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ON CREATIVITY: A CASE STUDY OF MILITARY INNOVATION

by

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Guided by the framework, this case study shows that there are strong forces in the Navy resisting change and defending the status quo. Still, it is possible to outmaneuver the hierarchy and bring ideas and suggestions straight to the commanding officer's attention. Faced with a rigid, conservative culture, USS Nimitz managed to create a climate of intrinsic motivation where individuals believed their ideas could make a difference and acted on those beliefs.

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ON CREATIVITY: A CASE STUDY OF MILITARY INNOVATION

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LIST OF ACRONYMS AND ABBREVIATIONS

1MC	1 Main Circuit
3MC	Maintenance Material Management Coordinator
3MO	Maintenance Material Management Officer
4 Ps	Person, Process, Press, Product
ADP	Automated Data Processing
CMC	Command Master Chief
CNO	Chief of Naval Operations
CO	Commanding Officer
CRIC	CNO's Rapid Innovation Cell
CTA	Cognitive Task Analysis
DITS	Division in the Spotlight
DNA	Deoxyribonucleic Acid
GEN	General
HSI	Human Systems Integration
IT	Information Technology
LT	Lieutenant
NPS	Naval Postgraduate School
OR	Operations Research
R&D	Research and Development
RO	Reactor Officer
Ro-ro	Roll-On/Roll-Off
SAMS	SNAP Automated Medical Systems
SECNAV	Secretary of the Navy
SME	Subject Matter Expert
SNAP	Ship Board Non-Tactical ATP Program
SPAWAR	Space and Naval Warfare Systems Command
TCI	Team Climate Inventory
USS	United States Ship
UUT	Unusual Uses Task
XO	Executive Officer

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EXECUTIVE SUMMARY

The U.S. Navy needs creative ideas and innovative products to adapt to changing times and novel threats. Unfortunately, the Navy is an organization that struggles between forces defying change and its need for innovation. There are multiple obstacles to overcome for an idea to surface or new products to be implemented in a military organization.

My aim here is to present a view on how military creativity and innovation occur, a view that draws on four lines of creativity research. This thesis explores whether factors found to influence creativity in this wide field of research can help explain innovation in military organizations. *Creativity research* is used herein as an all-encompassing term embracing research into creativity and innovation. Creativity research spans multiple fields of expertise including human factors, management, organizational behavior, psychology, and neuroscience. For this project, these areas of research are gathered under one umbrella both for the sake of simplicity and, more importantly, to distinguish creativity research from studies of military innovation. These two streams follow different paths: creativity research benefits from insights from the wide range of fields mentioned above, while the military innovation studies develop concepts and theories in relative isolation. Just as creativity research seldom uses military cases as a unit of analysis, studies of military innovation very rarely use concepts, theories, and definitions from creativity research to explain their observations. The enablers of creativity and innovation—in military organizations and elsewhere—are best understood in light of the insights from creativity research.

Herein, theories from creativity research are applied to the need for innovations in the Navy as exemplified by the USS Nimitz. The thesis uses a descriptive case study approach to understand creativity and innovation onboard that particular ship. Following that approach, the thesis presents a theoretical framework which is used to view the case from different angles. The use of theory makes the findings accessible and therefore relevant to other cases as well. Theory drives the collection and interpretation of data about the case. Triangulation is used to strengthen the analysis.

The case study methodology was chosen because of its ability to capture the complexity and uniqueness of human behavior in a real-world context. The rarity and heterogeneity of such a study in a naval context further strengthened the rationale for choosing a case study research design.

Data were gathered primarily through unstructured, one-on-one interviews with a selection of key personnel onboard the Nimitz. To ensure that the sample was representative, the snowball recruiting method was used. The participants included the ship's leadership, a sample of experienced petty officers from one particular ship division, and participants and facilitators of an innovation project initiated onboard (the Athena Project). Reports from previous NPS research on the Nimitz and observations made during that research provided valuable background and context descriptions, which are supported by two personal visits to the ship and 18 years of professional naval background.

The personal stories gathered through interviews were the primary source of evidence, while observations and secondary sources were valuable in supporting the context and background descriptions. The interview data were interpreted in light of the theoretical framework. The data have been organized by the theories underlying that framework. Furthermore, the participants interviewed have been organized by three perspectives. This organization is inspired by how ethnographic researchers create personas, or archetypes, representing important and distinct characters that stand out from the interview data. The three perspectives are the Leader, the Athena Sailor, and the Petty Officer.

Guided by the framework, the case study showed that there are strong forces in the Navy resisting change and defending the status quo. It is challenging to implement new ideas. Still, it is possible to outmaneuver the hierarchy and bring ideas and suggestions straight to the commanding officer's table. Faced with the most conservative culture, it is possible to create a climate of intrinsic motivation where individuals believe their ideas can make a difference.

The USS Nimitz innovated by adhering to factors such as intrinsic motivation and participative safety. By that measure, the case study echoed the findings of broad creativity research. Other factors, like transactional leadership, were more rarely given priority by previous studies. The unique military context of the case study made the role of transactional leadership more apparent. More surprising was how clear the process view illuminated the difference in the Nimitz*'s* approaches to idea generation and implementation. Initiatives like the Athena Project made the generation of new ideas considerably more effective. On the other hand, the implementation of those potentially radical ideas was entrusted to the established, traditional process. Finally, mostly unexpected was the insight about the positive effect that the alignment of goals and ideas had on participative safety. When goals and ideas were aligned, the crew of the Nimitz was able to innovate by taking advantage of existing efficient processes.

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I. INTRODUCTION

Like many large organizations, the U.S. Navy needs creative ideas and innovative products to adapt to changing times and novel threats. The Navy also has a long tradition of struggling to embrace opportunities to innovate. There are multiple obstacles to overcome for an idea to surface or a new product to be implemented in a military organization. There are notable exceptions: Some ship crews are willing to try innovative solutions; however, many fiercely resist change. The majority lies dead in water: unable or unwilling to innovate or unaware of opportunities. What sets the innovative few apart from the others? The overriding question posed by this research is: What conditions set the stage for creativity and innovation in the Navy? This thesis explores one of those cases.

A. CREATIVITY AND INNOVATION

My aim here is to present a view on how military creativity and innovation occur that draws on current developments in creativity research. *Creativity research* is used herein as an all-encompassing term embracing research into creativity and innovation. Creativity research spans multiple fields of expertise including human factors, management, organizational behavior, psychology, and neuroscience. For this project, these areas of research are gathered under one umbrella both for the sake of simplicity and, more importantly, to distinguish creativity research from studies of military innovation. These two streams follow different paths: creativity research benefits from insights from the wide range of fields mentioned above, while the military innovation studies develop concepts and theories in relative isolation. Just as creativity research seldom uses military cases as a unit of analysis, studies of military innovation very rarely use concepts, theories, and definitions from creativity research to explain their observations. The enablers of creativity and innovation—in military organizations and elsewhere—are best understood in light of the insights from creativity research. This thesis explores whether factors found to influence creativity in this wide field of research can help explain innovation in military organizations.

A majority of researchers (e.g., Hennessey & Amabile, 2010) on creativity argue that if creativity is the generation of novel and useful ideas (p. 570), innovation is the successful implementation of those ideas (p. 585). The distinction can be useful in addressing seemingly conflicting findings regarding the conditions necessary for creativity and innovation, and thereby provide more precision in addressing the topic. However, focusing solely on one of the two may result in gaining only a partial understanding of two closely related terms. After all, innovation cannot be achieved without prior creative efforts (Amabile, Conti, Coon, Lazenby, & Herron, 1996). As explained by Klijn and Tomic (2010), "So to be able to promote innovation, it is important to understand the process of creativity and its mediators." (p. 323) Herein, *innovation* is understood as the implementation phase of novel and useful ideas generated through creative behavior.

Traditional creativity research views creativity as a characteristic of the individual (Guilford, 1950; Torrance, 1965). More recent research has widened the scope to include the characteristics of team, organizational, and even cultural environments (Anderson & West, 1998; Elenkov & Manev, 2005; D. Jung, Wu, & Chow, 2008). With such a broad scope, conflicting factors contributing to creativity have been found, and theories to address these issues have been developed. The research on creativity in a military context is sparse, however, and is based more on narratives of single cases of innovation. Understanding the role of organizations in fostering creativity and innovation is especially important to military operations. Findings from creativity research could help broaden the understanding of creativity and innovation in the military, and bring the two fields closer together.

1. Creativity

There are multiple ways to define creativity. A common broad definition is that of novelty and quality: A creative accomplishment is judged to be both original and useful (Batey, 2012). Creativity has been linked to the most important scientific and cultural achievements, for example the discovery of DNA, or works of art by Mozart, the Beatles and Picasso (Weisberg, 2006). Early research into creativity found that these

breakthroughs could be attributed to more than individual intelligence as it is normally measured, and sparked an interest in uncovering the source from which creativity emerges (Guilford, 1950). The quest was on to learn what enabled creative geniuses such as Michelangelo, Watson and Crick, Darwin, Monet, van Gogh, and Einstein to achieve such extraordinary results, and how to identify and enhance similar potential among more ordinary individuals. One consistent finding is that innovative results are seldom achieved without inspiration, collaboration, and communication (Sawyer, 2007).

In this same manner, creativity research turned its focus also to innovation, social entities, and organizations. Extensive research has been conducted to understand the necessary conditions for creativity to thrive not just in individuals, but also in teams, groups, and organizations (e.g., Amabile et al., 1996; Anderson & West, 1998). In the business world, results come from being innovative, staying ahead of the competition, and adapting quickly to market needs. The market rewards those who are able to innovate and stay in front. Innovation is a means of survival, growth, and long-term performance (Klijn & Tomic, 2010). Exemplar firms have been promoted as having adopted highly creative practices. These innovations include flat organization structures, team diversity, risk taking, individual initiative, freedom to explore, information sharing, and playfulness and have been implemented by companies such as Google, IDEO, 3M, Gore, Semco, and Lego (Sawyer, 2007).

Lessons learned from creativity research studying primarily civilian entities should be just as applicable to military organizations. In fact, Human Systems Integration (HSI) relies on integrating into military organizations lessons learned from diverse fields of research that focus on studying individuals, organizations, and incidents outside the military sphere (Krueger, 2012). For example, studies of firefighters are used to understand military decision making (Klein, Calderwood, & Clinton-Cirocco, 1986). Cases from health care and tire manufactures are used to inform military manpower, personnel, and training issues (Archer, Headley, & Allender, 2005). It would be unthinkable in HSI not to use insights from psychology, organizational behavior, human factors, management, and so forth to make sense of observations and studies of the military.

To investigate whether this observation also holds true for insights from creativity research, we need a model—a common language—of creativity and innovation that we can fit later to a case study of military innovation.

We have already established definitions of creativity and innovation, and determined that they are separate, yet closely related, terms. Distinguishing between them will provide more precision when related effects surface during the course of the case study, effects that may appear conflicting when creativity and innovation are melded together. Nevertheless, that these conflicts exist justifies a discussion beyond our initial high-level, broad definition.

There are paradoxes in creativity and innovation that point to a dialectic process that can be found in studies of culture, psychology, and neuroscience (Holm-Hadulla, 2013). The creative process introduces new ideas to adjust current knowledge in a thesis, antithesis, and synthesis model (Sternberg, 2001). Building on that model, in the investment theory of creativity, Sternberg (2006) proposes that divergent thinking skills are essential in generating new, useful ideas, while, simultaneously, convergent thinking skills are required to realize and sell the product or idea to an audience still getting by on old, established beliefs.

The dialectic process of creativity and innovation can be examined with the aim of identifying management practices or potential challenges produced by the tension between seemingly conflicting demands. Bledow, Frese, Anderson, Erez, and Farr (2009) reviewed organization and management research to come up with principles that support innovation management. For example, they identified principles aimed at addressing the tension between the need for organizational conformity and stereotypes versus open-mindedness and change. In another attempt to address this inherent complexity of creativity and innovation, Cropley and Cropley (2012) use a process view of creativity. The dialectic approach, supported by the investment theory and the process view, are perspectives that were chosen to provide more depth and insight into the understanding of creativity and innovation in the case selected for the thesis.

These perspectives also suggest that the thesis should look into the creative idea itself and its relation to the context: how the idea that eventually resulted in new practice emerged (the idea generating process), and how innovative or radical it was perceived to be (the investment/risk it produces). Moreover, management processes are studied to uncover how the leadership managed the conflicting demands that emerged during the creative process.

This understanding of creativity and innovation is the foundation for a theoretical framework to guide the collection, interpretation, and communication of the data. The next step is to look at how creativity research can be organized. Two common taxonomic structures in creativity research are the 4 Ps and level of analysis.

Traditionally, creativity has been studied in terms of person, process, press, and product, commonly referred to as the "4 Ps of creativity" (Runco, 2004). Although modern creativity research has widened the scope considerably, the 4 Ps are still the foundation upon which this thesis builds:

- Person: Which human traits or states are associated with creativity?
- Process: What are the psychological processes that support creativity?
- Press: How does the environment influence creative persons?
- Product: How can creative products be categorized and measured?

One of the more important developments in creativity research is the step from studying individuals (person) to teams, organizations, and cultures. Consequently, summary articles and literature reviews are organized according to those levels (e.g., Anderson, Potocnik, & Zhou, 2014; Hennessey & Amabile, 2010; Klijn & Tomic, 2010).

At the individual level, researchers have measured the effect of cognitive processes, personality, traits, mood, or motivation on factors hypothesized to influence creativity and innovation. One example of such studies is the effect of incubation periods (mind-wandering) on creativity among students (Baird et al., 2012). For groups and teams, researchers have looked into the effect of team work, social climate, demands, task characteristics, team diversity, structure, and so forth, on creativity. Two notable examples of such efforts are found in Amabile et al. (1996) and West (2002). At the

organizational level, organizations have been assessed as hierarchical, risk adverse, goal setting, resourceful, and communicative (Anderson et al., 2014). Finally, cultures have been studied and found to be prone to collectivism rather than individualism, or to be restrictive in nature, through the promotion of censorship and tight corporate control (Elenkov & Manev, 2005; Seitz, 2003).

For all levels of abstraction (from individual to cultural), researchers have analyzed the factors that they hypothesize will have the greatest influence on creativity and innovation. To understand the complete picture, however, it is important to consider the possibility of interactions between the levels. When summarizing research on different levels of analysis (in this particular case, neurological, group/teams, organization, and culture), Hennessy and Amabile (2010) argue that a systems view must be taken. Creativity cannot be dissected to the sum of the effects found at each level, but is an emergent property of the interactions of the whole. This statement implies that the suggested predictors for each level are not synonymous with creativity *per se*; they merely imply its potential. For example, divergent thinking is found to foster originality. As an essential springboard for creativity, divergent thinking is a factor frequently measured in studies of creativity, and may or may not be predictive of creative outcomes (Runco & Acar, 2012). Taking the approach of systems theory means that separate analysis of all the measurable factors found to influence creativity at different levels of granularity does not guarantee a complete understanding of innovation as an emergent property of the system.

Batey (2012) observes that creativity research typically considers either individuals, team, organization, or culture as the level of analysis. Within each level, researchers investigate four *facets* - trait, process, press, or product (similar to the 4 Ps model). Data are gathered using subjective, objective, or other measurement approaches. A common self-report approach uses the KEYS survey tool to measure social climate in a project team (Amabile et al., 1996). As a heuristic to understand creativity research, Batey presents a model using Level, Facet, and Measurement Approach as the three planes of a cube, or as the *x*, *y*, and *z* axes of a three-dimensional coordinate system (see Figure 1). Creativity research typically develops its hypothesis about an intersection point

of the three axes, although this intersection point can represent only a fraction of the whole picture of creativity and innovation. Similar to the understanding of creativity and innovation in systems theory (Hennessey & Amabile, 2010), Batey suggests that creativity is more likely the whole picture of everything surrounding the points measured.

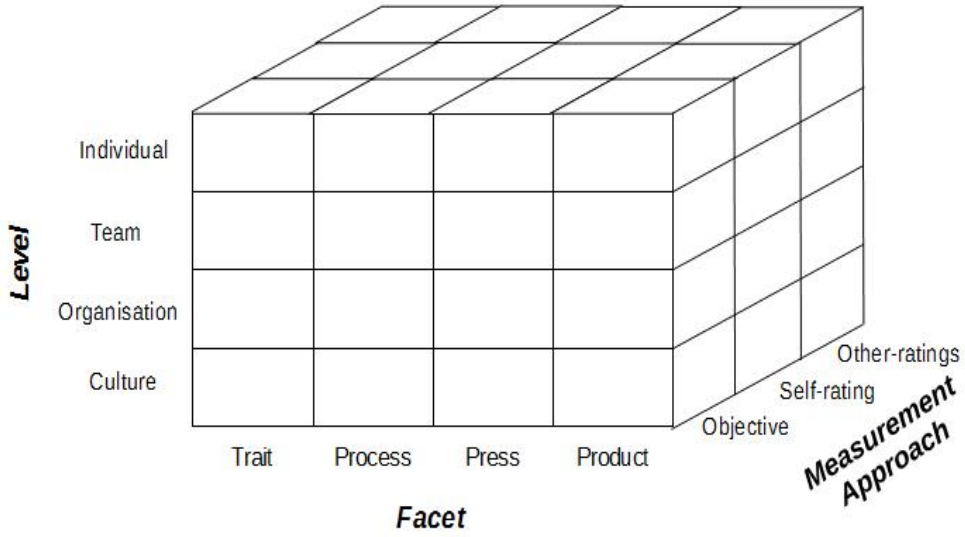

Figure 1. Creativity Research Heuristic (adapted from Batey, 2012)

Batey's model of multiple levels of abstraction, facets of creativity and measurement approaches inspires the search for system-wide effects in this thesis. The model brings together both the 4 Ps and the levels of abstraction. It can be used to describe very narrowly focused research concentrating on only one intersection point or to justify a whole system approach. The definitions of creativity and innovation, and the perspectives of a dialectic approach, a process view, and the investment theory serve to provide precision, depth, and hopefully a richer understanding when applying the model to the case study. Hence, the understanding of creativity and innovation suggested here, and the different aspects of the model are used to make sense of observations, guide interview questions, and introduce a language for thinking and talking about military innovation.

