total" column is the total average of all the badges for the action plans and the non-action plans. This column also does not have a difference. The next column of "# Authored" also did not have a difference. The last column of "# of Ideas Below" is the average count of how many ideas were posted below the action plans and the non-action plans. This column did have a difference in the statistical analysis. The t-test that was conducted in Figure 17 shows a p-value of <.0001 for the "# of Ideas Below" column. Therefore, there is statistical evidence that the gamemasters based their decision to make an action plan from an idea card based off of the number of ideas that were posted in response to an idea card.

B. LLA ANALYSIS OF MMOWGLI IDEA CARDS

After the Excel spreadsheets were created from the data sorting the action plans from the non-action plans, the text files were then analyzed using LLA. LLA gives a way to measure the uniqueness of each message by categorizing the idea cards into three categories (popular, emerging or anomalous). LLA also assigns each theme a number designator as well as a color (see Figure 18). Popular themes are green, emerging is blue and anomalous are yellow. Again, we are most interested in the emerging (blue) themes because they will identify the most unique innovative ideations.

all	48(P)	learning machine,machine learning,machine human,learning human,human machine
all	7(P)	based ai,ai future,ai based
all	21(E)	machines,power,data
all	27(E)	world real,humans
all	86(E)	game good,quantum
all	111(E)	systems combat,systems complex,combat complex
all	10(E)	making decision,multiple
all	106(E)	general,cyber,space
all	45(E)	global,require,determine
all	73(E)	system navy,ais
all	63(E)	design,give,large
all	66(E)	fire,high,nuclear
all	59(E)	swarm drone,counter
all	24(E)	defense term,defense support,bad
all	70(E)	information similar,moral
all	58(E)	weapons,command,kill
all	74(E)	network,potential,base
all	77(E)	military agree,logical
all	60(E)	complexity level,level higher
all	4(E)	specific,define,limited
all	104(E)	local,small,strategic
all	28(A)	singularity,direct,distributed
all	83(A)	existing,key,identify

Figure 18. Popular, Emerging and Anomalous Themes in LLA

LLA gives the user two visualizations. One visualization is above in Figure 18, which is given in list form from popular down to anomalous. The second visualization is below in Figure 19, which is a depiction of the theme in a word cloud.

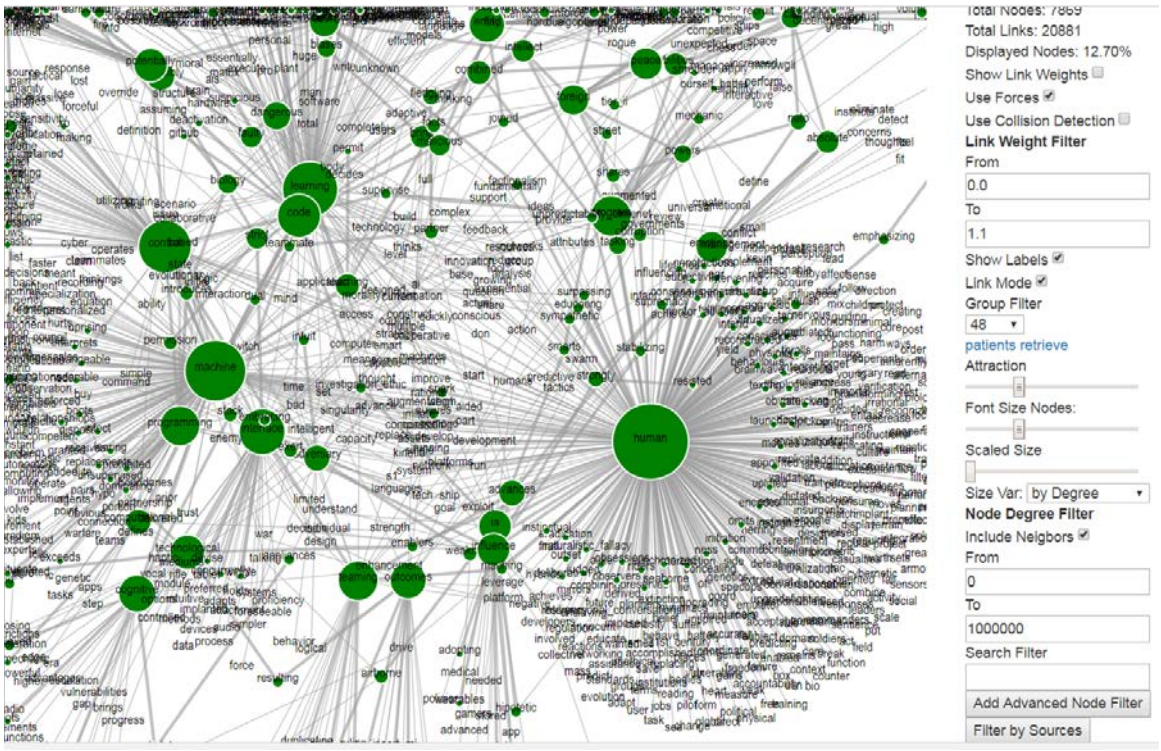

Figure 19. LLA Word Cloud of a Popular Theme

As shown in Figure 19, which is a depiction of a popular theme from the MMOWGLI Singularity game, the popular ideas have a large word cloud. These are the ideas that are often discussed and are connected to many other bigram word pairs. Below in Figure 20, the anomalous themes have a small word cloud and are often not connected to many other bigram word pairs and are also often secluded from other anomalous themes.

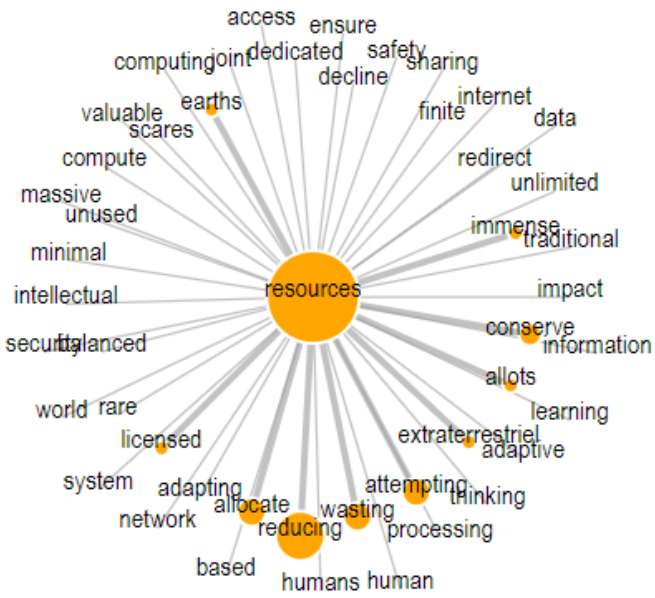

Figure 20. LLA Word Cloud of an Anomalous Theme

1. LLA Emerging Themes

After the LLA categorization, we found that there were 19 themes that were considered emerging. Emerging themes from the MMOWGLI Singularity game are shown in Figure 21. The data is centered around the following bigram word pairs: machines/power/data; world real/humans; game good/quantum; systems combat/systems complex/combat complex; making decision/multiple; general/cyber/space; global/require/determine; system navy; design/give/large; fire/high/nuclear; swarm/drone/counter; defense term/defense support/bad; information similar/moral; weapons/command/kill; network/potential/base; military/agree/logical; complexity level/level higher; specific/define/limited; local/small/strategic.

