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THESIS

DO MILITARY PERSONNEL PATENT?

by

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December 2016

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DO MILITARY PERSONNEL PATENT?

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This study identifies individual characteristics correlated with successful innovative behavior among all Marine Corps officers who accessed between 1990 and 2000. To measure innovation, it determines if an individual has ever received a patent by the United States Patent and Trademark Office (USPTO). Based on identical first and last name matches plus other assumptions, it identifies 20 officers with existing patents in the USPTO database of inventors. Using personnel data from the Marine Corps, it finds that officer inventors are more likely to be younger when they access, are less likely to be married, and serve slightly less time than non-inventors. However, these differences are not significant in a standard regression analysis. The most significant correlate of patenting is an officer's initial pistol score. The findings broadly suggest that pistol scores are likely a proxy for unobserved ability that is correlated with patenting. We recommend the study be expanded beyond the initial scope to identify more officer inventors and other correlates of patenting.

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LIST OF ACRONYMS AND ABBREVIATIONS

ARPA	Advanced Research Projects Agency
BFT	Blue Force Tracking
COCO	Characteristics, Operations, Context, and Outcomes
COIN	Counterinsurgency
DARPA	Defense Advanced Research Projects Agency
DOD	Department of Defense
FY	Fiscal Year
GDP	Gross Domestic Product
GPS	Global Positioning System
HQMC M&RA	Headquarters Marine Corps Manpower and Reserve Affairs
JTAC	Joint Terminal Attack Controller
MOS	Military Occupational Specialty
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
ONR	Office of Naval Research
PCAS	Persistent Close Air Support
PSR	Patent Success Ratio
R&D	Research and Development
SLR	State of Legal Residence
TIROS	Television and Infrared Observations Satellite
TTCT	Torrance Tests of Creative Thinking
USPTO	United States Patent and Trademark Office
WWII	World War II

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I. INTRODUCTION

As technology becomes more complex and U.S. adversaries continue to develop military capabilities, the Department of Defense (DOD) will need innovators to solve complex and evolving problems. Additionally, budget constraints like the sequestration of 2013 require the DOD to find new and cost-effective solutions to problems that did not exist a few years ago. Recently, the Commandant of the Marine Corps called for innovative Marines to step forward and offer solutions to complex or expensive problems facing their branch. Although the need and desire to identify and employ innovative people is stronger now than it has been in the past, there are no definitive methods to identify creative people.

A. RESEARCH QUESTION

To identify creative people, this study employs patents as a proxy for creativity; a patent signals that an individual has found a unique way to address a particular problem. While researchers have used this method to study creativity for years, no research has yet investigated patenting in a military context. This thesis seeks to answer the following questions: In what fields are military personnel most likely to patent, and how do demographics, such as age, race, and gender, along with military factors, influence patenting rates within the U.S. military? To answer these questions, this thesis examines Marine Corps officers who have been granted patents by the United States Patent and Trademark Office (USPTO). By examining these officers, this study intends to identify specific human traits or characteristics that the Marine Corps can use to predict human creativity. Armed with this information, the Marine Corps can identify Marines who likely possess creative potential and place them in billets that best utilize that potential.

B. METHODOLOGY

This study examines Marnie Corps officers who accessed between 1990 and 2000, because officers in this range are likely to have patented by now based on the average age of inventors in the United States. It then develops a search algorithm and uses well-informed assumptions to sort through the data. Finally, it develops indicator variables for use in linear probability models and probit regressions.

Once the data is sorted, this thesis discusses the differences in summary statistics between the inventors and non-inventors. Then it constructs linear probability models using an indicator variable for patenting and the number of patents received as dependent variables. Finally, it discusses the information associated with the patents of inventors. The summary statistics suggest that officer inventors are more likely to be younger when they access, are less likely to be married, and serve slightly less time than non-inventors. Additionally, using linear probability models, it finds that initial pistol qualification score correlates with patenting.

C. CHAPTER OUTLINE

Chapter II opens the study and provides information regarding the U.S. patent system and background information concerning historical innovation within the DOD. Chapter III reviews a number of studies concerning human creativity. Chapter IV discusses the data used in this study, the methodology employed to sort through them, and the variables used to perform regression analysis. Chapter V details the findings of this study. Chapter VI concludes the study and makes recommendations for follow-on studies.