Given this foundation, it is reasonable to expect to discover system properties in case studies of real-world military events. For example, there are likely to be interactions between multiple levels rather than a single main effect that might be isolated in a laboratory environment. A simple measurement of a trait at the individual, team, or organizational level is unlikely to explain how innovation occurred in the particular case that is studied. A linear cause-and-effect relationship might not be easily identified. Complex interactions may be present. Consequently, this study aims to capture as rich and diverse data as possible by using case study methodology.

B. WHY THE MILITARY?

Like their civilian counterparts, military organizations rely on being able to adapt to a rapidly changing environment and outsmart their competitors. New enemies, old enemies in new wrapping, and an ever-changing domestic and international political climate justify the catchphrase "innovate or die" to describe the reality facing military organizations (Spulak, 2010). However, military organizational culture seldom adopts the exemplar practices mentioned here. Military organizations value uniformity, hierarchy, risk reduction, orders, and standard operating procedures—all features that are known to degrade innovation and creativity (Hendrick & Kleiner, 2005). Fortunately, even from such poor soil, creativity can bloom. Yet, creativity research provides few answers on how innovation can happen in an environment that appears so different from the role-model firms often promoted as fostering creativity. Creativity research mostly overlooks the military. Similarly, research done on military innovation ignores both the methods and findings of creativity research. However, I have found no evidence to suggest that lessons learned from creativity research cannot benefit the military. This thesis is novel in how it attempts to use general models from creativity research to shed light on a case of military innovation.

A prevalent assumption is that the military organization is a machine bureaucracy: complex, hierarchical, and bureaucratic. This organizational structure is poor at promoting innovation (Hendrick & Kleiner, 2005). Even so, the military is able to, and

needs to, innovate. One example of naval innovation is changing the current routine of watch schedules onboard Navy ships.

The Navy does not rest. It is constantly challenged to perform. If it fails, it will soon find itself in the wake of adversaries steaming ahead. Sailors, on the other hand, need rest and recovery, but current practice does not necessarily provide sailors with the rest they need to perform at their optimal capacity.

Researchers from the Naval Postgraduate School (NPS) have demonstrated the effect of watch schedules and sleep habits on human performance. The effort has influenced a change in watch schedules on some U.S. Navy ships. When the leadership of the nuclear aircraft carrier USS Nimitz suspected they were witnessing degraded performance levels among some crewmembers, they decided to invite NPS onboard to measure the crew's sleep quality and performance. The studies inspired changes in their work schedules and also other routines thought to impact fatigue, rest, and performance. Ultimately, the mindset towards the importance of a proper balance between work and recovery was changing. This change is a major achievement considering how it challenges deeply-rooted traditional belief systems about sleep requirements in the military. It signifies a true innovation, an anti-thesis challenging the established order (the current thesis) followed by the synthesis of new and old knowledge into novel and useful solutions. This documented case of innovation provides an excellent opportunity to study creativity in a military setting. Additionally, the Nimitz is among the world's largest and most complex naval vessels and is therefore, on its own, an intriguing case to examine creative and innovative behavior.

Creativity and innovation is crucial for organizational success (Klijn & Tomic, 2010). Nevertheless, innovation can be a challenging investment. Barriers to change may make it seemingly impossible to improve on routines deeply rooted in tradition. The case study of innovation onboard the Nimitz shows that innovation is possible in a military context. By learning more of how a particular Navy vessel was able to innovate and adopt changes to its routines, the thesis may assist other ships in understanding the process of coming up with and implementing novel solutions aimed at improving total system performance.

C. SCOPE

This thesis is driven by one overriding question: What conditions set the stage for creativity and innovation in the Navy?

By using a case study of military innovation onboard the USS Nimitz, the thesis aims to investigate the circumstances under which a military organization with a climate that is seemingly so different from the ideal for fostering creativity is able to be innovative. The innovation is explained by predictors or factors found in creativity research.

First, creativity research is examined to find what researchers have put forward as the conditions necessary for creativity and innovation. Military innovation studies are reviewed to establish whether there are inconsistencies between the creativity research and the specific military innovation research. Then a specific case of military innovation is examined to determine how findings from creativity research can be applied to real-world military situations and to find out whether creativity and innovation in a military context can benefit from being viewed through the lens of creativity research.

The thesis is a case study of military innovation onboard a ship of the U.S. Navy, selected for its innovation in changing a well-established watch schedule onboard the ship. The thesis is limited to this one particular case: the USS Nimitz. The case is well-documented by previous NPS research and, thus, there are rich sources of data to draw upon (Shattuck, Matsangas, & Brown, 2015; Shattuck, Matsangas, & Powley, 2015). Additional data collection consists of interviews of key personnel involved with the innovation. Since the interviews are conducted outside of a controllable, repeatable laboratory setting, the research provides only a glimpse of a world that may or may not be describable by the terms established by cross-case, large-sample-size, correlational research on creativity; although, most likely, current creativity research will help to expand the understanding of observations from the case study.

D. COURSE OF STUDY

Type of study: Descriptive case study

The thesis is conducted in three steps:

1. Literature review
2. Interviews/Case study
3. Consolidation

The literature review covers research on creativity from major publications and a wide range of disciplines. Relevant publications include dedicated journals on the subject, for example, the *Creativity Research Journal*, and the *Journal of Creative Behavior*, and peer-reviewed journals dedicated to related fields, such as the *Journal of Management* and the *Journal of Applied Psychology*. Notable authors include Amabile, West, Sternberg, Anderson, Bledow, and others. Research on military innovation is mostly covered by articles from the *Journal of Strategic Studies*.

The case study is concentrated on the USS Nimitz. The ship discarded the traditional watch schedule, and implemented a new schedule, different from Navy standards, but better suited to human needs. The sheer size and complexity of the ship make it an interesting case study. Additionally, research teams from NPS studied the Nimitz on several occasions during 2014, and published several reports on their findings (Shattuck et al., 2015). The rich data available, although not on creativity *per se*, and the connections with key actors already established on the ship, make this an excellent opportunity for studying the links between innovation and creativity, and military organizations and minds.

Data collection for the case study includes a combination of reviewing previous research and identifying and interviewing key actors in the innovation process. The interviews are open/semi-structured to allow for exploration of the subject. This technique facilitates the collection of richer data than is possible using questionnaires and structured interviews that are designed to compare and average views from a larger population.

Finally, following a descriptive case study methodology, the data from the cases are consolidated with the findings from the literature. This procedure aligns the narrow/focused military study with the broader research, and enables lessons learned to be integrated in future research.

E. THE ROLE OF CREATIVITY IN HUMAN SYSTEMS INTEGRATION (HSI) AND OPERATIONS RESEARCH (OR)

Both the topic and outline of this thesis deviates some from the typical HSI thesis. No previous NPS HSI (or Operations Research) thesis has taken on the theme of creativity.[1] Also, unlike the majority of NPS HSI theses, it does not aim to define or refine the HSI process, nor does it seek to demonstrate how aspects of a problem pertain to or influence the understanding of particular domains of HSI. Hence, an orientation on how the topic pertains to the study of HSI is in order.

First of all, the reader should be left with an understanding that creativity, as with HSI, is a mindset: a way of thinking about human performance. Both creativity and HSI are holistic approaches that place human performance in their center—HSI in the broadest sense, creativity in a more focused sense. In the literature review, the HSI practitioner will recognize the importance of individual factors, team performance, and organizational behavior, as well as the presence of complex interactions in human systems and tradeoff decisions necessary to produce innovative products. With this in mind, it should be evident that creativity can be seen as a product of good HSI. Efforts in the domains of manpower, personnel, training and human factor engineering can produce creative behavior as a primary outcome. The methods described in Chapter III reveal a methodology familiar to the HSI mind: the case study. HSI recognizes the value of

[1] This statement is based on a search of the Calhoun database of NPS publications, accessed May 12, 2015. A search within the HSI department of all publications that some way or another include the word "creativity" obtained seven publications, "innovation" obtained six, "creativity AND innovation" four. These were publications only mentioning the words; none of the publications treated creativity or innovation as research topics. An expansion of the search to the entire Operations Research department yielded the following results: "creativity" 34 results, "innovation" 101 results, "creativity AND innovation" 10 results. None of these results had the word *creativity* in the abstract, whereas five mentioned innovation in the abstract (without treating it as a topic on its own). The results are not adjusted for the presence of duplicates.

separately studying influential, unique, rare, or complex events in case studies. The case studied in the subsequent chapter reveals how creativity in certain HSI domains can result in improved total system performance. The discussion amplifies an understanding of how human performance (creativity) is achieved in a military system. Lastly, the conclusion demonstrates how creativity and innovation can take HSI forward, and that the study of creativity and innovation in the context of a military system is a study of HSI.

Second, the reader should be left with an appreciation of the power of observational research and theory-driven qualitative analysis. Creativity and innovation arise spontaneously in uncontrolled, naturalistic environments. They are rare and must be uncovered using qualitative inquiry and analysis. Creativity resists experimental manipulation, random assignment, and the quantitative rigor of the methods that dominate the Operations Research curriculum. The case study methodology used here fits the domain of study far better than quantitative analytic techniques. As such, this thesis departs from the typical OR thesis template. Case studies are not uncommon within OR, but OR case studies typically examine phenomena were casual effects are well defined and quantifiable, historical data are available. Two examples illustrating such studies are a case study using historical maintenance data (e.g., failure rates) of a particular type of pump to better understand the wider field of age-replacement policies (Gaver, Jacobs, & Dudenhoeffer, 1997), and a case study using algorithms from search theory to develop a model of the deployment of assets during Maritime Interdiction Operations (Kress, Royset, & Rozen, 2012). Historical, numerical data and established algorithms are rare in the field of creativity research. In time, once additional case studies of creativity and innovation in the military have been conducted, a meta-analysis will likely apply more traditional OR methods to uncover the factors that enable and inhibit creativity and innovation in the military.

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II. LITERATURE REVIEW

A descriptive case study uses a theoretical framework to describe and examine a phenomenon. The framework guides the collection and interpretation of the data from the case study, and provides a means to communicate the results. The review of creativity research in this chapter provides that framework. To strengthen their argument, case study researchers use theory triangulation (Stake, 1995). Herein, multiple theories and perspectives are used to shed light on creativity and innovation in the Navy from different angles.

The discussion of the many ways to define and measure creativity and innovation tells us that every interview subject may have his or her unique understanding of what creativity and innovation mean. It also reveals the importance of using very precise terminology when communicating the results.

Four theories collectively form the foundation for the interpretive framework applied in Chapter IV. The four theories are the dialectic approach, process view, investment theory, and factor theory. Batey's model of creativity is the overarching model that visually ties the four theories together.

Scholars of the dialectic approach to creativity observed that some factors exhibit both a positive and negative relationship to creativity and innovation. The process view interprets creativity and innovation as a stage model with sequential phases, while the investment theory implies that there is a cost associated with being innovative. Both the process view and investment theory provide additional perspectives on why creativity and innovation have dialectic properties.

Factor theory is the fourth cornerstone of the foundation. It suggests that factors related to creativity and innovation can be found at many levels: at the individual, team, and organizational levels. Finally, Batey's (2012) model of creativity pulls the framework together, and is presented as a heuristic to interpret the data. Having a theoretical framework is useful to inform observations and interview questions, to interpret the data and to communicate the results. As such, this study aligns with traditional case study

methodology which relies on interpretive frameworks for a theory relevant description of the case. The novelty of this thesis' approach is to bring the theories described herein together when analyzing a case of military innovation.

A. MILITARY INNOVATION

The Navy wants creative and innovative sailors. The Secretary of the Navy (SECNAV) wants to promote innovation, but sees a large organization growing increasingly dependent on bureaucracy and processes that impose barriers on creative individuals within an American culture of innovation (Navy Office of Information, 2015). But what does the SECNAV mean by creativity and innovation? How are those terms understood? Will the Navy be able to recognize them when they see them, and where should the SECNAV start to look?

In this thesis, the literature's foremost contribution is to offer a common language with which we can examine creativity and innovation in the case study and add to the insights of others. This chapter offers a review of literature that will hopefully help readers broaden their understanding of creativity and innovation. It concludes by proposing a model that can be used to apply that understanding to military cases.

First, the chapter introduces military innovation studies to demonstrate how creativity research and military innovation studies have parted. Then follows a discussion of creativity and innovation and how these terms have been defined and measured. Following an introduction to four of the dominant theories of creativity and innovation, a framework is presented. This framework brings the four theories together and provides a language that can be used to better communicate the findings from the case study.

While working with U.S. Army Air Corps pilot selection during the Second World War, J. P. Guilford (i.e., the "founding father" of creativity studies, and later president of the American Psychological Association) discovered that pilots selected for their ability to think out of the box survived more missions. Guilford initially selected pilots who gave the right answer to how to act when facing a certain threat, while, in contrast, a colleague of his deliberately selected pilots who answered more creatively. When examining later survival rates, Guilford found "his pilots" were the ones shot

down. His pilots had answered correctly according to the manual and their training, but by doing so they proved predictable and unable to improvise their way out of a dangerous situation. The training and selection had failed to predict enemy reactions to the behavior the training had produced. Guilford went on to change the selection criteria such that creativity was rewarded as a desired human attribute. Creativity, or the ability to think out of the box, was established as a criterion for survivability (British Broadcasting Corporation, 2013).

Though frequently cited in non-peer-reviewed media, this anecdote demonstrates that there was indeed a military presence in the field of creativity at the early stage of modern creativity research. Guilford served as a Colonel in the Army Air Corps and was Director of Psychology Research Unit 3 during the Second World War, conducting research on personality and pilot selection (Comrey, 1992; Flanagan, 1948).

As one would expect, the field of creativity research has progressed tremendously since then. Numerous articles have been written in both dedicated journals (e.g., the *Creativity Research Journal* and the *Journal of Creative Behavior*) and peer-reviewed journals of related fields (e.g., the *Journal of Applied Psychology* and the *Journal of Management*). Nonetheless, research on creativity from a military perspective rarely appears.

Published literature on creativity in a military context is generally limited to articles that either describe single instances of innovative thinking (e.g., Goulding, 2011) or that call for creativity to receive more attention in military training (van Echo, 2009). Some are historical narratives studying doctrinal development and the environment in which an innovation took place (for example Stirrup, 2005; Terriff, 2006). As discussed by Grissom (2006), the military innovation studies describe well the influence of cultural factors like bureaucracy, rivalry, and competition on innovation, but seem unaware of experiment-based creativity research that builds on Guilford's psychometric approach.

Peer-reviewed research touching on both creativity and a military environment is usually not centered on creativity itself. More often, creativity is in the periphery of another construct. For example, in *Cognition in the Wild*, Hutchins (1995) examined the

case of a Navy navigation team onboard the USS *Palau*. As he learned about the relationship between culture and cognition, he also learned how the team, when under considerable pressure, innovated and adapted to an emergency situation.

The narrow focus of military innovation studies makes it difficult to generalize their findings to the broader field of creativity and innovation. In a state of the art review of military innovation studies, Grissom (2006) suggested that military innovation can be defined as "a change in operational praxis that produces a significant increase in military effectiveness' [sic] as measured by battlefield results" (p. 907). This definition is so narrow that it might not be useful for our case study. It excludes not only creativity and innovation studies outside a military setting, but also military studies where direct effects on "battlefield results" cannot be measured.

While the creativity research drinks from a well of knowledge shared by the fields of psychology, neuroscience, organizational behavior, education, management, and so forth, the authors of military innovation studies develop their own theories, concepts, and underlying factors to explain innovation in historical military cases. For example, Foley (2012) deemed it necessary to define innovation as either a horizontal or vertical process. Further, Foley made no reference to studies outside the sphere of military strategy to support his claims about horizontal innovation. By failing to draw from other fields, military innovation researchers risk becoming stove-piped and uncreative. To borrow West's (2002) words, their lack of diversity and knowledge sharing may leave them as stagnant ponds rather than sparkling fountains of innovation.

B. DEFINITION AND MEASUREMENT

Because case studies often collect data with high variance, multiple perspectives are required for the subsequent interpretation and validation of the data. Multiple perspectives provide strength through triangulation. Consequently, this thesis needs to be able to interpret many different respondent views on how creativity and innovation can be defined and measured. The existence of multiple views on creativity and innovation reminds us about the need for precision in communicating the results.

Most of the literature reviewed holds that creativity can be defined as the generation of novel and useful ideas, while innovation is the implementation of those ideas (e.g., Bledow et al., 2009, p.305). Treating the two terms separately enables the discussion of how some factors may behave differently depending on whether their effect on creativity or on innovation is measured. For example, West (2002) proposed that external demands influence innovation positively and creativity negatively. Creativity has also been suggested as the first step and a necessary, but not sufficient, stage for innovation (Amabile et al., 1996). This perspective supports the creation of measurement scales like Amabile et al.'s KEYS (1996) that measure factors proposed to affect only creativity but that are still valid scales for addressing the potential for innovation.