all	21(E)	machines,power,data
all	27(E)	world real,humans
all	86(E)	game good,quantum
all	111(E)	systems combat,systems complex,combat complex
all	10(E)	making decision,multiple
all	106(E)	general,cyber,space
all	45(E)	global,require,determine
all	73(E)	system navy,ais
all	63(E)	design,give,large
all	66(E)	fire,high,nuclear
all	59(E)	swarm drone,counter
all	24(E)	defense term,defense support,bad
all	70(E)	information similar,moral
all	58(E)	weapons,command,kill
all	74(E)	network,potential,base
all	77(E)	military agree,logical
all	60(E)	complexity level,level higher
all	4(E)	specific,define,limited
all	104(E)	local,small,strategic

Figure 21. MMOWGLI Singularity Game Emerging Themes

Figure 22 shows theme 21(E). In this visualization, some of the main words are data, power, machines, autonomous and automated. The larger the word circle, the more the word has been utilized. This means that they have the most connections to other words or themes and those words are more connected and are more general. The major bi-gram word pairs in this theme are data processing, machine data processing and data storage. The words that are connected but not in a blue circle are categorized into other themes more suitable for them overall. This does not mean that they are unimportant. Looking closer at the less connected words, we can see the word drone, logical, systems, technology, visualization, etc. Analyzing all of the connection in this theme can lead to an innovative idea that no one has thought of. For example, by putting together the words machines and visualization, we can perhaps think of a way that we will have to have a machine visualization for military personnel in regard to Wheeler's first question.

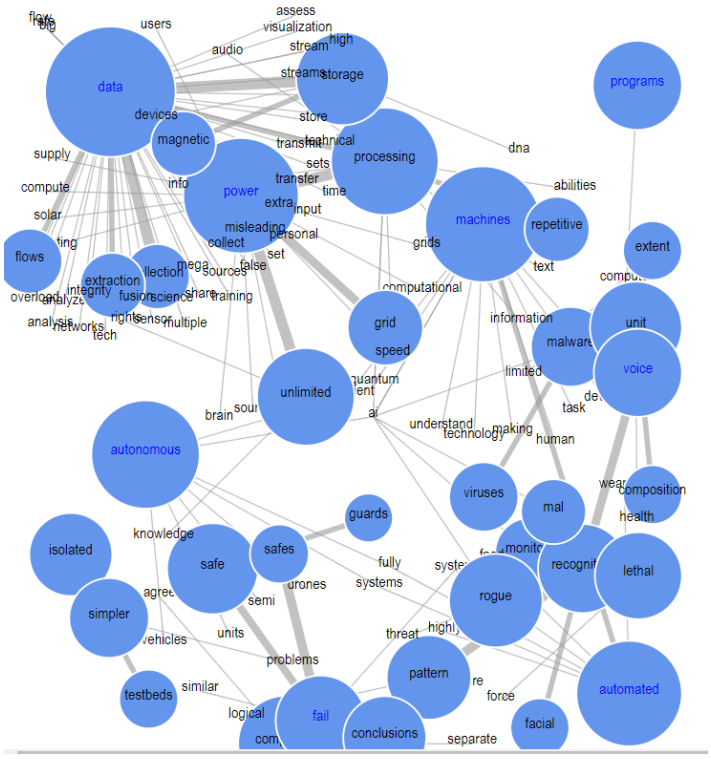

Figure 22. Emerging Theme 21(E), Summary Words: “Machines, Power, Data”

Theme 27(E) is shown in Figure 23. This theme has a lot of smaller word pairs that are connected to one another. Some of the major word pairs in this theme are real world and humans. The smaller word pairs include, interfacing, currency, invention, realm (in regard to a digital realm) and downloading.

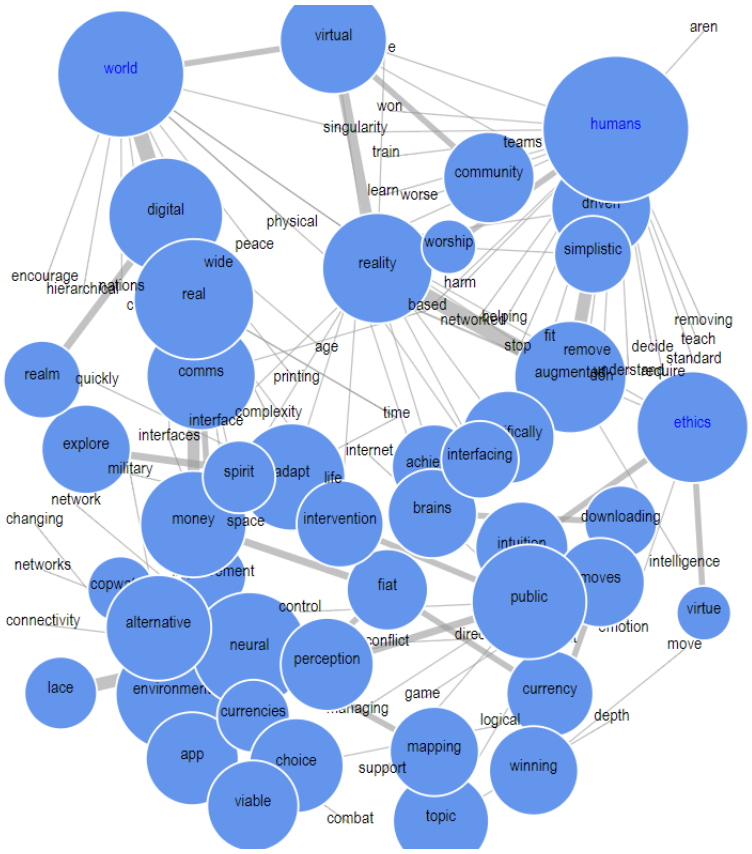

Figure 23. Emerging Theme 27(E), Summary Words: “Real World, Humans”

Figure 24 shows the theme 86(E). This theme also has a lot of word pairs with the same level of connectivity. Some of the major word pairs in this theme include quantum, sensor, computing, hierarchical, array, parent, good (which is connected to both interaction and seed), cloud, and faster. Some of the outliers include communication, video, technology, link, encryption, warfare, targeting and simulation.