II. BACKGROUND

The United States has the most powerful military the world has ever known primarily because it continues to improve its ability to deliver lethal effects against adversaries. Since the end of World War II (WWII), the United States through innovation has led the world in developing unique military capabilities aimed at defeating its enemies. As technology develops more quickly and the security threats facing the United States become more complex, the Department of Defense (DOD) needs to innovate in order to protect U.S. interests and keep Americans safe.

A. THE U.S. PATENT SYSTEM

The United States was the first country to include a means of protecting intellectual property in its Constitution (Haber, 2016). The United States patent system, the second largest patent authority in the world, dates back to the beginning of the country when Congress passed the Patent Act of 1790. The 1790 law gave inventors exclusive rights to their inventions for the first time in American history. Additionally, the Patent Act of 1790 established a Patent Board, the precursor to the United States Patent and Trademark Office (USPTO), which was responsible for granting patents (USPTO, 2002). Now the USPTO falls under the Department of Commerce and is responsible for granting patents and registering trademarks. The patent system established then remains the strongest patent system in the world because it offers the most protection to inventors at the lowest cost (Haber, 2016).

Getting a patent in the United States is relatively easy. Anyone, citizen or not, can get a patent so long as his invention meets the requirements set forth by the United States Patent and Trademark Office USPTO. The requirements for an invention include that an invention be novel, non-obvious, and useful. The USPTO maintains an extensive online database on which prospective inventors can research and examine issued patents and records. The USPTO database makes it easy for anyone to determine if his invention is unique. Additionally, the USPTO provides detailed systematic instructions for filing a patent application on its website. Anyone wishing to protect his invention in the United States can easily do so by filing for a patent with the USPTO.

One complaint about the patent system in the United States is that it can take a long time to receive a final decision from the USPTO. According to the USPTO (n.d.), the traditional total pendency, which measures the time from application filing to when the application has reached final disposition, has fallen gradually since the end of 2014 when the wait time was 28.9 months, as shown in Figure 1. The current traditional total pendency is 25.6 months. The USPTO (2016b) intends to reduce traditional total pendency to an average of 20 months by 2019. In addition to its stated goal of reducing time from filing to the decision, the USPTO has begun to offer a service called Track One, which expedites the patent review process and gets the inventor a final disposition in about 12 months. Anyone can use Track One for a fee (USPTO, 2015b).