Nevertheless, treating creativity and innovation as two separate stages does not exclude the fact that innovations can be based on ideas from outside the unit of analysis, so-called "open innovation" (Søndergaard & Burcharth, 2011), or that successful implementation often relies on creative attributions throughout the innovation stage. The launch of the Post-it is one of many examples of the latter (West, 2002). The notion that creative idea-generating activities go hand-in-hand with innovative idea-pursuing activities (exploration vs. exploitation), implies an iterative process more complex than the two-stage creativity—innovation process. Process views on innovation (e.g., Cropley & Cropley, 2012) have been used to better explain that complexity. Anderson et al. (2014), on the other hand, suggested using a definition that includes both creativity and innovation in an effort to resolve inconsistency in how researchers approach creativity.

Although most researchers agree on the novelty and quality definition of creativity and the exploration versus exploitation viewpoint, the differentiation between creativity and innovation has led to different operationalizations of the terms (Anderson et al., 2014). Some choose to differentiate between "big C" (radical, life changing ideas) and "small c" (everyday improvements) creativity. Other researchers argue that innovation includes incremental improvements whereas creativity can only be something completely new. Some assume clear boundaries between innovation and creativity as opposed to a cyclic process. The different viewpoints, together with differences in context (from school children to Michelangelo) and levels of abstraction (from brain cell

to western culture), have resulted in a variety of measurement approaches of varying quality (Amabile et al., 1996; Anderson et al., 2014; Batey, 2012).

Many studies[2] still rely on self-ratings, a measurement method that, not surprisingly, may be less valid than more objective methods (Sundstrom, McIntyre, Halfhill, & Richards, 2000). A majority of researchers use context-specific measurement scales (Anderson et al., 2014). Other subjective, but still popular, measurement scales are peer-review and expert judgment, both prone to biases (Batey, 2012). If available, expert opinions and even quasi-expert opinions are assumed to be useful (Kaufman & Baer, 2012), but experts often go wrong (e.g., contemporaries' judgment of van Gogh) and are no better at forecasting the future than the rest of us (Kahneman, 2011).

When assessing five measures for team work climate (hypothesized to greatly affect creativity and innovation), Mathisen and Einarsen (2004) found only two to be of "acceptable scientific quality": the TCI and the KEYS measurement scales. Moreover, as Runco and Acar (2012) found with measures for divergent thinking, the scales measure traits thought to be associated with creativity and innovation, and not creativity and innovation *per se*.

Objective measures should be less prone to bias and halo effects (DeChurch & Mesmer-Magnus, 2010), but they might not provide the whole picture. For instance, the much-used Unusual Uses Task (UUT) measures only the novelty and originality of ideas while disregarding the quality part of creativity. Baird et al. (2012) used the UUT to assess whether creativity is improved by engaging in tasks that maximize mind wandering. Incredibly, the researchers could show that by allowing the mind to wander participants became more divergent according to the UUT scores. However, when Baird et al. equate UUT and creativity they ignore that creative ideas must also be useful and purposeful. Paint randomly thrown at a canvas may create a highly unusual and original

[2] According to Anderson et al. (2014), 45 % of creativity and innovation studies rely on subjective measurements (24% of studies at the individual level, 7% for team level studies, and 14 % of multi-level studies).

picture, but without being purposefully created to convey a message it is not a creative work of art.

The inconsistency in measurement has been used to discount their validity and to justify disregarding their findings. Paulus (2000) presented consistent findings of lowered effectiveness for idea generation during group brainstorming sessions, compared to results achieved by the summing of individuals' contributions. Sawyer (2007), however, discounted these findings by claiming that they were only true because the type of ideas measured in laboratory experiments are overly simplistic compared to real-life design challenges where group collaboration is essential. Klijn and Tomic (2010) went so far as to "conclude that there is a methodological obstacle to objectively measure creativity" (p. 336) since the measurements were subjective and situational. They also objected to analyses of creativity based on laboratory experiments, arguing that work in a laboratory setting necessarily lacked ecological validity.

Dewett (2007) critiqued researchers' reliance on subjective measures of creativity as the dependent variable and of the independent variables thought to predict creativity. His report serves as an illustration of how measurement and definition inconsistencies raise obstacles to measuring creativity and innovation objectively. In a study of employees of a U.S. research and development (R&D) organization, Dewett used self-report measures (surveys) of intrinsic motivation and willingness to take risks to predict creativity. Creativity was measured by subjective supervisor ratings and objective measures such as patents, papers presented, and awards received. In this mixture of subjective, objective, self-reported and peer assessments, Dewett was surprised to find big differences between the subjective and objective scales. Subjective supervisor ratings supported previous findings, using similar scales, on the importance of intrinsic motivation to creativity. In contrast, objective measures did not show the same positive relationships between intrinsic motivation, risk taking, and creativity. Dewett argued that subjective measures may not be a valid measure of creative end products useful to an organization, but leaves it to future research to establish valid objective measures. Without saying so explicitly, he also left it to future research to establish if the inconsistencies he reported can be attributed to a divergent level of analysis. The

subjective measures assessed creativity at the employee or individual level, while the objective measures can be said to have assessed either creativity, innovation, or just productivity at the organizational level.

The impact of the inconsistencies in measurement is that creativity and innovation in a real-world scenario is context dependent and may be difficult to assess objectively. The only visible aspects of creativity and innovation may be factors (e.g., team knowledge diversity) assumed to be related to either of the terms, as opposed to having an objective, quantifiable and context-free scale that provides a direct measure of creativity or innovation. This is not to say that we should let ourselves be entrenched by the, in our case, military context, and not look to other disciplines for insights. It merely implies that we need to approach both the data and our interpretation with sound skepticism and caution. The case must be assessed with knowledge of the measurement inconsistencies. Furthermore, while this thesis uses the definitions of creativity as the generation of novel and useful ideas, and of innovation as their successful implementation, their close relationship and dependency signifies the need for consistency and preciseness when they are being addressed.

C. THEORIES AND PERSPECTIVES

The dialectic approach to creativity, together with the related concepts of process view and the investment theory, form three of the cornerstones of the theoretical framework in the case study.

1. The Dialectic Approach to Creativity

New ideas move the society forward, but before they are accepted and implemented as current practice, they are fought fiercely. The dialectic approach addresses this tension. It implies that conditions and characteristics needed for innovation may be seen as contradictory. Familiarity with this view allows us to see beyond those contradictions, and instead of becoming bewildered when finding evidence pointing in what appears to be different directions, we can keep a steady course towards understanding creativity and innovation.

There is a paradox in creativity. As outlined in the investment model, the creative process introduces new ideas to adjust current knowledge in a thesis, antithesis and synthesis model. A creator, team or leader needs to be able to both use his divergent thinking skills in generating new, useful ideas, and to use convergent thinking to be able to realize and sell the product or idea to an audience still getting by on old, established beliefs. Thus, the creative process has a Janus head. Seemingly there are multiple, and at times conflicting courses that lead to innovation. This gives rise to the concept of creativity as a dialectic process; evidence of the dialectic can be found in creativity research on culture, neuroscience, and psychology (Holm-Hadulla, 2013). For example, from a psychological point of view, the dialectic is to find a balance between convergent and divergent thinking, open-mindedness and sharp focus. There is a need for knowledge and intelligence, but not too much knowledge or intelligence (Runco, 2006). There is a need for pressure, but not too much pressure, and there is a need for diversity, while maintaining unity of effort (Hennessey & Amabile, 2010; Paulus, 2000).

In neuroscience, even more signs of the duality have been found. Neuroscientists have found that the brain operates in both an externally focused, goal-directed mode, solving problems by the use of known patterns, and an exploratory, diffused, default network mode where novel connections and spontaneous thoughts are generated (Andrews-Hanna, 2012). Although researchers of creativity often show special interest in the prefrontal cortex of the brain, i.a., required for cognition, (Runco, 2006), from a physiological standpoint, creativity cannot be localized in one particular brain region. Certain aspects of creative behavior may activate particular brain regions, but in general, during idea generation, dynamic networks combining many different regions are formed (R. E. Jung, Mead, Carrasco, & Flores, 2013). The entire brain is active when engaged in creative problem solving. During the creative process, an increase of new neurological connections between various brain regions is observed. The creative process recruits resources from different regions of the brain, associating and connecting them in new ways to come up with novel solutions (Sawyer, 2011). In innovation, there is an obvious need for focused thinking and decision making, yet more creative ideas are formulated when an individual is allowed to take his or her focus off the problem for a while, and

then later return to the problem. Mind wandering, or incubation, has been found to have a positive effect on idea generation (Baird et al., 2012).

Holm-Hadulla (2013) extended the dialectic model to cultural views on creativity, arguing that creativity can be viewed as the classic struggle between order and chaos. Creation is to create light from nothing; to find inspiration for an artistic masterpiece in the terror and destruction of Guernica during the Spanish Civil War; or, from the structured order of quantum physics, to create ultimate destruction. Creativity is the ability to see order in chaos, and the ability to deconstruct an orderly system, only to rearrange the pieces in a new composition that brings new insight and wisdom. In more practical terms, the dialectics of creativity and innovation can be examined with the aim of identifying management practices to address tensions resulting from at times conflicting demands. With these tensions in mind, Bledow et al. (2009) reviewed organizational and management research to come up with principles that support innovation management.

Tensions of innovation exist at the individual, team and organizational levels (Bledow et al., 2009). Common sources of tension are: organizational conformity and stereotypes versus open-mindedness and change, the need for discussion and challenging viewpoints versus streamlined effectiveness, and communication issues between exploratory and exploitative activities. Several management strategies have been suggested to overcome these tensions. Among them are dialogue and communication, separating activities/departments (e.g., Research & Development and Marketing) while integrating them at higher levels, diversity and variability integrated by higher level leadership, openness to diversity and challenging viewpoints, situation-dependent and proactive leadership, and a flexible company vision (Bledow et al., 2009). While these approaches are not evidence-based success recipes for management, they can be used to identify possible areas of tension, and potential strategies for addressing them.

When examining the case at hand, the dialectic approach to creativity may help to explain seemingly conflicting findings or tensions between goal-directed behavior and more exploratory, idea-generating behavior in individual sailors, teams, ship departments, the leadership, or the Navy as a whole.

a. Process View of Creativity

The paradox or dilemma of creativity may be easier to grasp when creativity is separated from innovation, or when a more detailed process of the movement from idea to product is described. West (2002) made the distinction between creativity as idea generation on the one hand, and innovation—in which an idea is implemented—on the other hand. He suggested different or competing drivers needed in each phase for the idea to be both generated and implemented. As an example, external demands or pressure may inhibit the creative generation of new ideas, but may serve to encourage and motivate idea implementation. West proposed that team innovation is dependent on different factors that may compete or have an inverted u-shaped relationship to each other, but they all contribute to the overall level of innovation.

Team diversity is one factor found to contribute differently to the idea generation phase and the innovation phase. A diverse team is regarded as instrumental to idea generation, but how diverse can the team be before the mental models are no longer shared among the members, or before conflict inhibits the process from moving forward? Sometimes it might be necessary with military effectiveness, uniformity, and unity of effort to get the idea through, but pressure to conform and group thinking may moderate the novelty of that idea (Lau & Murnighan, 1998).

The use of stage models is well established in creativity research. Guilford (1950), for instance, described Preparation, Incubation, Inspiration, and Evaluation/Verification. Cropley and Cropley (2012) extended the process view to include not only creation and innovation, but also Preparation, Activation, Generation, Illumination, Verification, Communication, and Validation. These seven phases were constructed to encompass all the nuances in creativity and innovation, and thereby address all the tensions described by Bledow et al. (2009). By studying the phenomenon in such detail, the dialectics of creativity are managed by assigning competing factors, for example, convergent versus divergent thinking, to respective phases. Moreover, the four Ps of creativity (Person, Process, Press, and Product) can be studied in terms of each phase. An organization's creative potential can be analyzed down to the individual's needs based on psychological factors contained in the four Ps. Nevertheless, a model with such resolution may miss the

big picture. Will an organization be able to clearly distinguish between the different phases, could they occur simultaneously, and are these phases an accurate description of how every organization innovates?

An innovation process would most likely have to be tailored to its organization. The detailed information required for an analysis by Cropley and Cropley's seven stage process may not be easily accessible. The more simplified, general view of creativity and innovation as the two only stages of the process may prove to be more useful in this time-limited case study. Nevertheless, recognizing the existence of separate needs during different stages of the process may improve the understanding of the conditions which promote or inhibit creativity and innovation. If paradoxes or tensions are found during the case study, a process view could be helpful to form a clearer picture of the situation.

b. Investment Theory

The investment theory of creativity states that creativity is to make the choice to defy old thinking and accept the risk (or cost) of being seen as unconventional (Sternberg, 2006). As the third part of the theoretical framework, investment theory advocates interpreting the data in light of the risks and challenges that arise when defying old thinking.

The role of creativity is to question and defy common knowledge. As such, creative ideas can be understood as the antithesis that questions established beliefs. If intelligence is defined as the current *modus operandi* (i.e., the way in which society is currently thinking, the thesis to which we anchor our beliefs), creativity suggests a new direction that will eventually result in wisdom (i.e., the synthesis of the old and the new knowledge) (Sternberg, 2001). An intelligent suggestion will add quality to a current system, but without creativity, the solution will lack novelty; eventually, the system will experience stagnation. Hence, both creativity and intelligence are desired. From the point of view of investment theory, to advance an idea from its generating to implementing stage requires three types of skill: synthetic, analytic, and practical. If the entire innovation process is laid in the hands of one individual, he or she would need to be as curious and divergent as a multitalented artist, while also being calculating like an

engineer, focused like the stereotypical drill sergeant, and persuasive like the most talented salesman. These conflicting traits are necessary because creativity is to choose to challenge current tradition, and creative individuals and groups must expect their initiatives to be attacked by those still rooted in old belief systems. The less radical the idea (that is, the closer to current intelligence), the less resistance should be expected.

An innovation can then occur only if the investment is worth the risk. A low risk environment can be created by not letting an organization be entrenched in current knowledge, but by lowering the bar for new suggestions and outside knowledge and "selling" the idea effectively. Innovators onboard USS Nimitz may have consciously or unconsciously used this strategy.

Investment theory suggests that when interpreting the data from this case study, we should consider how radical the idea was perceived by the crewmembers onboard. Consequently, it is important to also consider the potential measures that were taken to make the idea appear less radical, and to mitigate the perceived risks of its implementation.

2. Factor Theory

The Factor Theory of creativity is the fourth cornerstone of the theoretical framework's foundation. It emphasizes that factors related to creativity and innovation can be found at the individual, team, organizational, and cultural levels. This perspective stems from earlier, largely psychometric creativity research aimed at understanding the traits and states of the individuals. The research was performed within the framework of 4 Ps: person, process, press, and product. A significant leap forward was taken when the perspective was expanded to include teams, organizations, and cultures (Anderson et al., 2014). The notion that different factors exist at different levels of abstraction implies that (1) it is valuable to examine interactions across levels and (2) creativity and innovation may be understood as an emergent property from a system of interacting subsystems of organizations, teams, and individuals. Factor theory can benefit the case study by offering a view of the ship as consisting of layers of individuals, team, and organizations within

an even larger organization. Each layer has unique attributes worthy of separate examination. This section investigates each of the four levels in turn.

a. Individual Factors

Guilford (1950) understood creativity as a matter of human personality: the "pattern of traits that are characteristic of creative persons" (p. 444). In his vision, the aim of creativity research should be to identify the traits belonging to creative individuals, and subsequently, to design appropriate measures to quantify them. A basis for the selection and training of creative individuals can be established once a test can reliably identify traits associated with creativity. Torrance (1965) took a similar perspective in investigating individual traits associated with creativity and hypothesized promotion of the traits by proper education.

The research approach Guilford and Torrance outlined is centered on an individual's abilities, temperament, and his or her intrinsic motivation to continue exploring. The underlying assumption is that creativity is a state that can be improved by training and a trait that a few creative geniuses possess in great quantity. The left-hand column of Table 1 presents the traits Guilford hypothesized as characterizing creative people.

Table 1. Individual Factors of Creativity (data from Guilford, 1950; Sternberg, 2006)

Individual Factors, From Guilford to Sternberg	
Guilford's traits	**Sternberg's resources**
1. Sensitivity to problems	1. Intellectual skills
2. Ideational fluency	2. Knowledge
3. Flexibility of set	3. Thinking styles
4. Ideational novelty	4. Personality
5. Synthesizing ability	5. Motivation
6. Analyzing ability	6. Environment
7. Reorganizing or redefining ability	
8. Span of ideational structure	
9. Evaluating ability	
10. Motivation and Temperament	

The human trait perspective enables the measurement, selection, and training of creative individuals, but even Guilford's pilots operated within a squadron. Purely focusing on individuals may overlook the larger organization and environment in which the individuals operate. Unless our emphasis lay on the "lone creative genius," the research needs to consider a broader perspective. There is perhaps an irony in the way that Guilford recognized the importance of promoting creative traits, but did not recognize the organizational impediments to creativity designed into the selection process he was using.