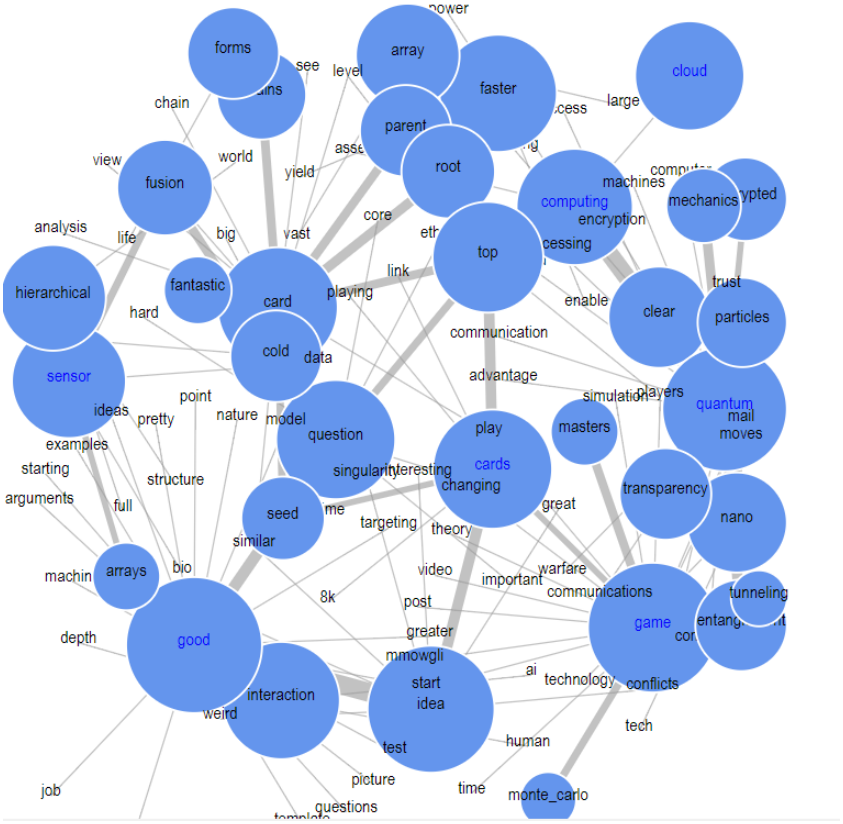

Figure 24. Emerging Theme 86(E), Summary words: “good game, quantum”

Theme 111(E) is shown in Figure 25. The major word pair in this theme is systems. Systems is connected to balances, adaptive, communication and complex. Adaptive is also connected heavily with complex, suggesting that this theme may be focused on adaptive complex systems as we move closer to the Singularity. Some of the smaller word pairs include education, moral, direct, network, mechanical, unmanned, computers, etc. We find it interesting that so far, many of the themes include a word pair that is connected to morals, ethics or laws. Many of the player apparently have a strong feeling that as we approach a Singularity (or so the game suggests), there will need to be a new set of laws and ethics that accompany the machine human team.

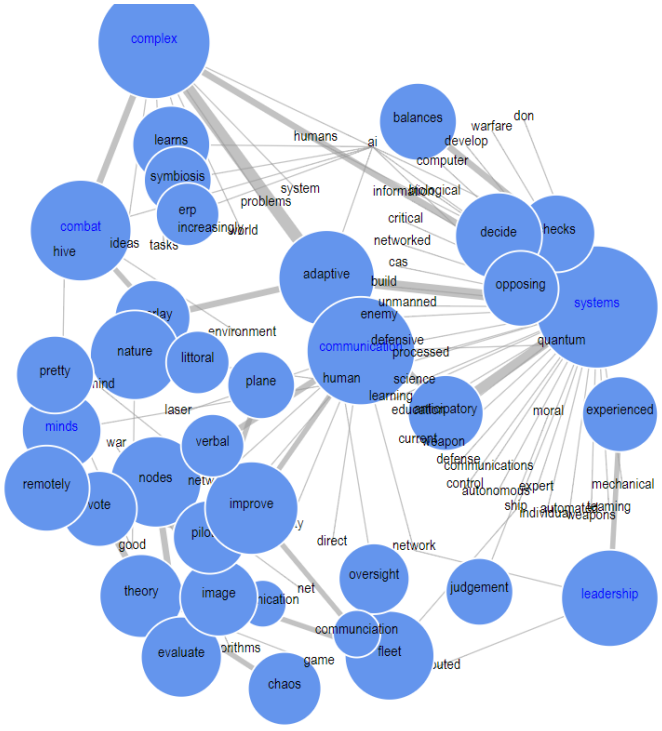

Figure 25. Emerging Theme 111(E), Summary Words: “Combat Systems, Complex Systems, Communication Systems”

Theme 10(E) is shown in Figure 26. This theme has a lot of emphasis on tactical decision making and analysis. The major word pairs include decision (directly connected to making), multiple, analysis, decisions, unit, tactical, ethical, maker (in regard to decision maker), predict, input, gathering (gathering intel) etc. Some of the smaller word pairs include aided, decentralized, autonomous, manned, drones, predictive, information. We believe that the main focus of this theme is the DoNs ability to quickly gather intel and use the data to predict scenarios for decision making.

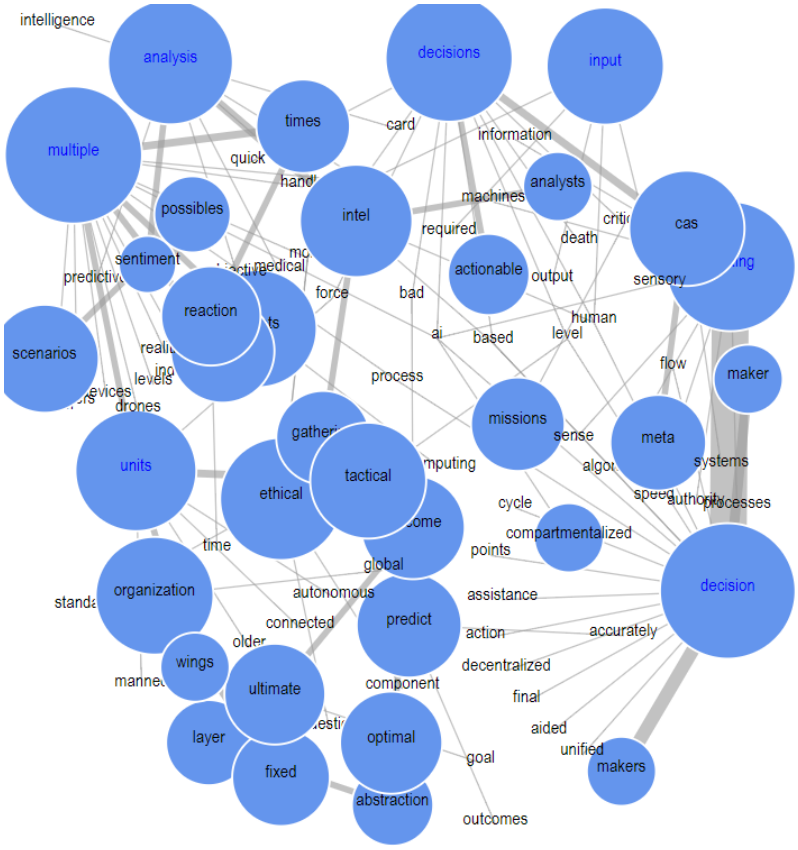

Figure 26. Emerging Theme 10(E), Summary Words: “Making Decision(s), Multiple”

Theme 106(E) as shown in Figure 27, is another theme where all of the word pairs seem to have the same size connectivity to other word pairs. There are very few outliers in this theme. Some of the major word pairs that caught our attention are economic, feedback, space, strategy, cyber, video, audio, assistance, assist, fast, language, control etc. The few outliers include damage, tech, loop, warfare, human, decision, threats, attacks, command, solutions, early (which is connected directly to strategy), data (which is connected directly to asses) etc.