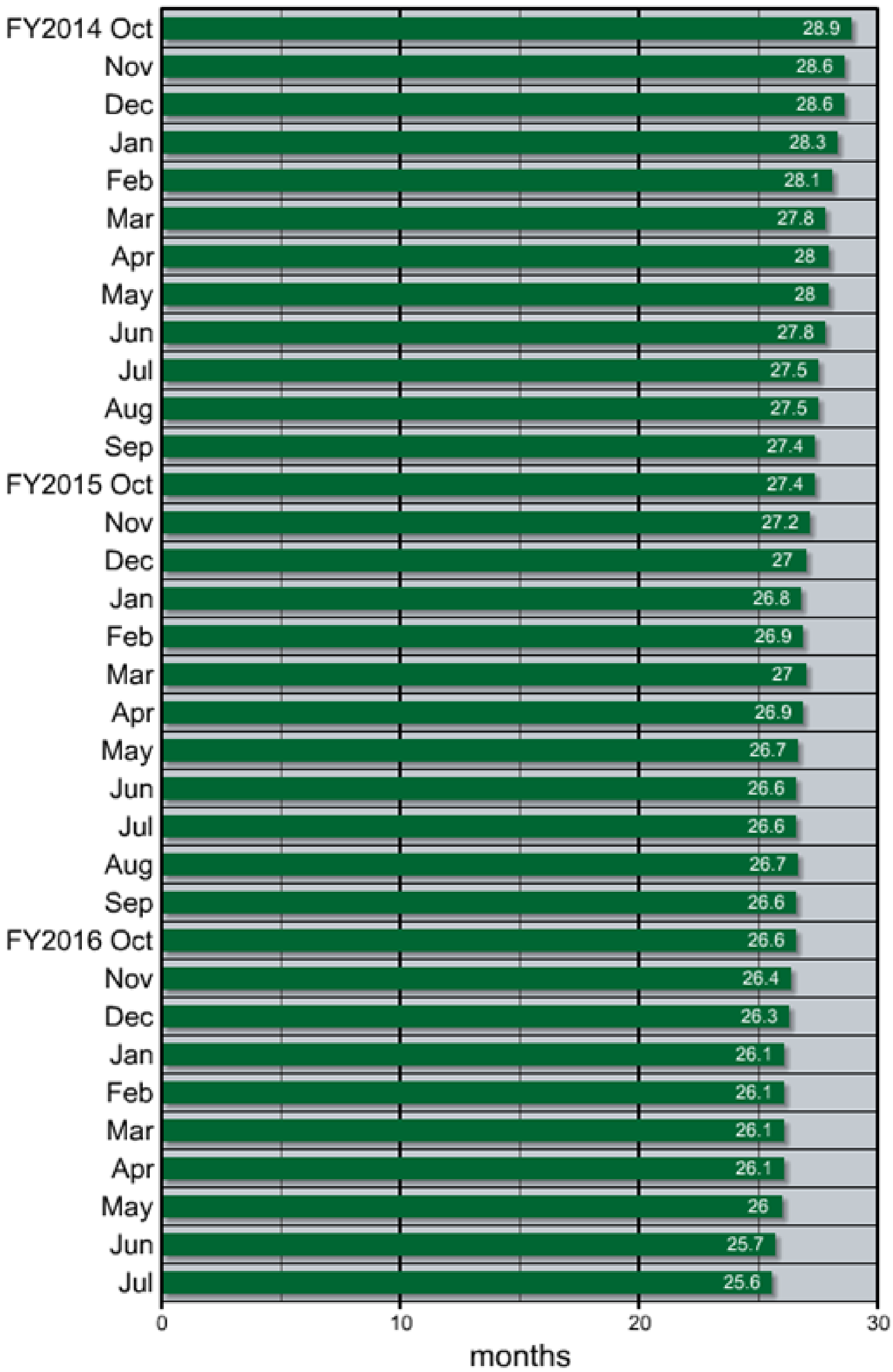

Figure 1. USPTO Traditional Total Pendency FY2014 to FY2016. Source: USPTO (n.d.).

The USPTO issues three kinds of patents: utility, design, and plant patents. Utility and plant patents protect an invention for up to 20 years from the date of application whereas design patents protect inventions for up to 15 years from the date of application. Utility and plant patents are very similar and protect an invention's function while a design patent protects the appearance of an invention. Nearly nine out of 10 patents issued by the USPTO in recent years have been utility patents (USPTO, 2016a). People commonly refer to utility patents as patents for inventions, and they provide significant protection for inventors. A utility patent prevents others from using, making, or selling a particular invention without permission from the patent holder. Plant patents are similar to utility patents except that they protect new and distinct asexually reproduced plants. A design patent protects the outward appearance of an invention but does not protect the functionality of an invention. Consequently, inventors use design patents to protect inventions only if one of the main features of an invention is its appearance (USPTO, 2015a).

The USPTO issued more than 300,000 utility patents for the first time ever in 2014 (World Intellectual Property Organization [WIPO], 2014). As shown in Figure 2, there has been a significant upward trend over the last 40 years, with the number of patents granted doubling in the last six years (Crouch, 2014). Most of the patents granted to the defense industry in the United States are utility patents. This growing trend of granted utility patents could mean the defense industry will be granted more patents in the future.

The U.S. patent system is considered the strongest system for protecting intellectual property in the world primarily because it offers cost-effective protection to inventors. The USPTO offers a range of patents that protect an invention's functionality or design. Despite some of the problems associated with the U.S. patent system, it is relatively easy for anyone to get a patent here.