More than 50 years later, Guilford's footprints are still visible in creativity research. Scholars have built on, and gradually expanded his mostly psychometric foundation. In a later model, Sternberg (2006) maintained the focus on creative individuals, but expanded the understanding of the subject by adding environmental

factors, and stating how the different elements/traits may influence each other (see Table 1). As in systems theory, the whole is more than the sum of its parts. For example, differences in motivation and environment influence the intellectual skills of personality types needed to be judged as creative.

In reviewing the most recent research on the effect of individual traits and states on creativity and innovation, Anderson et al. (2014) did not find a definite answer to the earlier research's (ref. Guilford) quest for defining the "right" individual factors promoting creativity. Context, type of innovation, and definition of the subject (e.g., creativity vs. innovation) influence the predictive value of the various individual human factors measured. "The relation between personality and creativity is complex, which is shaped by contextual variables" (Anderson et al., 2014, p. 1303).

In a quest to find which personality dimension, leadership style, knowledge, and abilities an organization like the Navy should consider in order to recruit, retain, and promote creative and innovative individuals, the answer might be this: It depends. "In other words, this body of work is especially difficult to decipher"—(as Hennessy and Amabile [2010, p. 77] expressed it in regard to the relationship between creativity and individual differences and personality). Klijn and Tomic (2010) supported the same view. With regard to personality dimension, they claimed that "employers who select employees for creative behavior based on perceived personality traits have not had much success" (p. 329). In terms of divergent versus convergent thinking style, "the most appropriate heuristic depends on the type of question or the problem to be solved" (Klijn & Tomic, 2010, p. 330).

One can only conclude that the effect of individual factors seems highly dependent on the situation, context and work environment within which the innovation is supposed to take place.

b. Team/Groups

By expanding the viewpoint to team, group, or organization, we are able to address the work environment's influence on the individual's creative or innovative effort. Amabile et al. (1996) argued that creativity and innovation are a result of

individual team members' intrinsic motivation: "People will be most creative when they are primarily intrinsically motivated, by the interest, satisfaction, and challenge of the work itself" (p. 1158). Intrinsic motivation—an individual trait—is influenced by team factors and/or pressure from the environment.

Amabile et al. (1996) understood creativity as idea generation, and suggested that creative ideas are the foundation for innovative products. To capture their insights about the link between intrinsic motivation and creativity, Amabile et al. designed the KEYS creativity scale. The scale, Table 2, measures individuals' perceptions of factors in the social work environment.

In a related effort, Anderson and West (1998) aimed to identify and measure factors in the team climate hypothesized to promote innovation. Anderson and West considered the implementation of ideas, and took an approach that looked at both the traits of the individual and the traits of the group itself. Based on their research, they designed the Team Climate Inventory (TCI) to measure factors in the team climate suggested to promote innovation. The TCI includes not only the individual in the team, but also characteristics of the problem to be solved, the skillset of the team as a whole (e.g., collaboration skills and shared knowledge), and group processes.

Both the KEYS and TCI are commercially available surveys intended to measure factors influencing creativity and innovation in a team's work and social climate. This case study—based on open-ended interviews—does not use the surveys directly, but the factors the surveys emphasize may surface during the interviews and are important indicators of a climate favorable to creativity and innovation.

Table 2. Team Factors (data from Amabile et al., 1996; Anderson & West, 1998)

Factors influencing the work environment	
KEYS	
1. Organizational encouragement	- Encouragement of risk taking and idea generation. Valuing innovation from highest to lowest level of management. - Fair, supportive and non-threatening evaluation of new ideas. - Reward and recognition of creativity. - Collaborative idea flow across the organization. participative management and decision making. Exposure to other ideas.
2. Supervisory encouragement	- Goal clarity. Open interaction between supervisors and subordinates. Supervisory support.
3. Work group support	- Team diversity, openness, constructive challenging of ideas, shared commitment.
4. Freedom and autonomy	
5. Sufficient resources	
6. Challenging work	
7. Workload pressure	- Excessive workload pressure. - Challenges.
8. Organizational impediments	- Internal strife, conservatism, rigid and formal management.
TCI	
1. Vision	
2. Participative safety	
3. Task orientation	
4. Support for innovation	

The perspectives offered by Amabile et al., (1996) and Anderson and West (1998) suggest that both group and individual traits are important to data collection and analysis, and that there may be interactions between the two. Both perspectives focus primarily on positive conditions for creativity and innovation. A favorable perception of the environment suggests that the individual is intrinsically motivated to innovate. Extrinsic

motivation is, on the other hand, said to undermine creativity and innovation, as it will, most likely, make the individual feel externally controlled. Nevertheless, rewards and instructions given under the right conditions have in some instances been found to positively impact creativity (Eisenberger & Rhoades, 2001; Eisenberger & Shanock, 2003; O'Hara & Sternberg, 2001). Similarly, perceived leadership expectancy has been shown to increase employees' creative results (Tierney & Farmer, 2011).

Paulus (2000) provided additional detail on group processes that undermine creativity. He suggested that social inhibitors and cognitive interferers inhibit the creative potential of groups. Paulus illustrated a darker side of team processes concerning creative productivity that complements the two perspectives focused on intrinsic motivation.

Table 3. Inhibitors of Creative Potential in Teams (after Paulus, 2000)

Inhibitors of Creative Potential in Teams	
Social Inhibitors	**Cognitive Interferers**
Social anxiety	Production blocking
Social loafing/free riding	Task irrelevant behavior
Illusion of productivity	Cognitive load
Matching and downward comparison	

Intrinsic motivation is an outcome of team and organizational behavior encouraging creative and innovative effort, i.e., the social environment of the workgroup. Almost two decades of research on the social psychology of creativity has led to the conclusion that despite the importance of a person's expertise and creative abilities, it is the person's intrinsic motivation that will have the most significant effect on creativity. In promoting creativity and innovation, this inner drive and curiosity is the factor that organizations can benefit the most from promoting, or, conversely, that they can lose by inhibiting (Amabile, 1998; Hennessey & Amabile, 2010). Therefore, factors regarding

intrinsic motivation are important to support the interviews held during the case study, and their subsequent analysis.

Creativity and the subsequent innovation can be seen as the sum of the positive effect of intrinsic motivation and the negative effect of pressure from extrinsic motivation as it is perceived by the individual. This thesis relies on the power of open-ended interviews to capture the individual sailor's perception of the motivating factors in his or her team climate.

Factors in a team's work climate, such as those measured by KEYS, were assumed to be a valid measure for organizations as well (Amabile et al., 1996). Similarly, Jung et al. (2008) found climate for innovation to be positively related to organizational innovation. Still, as the next section shows, when assessing a whole organization, there are more aspects to consider.

c. Organization/Culture

To understand the drivers and inhibitors of creativity, one may also choose to look at the environment at a macro level. Seitz (2003) included not only the individual's abilities, and work-domain, but also the social, institutional, and political forces that influence the process. Forces like corporate control, censorship, monopoly, economic interests, conformism, copyright, and protection of intellectual property may all inhibit creativity. The industries of Silicon Valley are prime examples of creative entrepreneurship. Seitz argued that in this environment ideas are exchanged freely in wide social networks. Bureaucracy and corporate hierarchies are kept as low as possible. The industries thrive in a social climate where cooperation and collaboration are common practice. They avoid the pitfalls of being entrenched in old thinking and tradition by engaging in a domain that is still open to new ideas and inventions. Furthermore, creative ideas from Silicon Valley inventors benefit from an ecosystem of risk-tolerant investors, nearby top universities, supportive infrastructure, and leading IT businesses. Both social and institutional/political structures are in place to promote innovation. With a sample of 50 Taiwanese electronic and telecommunications companies, Jung et al. (2008) found

similar traits to be positively related to innovation: namely, low formalization, low centralization, competition and a sense of urgency to get new ideas to the market.

Leaders of such organizations must facilitate communication, collaboration and knowledge sharing (Sawyer, 2007). Their leadership style should be characterized by their charisma, idealized influence, inspirational motivation, intellectual stimulation, and individual consideration: a transformational leadership style (Jung et al., 2008). Al though context-dependent, leadership behavior stimulates creative behavior (Anderson et al., 2014), and even perceived management support for innovation enhances creative climate scores (Isaksen & Akkermans, 2011). Leader qualities are essential to military organizations and the interviews with the leadership onboard the Nimitz are essential parts of this study.

Amabile et al. (1996) held that transactional leadership which defends the status quo and motivates through contractual agreements, is detrimental for creativity. This view is contrasted with transformational leadership which is thought to enhance both creativity and innovation "by encouraging followers to think 'out of the box' and to adopt generative and exploratory ideas and solutions" (Jung et al., 2008, p. 584). When testing this hypothesis, Jung et al. found evidence to support the claim that transformational CEO leadership is positively related to organizational innovation. CEOs with a more liberal attitude towards change are associated with more innovative organizations, while conservative CEOs are associated with corporations that emphasize quality over novelty (Musteen, Barker III, & Baeten, 2010). However, top management's effect on innovation is moderated by the socio-cultural context within which the leadership is performed (Elenkov & Manev, 2005). When national, socio-cultural differences are taken into account, there is no consensus about the impact of leadership style on organizational innovation, whether the leadership is transformational, transactional or corrective-avoidant. Leaders must manage conflicting demands (Bledow et al., 2009). Behavior that stimulates idea generation might not stimulate the same idea's implementation. To be innovative, organizations must pursue both the idea generating and implementing path. A dialectic approach may be the answer. Bledow et al. argued for the need for situation-dependent, proactive leadership that can overcome the tensions between conflicting

demands of creativity and innovation. An understanding of the cultural context needs to be added to that argument.

D. BATEY'S MODEL OF CREATIVITY

In an extensive review of creativity research, Batey (2012) suggested a comprehensive model to understand creativity (See Figure 1). Batey proposed that creativity could be understood by three dimensions. First, he observed that historically, the novelty and quality definition of creativity has been used when assessing the areas of Person, Process, Press, and Product: the four Ps of creativity. Secondly, there is the level at which creativity had been measured, and third, there was the approach taken to measure it. Creativity studies, he argued, typically measure a variable represented by an intersection of the three axes, such as self-rating of an individual's trait.

The model (see Figure 1) was illustrated by a three-dimensional cube where Level, Facet and Measurement Approach were represented by the *x*, *y*, or *z* axis. The *x*-axis represented the 4 Ps of creativity where "Person" was reworded to "Trait" to comply better with studies that used a level of analysis above the individual. Level, which were individual, team, organization, and culture, formed the *y*-axis. Finally, the *z*-axis represented the different measurement approaches creativity studies would take.

Batey presented the model as a heuristic to understand creativity research. It is heuristic because it may not be completely accurate, some factors may fit in more than one place of the model, and creativity may exist somewhere between the factors measured. The measured factor is only a construct related to creativity, not creativity itself. Creativity may be seen as the product of all the intersections in the model. This last point resonates with Hennessey and Amabile's (2010) conclusion that to understand creativity, a systems view must be taken. Factors found at all levels of abstraction contribute to the overall picture, and their combined effects and interactions are what ultimately shape the emergent properties of creativity and innovation (Hennessey & Amabile, 2010).

Batey's model brings the thesis' interpretive framework together. In this thesis, his model has been adapted to include the theories that were used for the case study

(Figure 2). Factor theory stands out as the most visible part of the model. In line with factor theory, Batey expanded the understanding of creativity to include not only individuals, but also teams, organizations, and even whole cultures. The dialectic approach, the process view, and the investment theory come into play as soon as we go below its surface, when we need an understanding of the data that goes beyond describing the presence of a factor at a certain level of abstraction. To illustrate, Holm-Hadulla (2013) made it clear that, dialectic tensions may exist at any level of abstraction, from culture to individual. At those levels, tensions may occur between for instance desired traits (e.g., divergent vs. convergent thinking skills) or different types of press (e.g., intrinsic vs. extrinsic motivation). Similarly, the investment theory may help in explaining why a certain trait was helpful to an individual during the innovation process, or why leadership encouragement (press) helped a team to advance their creative ideas into innovative products.

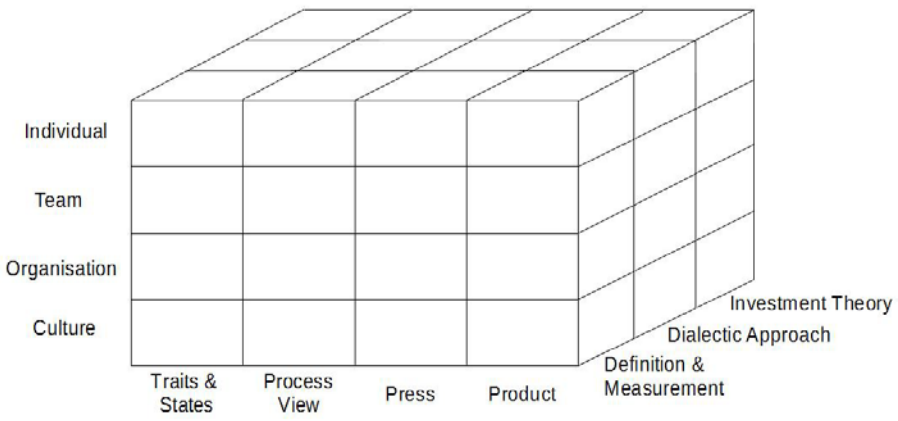

Figure 2. A theoretical framework based on Batey (2012)

Armed with clear definitions of creativity and innovation, this model was used as a rule of thumb to explore the case study. It represented a readily available anchor rooted in theories of creativity and innovation. Batey chose to illustrate the model as a cube. This cube can be held over the case as a loupe, and by adjusting the angle, different aspects of the case become visible. Can an incident from the case be understood as a

result of an individual trait, or, from another perspective, an organizational process? And are there signs of a dialectic process regarding that individual trait? By turning also to the measurement approach, are there reasons for being critical of the validity of what we measure?

E. CONCLUSION

At the beginning of this chapter, I presented the SECNAV's call for creativity and innovation, and asked if we actually understand the meaning of those words. With the perspectives offered by creativity research and a model with which to assess creativity and innovation, we are closer to that understanding. We know the conditions others have looked for in assessing creativity and innovation, and have a common language to discuss their findings.

The perspectives offered by military innovation studies are unique and interesting. This review is by no means an attempt to downplay their role, but instead strives to link cases of military innovation to a richer source of research. Bringing creativity research and military innovation together will provide more angles of approach and subsequently, a better understanding of the data from cases of military innovation. The framework of theories and perspectives offered in this chapter contributes to a more focused data collection and interpretation, more precise communication of the results and, eventually, an enhanced comprehension of the case of military innovation we are about to analyze.

Table 4 summarizes the theories and perspectives behind the theoretical framework by listing each theory together with an illustrative quote. The quotes are intended as a demonstration of how that particular perspective may surface during the interviews. The quotes put together illustrate how a too narrowly focused theoretical framework may miss valuable insights that are likely to appear during open-ended interviews on a case of creativity and innovation.

Table 4. Summary Table

Summary table of theories and perspectives in the theoretical framework
Definition and measurement "They had so many brilliant ideas; too bad none of them were implemented." "Do you think it is an innovation?" "Of course, our performance increased by 50%." "It wasn't very creative. I heard that idea had been tried before."
Dialectic approach "I want my crew to take the time to think and come up with new ideas." "I want dedicated, focused and hardworking sailors!" "She always sees things with a fresh perspective. It's good to have her on the team, but sometimes we just need to move forward." "It was amazing how much we achieved in so little time, but our solution wasn't exactly 'outside-the-box.'"
Process view "At first we were brainstorming and throwing ideas around, later the CO decided on a plan, and we set to work." "Some very creative ideas came up as we were implementing the project." "It felt like we were going back to idea generation."
Investment theory "It was a good suggestion, but we have always done it the way we do. There is no need for improvement." "I had to work hard to win them over." "It was an unpopular initiative at first, but when we got used to it, it made a lot of sense."
Individual Factors "He has got this amazing ability to come up with crazy ideas no one else has considered." "I'm very passionate about this; I really want to find a solution." "If it wasn't for Jones' expert knowledge, we would never have thought about that."
Team/Groups "We had a clear vision of what we wanted to achieve." "Everyone that was working on the project had similar background and experience." "We lacked the resources to do this."
Organization/Culture "The XO made it clear that we had to follow procedure." "In our department we always go by the chain-of-command." "When it's needed, we know that we can go directly to the leadership with our problems."

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III. ON CASE STUDY METHODOLOGY

A case study is "an intensive study of a single unit or a small number of units (the cases), for the purpose of understanding a larger class of similar units (a population of cases)" (Gerring, 2007, p. 37). For example, a study of a single ship can shed light on a navy. Every case study revolves around a bounded phenomenon to capture its inherent complexity and uniqueness, just as this particular case study revolves around creativity and innovation within the boundaries formed by the hull of the USS Nimitz. Setting the boundaries allows the case study to go deeper and in greater detail, and sets it apart from the broad sampling of correlation research.

Case studies should be familiar terrain for HSI practitioners. HSI is a field that recognizes the value of individual differences in human factors, the complexity of people interacting in the real world, and the insights that can be gained from the study of a single occurrence like an accident or a defense acquisition program. Here, the case study methodology is used in a descriptive manner to refine the understanding of conditions allowing for creativity and innovation on board U.S. Navy ships.

The case study methodology can also be used to generate and explore research questions or hypotheses, or to explain or illustrate established theory (Yin, 2009). Compared to correlational research, the methodology is also powerful in its ability to capture variability, handle a heterogeneous population, investigate rare instances, and identify causal mechanisms (Gerring, 2007; Stake, 1995; Yin, 2003). Validity is gained by the triangulation of data collected from multiple sources, and careful selection of a strong and relevant case (Gerring, 2007; Stake, 1995). This chapter discusses each of those points in turn, and shows why the case study methodology is appropriate and necessary for the research questions posed.