Figure 27. Emerging Theme 106(E), Summary Words: “General, Cyber Space”

Theme 45(E) is shown in Figure 28. The major word pairs in this theme are legal, global, ecosystem, standard, naval, health, planet, relationship, autonomy, etc. This is the first time that we have seen Naval in the themes. In this theme, Naval is directly connected to operations, military, action, ships, simulation, air, and approach. This is also the first time that we have seen word pairs that relate to worldwide or global ideas. The word pair global is directly connected to warming, ecosystem, goal, decrease, threat and problems. This theme may be suggesting that as we move closer to a singularity, then there will be unforeseen global level issues and threats.

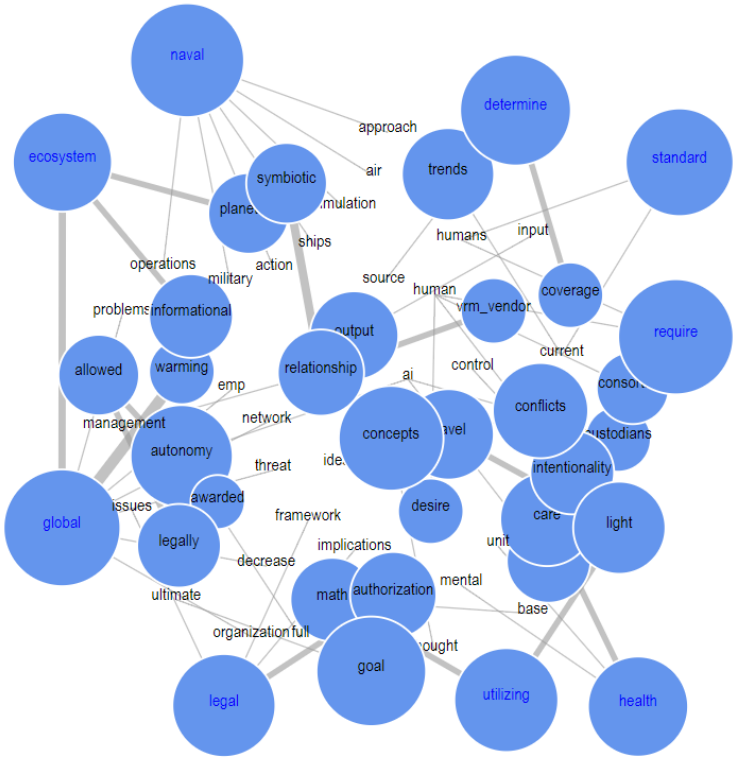

Figure 28. Emerging Theme 45(E), Summary Words: “Global, Require, Determine”

Theme 73(E) is shown in Figure 29. This theme has a major word pair of system. Not only is system connected to computer, automated, media and software, but it is also connected to immune, as in a human's immune system. The word immune is also part of the word pair of latency (dormancy). This is an interesting idea as we move towards a singularity. Not only has there been ideations regarding ethics, laws and global threats, but now there is an ideation that there may be latency for human's immune system. Other major word pairs in this theme include, navy, army, guardian, earth, online, rapid, perfect, planet, etc.

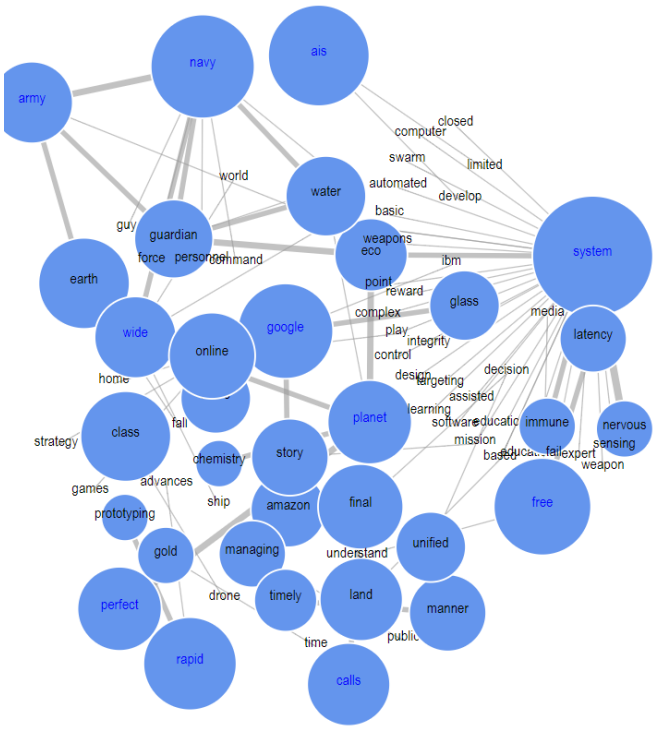

Figure 29. Emerging Theme 73(E), Summary Words: "Navy, AIS System"

Theme 63(E) is shown in Figure 30. This theme does not have many outliers. The word pairs are very well connected in this theme. Some of the major ideas include large, collaboration, mass, risk, increase, give, stress, fear, emotion, vast, design etc. The ideation that stands out most is the idea of increased risk. There is a strong connection between those word pairs. Other words that are connected to risk is management and averse, meaning that there may be an increased risk as we move closer to singularity and there needs to be an appropriate amount of risk management, possibly even risk adversity.

Figure 30. Emerging Theme 63(E), Summary Words: “Design, Give, Large”

Theme 66(E) is shown in Figure 31. This theme shows some new word pairs, including fire, satellite, nuclear, and spy. This is the first time we have seen these word pairs in an emerging theme. Some of the connector word pairs are scale, sensors, agreement, sources, commands, closed loop etc. The outliers in this theme are weapons, units, controls, awareness, system, friendly, learning, etc.

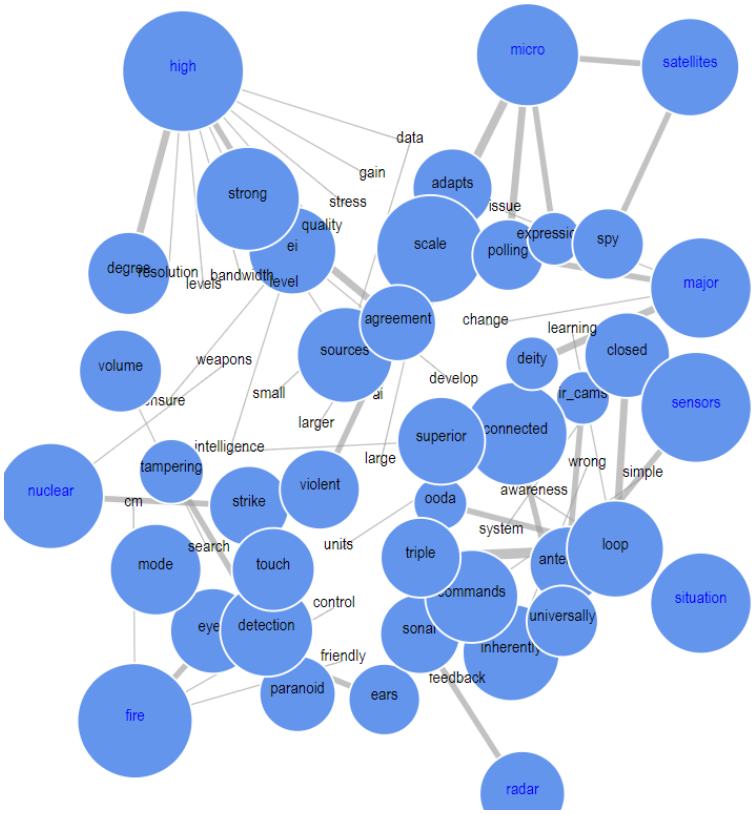

Figure 31. Emerging Theme 66(E), Summary Words: “High, Fire, Nuclear”

Theme 59(E) is shown in Figure 32. This theme is heavily focused on military operations. As shown in Figure 32, the major word pairs are aircraft, carrier, tasks, swarm, drone, attacks, counter, launch, trained, ops, tactics, etc. Some of the outliers include maintenance, ship, targets, machines, intelligence, cyber, war, forces, complex. Military operations are a major concern as we move towards a singularity. What would training, operations and wartime look like in a singularity? This theme may be a main focus for the DoN as we become more technologically advanced and the possibility of a singularity moves closer.