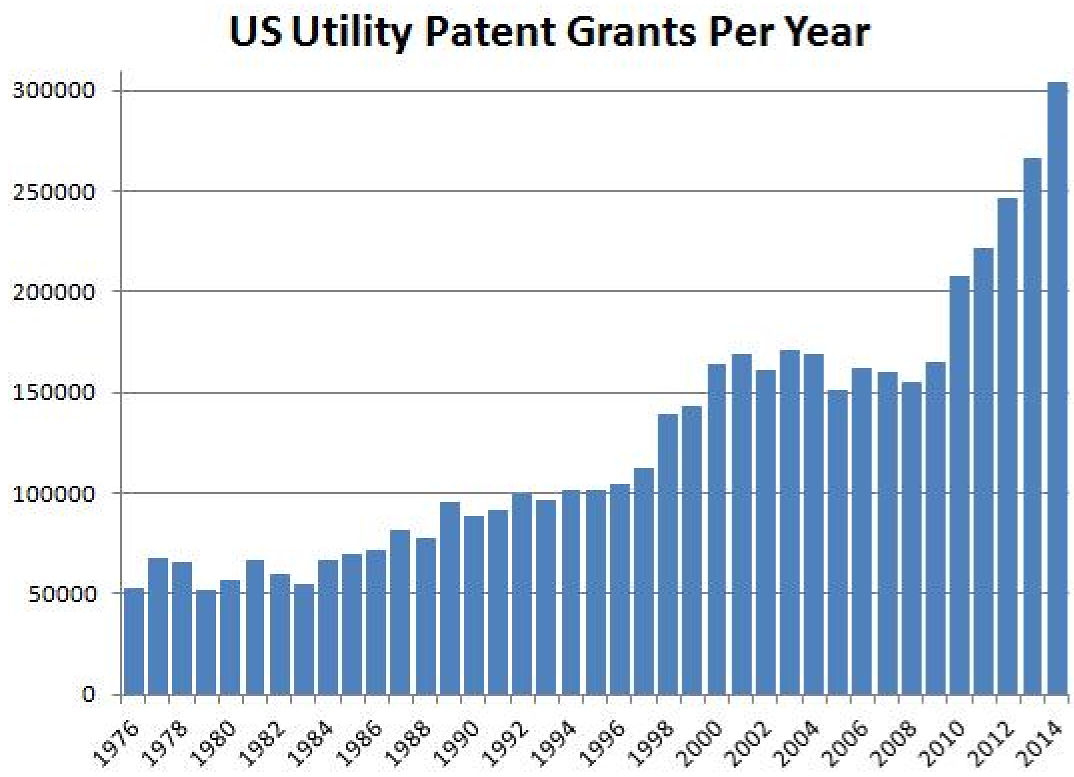

Figure 2. U.S. Utility Patent Grants per Year. Source: Crouch (2014).

B. THE DOD'S NEED FOR INNOVATION

The United States has always required innovative technology or equipment to protect itself. From the time the United States assumed the role of lone superpower at the end of WWII through today, it has led the world in defense-related innovations. Initially, the United States demonstrated its innovative prowess by developing nuclear weapons before any other country, and it continued its drive for innovation as it faced an insurgency in Iraq in 2003. Today, the DOD is planning for a future filled with groundbreaking innovations because of its enormous financial commitment to research and development (R&D).

The United States won the race for nuclear weapons during WWII and used two atomic bombs against the Japanese Empire, which forced Japan to surrender. If the United States had not developed atomic weapons before its enemies, WWII could have ended very differently than it did. Additionally, by using nuclear weapons against Japan, the United States likely spared the lives of millions of people, both civilians and military (Roberts, 2015). The United States catapulted itself to a world superpower and laid the foundation for future defense-related innovations by developing nuclear weapons.

Following the invasion of Iraq in 2003, the DOD's heavy use of precision guided munitions in counterinsurgency (COIN) operations demonstrated the importance of defense related innovations today. COIN environments differ from conventional military environments in that noncombatants are often located in proximity to insurgent forces. When employing ordnance from aerial platforms in a COIN environment, the DOD endeavors to limit collateral damage and civilian casualties because it cannot succeed in defeating an insurgency if it destroys civilian infrastructure or kills as many civilians as it does insurgents.