A. THE ROLE OF CASE STUDIES IN HSI

Case studies play an important role in HSI. In fact, the very first sources of information that Booher (2003)—in the Handbook of HSI—turns to for an explanation of the importance of HSI were the case of Three Mile Island and the case of the USS

Vincennes. The use of the cases demonstrates the explanatory power of such, fortunately, rare incidents. Their complexity and rarity make them unsuitable for large-sample-size cross-case analysis or a laboratory experiment. However, insights gleaned from case studies of these accidents can further advance the field of HSI.

To revisit *Cognition in the Wild*, in analyzing human behavior, "It is notoriously difficult to generalize laboratory findings to real-world situations" (Hutchins, 1995, p. xiii). If we are to study what Hutchins referred to as naturally situated cognition, the context cannot be ignored. A socio-technical system is embedded in a unique and dynamic environment. Consequently, the method of studying such systems should be able to capture that complexity. The reductionism inherent in traditional experiments considering a large population of cases might lead us to "eliminate the very phenomenon of interest in the process of simplification" (Hoffman & Woods, 2000, p. 1). The "complex conglomerate of interdependent variables" from socio-technical systems studied in their context is not easily reduced to comprehensible interaction models (Hoffman & Woods, 2000).

The human factors domain also emphasizes the need to study individuality and complexity before generalization: "As a result, in human factors we are faced with the problems of trying to arrive at generalizations about organisms whose structures are only approximately delineated and whose mechanisms are imperfectly understood" (Chapanis, 1996, p. 144). Even in the easily measureable field of anthropometry, there is no "average" person. When more than two measures of bodily dimensions are taken, the variance is too widely distributed for the average value to be useful (Chapanis, 1996). Accordingly, cases must be examined on an individual basis.

Hutchins (1995) demonstrated how an observation-based case study is able to capture the complexity of the Navy as an organization, the interactions among the navigation team, and an unexpected emergency situation. This is the power of case studies and fieldwork in the domain of human factors. In the study of human cognition and workplace collaboration (also known as cognitive task analysis [CTA]), fieldwork and case studies based on document analysis followed by field observations, interviews and critical incident analysis are the researcher's method of choice (Clancey, 2006;

Committee on Human-System Design Support for Changing Technology, Mavor, & Pew, 2007; Hoffman & Lintern, 2006; Hoffman & Woods, 2000). CTA acknowledges the need to move away from artificially constructed laboratory situations with students as research subjects, and instead study domain experts in real-world settings (Hoffman & Lintern, 2006). According to Clancey (2006), "Thus, a study of a work practice is actually a study of a setting; this context makes the observed behavior understandable" (p. 129), or according to Hutchins (1995), "Human cognition is always situated in a complex sociocultural world and cannot be unaffected by it" (p. xiii).

In the safety domain, case studies of single accidents are a natural foundation for insight and learning. For example, resilience engineering has been proposed to take the safety domain forward from its predominantly linear cause–effect view of accidents and mishaps (Hollnagel, Woods, & Leveson, 2006). In a review article on resilience engineering, Madni and Jackson (2009) cited case studies of 13 mishaps and accidents[3] to explain concepts of resilience engineering theory. The concepts were used to build a framework of resilience engineering. According to the authors, the study of cases is key to developing design methods to engineer more resilient systems. That is, to "enhance the ability of organizations to explicitly monitor risks, and to make appropriate tradeoffs between safety levels and production and economic pressures" (Madni & Jackson, 2009, p. 181). "Analysis of past accidents … and case studies point to the need to explicitly manage risk continuously and throughout the system life cycle" (Madni & Jackson, 2009, p. 186).

B. PRACTICAL USE OF CASE STUDY METHODS IN AN HSI SETTING

HSI requires an understanding of the unique characteristics of the user/operator, situation, environment, and systems. Generalizable studies across systems or cases, or context-independent experiments do not provide precise enough answers: "Note, too, that

[3] The 2003 Columbia space shuttle disaster, the 1996 TWA Flight 800 aircraft accident, the 2001 9-11 attacks on the World trade center, the 2005 New Orleans flooding after Hurricane Katrina, the 1900 Galveston Hurricane, the 2000 Concorde aircraft accident, the 1969 Apollo 11 landing craft near mishap, the 2007 F-22 software failure, the 1994 Nagoya aircraft accident, the 1986 Challenger space shuttle disaster, the 1970 Apollo 13 mishap, the 1999 Mars Climate Orbiter mishaps, and the 1940 Tacoma Narrows bridge collapse.

generalizations will not suffice. What is required is specific and dependable answers" (Chapanis, 1996, p. 80).

In the HSI literature, some guidelines on the practical use of case study methods are given. They coincide with more general applications of case studies, and also guide the approach of the case study in this thesis. When discussing methods to assess human factors, Chapanis calls for the use of applied research with the objective of matching the problem to the operational situation, specific population, tasks and methods. The aim is to apply theory to real-world problems. Information gathering is done by interviews, observations, accident investigations, critical incident studies, activity logs, and scenario/environment descriptions. Also outside the HSI realm, interviews, observations, context descriptions, and document reviews are all essential case study methods designed to capture the complexity of a single case while paying attention to its context (Stake, 1995).

In HSI, as in general case study research, the interviews and observations are typically open-ended, and to compensate for the relative small number of samples, the most representative samples are investigated. Sampling is done by purposeful selection according to requirements generated by theory and from project objectives. Snowball sampling can be used to improve the representativeness of samples based largely on availability and convenience (Committee on Human-System Design Support for Changing Technology et al., 2007). In snowball sampling, the interview subject is asked to refer the interviewer to another participant who in turn refers the interviewer to yet another participant. The snowball steadily grows larger while ensuring representative samples.

Note the practical approach Chapanis (1996) takes. The research is used to make predictions about human-system performance, not to develop or evolve human factors theory. As a research method in general, case studies are used in a holistic, exploratory manner and are also used to develop and evolve theory (Yin, 2003). HSI can also benefit from the less "results-oriented" holistic nature of case study methods. Ethnographic principles and field work in HSI are used as flexible instruments to holistically explore a context or problem by examining in-depth a limited number of cases in a natural setting.

This approach is in contrast to less flexible quantitative, experiments in laboratory settings where variables are few and controlled. Engineers preferring a reductionist summary may feel challenged when trying to generalize from the ethnography's richness in detail (Committee on Human-System Design Support for Changing Technology et al., 2007). Case study researchers' answer to that challenge is to use a theoretical framework to support their observations (Yin, 2003, 2004).

Herein, theories from creativity research are applied to the need for innovations in the Navy as exemplified by the USS Nimitz. The use of theory makes the findings accessible and therefore relevant to other cases as well. Data were gathered primarily through unstructured, one-on-one interviews[4] with a selection of key personnel onboard the Nimitz. To ensure that the sample was representative, the snowball recruiting method was used. The participants included the ship's leadership, a sample of experienced petty officers from one particular ship division, and participants and facilitators of an innovation project initiated onboard (the Athena Project). Reports from previous NPS research on the Nimitz and observations made during that research provided valuable background and context descriptions, which are supported by two personal visits to the ship and 18 years of professional naval background.

C. TYPES OF CASE STUDIES

1. Descriptive

Case studies can be conducted in either an exploratory, explanatory, or descriptive manner (Yin, 2003). In this study, theories of creativity research are used as a framework to describe military innovation as it happened onboard the Nimitz. Following a descriptive case study methodology, the theory is used not so much to hypothesize about cause-effect relationships, but to scope the thesis, guide the data collection, and to present and describe the results in a manner relevant for the field of creativity research. Theory plays a critical role in a descriptive study. Without the theory, the case cannot be

[4] The data from the interviews are stored at the Naval Postgraduate School and can be obtained by contacting the Principal Investigator Dr. Nita L. Shattuck.

described in a logical, comprehensible manner. In a descriptive case study, theory is used to form an ideal model of reality. This model is then used as a lens to view and describe the case. The result is a case analyzed by established theories and frameworks, and insights that aid and broaden the understanding of both the theory and the case itself.

Few previous case studies of military innovation have adopted the theories of creativity research to describe the forces driving innovation. Consequently, the studies' relevance to the field of creativity research is fading.

2. Explanatory

In an explanatory case study, theory also plays a prominent role by being the foundation upon which the researcher builds a framework to guide data collection and generalize from the findings. In an explanatory case study, the case is used to illustrate a theory. Extensive data extracted from the case is used to support or test the complexity of the theory.

Madni and Jackson (2009) used case studies of accidents to illustrate and explain the concepts of resilience engineering. A more renowned example of an explanatory case study is the discussion of the Cuban Missile Crisis by Allison and Zelikow (1999). The authors use the crisis to explain three different decision-making theories: the rational actor model, the organizational process model, and the governmental politics model. Different aspects of the events surrounding the Cuban Missile Crisis illustrate the relevance of the three theories to the study of international politics. The innovative twist of that particular case study is that the three theories are in turn used to help explain why certain decisions were made during those very important days in modern history. This turn from an explanatory approach to a more descriptive one illustrates how case studies seldom reside solely within the boundaries of one of the three types of approaches, but are flexible enough to borrow from all three.

3. Exploratory

Exploratory case studies are designed to explore aspects of a case in preparation for a subsequent study. The objective of a case study, to learn more about a situation,

causes continuous revelation of important factors that inform and refine the premise of the study. It is not given that the mechanisms behind the phenomenon under investigation are so evident at the outset of the study that the research question can be fully defined upfront. The pilot study should, however, be followed by a separate study with a research design based on the findings from the pilot. The exploratory case study is not always published, but the need for such studies illustrates the cyclic relationship and the feedback loop between insights gained during the course of the study and the design of the study itself. The exploratory nature also demonstrates the importance of using flexible data collection methods such as open-ended interviews and observations instead of prefabricated surveys.

A renowned example of an exploratory case study is that of Middletown (as rendered by Yin [2004]). Its objective was to study the life of an average American town during the course of a generation. The researchers did not enter the town with expectations of possible findings, or with a clear conception of what (and how) they needed to measure. They wanted to record an observed phenomenon rather than to prove a thesis. Their findings inspired a later revisit, and, based on the study's seminal status in social science, numerous other related studies as well.

D. STRENGTHS/CHARACTERISTICS OF THE CASE STUDY METHOD

Field studies are often attacked by advocates of laboratory experiments. The study of a single case is said to be too specialized to add anything useful to the general body of knowledge (Hoffman & Woods, 2000). Likewise, the case study methodology in general is criticized for being purely qualitative when quantitative data are needed to construct generalizable prediction models (Gerring, 2007; Stake, 1995). The divide between purely applied research and clean, controllable experiments is, however, artificial. The case study methodology does not rule out the use of quantitative data. Any available data or information that can help build the case will be used. Consider the famous case study of Middletown. The wealth of information gathered both in selecting a representative town and in analyzing its inhabitants and context originated from not only observations and interviews, but also from statistical data and surveys (Yin, 2004). Similarly, whenever

possible, fieldwork includes the scientific principles of control, falsification, randomization and models to support the arguments (Gerring, 2007; Hoffman & Woods, 2000).

Still, the two research approaches—qualitative and quantitative—have different properties that must be considered when choosing the research design. Table 5 lists attributes most commonly related to case study research. The table is meant to demonstrate the tradeoffs a researcher must consider when choosing an appropriate research design. The table indicates where the case study method is typically strong, namely, because of its exploratory nature and consideration of multiple variables, in generating hypotheses. Testing a hypothesis, on the other hand, is often easier in repeatable and controllable laboratory conditions with few variables and little contextual influence, that is, if the context-deprived laboratory environment can be said to be representative enough of the real-world phenomenon.

Table 5. Case Study and Cross-Case Research Designs: Considerations (adapted from Gerring, 2007, p. 38)

	Affinity	
	Case Study	**Cross-Case Experimental Study**
Research goals		
1. Hypothesis	Generating	Testing
2. Validity	Internal	External
3. Causal Insight	Mechanisms	Effects
4. Scope of Proposition	Deep	Broad
Empirical factors		
5. Population of cases	Heterogeneous	Homogeneous
6. Causal strength	Strong	Weak
7. Useful variation	Rare	Common
8. Data availability	Concentrated	Dispersed

In this thesis, Gerring's (2007) research design considerations were used to support the decision to adopt a case study methodology rather than a cross-case methodology. Most important for that decision was that the thesis topic required using a research design that could address both complexity and richness in detail. The ability to have a deep scope, to address a heterogeneous population, and to examine a rare incident was preferred to an experimental cross-case design. The decision to adopt a case study approach was reinforced by relative weakness of cross-case designs at addressing situations where causal effects are difficult to identify and measure. Furthermore, when the research design was determined, internal validity became an important property. The following discussion provides more detail on the logic behind those decisions.

1. A Deep Scope and a Heterogeneous Population

A case study is used when there is a desire for a deep understanding of a question and the context of the selected case is given priority. Experimental analysis across cases typically provides a broad scope and generalization. In a case study, richness of detail and the ability to explain the sources of the variability are preferred to generalization. This tradeoff is made with the realization that the case population is heterogeneous. The study reported here was designed to capture individual differences by focusing on one instance of innovation rather than merging several different instances. The grey-painted ships of the Navy are not a homogeneous grey mass, and neither are their crews. They are individuals with unique characteristics and personalities that interact within a unique context. A case study is able to treat them as individuals.

2. A Rare Incident

When there are few available instances of a phenomenon, a case study is the preferred option. Unfortunately, creativity and innovation in the Navy are still one of those rarely documented events. Once a larger number of documented cases of innovation in the Navy becomes available, cross-case analysis will become more appropriate. This single case on the Nimitz provides one piece of the puzzle that might later lead to insights about the bigger picture.

3. Causal Insights

Studies of creativity and innovation in the Navy are rare and the data are complex. The data do not meet the assumptions of traditional experimentally-based hypothesis testing, and require case study methodology. Measuring causal effects is the strength of a quantitative study. Cross-case correlation research calculates the effect of different factors on a dependent variable, $y = a + bx$. Implicit in such a method is the assumption or knowledge of a causal relationship between y, a, and b. In contrast, identification of these causal mechanisms is a case study's power. Considerable research has been conducted on the mechanisms behind creativity, but there are still conflicting findings, the holistic systems view indicates complex interactions, and few studies have been performed in a military setting. Consequently, causal effects were not readily identifiable at the beginning of this study. The case study methodology was therefore assessed to be better suited to investigate creativity and innovation in the Navy than purely quantitative research methods.

4. Internal Validity

To provide relevant information about how innovation occurs in the Navy, it is important that the case study is strong in terms of internal validity. It must be able to provide a valid and credible description of the case in question. Identifying and interviewing key personnel on board was therefore essential. Personal interviews were able to capture the participants' individual stories. Their knowledge, background, and experience made this case study a trustworthy account of an instance of innovation in the Navy. In contrast, quantitative analysis of a survey of a broad, diverse population would likely average out much of the expected uniqueness.

E. CASE SELECTION

Once this analysis found that a case study is the preferred analysis method, it became important to identify a strong, representative case. A good case is one that provides opportunities for learning. Learning can happen only if the case catches the reader's interest (Stake, 1995). Table 6 shows the most common methods for case

selection. Apart from the two pragmatic aspects, a case that contains one or more of the characteristics in Table 6 should be able to catch interest and promote learning.

The decision to make USS Nimitz the unit of analysis was guided by the methods in Table 6, the desire for learning, and the more pragmatic reasons of case accessibility and data availability. The case selected in this thesis provides opportunities for learning because it is

- Typical: The Nimitz*'s* organization, training, tactics and procedures follow the same standards as all the ships of the U.S. Navy. It is representative of a Navy ship.
- Diverse: The complexity and size of the organization onboard suggest that it is a case that may be able to capture a high degree of variance.
- Extreme and deviant: The nature of a nuclear aircraft carrier may be seen as extreme and unusual compared to studies of creativity and innovation in civilian organizations.
- Crucial: The nature of a naval organization points toward the likelihood of the case to exhibit properties (e.g., hierarchy and bureaucracy) assumed to be crucial to creativity and innovation.
- Important: The SECNAV underlined the importance of creativity and innovation to the Navy. USS Nimitz being the first of class, and nuclear carriers' general strategic importance indicate that this is an important case to examine

Table 6. Methods for Case Selection

Methods for case selection	
Methods for representativeness (Gerring, 2007)	**Other methods**
Typical	Data availability
Diverse	Case accessibility
Extreme	Importance
Deviant	
Influential	
Crucial	
Pathway	
Most-similar	
Most-different	

F. DATA COLLECTION

A study of a real-world phenomenon (e.g., observations of the sun) can result in fundamental rejections of the most established scientific models (e.g., the geocentric worldview). Historically, it has proven more difficult to change established beliefs by referring to a phenomenon that is not easily observed in laboratory conditions or explained by formulae with only a few variables. To make a convincing argument, the data must be as robust as possible. Copernicus, Kepler, Galileo and others used (literally) triangulation of data from several sources, gathered over centuries, to build their arguments.

Similarly, a case study gets its strength from the triangulation of data (Gerring, 2007; Stake, 1995). Triangulation compensates for the small sample size inherent in a case study. Like a navigator constructs an accurate position fix from at least three intersecting lines of positions, a case study researcher establishes his or her position from the triangulation of different perspectives.