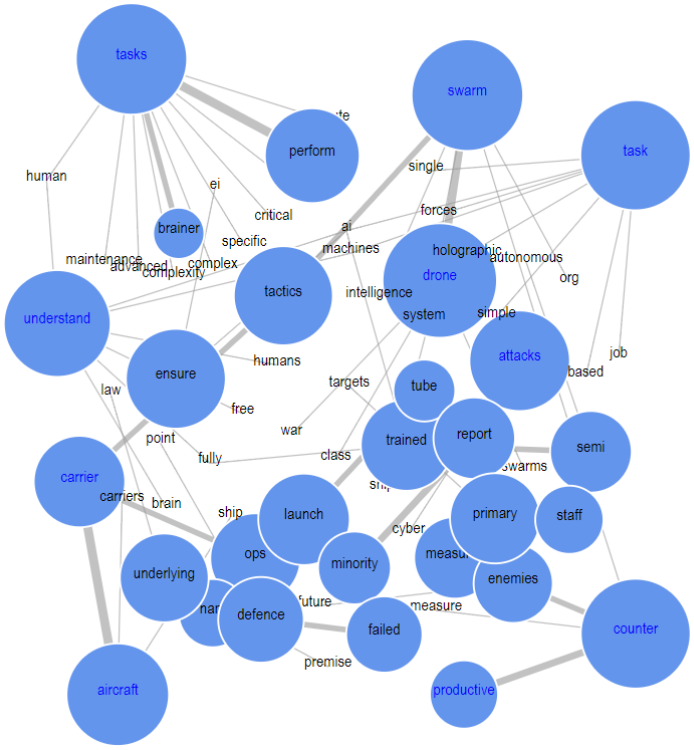

Figure 32. Emerging Theme 59(E), Summary Words: “Counter, Swarm Drone”

Figure 32 creates ideations that are heavily focused on military operations. Theme 24(E), shown in Figure 33, creates ideations regarding the defense of our military. The major word pairs in this theme are defense, threat, air, establish trust, support, bandwidth, long term, short term etc. Some of the outliers include history, force, system, decisions, networks, etc. We believe that the main take away of this theme is the short-term and long-term defense of the DoN as a singularity emerges.

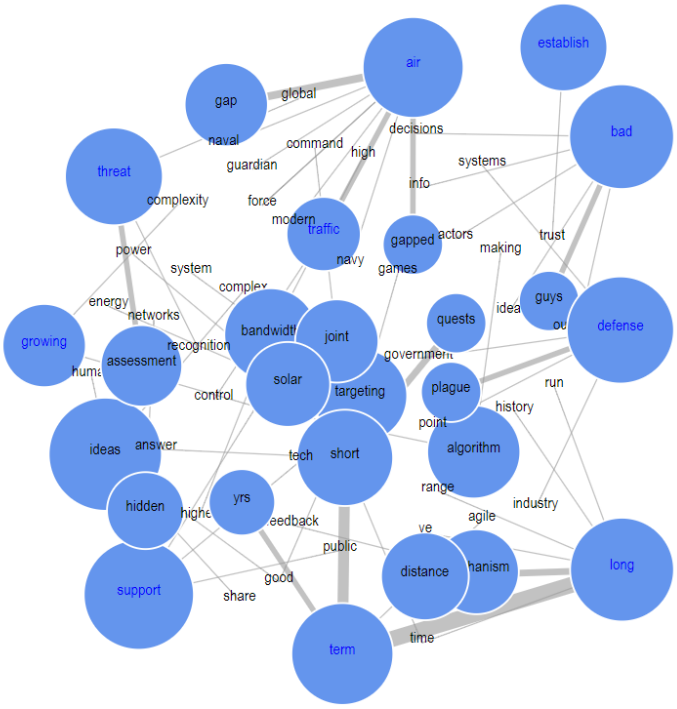

Figure 33. Emerging Theme 24(E), Summary Words: “Defense, Support, Term”

Figure 34 is a visualization of theme 70(E). The main word pairs in this theme are information, moral, similar, solutions and act. Some of the smaller blue circles include guidelines, vein, convention, objective, goals, etc. The outlier connections are strategic goals, personal data, organize information, classified information, decisions, programming, ethical, judgement etc. Again, we are seeing a theme revolved around laws and ethics. From this themes and collections of words it may be an innovative idea to create ethical guidelines for computer systems in the era of singularity.

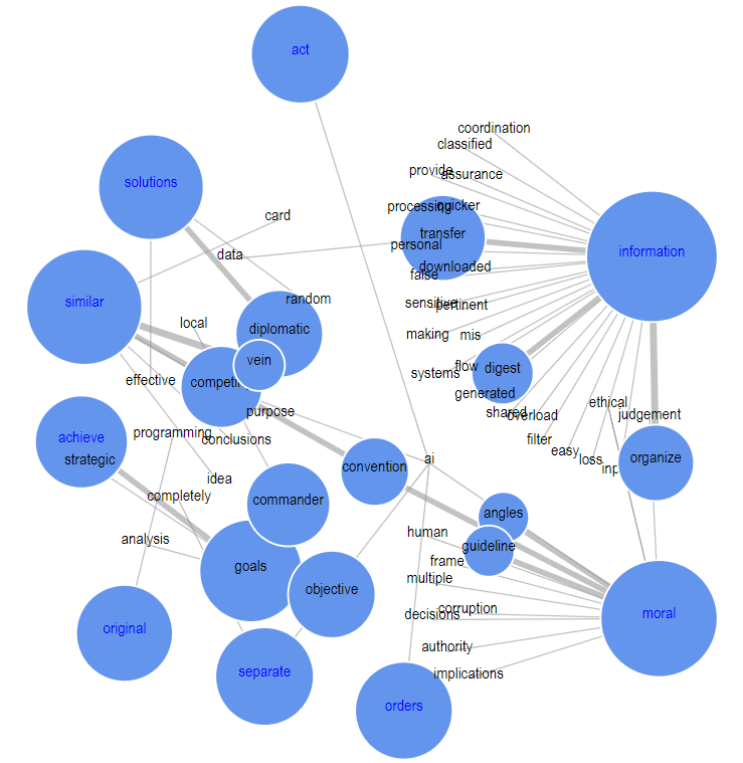

Figure 34. Emerging Theme 70(E), Summary Words: “Moral, Information, Similar”

Theme 58(E) is shown in Figure 35. Up until now we have seen themes revolving around military operations and defense. This theme seems to be focused on weaponry and offense. The main word pairs in this theme are weapons, authority, chain, command, kill (directly connected to switches and switch), and decentralized. We believe that the ideation behind this theme is to be offensive if a singularity does occur. The main take always that we believe are most important are using the chain of command and decentralized control to kill switches if it escalates to that point.