The DOD (2016) plans to spend approximately $71.8 billion in fiscal year (FY) 2017, or about 12 percent of its budget, on R&D. The DOD accounted for nearly half of the total amount, $152.3 billion, President Obama request for R&D across the government. This financial commitment demonstrates how important innovation is to the DOD. As shown in Table 1, the DOD spends a comparable percentage of its budget on R&D as some of the most innovative companies in the world (Jaruzelski, Schwartz, & Staack (2015).

As the enemies of the United States evolve to defeat its newest defense-related innovations, the United States will need to continually evolve and innovate its weapons and means of engaging these enemies. Not only will the need for innovation increase, but so will the need to innovate quickly as newer technologies overtake older technologies more rapidly. The DOD has required innovation in the past and it will certainly need it in the future.

Company	R&D Spending	
	2015 US $Bil.	% of Revenue
Apple	$6.0	3%
Google	$9.8	15%
Tesla Motors	$0.5	15%
Samsung	$14.1	7%
Amazon	$9.3	10%
3M	$1.8	6%
GE	$4.2	3%
Microsoft	$11.4	13%
IBM	$5.4	6%
Toyota	$9.2	4%

Table 1. R&D Spending by the Ten Most Innovative Companies. Adapted from Jaruzelski, Schwartz, & Staack (2015).

C. THE DOD'S HISTORY OF INNOVATION

The DOD has a history of profound innovations since the end of WWII because it has believed that staying ahead of current and potential adversaries is vital to protecting U.S. interests. When the Russians launched Sputnik in 1958, the United States realized it was behind its rival in the space race and founded the Advanced Research Projects Agency (ARPA) to develop rocket technology and surpass the Russians' technology (Defense Advanced Research Projects Agency [DARPA], n.d.b). Since its founding, the Defense Advanced Research Projects Agency (DARPA), formally ARPA, has developed some of the most radical technologies, which have transformed how the United States wages war. DARPA continues to develop new technologies and capabilities for the U.S. military today.

ARPA created Television and Infrared Observation Satellite (TIROS-1), the first dedicated weather satellite, and the National Aeronautics and Space Administration (NASA) put it in orbit on April 1, 1960 (DARPA, n.d.c). TIROS-1 laid the groundwork for future weather satellites and satellite imagery that the first world now takes for granted. Today, the National Environmental Satellite, Data, and Information Service (2014) provides real-time satellite weather images to the National Weather Service, numerous federal agencies (including the DOD), and allies of the United States. Satellite imagery provides the DOD with accurate and timely intelligence that would be difficult or impossible to obtain by other means. Through the development of satellite technology by DARPA, the DOD enjoys advantages on the battlefield.

While ARPA was developing TIROS-1, it was also working on another satellite system called the Transit Satellite, the precursor to the modern-day Global Positioning System (GPS). Transit was a joint venture between ARPA and the Applied Physics Laboratory at Johns Hopkins University. ARPA managed Transit during the experimental phase, while the Navy managed the program during the operation phase, which began in the mid-1960s (Danchik, 1998). By 1968, 36 satellites encircled the earth and provided reliable, accurate, all-weather navigation for the Navy. Transit was continuously improved and updated over its lifespan, allowing it to operate until the DOD replaced it with GPS in 1996. In 2016, the DOD uses GPS for many different applications including monitoring the movement and positioning of friendly forces on the battlefield through a system called Blue Force Tracker (BFT).

ARPA’s most notable creation however did not pertain to space or satellites but instead concerned information sharing and networking. In 1969, ARPA demonstrated that it could share digital resources among geographically separated computers and the Internet was born (DARPA, n.d.a). Today, the DOD uses networks in nearly everything that it does. Pilots operate Unmanned Aerial Vehicles remotely because of networks; Combatant Commanders can connect to subordinates and superiors alike in real time through networks, and time-sensitive information can be shared around the globe quickly because of networks.

DARPA continues to push the envelope with new technologies and innovation as demonstrated by its Persistent Close Air Support (PCAS) technology. In 2015, DARPA announced a successful test of its PCAS technology, which allows a Joint Terminal Attack Controller (JTAC) to call in air strikes using a specially configured Android tablet. With just three clicks on a tablet, a JTAC coordinated an airstrike and got bombs on target during a demonstration of the PCAS technology (McGarry, 2015). DARPA has a number of innovative technologies that it is currently working on, many of which would seem like science fiction not so long ago.