The primary method of data collection for this thesis was 11 open-ended interviews conducted in person, on Skype, and over the phone. Three distinct personas/archetypes emerged from the interviews: the Leader, the Petty Officer, and the Athena Sailor. The three personas saw the organization and interpreted creativity and innovation from very different points of view. Drawing the lines of position from these viewpoints provides our primary position fix. Nonetheless, for this triangulation to be a good position fix, it must take its bearings from reliable sources. The data points must be relevant to the case. In this case study, a snowball sampling technique was used to ensure relevant samples of participants.

Another strong position fix for this study is theory triangulation. Theory triangulation applies multiple, and sometimes even competing, theories to support and interpret the data (Stake, 1995). The different theories on creativity and innovation provide multiple viewpoints that strengthen the interpretation of the data from the case.

Further triangulation was possible by having access to both researchers and their reports from previous NPS research onboard the same ship. This provided valuable perspectives about the context. Context descriptions were further augmented by site visits and my own naval background.

G. CLOSING

This chapter has argued that the case study methodology is appropriate for the analysis of creativity and innovation in the Navy because of its ability to capture the complexity and uniqueness of human behavior in a real-world context. The rarity and heterogeneity of such a study in a naval context further strengthen the rationale for choosing a case study research design. This thesis is concerned with the case of USS Nimitz. The thesis uses a descriptive approach to understand creativity and innovation onboard that particular ship. Theory drives the collection and interpretation of data about the case. Triangulation is used to strengthen the data.

USS Nimitz is a representative case both within the Navy and within studies of creativity and innovation, and should be able to capture the interest of the readers and provide opportunities for learning.

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IV. THE USS NIMITZ

There are about 3,000 sailors on board the Nimitz, and probably tenfold the number of stories of innovation. This is one of them. It does not capture every individual story, nor even a weighted average. It offers, however, a perspective on how innovation can be achieved on board one ship in the U.S. Navy. As such, it contributes to the body of knowledge concerning the conditions for creativity and innovation in the military.

Creativity and innovation can only be understood within its context. This case study is discussed against a backdrop of the big Navy, the ship itself, and the events surrounding the change of the watch schedule. The case study sought to gather personal perspectives and stories as they were recounted by the crew. Three groups with different backgrounds and points of view stood out from the interviews. They are presented as three *personas* with supporting but unique perspectives of the situation.

This chapter is based on evidence collected through interviews, observations, and secondary sources such as document analysis and presentations. The personal stories gathered through interviews were the primary source of evidence, while observations and secondary sources were valuable in supporting the context and background descriptions.

A. CONTEXT

1. The Navy

The Navy needs innovations to keep up with an uncertain environment. It is constantly challenged by an uncertain strategic, political, economic, and technological environment. Fortunately for Navy innovation, the Navy is characterized by its highly trained, knowledgeable, and dedicated officers and enlisted personnel who are motivated by strong tradition, corps de esprit, and culture. With approximately 325,000 personnel on active duty, there should be a myriad of ideas out there in the fleet ready for harvest. Unfortunately, the Navy is an organization that struggles between forces that defy change and its need for innovation. It is a large, governmental organization; it can be characterized as hierarchic, complex, procedural, bureaucratic, uniform, traditional, risk adverse, and inflexible.

Unless faced with the possibility of loss, most humans prefer to be careful, avoid risk, and defend their status quo (Kahneman, 2011). The Navy as an organization behaves similarly. It is an organization that prefers the present situation to an unknown future: In the words of Retired U.S. Army General Stanley McChrystal (2015) “The problem with changing a well performing organization is that they (the people within the organization) are ok where they are.” McChrystal (2015) described a military organization that defied change because of tradition, habit, personal pride, and ambition. During operations, the complexity and size of the military organization was such that it became a challenge to understand the big picture and to get everyone onboard. McChrystal further explained how a centralized military organization has difficulties in keeping up with the pace of change. The traditional military organization assumes that wisdom sits at the top of the hierarchy and from there can issue detailed instructions. This illusion of seeing the big picture is reinforced by modern technology. To be able to implement change fast enough to compete with modern adversaries, McChrystal wanted a military that empowers its personnel to make decisions at a local level. A compelling illustration of the complexity and centralization of the Navy—and the effect this can have on the intrinsic motivation of a sailor—came up during the interviews:

> However … I fear, as the Navy becomes more digitalized, control of digitization … from manpower management, to leave management, to everything that I do on board, is now slowly completely controlled by electronic computer database. Which is fine. Except because it does increase efficiency, reduce paper work load, but what I notice in the two major programs that I deal with and that have completely rendered me powerless in many situations to do my job effectively and to do my job better, is the centralization of computer program management systems Navy wide.
>
> Specifically I work with a program called SAMS which is an acronym for an acronym of an acronym, which to me I think epitomizes the Navy. It stands for SNAP automated medical systems; SNAP stands for ship board non tactical ADP program; and ADP stands for automated data processing. So that’s SAMS. SAMS is a medical program.
>
> But I do, I work within a subset of that, a module for radiation health, that’s all I do. That’s my bread and butter. And I encounter, from a lean 6 Sigma perspective, your brain would explode from the inefficiencies of trying to do … something as simple as checking someone into or out of

> this program. I have to enter in, so to enter in a person in the program, I have to type in their name, probably 10 or 15 times to query search, recall and input over and over again.
>
> I could spend this entire Skype phone call going over the myriad of problems both technical and streamline and inefficiencies and everything. And I have let SPAWAR, the owner of this program, let [it] know through trouble tickets and countless teleconferences, and hours spent going back and forth, and up loading, and walking through with issues, and the whole cost of the problem is that this program is so centralized and we do not have the authority and ability to modify and/or fix it or even use a replacement that we are handcuffed and restricted by the imposition of ineffective software. And it's such a bloated … bureaucracy that changes slow, [and even though] changes [are] effective most of the time … a lot of my counterparts don't even go through the effort [of trying to change the system] that I've exhibited. And this is coming from the SPAWAR representatives that cared and were trying to help me, who were equally frustrated. Because they are limited as well. Most people end up giving up, providing a feedback which is the only hope that there would be hope for innovation within this program. Because it's waste of time [to suggest improvements], because at a certain point they (SPAWAR) don't do any change, so it's more work to provide the feedback, that's gonna result in a change that will probably never occur, while they (the crewmembers) are on board. So, not only do I see centralization as a problem, but it's almost a strangulation of innovation there.
>
> That is not even the Athena idea that I was pitching, which was something else. But I have concerns with regard to that. And that's a big issue. There is no way that's gonna budge, because SPAWAR owns much, fighting, picking a fight with them. Some people I can see even be hesitant to them for potential negative blow back. But I didn't care. I was so frustrated that many manpower hours I was wasting doing data input and then having the program corrupt on me. That I, at that point really had nothing to lose. It just blew my mind. The inefficiencies that were allowed to exist. And that's just me, and that's doing a small job, and that's just a tiny subset, and I'm just one person in this big program. I'm concerned about that for sure, from an innovation standpoint. (LTC, USS Nimitz)

Navy leaders recognize the need for innovation, and Navy innovation initiatives range from projects anchored to the Navy's top brass, including the Chief of Naval Operations' (CNO) Rapid Innovation Cell (CRIC), to grassroots initiatives such as the Athena Project.

The CRIC was established in recognition of the combination of talented personnel, a need for ideas, and the multiple forces defying them. It gives selected personnel the opportunity to work with their ideas in a supportive climate where parts of the bureaucratic process have been circumvented. CRIC personnel described a multilayered organization where ideas and suggestions, as they travelled up the organization, faced multiple barriers at each level of command before they reach a decision maker with funds and authority to see them through. Then, as they travelled back down the organization again, they competed for time, interest, and commitment from local authorities for their execution (Kohlmann & Lademan, 2015).

The Athena Project was initiated onboard the USS *Benfold*. A junior officer's ambition to bring the discussions of the wardroom to a wider audience met with the CO's need for new ideas to improve performance. The wardroom was buzzing with ideas that needed feedback, improvement, and above all, decision makers who listened (Cannon, 2015). Both CRIC and Athena are examples of reactions to counter the challenging conditions that inhibit creativity and innovation in the Navy. Naturally, the Nimitz faces those same conditions.

2. The Ship

USS Nimitz is not alone at sea. The ship will always exist within a larger organization adding complexity, supervision, and pressure. For example, to visit the ship in its dock in Bremerton, one has to conform not only to the regular security requirements of a military base, but also the separate safety and security procedures and training of the shipyard, and finally, the procedures to get access to the ship itself. In the shipyard, the ship was crawling with contractors wearing hardhats as well as the ship crew, both doing their jobs while adapting to the other's routines and procedures.

The Nimitz's organization includes a crew or "ship's company" of almost 3,000 sailors commanded by a Navy captain (the CO) assisted by his staff. The organization is broken down into divisions and departments based on task, role, and technical competency. This hierarchy creates multiple layers of command reporting up the organizational structure to the senior leadership. Each technical area (e.g., the Reactor

Division) answers through their division head and the CO to their respective ashore organization (e.g., the Naval Nuclear Propulsion Program), while the ship also reports to a Naval Command. For example, when deployed, a ship reports to a Fleet which again reports to a Combatant Command (COCOM). During deployments, the ship will embark an air wing of almost 90 aircraft and 2,000 additional crewmembers—not included in "ship's company." She will sail as the flagship of a Carrier Strike Group (CSG) of other Navy vessels commanded by a one-star admiral. The CSG commander and his/her staff will be embarked on the ship. The CSG will be organized by warfare areas (e.g., surface, sub-surface, and strike) in a composite warfare command structure. The ship must innovate within this complex hierarchy while answering to multiple stakeholders.

As the first of class of the Nimitz class nuclear aircraft carriers and one of the world's largest warships, the Nimitz is literally unable to fly below the radar. The Carrier Strike Group is a strategic pillar for U.S. Defense policy makers. The Nimitz attracts attention wherever she sails. The ship attracted attention by its big superstructure, which dominated the waterfront when it was stationed in Everett Naval Base, and its pennant number (68) which illuminated the night sky. Arriving in Victoria, B.C., after a short cruise from Everett, WA, in June 2014, local newspaper headlines indicated how quickly the local populace took notice of the super-sized guest. The ship not only answers to multiple stakeholders, but there is also the added pressure of being so prominent in the stakeholders' view.

When one boards the Nimitz, the first striking feature of the ship is its obvious size; a second feature is the number of people onboard: With 5,000+ souls on board, it is a small floating city. Then there is the challenge of finding order in what appears to be orchestrated chaos with similar-looking individuals moving around according to invisible norms and rules through a maze of ladders and corridors. One example is on the navigation bridge: To an outsider, the bridge seems crowded but orderly. Orders are passed down the bridge's chain of command, confirmations are passed back up. Every command is logged, together with ship and navigational data. Personnel "in training" stand by, observing everything and concentrating on getting their qualifications. As a similarly sized Wallenius Wilhelmsen roll-on/roll-off (ro-ro) ship passed by, one could

not help but wonder whether they had a more streamlined bridge organization. The Nimitz is complex, but organizational structure in the form of a hierarchy soon becomes visible: the difference between officers and enlisted, or "khaki" versus "blue." Privileges are obtained by advancement in rank; there is a big difference between the CO's quarters and an enlisted bunk. This strict hierarchy implies difficulties for junior personnel in getting their ideas across and voicing opinions to the personnel in charge. An enlisted Sailor onboard admitted, "The officer and the enlisted often is a gap and divide when it comes to value of a person's idea. So I think that was the trouble."

The sailors are unified in their training, indoctrination, uniform, and code of conduct. Still, a closer look reveals the communities that divide the ship into departments and divisions. Badges, uniforms, and locale are indicators of the different organizational structures that exist within the ship. Both team diversity and knowledge-sharing across communities may suffer in the face of this organizational structure. The CO of the Nimitz acknowledged that inviting outsiders onboard, in this case an NPS research team, was a strategy to compensate for the lack of team diversity.

The organization is there to provide oversight and prevent anyone from getting lost in a large and intricate system. For a newcomer, it is easy to get lost onboard. Except for the cryptic numbers marking each compartment, the "bull's eyes," every corridor looks the same, the same greyish color scheme, few signs, no décor or distinguishable features. The uniformity invites a desire to stay within known spaces, with familiar faces, and accept the directions of those individuals with experience. Fortunately, most of the crewmembers are more than willing to give directions.

During the first visit of the NPS research team to the Nimitz, on a quest to find a security office to confirm our security clearance (at least three possible candidate offices emerged), we quickly became lost. But soon an eager crewmember came to our assistance and proudly led the way up and down what seemed like endless corridors and passageways. The sailor eventually found all the offices we needed, but admitted it had taken him about six months to learn how to navigate around the ship. Knowledge and experience seem crucial to navigate the ship's complexity. Similarly, in terms of creativity and innovation, the interviews confirmed the role of domain knowledge in

coming up with creative ideas. Facilitators from the Athena Project were used to provide knowledge on how to navigate the organization and communicate the idea to the leadership.

The work environment on a nuclear aircraft carrier can be stressful. The individual crewmember workload reported by Shattuck et al. (2014) greatly exceeded the Navy standard work week, and crewmembers regularly reported being fatigued. Of further concern for creativity and innovation was Shattuck et al.'s finding of low "psychological safety"—a term comparable to participative safety (see Table 2). The participants were afraid to speak up and take risks. They feared that mistakes would be held against them. The crewmembers interviewed for this thesis confirmed that they worked in a stressful environment, but acknowledged that conditions had improved since the Shattuck et al. (2014) study. No evidence of adverse effects from stress or fear of speaking up was found during the interviews. In contrast, the interviewees reported that they felt safe and motivated to contribute to improvements.

3. The Innovation

Within the hull of the USS Nimitz, this thesis explored creativity and innovation related to a new watch standing schedule. In June 2014, a research team from NPS embarked on the USS Nimitz to conduct a study of sleep and fatigue among the crewmembers. The leadership of the Nimitz, at the time, had experienced a performance deviation among the crew and suspected that it could be caused by fatigue, high workload, and lack of sleep. Indeed, the initial NPS study described a situation of poor sleep hygiene, excessive fatigue, and dissatisfaction in a sample of Sailors predominantly from the Reactor Department (Shattuck et al., 2014). The results of the initial study led to a change in the watch schedule of the Reactor Department from a three-section "five and dime" or 5 hours on watch followed by 10 hours off watch to a four-section 3 hours on watch followed by 9 hours off watch or 3/9 watchbill. The decision to adopt a new watchbill was evaluated in a follow-up study to assess the effect of that change. As was confirmed by many of the participants interviewed for this thesis, the change had a positive effect on the sleep and performance of crewmembers (Shattuck et al., 2015). In

terms of novelty and usefulness, this change represents an innovation. Or, in the words of one Petty Officer, “If we got some new information or some results back from the study and then changed the watch schedule based on that, that sounds like innovation to me.”

Changing a watch schedule may not seem like groundbreaking, “big C” creativity. Nonetheless, on the Nimitz, the CO decided to invite researchers onboard to conduct a lengthy study of the crew and employ the scientific evidence provided to support further decisions. When it comes to improving performance, of the many tools a Navy CO has at his or her disposal, this approach may not be the most obvious choice. From the crewmembers’ point of view, the change itself was perceived as something new, but not radical. What they found to be radical was the change of mindset that occurred as a result of the NPS study. Several small changes were conducted to accommodate first the new watch schedule and later the general work conditions onboard. Suddenly, individual crewmembers’ work–life balance, circadian rhythm, sleep, and eating habits became important parts of the department’s performance evaluations.

B. THE APPLICATION OF THEORIES

The interview data have been interpreted in light of the theoretical framework described in Chapter II. In this section, the data have been organized by the theories underlying that framework. Furthermore, the participants interviewed have been organized by three perspectives. This organization is inspired by how ethnographic researchers create personas, or archetypes, representing important and distinct characters that stand out from the interview data (see, for example, Liedtka & Ogilvie, 2011). The three perspectives are the Leader, the Athena Sailor, and the Petty Officer.

The Leader perspective provided the big picture of the situation. It was provided by individuals with a long naval career and a high level of experience. They believed in improving the Navy by challenging the current way of business. The Athena Sailor provided the perspective of crewmembers participating in the Athena Project. True to the exploratory nature of case study methods, the Athena Sailors emerged during the study as having an unexpected perspective on creativity and innovation in practice. The Athena Sailors had different levels of experience, but came together in their passion for

innovation. The Petty Officer provided the perspective of the highly trained and professional petty officers of the Reactor Department. They offered first-hand insights into the events concerning sleep and performance in the Reactor Department, and provided a unique perspective from the deck.

1. Individual Factors

a. The Leader

From the leadership's point of view, the following individual factors were emphasized: motivation, willingness to take risks, knowledge, and communication.

The CO of the USS Nimitz expressed a strong motivation to change something on his ship and to improve the Navy. Changes are driven by innovation, and by having a positive attitude towards change, the CO wanted to inspire innovative behavior in the organization. The leadership's innovative nature and acceptance of risk were intended to "set the tone" for the crew. The CO recalled a willingness to take risks to achieve overall objectives already in his first command, and now, with increased experience, expressed confidence that accepting risk was necessary for the continued improvement of the Navy.