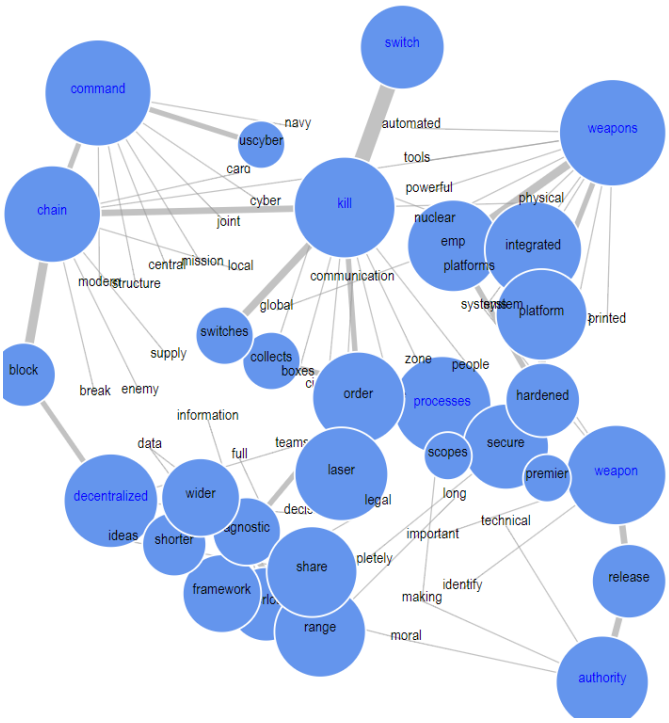

Figure 35. Emerging Theme 58(E), Summary Words: “Kill, Command, Weapons”

Theme 74(E) is shown in Figure 36. The major word pairs in this theme are actions, base, network, morality, robotic, teamed, policy, laws, coded, state, age. Some of the outlier word pairs include military, knowledge, tech, leadership, application, human (which is directly connected to teamed). Again, we see the idea of policies and laws, but this theme also goes down to the state level and has a word pair of state actors. This theme also mentions the robotic human team.

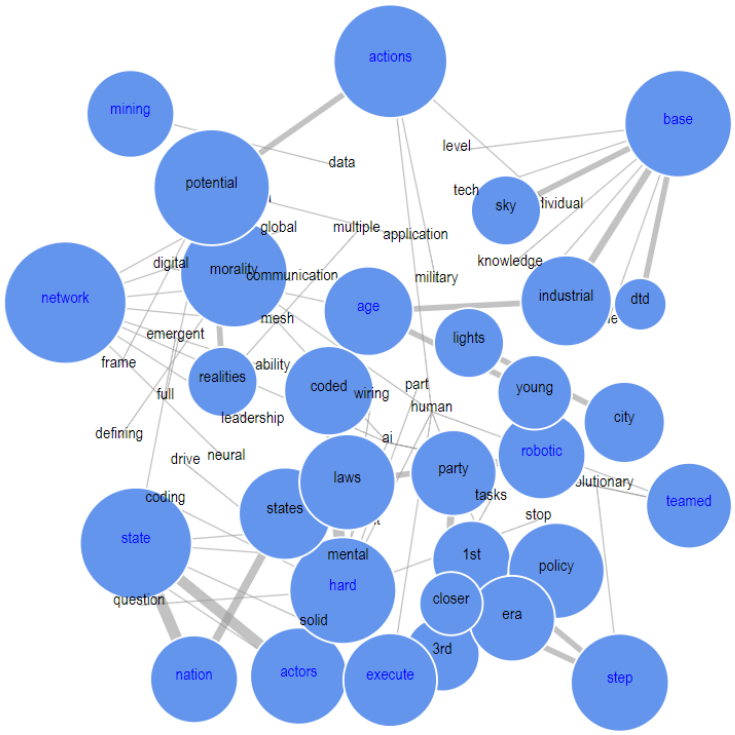

Figure 36. Emerging Theme 74(E), Summary Words: “Potential, Network, Base”

Theme 77(E) is shown in Figure 37. This theme has main word pairs that include, military, defensive, national, commercial sector, private sector, controlling, and consensus. Most of the outliers in this theme are connected to military and include hardware, systems, doctrine, infrastructure, application, actions, naval and background.

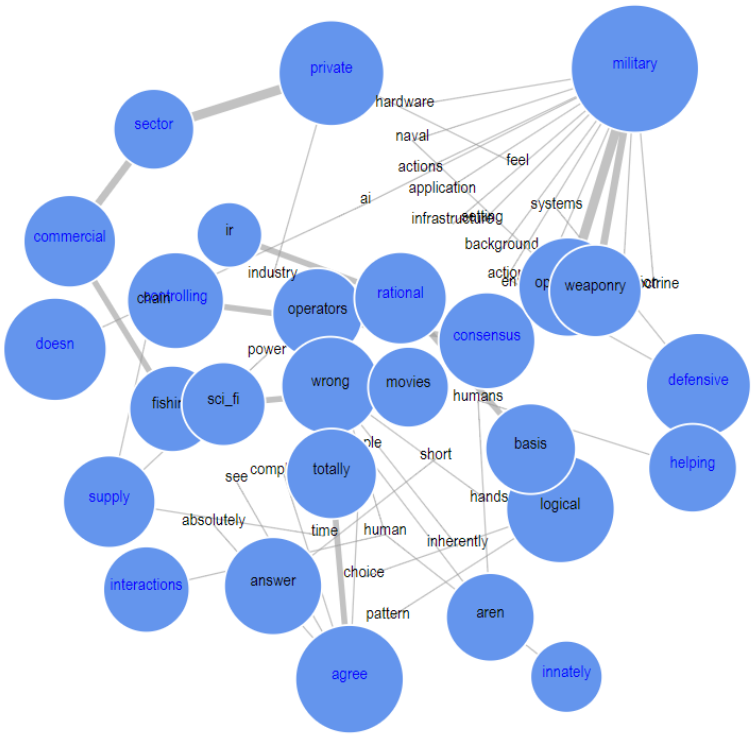

Figure 37. Emerging Theme 77(E), Summary Words: “Military, Agree, Logical”

Theme 60(E) is shown in Figure 38. The main word pair in this theme is higher level. Higher is also directly connected to bandwidth and power. Level is also directly connected to naval, base, individual, decision, top, entry, tactical, operational, and security. Other major word pairs include complexity, extremely (directly connected to vulnerable and dangerous), dynamic, simulation and hackers and designers.