The DOD supports a number of initiatives aimed at spurring new innovations or developing existing technologies both within and outside the department. The DOD's Office of Small Business Programs administers the Rapid Innovation Fund and partners with small businesses that possess DOD-ready innovative technologies. Additionally, each service has its own portfolio of programs that awards innovative individuals. The prominent program administered by the U.S. Navy is the Secretary of the Navy's Innovation Awards Program. Within this program, service members can compete in eight different award categories, ranging from innovation leadership to data analytics. The DOD leadership demonstrates the department's commitment to innovation by supporting a wide array of programs that encourage innovation.

D. THE U.S. NAVY'S HISTORY OF INNOVATION

The U.S. Navy has a long history of innovation dating back to its very founding. After the American Revolution, the United States no longer enjoyed the protection that the British Royal Navy had been providing before the war but the threats to its merchant shipping in the Mediterranean Sea remained. The United States needed a capable and relatively inexpensive navy. It is worth reviewing how the U.S. Navy interlaced innovation with the very bedrock of the organization to achieve this outcome.

In the late 18th century, the United States badly needed a naval force to protect American merchant vessels from the Barbary pirates in the Mediterranean Sea. The United States Congress passed the Naval Act of 1794, which authorized the United States Navy to build six frigates. There was a lot of money at stake, and many shipbuilders submitted designs. One among them submitted a creative and innovative design that challenged conventional shipbuilding wisdom in the United States.

Through fortune or divine providence, the *Quercus virens* (live oak), which is especially well suited for building wooden war ships because of its hardness, grows only in the southeastern United States. In his book, Toll (2008) tells of a shipbuilder named Joshua Humphreys understood the value live oak trees would add to any ship constructed of it so he incorporated live oak into his construction plans for the six frigates authorized by Congress. Humphrey's decision to use live oak to construct the ships coupled with the sheer size of his designs resulted in controversy (Toll, 2008).

Humphreys' designs were unconventional and rejected by many of his colleagues for a number of different reasons. Even though Congress had authorized the construction of frigates only to safeguard American merchant ships in the Mediterranean Sea, Humphreys had enough foresight to design the frigates so they could fight European navies if the need arose. Humphreys sought to produce exceptionally heavy, well-armed, and fast-sailing frigates that could defeat enemy frigates yet travel fast enough to out run enemy battleships. The United States Navy eventually selected Humphreys' designs for the frigates even though many shipbuilders in the United States doubted them (Toll, 2008).

The United States faced a difficult decision when it decided to build a navy in the late 18th century. The country knew that it could not out build the European navies so it instead decided to utilize an innovative ship design to exploit a gap specific to the British Royal Navy. The six American frigates helped defeat the Barbary pirates and saw a great deal of action in the War of 1812 during which combat proved the value of Humphreys' innovative design. The U.S. Navy was born out of necessity but it prevailed in battle against the most powerful navy in the world because of an innovative shipbuilder and brave sailors. The history of the U.S. military is filled with examples much like the birth of the U.S. Navy wherein innovation helped carry the day.

Today the Navy continues to lead the U.S. federal government and government agencies around the world in innovation. The Institute of Electrical and Electronics Engineers (IEEE) (2015) uses USPTO records to rank organizations based on the strength of their patent portfolios, accounting for both their sizes and qualities. The IEEE has ranked the U.S. Navy at or near the top of its Patent Power Scorecard for the past 10 years. Similar to the method IEEE uses to construct its rankings, the Intellectual Property Owner's Association (IPO) obtains patent data from the USPTO and publishes a patent owner list. The U.S. Navy has consistently ranked high on the IPO annual report detailing the top organizations granted U.S. patents (McCaney, 2015). It comes as no surprise that the Navy consistently scores well on innovation given the important role innovation has played in the Navy since its founding.