Knowledge of related fields, such as management and public administration, had informed the CO's command philosophy and decisions on how to innovate. In the business world, corporations look outside their organization for inspiration. Shouldn't the Navy do the same? To gain knowledge from within his own organization, the CO believed in "management by walking around," listening, and being curious. The CO, the executive officer (XO), and the command master chief (CMC) used forums such as the Captain's Call, Division-in-the-Spotlight (DITS), and the Athena Project to communicate directly with the crew and identify "crew dissatisfiers." The leadership recognized that the younger "millennial" generation, within which enlisted and junior officers belonged, demanded explanation and education rather than traditional one-way directives. The crew seemed to respond well to that approach. For example, in terms of changing the watch schedule, resistance was overcome by explaining how the sailors could benefit from the change, and communicating that the change was done in the interest of the welfare of the

crew, not for the sake of the leaders. Likewise, changes to align the ship's and the Bremerton shipyard's routines demanded explanation to be fully accepted.

b. The Athena Sailor

For the Athena Sailors, individual factors such as domain knowledge, personal experience, intrinsic motivation, and a stubborn belief in their own ideas were essential in transforming creative ideas into a creative product ready for implementation. In their peers and supervisors, they saw the value of expertise, curiosity, listening skills, and determination.

The Athena Sailors' creative products emerged from experience and knowledge in their field. For example, as one junior officer formulated it, "it's based on experiences. Experiences they've had with the ship. So they have done something themselves several times and it never really made sense to them, to do it that way," or more specifically, "That's in fact where I got my idea. Was at last ship. Wearing a gas mask, in general quarters, sitting in a repair locker while everyone else was stressed out in these [other breathing apparatus]." (LTC, USS Nimitz).

The Athena Sailors were motivated and committed to change their work situation and, ultimately, to improve the Navy: "We take innovative ideas on how to make the Navy and the ship yard more efficient and safer: save money" (Petty Officer A., USS Nimitz).

Through the Athena process, they get valuable feedback from subject matter experts (SMEs) brought in to listen to their ideas:

> And so I told them my idea, they gave me some feedback and said ok. That sounds great, and it's a great idea. Here are some notes for you, you can take back with you. Do some homework here, do some research there. And then we'll meet again and we'll refinance. That's what I did. I took it back, added a little bit of homework and thinking and found some instructions. (Petty Officer A., USS Nimitz)

The sailors and their ideas benefitted from leaders who were supportive, curious, and listening instead of judging. One Athena Sailor reflected that: "So my CO … is very open and supportive of those ideas and has a tremendous amount of my respect for that."

Finally, during implementation, the ideas benefitted from "strong leadership from CO, XO, RO and then insuring that chiefs bought off on it and changed the mindset and the culture that existed" (LTC, USS Nimitz).

c. The Petty Officer

The petty officers of the Reactor Department identified domain knowledge and openness to change as individual factors that influenced creativity and innovation.

Nuclear reactor operators are held to high standards. The interviewees reported that they were specially selected and received up to two years of training before they were allowed to stand watch. They expressed professionalism in how they described their work, and appeared to value expertise. Their emphasis on expertise, however, made them prone to believe that changes, even for the good, were very difficult to accomplish. For example, "There may be a better way to perform the procedure, but if we know the procedure works the way it's written, it's probably not gonna change." The mindset they reflected was that expertise and knowledge come with experience, and sit at the top of the hierarchy:

> In (the) reactor department we pretty much have everything by the book. We don't touch anything and do anything unless we have a book open that tells us exactly what to do and how to do it. We always try to harp on the fact that the books are written by experts. So, it's hard to say: "I think we should do it in a different way," when they have a book that a lot of smart and high rated people say that is how you're supposed to do it. (Petty Officer R., USS Nimitz)

The same professionalism made the Petty Officers willing to raise issues related to work performance (e.g., issues related to safety or maintenance), but only if those issues did not involve procedural changes. Procedural changes involved a long, but professionally justified, struggle against a very bureaucratic and conservative culture—a culture that was often carried on the shoulders of individuals with a conservative mindset closed to creativity and innovation. Repeatedly, the Petty Officers reflected on the lack of an open mindset among chiefs and officers in their department:

> They are very resistant to change. They have this mindset of "this is the way we have always done it. It has always worked before, so we just keep

> doing it." So if they had a more open mindset, it would be easier to get them to change a little bit.
>
> Just because it's the way it has always been done, doesn't necessarily mean that it's the best way.
>
> They are trapped in it, and can't get free of it. So they need to try to be more open to change. Even if it is a little scary. You know it could be good. Could be bad. Give it a shot. (Petty Officer G., USS Nimitz)

2. Team/Groups

a. The Leader

The interviews of the leadership revealed that team factors influencing creativity and innovation were team diversity, shared vision, pressure, and supervisory encouragement.

A shared military background "cuts off the edges" and reduces team diversity. As demonstrated by inviting the NPS research team onboard, it felt natural for the leaders to look outside the ship for inputs. Outsiders were used to reduce the risk of "group think" and introduce diverse opinions. Team alignment was still found necessary. Shared goals and vision were provided by a command philosophy tailored to the situation. The command philosophy was the leaders' "alignment tool" intended to "get the message down" and steer the innovations towards a set course. Furthermore, the command philosophy was a way to remind the crew of the importance of the ship's overall mission. The philosophy, together with an expressed expectancy of high standards, created a pressure to perform and maintain readiness. For example, the CO wanted to personally make sure the ship was kept clean, tidy, and "that the lights were off in the berthing areas."

Most prominent among the team factors was supervisory encouragement. The CO felt he had "top cover" from his own leadership, the admiral in charge of all nuclear reactors, telling him to think differently, "challenge my [the admiral's] perception," and "challenge the way we do business." Instilling a similar climate of participative safety for creativity and innovation was a management goal onboard. The leadership wanted to hear suggestions for improvement from the crew instead of imposing solutions. Creative ideas

should, in the CO's mind, be encouraged and rewarded: "Don't shoot the messenger," and "be willing to challenge all assumptions." In fact, the leaders felt that after encouragement, the situation went from "no one would say anything" to almost too many suggestions.

b. The Athena Sailor

The Athena Project is about creating a supportive, safe environment and bringing together a team with diverse, but complementary knowledge.

On one occasion, the Athena meeting was held in a coffee house with representatives from other ships, the shore-based organization, and industry. The climate of the meeting was that of collaboration and contribution as opposed to criticism and judging. Back onboard the Nimitz, the meetings were typically set up as round table discussions. The Athena Sailors met with the upper chain-of-command (typically the CO, XO, and CMC), domain experts from the ship, and other interested crewmembers. The atmosphere was similar to that of the coffee house, supportive rather than judging. A junior officer onboard described the meeting as follows:

> It's very much … like a round table of discussion you have with your leadership. They want to get the idea pushed through. They don't want to see your PowerPoint, they don't see that. They want to sit down and actually talk to individuals.

The opportunity to meet with the leadership and the feeling of being heard seemed to be intrinsically motivating for the Athena Sailors.

c. The Petty Officer

When the Reactor Department is interpreted as a group or team trying to innovate together, the following factors surface: common goal/vision, participative safety, organizational impediments, resource constraints, task irrelevant behavior, and freeriding.

The most prominent factor was the emphasis the interviewees placed on the common goal of safety and stability in performance. When an idea contributed to that goal, they felt safe and obliged to voice their opinions and participate in finding a solution. The feeling of participative safety was reflected in how, in their opinion,

changing of the watch schedule went from a top-down directive to a bottom-up, participative approach when it was interpreted as contributing to the common goal. The belief in a participative innovation process decreased when organizational impediments such as a tedious bureaucracy were believed to block the process, for example, changing written procedures involving decisions above their local level of authority.

Most of the Petty Officers reported resource constraints regarding manpower and personnel as negatively influencing creativity and innovation. The lack of personnel with the right qualifications meant that they were not able to change or experiment with new solutions. One Petty Officer described how task-irrelevant behavior affected the ability to change:

> Like I said, they are resistant to changing the old ways because it's the way it's always been done. Kind of like the situation we sometimes have, where senior personnel are mean to the non-quals because they have gotten trash by the people ahead of them and so they feel that they have to keep doing it. We don't do that now. We kind of broke that when some certain people left.

Another participant described a situation where his team was freeriding on a watch scheduling solution for a while, but then gave up due to lack of motivation to improve the situation.

3. Organization/Culture

a. The Leader

Innovation in the Navy is challenged by a risk averse organization. Still, onboard the Nimitz, the Leader wanted to encourage innovative behavior. A transformational leadership style was adopted to support creativity and innovation.

Despite individual Navy leaders' support for independent thinking, in general terms, it was voiced that "the Navy is breeding risk out of leadership." The Navy seems to prefer streamlined, uniform leaders compared to, for example, the strong personalities of World War II admirals. From the wider organization, there was pressure on the Nimitz to conform, with simultaneous pressure to perform by setting an example for others. Within this organization, the leadership of the Nimitz wanted to create a culture with

perceived support for creative initiatives. Communication, intrinsic motivation, and education were among the chosen management strategies. By hearing out the crew's suggestions and keeping an open dialogue, the leadership hoped to inspire creative ideas and ease their implementation. Traditional organizational barriers were broken down by DITS or Captain's Calls. The transformational leadership style was prioritized over the transactional, order-driven leadership style inherent in most of the military organization.

b. The Athena Sailor

The Athena Sailors witnessed how the traditions, hierarchy, and bureaucracy of the military organization kept new ideas from being brought forward. They saw big Navy issues hindering implementation. They feared that an inwardly focused Navy will never be able to innovate. They were motivated by a very supportive upper chain-of-command, which was fortunate in a culture they described as very leader-dependent.

The Athena Project was designed to circumvent the barriers to innovation inherent in the military organization (see also Cannon, 2015.) For those fortunate enough to be involved, the Athena Project took the ideas straight to the CO and past the treacherous waters of tradition and the multiple layers of the chain-of-command. From the perspective of the Athena Sailors,

> I tried a couple of times to do something like this beforehand. And it was shut down by my chain of command. More or less just told: "This is the way we've always done it. Keep it traditional." In contrast with what the Athena Project wanted to achieve: "We take innovative ideas …, and we put that in like a pipe line to make the change happen." Which is opposed to the rank structure and all the paper work and all the unnecessary things that would just take so much time, we pipeline it straight to the source of change.

Still, if an idea was regarded as "against written regulations," the Athena Project was less willing to take up the fight.

In implementation, the support from the CO, and the execution of the XO and CMC meant everything to the sailors. However, when it came to ideas that involved the larger naval organization, for example regarding firefighting and personal safety equipment, the defense acquisition system and the Navy's preference for maintaining the

status quo presented almost watertight barriers that proved virtually impossible to overcome.

c. The Petty Officer

Viewed from the lens of organizational factors, the Petty Officers told the story of complexity, leader-dependence, both transactional and transformational leadership, and a high degree of conservatism.

The Nimitz was described as a complex organization to which the Reactor Department had to adapt. Changing the watch schedule affected most other department activities, for instance, maintenance, drills, training, and watch rotations. The Reactor Department activities were in turn affected by shipboard activities, examples of which were flight operations, meals, general quarter drills, use of the announcement circuit (1MC), and other scheduled ship events. The department was therefore highly reliant on the XO's willingness to adjust the ship's schedule to the department's new watch schedule. Fortunately, they had leadership support: "The final thing that they changed is the time when we ran general quarter drills to be more in line with the sleeping/waking rhythm of the watch teams" (Petty Officer J., USS Nimitz).

In changing the watch schedule, the Petty Officers saw an initiative that was "brought down from our leadership through the chain-of-command." They felt the change was coming from the CO, XO, and Reactor Officer (RO), and consequently had to be implemented regardless of resistance. Then, as the change had leadership support, the Petty Officers felt responsible for adopting and improving it. In their opinion, the organization was too large and complex for higher level decision makers to understand fully the effect the change could have on those directly influenced. For the innovation to be successful, it had to be driven by the "lowest supervisory level." Still, they felt motivated by the fact that the leadership was trying "to improve your quality of life," and from their interview answers, it was evident that they had adopted and were defending the ideas behind the change.

Creativity and innovation in the Reactor Department met its fiercest opponent in the department's conservative culture. The department and the wider nuclear organization

were defending the status quo and were almost locked to procedures, historical performance, rules, and regulations. The interviewees described a long and tedious process for change: “It could take months. It could take years.” They needed very good reasons to suggest changing a written procedure:

> There may be a better way to perform the procedure, but if we know the procedure works the way it’s written, it’s probably not gonna change. (Petty Officer G., USS Nimitz)

> Very, very difficult to change. In my opinion. And the reason is that for however many years naval nuclear power has existed, a lot of things exist the way now because of lessons we learnt in the past. So, the procedures that are implemented now exist or at least seem to exist for a reason. So, the moment you want to change the way we operate you find a lot of hesitation. One, because people who work now may or may not know the lessons learnt, so changing something without knowing the history of it, can frighten people. So you find the first hesitation there, and then secondly if you look at, I guess, the track record of it, it seems that for the most part this program has existed relatively incident free with regards to the public and public safety. So, to change something in our policies and procedures you’ll find hesitation because we have a successful record. (Petty Officer G., USS Nimitz)

Smaller changes, not bound by rules and regulations to the same degree, could be easier to approve, but still hard to implement:

> Small changes are definitely easier. First of all because of the things I just mentioned before, but also as you start to implement those bigger and bigger changes it needs more approval. And you’ll find that, because there is such great complexity to the organization, that if you were to implement a change, or a sweeping change, it’s hard, I feel for the higher level supervisors, to really understand how that change is gonna impact down at the very bottom. So you’ll find that those changes are often harder to implement. (Petty Officer G., USS Nimitz)

Nevertheless, the Petty Officers supported the rationale behind the conservatism. The profession had a tradition of thoroughness, safety, high performance, and scrutiny. Or, as one participant formulated it, “I guess nuclear power is little bit delicate.”

4. Dialectic Approach

a. The Leader

From the Leader interview data, ambidexterity was visible in the changing roles innovation demanded. Both the transformational and the transactional leader were needed. While necessary for innovation, intellectual ambidexterity is believed to cause tension (Bledow et al., 2009). Listening, communicating, and idea-generating behavior were balanced against rapid implementation through the chain-of-command. The CO wanted to have time to listen to new ideas, and to provide time for crewmembers to pursue ideas while simultaneously managing the ship's limited time and manpower resources as efficiently as possible. Similarly, the emphasis on direct communication with crewmembers implied a desire for a flatter organization compared to the current top-down organization focused on efficient order execution. The CO's strategy was to trust his subordinate leaders to know his intentions, solve problems at the lowest possible level, and have the required experience to confidently filter ideas before they reached him.

b. The Athena Sailor

The Athena Project onboard the Nimitz can be interpreted as a strategy similar to what Bledow et al. (2009) called the principle of overcoming dichotomous "either/or thinking" when faced with activities regarded as contradictory. The Athena Sailors preferred an informal Leader who listened to their individual needs without the normal gap between subordinate and supervisor. Yet, they needed a leadership that could give orders and "make it happen." They wanted the CO's personal attention, but realized his constraints in running a ship with a complement of about 3,000 men and women. They recognized the importance of performance stability for a nuclear carrier, but also understood the need for improvements through change. As one Athena Sailor put it,

> The CO does not necessarily realize what an E3 or E4 is doing. He has much larger things to worry about. … but it's also about being efficient and also about innovations. So he didn't realize that we were wasting those hours. And I couldn't get the information to him through the chain of command. (Petty Officer A., USS Nimitz)

c. The Petty Officer

The dialectic approach to creativity extracts a few significant observations from the Petty Officer data. The Reactor Department had to balance the objective of improvement against safe and stable performance. They had a very rigid, conservative culture, but were still able to conduct changes when needed. The changes were possible when an issue addressed the overall goal of safety and performance, and when the issue could be solved without involving the larger naval nuclear organization. The department seemed to have adopted a separate process for more rapid changes of a smaller scale.

> Like I said, the nuclear Navy is a very conservative organization by nature. Because what we do is so sensitive. But there is a very large inertia that has to be overcome. And the general culture is frequently that if something is working out, there is no need to rock the boat or upset things in order to maybe make some small improvements. Now on the flip side, when something is obviously a problem, I think, that if it is recognized by the chain of command that something is clearly not working. So if you say you want to do a maintenance [procedure] and you find out that the procedure can't just be done as written, there's something wrong there. It is a fairly straightforward process to get that changed. (Petty Officer J., USS Nimitz)

The interesting aspect of this observation is that when issues surrounding sleep and workload were associated with the department's goal of safety and performance, the gates to innovation were opened. The mindset had changed and creative ideas were encouraged.

5. Investment Theory

a. The Leader

Seen through the lens of the investment theory, the Nimitz leadership had two strategies to promote creativity and innovation: first to create a safe environment, and second to create a demand for innovation.

The Leader wanted to encourage and reward creative ideas. Leadership wanted to show that they valued diverse opinions. By doing so, the threshold for voicing opinions and suggestions was lowered. Secondly, the CO had the opinion that "you need the willingness to look for trouble," and "catastrophe opens the window for change." When

"bad things" or a crisis situation have shifted the organization away from its status quo, the cost of staying put is perceived as higher compared to the cost of trying something new.

The CO introduced the idea that the U.S. Navy is under constant pressure from strategic, political, and economic forces. In his command philosophy, he underlined that his ship operated in world of uncertainty. Consequently, the risk associated with stagnation was greater than the risk associated with being innovative. In the situation leading up to changing the watch schedule, the CO saw a window of opportunity: "The situation demanded a rudder change." It was an opportunity to turn things around, take risk, and improve the running of the ship. Other ships have failed in in their attempt to change the watch schedule. The CO speculated whether those ships only took half measures. When the innovation process had started, it was important to keep the momentum, "give full rudder," and "embrace the change."