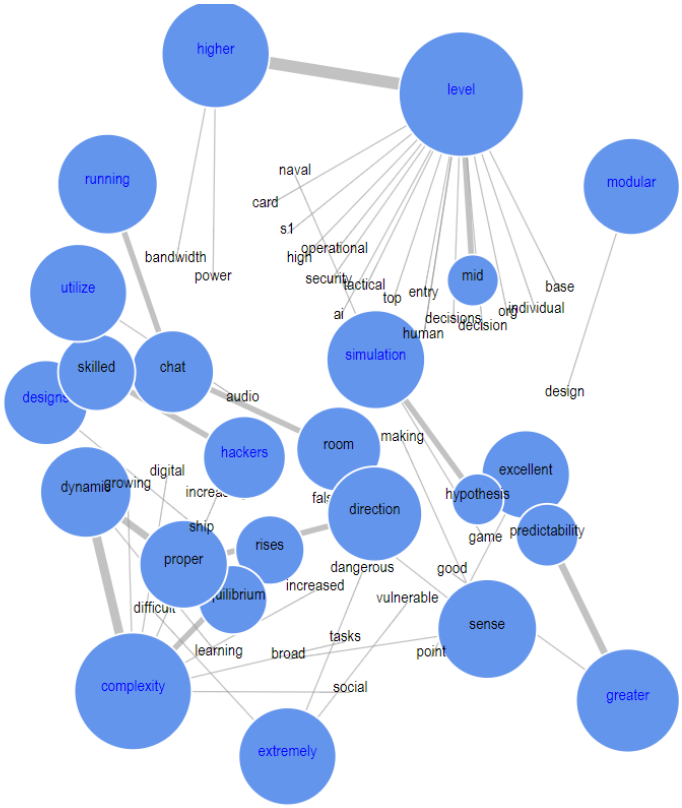

Figure 38. Emerging Theme 60(E), Summary Words: “Complexity Level, Higher Level”

Theme 4(E) is shown in Figure 39. The major connection that we found in this theme is the idea of viruses. This is an extremely relevant ideation considering that the MMOWGLI game is played around the idea that we are moving toward a singularity. In this theme, the word virus is directly connected to software and protection. Other word pairs in the theme are limited (directly connected to action and purview), plans, networked and error. Some of the outliers are resources (directly connected to limited) and humans and systems which are directly connected to networks.

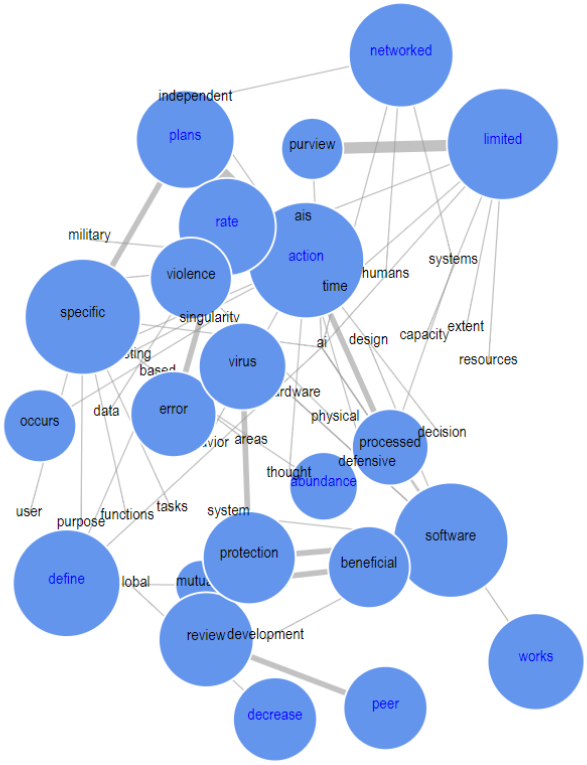

Figure 39. Emerging Theme 4(E), Summary Words: “Specific, Define, Limited”

The last emerging theme identified by LLA is theme 104(E), shown in Figure 40. There are very few outliers in this theme, there are mostly very closely connected word pairs. The word pairs include, small, groups, cheap, protocols, local, strategic opportunity, mental (directly connected to illness), hierarchy, flexible, and career path. Some of the outliers include, commander, chain networks, development, health and security.

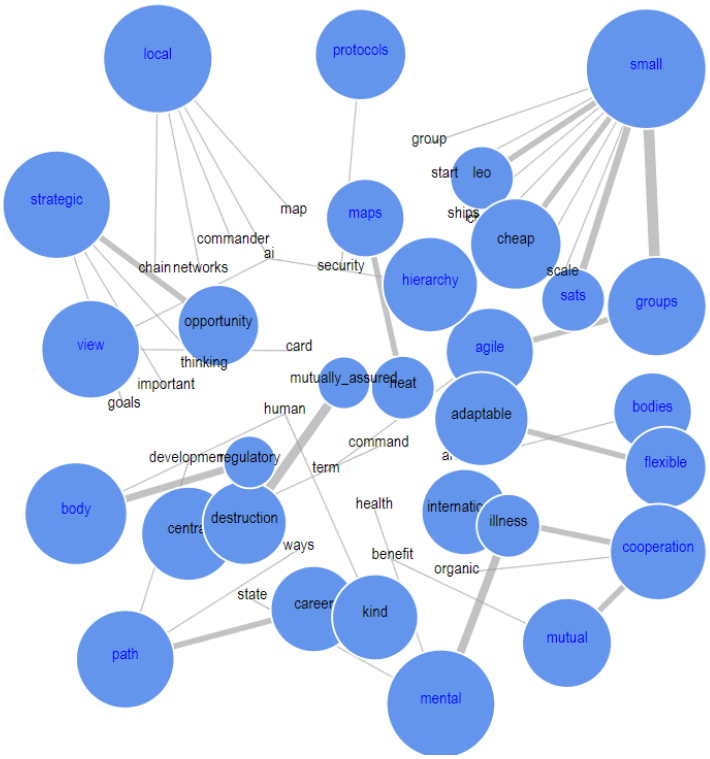

Figure 40. Emerging Theme 104(E), Summary Words: “Strategic, Local, Small”

2. LLA Emerging Themes Compared to Action Plans

The final step of the analysis was to compare LLAs emerging themes with the action plans. Since we are only concerned with the action plans, we sort the idea cards by thumbs and only use the idea cards that have been turned into action plans. LLA gives each action plan a value, that value is indicative of the amount of anomaly, emerging and popular word pairs in each idea card. For example, the action plan that had the most thumbs got a value of 12. It was categorized by LLA as popular. The value of 12 comes from a breakdown of four anomalous word pairs, four emerging word pairs and four popular word

pairs from that action plan. Figure 41 shows how those values look on the Excel spreadsheet.

id	Type	Value	Anomaly	Popularity	Emerging	T
105	Popularity	12	4	4	4	
3329	Emerging	4	1	0	3	
3443	Popularity	13	3	6	4	
27	Emerging	6	3	1	2	
5336	Anomaly	4	3	1	0	
5104	Emerging	7	3	1	3	
8201	Emerging	6	3	1	2	
2822	Anomaly	2	1	0	1	
24	Emerging	10	6	0	4	
20	Emerging	9	3	1	5	
3059	Emerging	1	0	0	1	
5192	Anomaly	8	5	2	1	
542	Emerging	8	3	2	3	
8980	Emerging	5	2	0	3	
9	Popularity	2	0	2	0	
3266	Anomaly	7	5	0	2	
6675	Anomaly	5	3	0	2	
601	Emerging	10	4	0	6	
2142	Anomaly	9	8	0	1	
11	Anomaly	6	4	0	2	
10	Anomaly	1	1	0	0	
1504	Emerging	4	2	1	1	
327	Emerging	7	1	1	5	
6189	Popularity	8	3	3	2	
79	Anomaly	5	1	1	3	
5695	Anomaly	11	10	1	0	
671	Anomaly	8	6	0	2	
477	Emerging	3	1	0	2	
3272	Emerging	14	7	0	7	
345	Anomaly	10	5	1	4	
2977	Emerging	10	5	0	5	
4893	Emerging	8	3	1	4	
8104	Emerging	4	2	0	2	
2283	Emerging	3	1	1	1	
1462	Popularity	4	2	2	0	
8081	Anomaly	1	1	0	0	
4186	Anomaly	5	3	1	1	
6051	Anomaly	6	6	0	0	
244	Anomaly	5	3	0	2	
7956	Anomaly	7	5	0	2	
4649	Emerging	6	3	0	3	
8105	Popularity	4	1	2	1	

Figure 41. LLA Categorization of Action Plans

As shown in Figure 41, the action plans (labeled by their ID number in the left-hand column) from the MMOWGLI Singularity game have a wide range of popular, emerging and anomalous themes. Out of the 42 action plans, LLA labeled 19 of them as emerging. This shows that almost half of the action plans are connected to an emerging theme (almost half are correlated). The LLA and the gamemasters analysis have some similarities but are ultimately different. This means that the LLA analysis of emerging themes has some correlation with the gamemasters action plans. It is also possible for an anomaly theme to be considered an innovative idea, but they are just more isolated. Taking that into consideration 36 out of the 42 are either emerging or anomalous, which is about 85% of the action plans. Although an anomalous theme can be innovative, this thesis did not analyze the anomalous ideas. In the next paragraph, we discuss some of the more interesting emerging themes as categorized by LLA.

The first emerging action plan that LLA identified was ID number 3329. Referencing the ID number with its original text, we can see that this idea card discusses understating complex adaptive systems. The next emerging theme is ID number 27. This idea card discusses the need to train humans and machines to understand each other's thought process. ID number 5104 discusses new modifications to naval ships to have a modular design to allow for flexible connectivity as new artificial intelligence develops. ID numbers 8201 and 2283 are also labeled as emerging themes and they both discuss the human machine team. Another interesting emerging theme is ID number 3059. This idea card discusses the morals and ethics behind new artificial intelligence. Lastly, ID number 601 discusses decentralized control and utilizing drone swarms.

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V. CONCLUSIONS, RECOMMENDATIONS, AND FUTURE RESEARCH

This research explored whether data from an ideation platform, Massive Multiplayer Online Wargame Leveraging the Internet (MMOWGLI), could be analyzed using Lexical Link Analysis (LLA) software to identify and visualize unique ideations. The volume, variety and veracity of data, especially in the MMOWGLI Singularity game, provides the possibility for improvements with big data analysis. The patterns and themes within the data set were uncovered by LLA to show the bigram word pairs of emerging themes. In regard to the two research questions, the following finding are discussed.

A. RESEARCH QUESTION ONE

- How can big data in the Department of the Navy (DoN) be analyzed and visualized by LLA to identify innovative ideations from crowdsourcing platforms?

We propose that the answer is that big data in the DoN can be analyzed and visualized using LLA to identify innovative ideations through emerging themes and bigram word pairs, categorized as such by LLA algorithms. LLA has the ability to analyze unstructured data in the form of text files. This analysis depicts major word themes and word connections leading to innovative ideations. The value that the visualizations offer to the DoN exceeds the value of the current analysis methods.

Prior to the analysis by LLA, the MMOWGLI Singularity game data was analyzed by humans. This used up many resources and manpower hours due to the sheer volume of the data. This type of analysis also left room for human error and analysis based on responses to level one posts as discussed in Chapter IV, Section A of this thesis. The LLA software provides for expedited analysis of the MMOWGLI data set and produces valuable output for leaders which in turn allows for data-based decision making.

B. RESEARCH QUESTION TWO

- What are the main innovative ideations derived from the MMOWGLI data set?

Taking the Singularity game questions into consideration, we revisit Wheeler's two main questions from her 2017 video:

> What concepts for human machine teaming might we develop as we approach Singularity 1?
>
> As complexity rises all around us, what new organizational constructs should we consider?

As stated in Chapter IV, Section B, Paragraph 2 of this thesis, LLA categorized the MMOWGLI action plans as popular, emerging and anomalous. From that analysis, there were 19 out of 42 action plans that were emerging, showing that almost half of the action plans are connected to an emerging theme. From those emerging themes, we believe that the main innovative ideations pulled from the MMOWGLI Singularity game are:

- The creation of human machine teaming laws, ethics and morals as seen in theme 70(E)
- The advanced technological ability to quickly gather and analyze data for tactical decision making as seen in theme 10(E)
- Drone swarms for the purposes of intelligence gathering, offense and defensive operations as seen in theme 59(E)
- The DoN must be able to quickly identify and be prepared to react to unforeseen global issues, threats and increased risk as seen in themes 63(E) and 77(E)
- Create short-term and long-term defensive to include kill switches to machines if singularity advances too far and/or fast as seen in theme 24(E)

- Some of the differences between the action plans and the LLA categorization are:
- Develop algorithms, training and testing methods for AI (labeled by LLA as popular)
- Engaging the public in developing autonomous AI with commercial games (labeled as popular by LLA)
- Human machine integration can be scalable from individual machine to a community network (labeled as popular by LLA)
- Incorporating AI into armor to detect internal injuries (labeled as anomaly by LLA)
- Electromagnetic pulse as a weapon (labeled as anomaly by LLA)

C. FUTURE RESEARCH

The conclusions and findings of this thesis were limited to one MMOWGLI game data set of the Singularity game. The conclusions should be tested again for other MMOWGLI data sets. Furthermore, the analysis of other data sets can prove to be beneficial. This can be for other ideation platforms or even military occupational specialty specific data. This thesis also only analyzed the emerging themes. In future MMOWGLI analysis, the emerging and anomalous themes can be tested to compare the differences.

This thesis is labeled as approved for public release but LLA software can be applied to a wide range classified data sets. This can range from exercise data pulled from military systems to analyze themes and patterns in military training to deployment data to analyze enemy activity during deployed military operations. The DoN can continue to use this form of analysis to build databases of themes and patterns so that future decision making is based off of historical and real time data.

D. RECOMMENDATIONS

It is recommended that the DoN continue to utilize crowdsourcing ideation platforms, like MMOWGLI, as a method to collect ideations from personnel with a wide range of experience and expertise. Not only are ideation platforms necessary for innovation but these platforms connect subject matter experts and other interested personnel. It is also recommended that the data from the ideation platforms be analyzed using both their current method as well as LLA software to compare the outcomes from each.

It is further recommended to use LLA software on ideation platforms, and also that the DoN look for a way to utilize LLA to find themes and patterners in everyday data sets, such a training evolution data, personnel data, logistical data and deployment data sets.

This research focused on finding themes and patterns in an ideation platform data set. The conclusions that were drawn were only possible due to the accessibility of the raw data and the capability to convert that data into a text file. It is highly recommended to continue to archive data sets and make them accessible for research and analysis. By studying archived data, the DoN can prepare and plan for the future.

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