The creative ideas onboard the Nimitz were not limited to changing the watch schedule. There was a series of ideas, from inviting researchers to assess the situation, changing to a 3/9 schedule, assessing the implication of the change, to continuing to do small changes inspired by the sleep and fatigue studies. The leadership wanted to turn a problem into an opportunity for improvement. The initial implementation might prove to be painful, but they wanted to embrace the change and continue to build on it. In this way, they could keep the momentum and reduce the pain by introducing minor increments designed to lessen resistance. The initial change of watch schedule was supported by changes to the usage of 1MC (shipboard public address system) during shared awake hours. Loud general announcements should not disrupt the sleep of those who were off duty. Further incremental steps towards better sleep quality were discussed. A reduction of ambient noise and light was introduced as another possible area of improvement. The leadership was also receptive to look into new berthing arrangements to allow for fewer interruptions for those off duty. Further changes would then be necessary to support the new arrangements. The new ideas were challenging to implement and met resistance, but the leadership felt that they needed to keep the momentum and make adjustments as the process went along. Interestingly, one of the

changes that met the most resistance was an adjustment to how the evening prayer was conducted. A change was made to make the evening prayer more in sync with the new watch schedule. Because the evening prayer is such an important part of Navy tradition, this change was resisted.

b. The Athena Sailor

There is a cost, even for Athena Sailors, to defying established norms. The Athena Project was used to break down the barriers between junior and senior personnel and to make it easier to come forward with new ideas. The project created a norm of coming up with ideas, and a safe environment for pursuing them. Facilitators made sure that the sailors were prepared to meet with the upper chain-of-command by doing dry-runs and making sure the sailors "spoke a language" that resonated with the leadership. Backed up by the Athena Project, it became easier to overcome resistance:

> I know the maintenance department on the ship originally was not sure if this idea would work. Because we have always accomplished our inspections the other way with using two people. And they did not want to, the inspectors themselves, they did not want them to be less effective. So there was some resistance. (Ensign P., USS Nimitz)

> So once I had done the Athena Project, I had an officer on my side. I had LT N. He has more the will power to go and talk to the CO directly and say: "Hey captain, we have had a sailor who has this great idea that I really would like you to hear if you have some time." So it took about a week or so to meet with the CO, but once I had seen him, he was all about hearing. He said, "I had no idea this was what was going on. That this was the reality. Thank you for bringing this to my attention. Let's make some changes."

> That is the great thing about the Athena Project. It takes a lot of enlisted and even officers or junior sailors who have great ideas that are just too afraid to speak out. And this allows them to speak to people on a comfortable level and they connect them with certain people to make those changes happen. (Petty Officer A., USS Nimitz)

c. The Petty Officer

The changes in the Reactor Department can be said to have followed a pattern similar to that illustrated by the investment theory. Furthermore, as with the Leaders, the

Petty Officers realized the value of keeping momentum and presenting an issue as a bigger problem.

Initially, the reception towards the sleep study and changing the watch schedule was mixed. Early adopters would buy in to the idea rapidly, some would stay indifferently, but for others the transition was hard. The wheel was turning slowly and top-down pressure was needed. Eventually, the attitude changed, more people came aboard, and it became a comprehensive, collaborative effort towards improving work conditions in general. The new idea had been incorporated as a part of the current knowledge. Some of the Petty Officers interpreted the change as the result of many small steps towards something very innovative. They saw a need for keeping up the momentum with constant improvements. Others felt that as long the department members were unsatisfied with their current situation, and sensed a chance of improvement, the risk of change appeared as less threatening. One Petty Officer echoed the CO's opinion on the need of a crisis situation to motivate innovation:

> The only real frustration we ran into with trying to innovate is, like I said, that there is generally a lot of resistance to it if there isn't a big glaring problem. It can be hard to make the kind of slow gradual improvement. You would prefer, I suppose, [to instead let] the system break entirely before we overhaul it. That would be the only thing I would add.
>
> It has to be a big issue, it seems like. You know it's kind of harder to get things done when it's smaller, like I said, if it's not fixing a glaring problem. Then there is a lot more resistance. (Petty Officer J., USS Nimitz)

6. Process View

a. The Leader

When the process of creating ideas is held separate from the process of implementing ideas, it becomes evident that the leadership has employed new processes for idea generation, but kept the implementation process relatively unchanged. Idea generation or exploration had acquired avenues, for example, DITS or the Athena Project, separate from the ordinary chain-of-command. The leadership employed these avenues to "help ideas bubble up the organization." The new avenues supported

inspiration, ideation, and initial evaluation, but not the implementation of ideas. For the implementation of new, untried ideas, the leadership had confidence in the ability of the chain-of-command to let the ideas drip back down again

b. The Athena Sailor

On the Nimitz, the Athena Project was a process for idea generation, initial evaluation, and feedback. In Athena, they had a mentoring process of improving their ideas and eventually presenting them to the CO. The implementation process, however, was conducted traditionally via the chain-of-command. Similarly, ideas that went beyond the scope of the ship had to rely on the Navy's existing processes for implementation. This observation is similar to how the overall Athena Project is described by Cannon (2015) in his case study of the Athena Project itself. Athena helped creative ideas to become noticed by the Navy's top management. On the way up, the ideas benefitted from feedback and support, but the implementation of the ideas seemed to meet resistance. Innovation was still inhibited by a slow-moving hierarchical process. Onboard the Nimitz, the idea exploration stage was, for those involved with the Athena Project, perceived as successful. When questioned whether having the Athena Project affected how people onboard respond to new ideas in general, the answer was,

> I think so, yes. Because it gives our junior sailors the chance to present ideas. Regardless of their rank. That they are able to come forth with ideas and I think it gives them an avenue to present ideas to a wide audience. (Ensign P., USS Nimitz)

Nevertheless, the idea exploitation stage, from the CO's decision down through the organization's layers, was not always perceived as the most effective. Two contrasting viewpoints were provided. According to one Petty Officer, in his department, a particular innovation was executed without resistance:

> I basically pictured that idea to the commanding officer and he really liked it. And he told the people who needed to be told: "Make it happen!" And that's what happened. That's what we are doing now. We are saving a lot of man-hours and overall, the material readiness condition is improving because we have trained and professional people doing the recording. (Petty Officer A. USS Nimitz)

> That would be the 3MC. He's the maintenance material management coordinator for the ship. And he is in overall charge of zone inspections, and he reports directly to the 3MO which is the maintenance material management officer and he reports to the executive officer. So the 3MO and the 3MC kind of work together. The XO had told him "Hey, so here is the idea. Here it is on paper. I want you to fuse it into zone inspection." And he, the 3MC, is the one who makes the necessary changes. They basically just took my idea and sent it out to all the departments and said, "Hey, this is how we are going to do zone now." (Petty Officer A. USS Nimitz)

> The departments will disseminate it accordingly. … Basically it's just the flow of command from the officers to department head and they are making sure to train the individuals that needed to be trained to get the job done. (Petty Officer A. USS Nimitz)

Unfortunately, in another department of the ship, the implementation of that same innovation did not go as smoothly:

> I saw it from inception, to proposal to Athena, to proposal to commanding officer, to buy off, to the entire chain of command, to the subsequent trickle down to the department heads, and then down to lower level middle management, like myself, junior officers and chiefs and my perspective is limited to my department and my perspective is not a slide on any one individual in particular. But I had to laugh when it was presented by my own department head and totally written off and it didn't go anywhere from that point forward.
>
> It was kind of written off more so because I think there was not full understanding of how it was to be enacted. There was a significant delay in implementing that. (LTC, USS Nimitz)

c. The Petty Officer

From a process viewpoint, the Reactor Department had two different processes for creativity and innovation. There was a very bureaucratic process for changes to procedures and a more rapid process for smaller changes. Both type of changes had to support the department's goals, but the smaller changes did not involve the rigid, larger nuclear organization. The problem with the rapid process was that it did not include changes that "only" affected quality of life. As mentioned earlier in this chapter under the discussion of the dialectic approach, the mindset changed when sleep issues were incorporated as a performance and safety factor. Suddenly, a more comprehensive view

on human performance—including work-life balance, rest, and recovery—was taken, and suggestions for improvements were welcomed. The change in attitude was illustrated by how human factors had become a natural part of performance evaluations:

> And we've had some problems with people recently in maintenance. So now they ask usually at a brief "Were you on duty last night? If so, how long were you on watch and how much sleep did you get? How tired are you? Are you hungry?" So I think they have become a little more careful about the actual condition of the people doing the maintenance. So I think they are starting to pay attention a little bit more to it. Instead of just assuming that we are ready to go at all times. (Petty Officer G., USS Nimitz)

C. CONCLUSION

The story about the Nimitz is a story about motivation. It is about having top cover from leaders promoting an innovative mindset. It is about the ship's own leadership's intrinsic motivation to promote change and to encourage innovative behavior. It is also a story about a complex organization within an environment where creativity and innovation struggle to surface. Even in such an environment, ideas may bubble up to the decision makers. On the Nimitz, the leadership successfully introduced processes to steer the ideas around the many obstacles the organization presented them with. Some ideas, however, collided with a very conservative and rigid mindset. Once more, top cover from the decision makers and, this time, also from the alignment of departmental goals to the idea's purpose, came to the rescue.

The story about the Nimitz is about a very leader-dependent culture. True leadership was needed to trigger changes and "rock the boat," to enforce a difficult implementation process and, above all, to close the circle. Leadership needed to listen, encourage, and inspire intrinsic motivation for innovation among the crew.

It is also about how innovation—implementing creatively—differs from fostering creativity. As the "I had to laugh" quote shows, the Nimitz was better at fostering creativity than implementing the innovation. The forces that defy innovation may be stronger than those that discourage creativity.

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V. DISCUSSION AND CONCLUSION

In this study, I embarked with the question, what conditions set the stage for creativity and innovation in the Navy? The question was answered by the case study of USS Nimitz. During that pursuit, I found a rich source of creativity research sharing a military origin. Unfortunately, military innovation studies and creativity research seemed to have parted, and the military innovation studies seemed to have ignored a well of theories that could have been used to better explain and communicate their findings. In an effort to bring them closer together, I investigated creativity research and formulated a theoretical framework that I propose can be used to describe military innovation. Creativity and innovation, as well as human interaction, are unique, context-dependent phenomenon, well-suited for examination by case study methodology. In this case study, data were primarily gathered by open-ended interviews. The theoretical framework guided the interviews and their analysis, and it helped to structure and communicate the results.

A. DISCUSSION OF THE FINDINGS

1. Definitions and Measurements

Definitions and measurements are not theories on their own and do not by themselves expose any conditions required for creativity and innovation onboard the Nimitz. Nevertheless, they were a fundamental part of the theoretical framework. Clear, concise, theory-driven definitions were invaluable in providing consistency and clarity. Moreover, they provided the lens for interpreting the participants' stories, and sharing them without having to rely on military jargon, layman terms, or imprecise terminology.

Measurements were the part of the framework that contributed the least to the case. The findings did reveal that two objective measures of usefulness, or the quality part of creativity, were used. Those were the assessment of the effects of changing the watch schedule (documented by Shattuck et al., 2014, and Shattuck et al., 2015), and the reduction in man-hours (450) for a novel inspection approach. It would be tempting to say that objective confirmation of positive effects improved idea implementation, but the

data provided little support for or against that thought. Apart from subjective statements of ideas being more or less novel, the novelty of ideas was not measured. From this case study, it was difficult to determine the potential effect of such assessments.

2. Factor Theory

Factor theory was probably the most comprehensive part of the framework. Seeing the data through factor theory provided the greatest number of findings about conditions for creativity and innovation onboard the ship. Factor theory gave the opportunity to focus on the different levels—from individual to culture—in turn. All the levels turned out to be essential for the study. Important insights could have been overlooked if the theoretical framework had excluded any of the levels. Additionally, certain factors, such as conservative mindset, could be interpreted as both an individual and organizational trait, and the possible interaction between the two became more evident.

The following were the most prevailing positive factors for creativity and innovation to occur:

- Intrinsic motivation to offer new ideas and suggestions to improve the local work situation and subsequently the Navy
- A leadership willing to take risk in order to improve
- Diverse, relevant domain knowledge and expertise, availability of subject matter experts, and the willingness to seek out knowledge outside and within the organization
- A leader-driven shared goal and vision to bring everyone aboard and align ideas with overall objectives
- A climate of participative safety that encourages ideation
- Predominantly transformational leadership encouraging contributions combined with transactional leadership intervention

The following were the most prevailing negative factors:

- An individual mindset opposed to change (possibly influenced by a conservative culture)
- Organizational impediments such as hierarchy, traditions, and tedious procedure

- A conservative culture that values tradition, status quo, and bureaucracy
- A complex and leader-dependent organization

3. The Dialectic Approach

Interpreting the case with the dialectic approach as an anchor made it possible to contrast various factors. For example, the factor theory perspective found that two opposite management styles—transactional and transformational—were required. The dialectic approach underlined the paradoxes that a desire for creativity and innovation bring to the table. The organization, especially the leadership, is pulled between demands for competing management styles and resources (e.g., time and attention, and organizational structures). The dialectic approach highlighted the need to balance the objectives of safe, stable performance and dynamic improvements. When the Reactor Department realized that the latter could lead to the first, that is, aligning continuous human factors improvements to the overall goal of safety and performance, collaborative efforts followed.

4. Investment Theory

The case of the Nimitz can be interpreted as investment theory in practice. Resistance and doubt were gradually turned into participation. Communication of intents and benefits, education, and directives took the idea, relatively quickly, from a hypothesis defying old knowledge to accepted common wisdom. Onboard, participative safety increased when spaces for creativity were created, barriers between leadership and crew were broken down, and the promotion of new ideas was encouraged. According to investment theory, an investor would like to buy low and sell high. Ideas became easier to sell in an environment of participative safety. Ideas became cheap when the current situation was defined as a crisis. A sense of urgency created a demand for innovation, and the cost of following in the wake of others—stagnation—seemed higher than trying something new. Then, once the ship had started moving, both the Leader and the Petty Officer considered it essential to keep momentum and continue to innovate and evolve.

5. Process View

The USS Nimitz incorporated separate idea generation and implementation processes. Challenges in getting ideas to the leadership led to improvements to the process for idea generation, but, in spite of some inefficiency, the implementation process was kept the same. Onboard, organizational layers presented barriers to implementation. Off the ship, big Navy's bureaucracy added to the challenge. The Reactor Department employed a particularly rigid process for procedural changes, but minor improvements that could be integrated without big Navy involvement were dealt with effectively—if those changes were found to contribute positively to safety and performance. The process view complemented the dialectic approach in shedding light on an interesting phenomenon. When the goals of the Reactor Department were found to be in alignment with the ideas planted by the NPS sleep study, the mindset changed and suggestions for improvement were welcomed. This insight could easily have been overlooked without the process view and the dialectic approach included in the theoretical framework. It demonstrates the descriptive power of the framework and the value of case study research.

B. CONCLUSION

A goal of this thesis was to introduce a language for thinking and talking about creativity and innovation in the military. The conditions under which creativity and innovation occur are better understood now that they can be viewed through a theoretical framework based on current creativity research. We can safely conclude that theories and perspectives from the broad research on creativity and innovation can be used to explain a case of military innovation.

Guided by the framework, the case study showed that there are strong forces in the Navy resisting change and defending the status quo. It is challenging to implement new ideas. Still, it is possible to outmaneuver the hierarchy and bring ideas and suggestions straight to the CO's attention. Faced with the most conservative culture, it is possible to create a climate of intrinsic motivation where individuals think their ideas can make a difference.

The USS Nimitz innovated by adhering to factors such as intrinsic motivation and participative safety. By that measure, the case study echoed the findings of broad creativity research. Other factors, like transactional leadership, were more rarely given priority by previous studies. The unique military context of the case study made the role of transactional leadership more apparent. More surprising was how clear the process view illuminated the difference in the Nimitz*'s* approaches to idea generation and implementation. Initiatives like the Athena Project made the generation of new ideas considerably less stressful and more effective. On the other hand, the implementation of those potentially radical ideas was entrusted to the established, traditional process. Finally, mostly unexpected was the insight about the positive effect that the alignment of goals and ideas had on participative safety. When goals and ideas were aligned, the crew of the Nimitz was able to innovate by taking advantage of existing efficient processes.

One potential critique of these findings is that only a small subset of officers and enlisted onboard a big ship, in an even larger navy, was interviewed. Even so, the case provided unique perspectives and insights, which a larger, homogeneous, random sample would be unlikely to uncover. Moreover, all four cornerstones of the framework were found to produce valid insights about the case.

There is always a risk that a confirmatory bias is present, and, subsequently, that some elements of the framework have received more praise than they deserve. In the thesis' defense, it should be noted that it is a descriptive case study. It did not try to prove a theory as right or wrong. It has just described the case from different angles, trusting in triangulation to enhance the reader's understanding.

Creativity is the production of something both novel and useful (Amabile et al., 1996). This thesis is novel in its formulation of a framework based on creativity research to investigate a case of military innovation. It is also novel in its definition of creativity and innovation as a part of HSI, and its use of case study as its research design. Useful and valuable insights were found through the interpretation of data and the communication of the findings with the language established by creativity researchers.

"Try to be more open to change. Even if it is a little scary. You know, it could be good. Could be bad. Give it a shot" (Petty Officer G, USS Nimitz).

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