E. COMMANDANT OF THE MARINE CORPS CALLS FOR INNOVATION

General Neller assumed the duties of Commandant of the Marine Corps in September 2015 as the DOD and the Marine Corps specifically anticipated a deeply constrained fiscal environment because of the sequester. While the amount of financial resources available to the Marine Corps is uncertain, the American people still expect it to defeat evolving threats in complex environments. General Neller wants to leverage the creative potential of Marines to help solve complicated and expensive problems in simple and inexpensive ways.

In a speech at a Marine Corps Warfighting Lab innovation symposium in early 2016, General Neller called for disruptive thinkers within the Marine Corps to step forward and offer solutions to various problems they have identified in the Marine Corps. General Neller understands that innovation and creative thinking from within the Marine Corps' ranks have the potential to solve problems in unique ways. One example of a DOD "home-grown" innovation is a statistically driven model, developed by Avionics Technician 1st Class Richard Walsh, that improves repair time and saves the U.S. Navy millions of dollars (Bacon, 2016). Individual Marines can offer innovative solutions because they are intimately familiar with Marine Corps technology, equipment, and processes. To answer General Neller's call, the Marine Corps must identify Marines who have the most creative and innovative potential, so it can foster their creativity.

The DOD's sizeable commitment to future innovation demands a better understanding of creative people. A number of researchers have devoted much effort to understanding human creativity, but identifying individuals who possess a great deal of creative potential remains a difficult task. The following chapter explores many of these researchers and the methods they have used to understand human creativity.

From its very beginning, the United States has valued innovation and put a robust patent system in place to foster it. Since its founding, the DOD has developed some of the most innovative technology ever in an effort to keep America safe. Through innovation, the U.S. Navy built uniquely capable ships that helped it defeat the Barbary Pirates in the early 1800s and survive the War of 1812. Approximately 150 years later, innovation helped the United States overtake the Soviets in the space race. In 2016, the DOD continues to use innovation in developing weapons with increased lethality, speed, range, and automation. Innovation has been a critical part of defending the United States since its founding and it will remain important for years to come. What DOD needs now, is a better way to identify who are its innovators. The following chapters seek to identify them.

III. LITERATURE REVIEW

The roots of creativity have a long pedigree across the social sciences, but economists have only just begun to study the subjects of creativity and innovators. Economist David Galenson (2010) from the University of Chicago notes, "For the first time in the history of the discipline, … economists have begun to study how these extraordinary individuals make their discoveries, and the results have been dramatic" (p. 1). Chapter III shows how this new area of research has opened the door for many new kinds of studies. It first discusses the social science literature on creativity and then summarizes the role of patents in measuring innovation and creativity.

A. METHODS USED TO MEASURE INNOVATION

Researchers have conducted studies to glean information from artists to help understand human creativity. Galenson (2010) has shown that artistic innovators can be divided into two groups. The first group, experimental innovators, uses trial and error and an incremental approach to creativity. The second group, conceptual innovators, expresses ideas and emotions through art. Experimental innovators normally create their best work toward the end of their careers whereas conceptual innovators tend to create their best work at the beginning of their careers. Another difference between the two types of innovators is that conceptual innovators tend to work deductively while conceptual innovators tend to work inductively (Galenson, 2010). In another study, Galenson (2003) has compared the taxonomy of artwork by Pablo Picasso and Paul Cezanne to determine when each artist performed his best work. The study found that Picasso performed his best work when he was 26 but Cezanne performed his best work at age 67. According to Galenson, Picasso was a conceptual innovator while Cezanne was an experimental innovator.

Researchers have also measured the creative potential of individuals based on their personality traits. Using meta-analysis, Gregory Feist (1998) has compared personality traits of scientists and artists from various studies to assess the leading indicators, or *effect sizes*, of creativity. In selecting samples for his study, Feist has focused on published studies that compared personality characteristics of scientists and artists. The study found that creative artists and non-artists share many personality characteristics including openness, self-acceptance, conscientiousness, impulsivity, and hostility. However, they do not necessarily share identical personality profiles (Feist, 1998). Therefore, it is reasonable to expect similar personality traits for creative people in future studies even when their professions differ.

In addition to personality traits, researchers have used individual characteristics to measure creativity. Using other studies, Thomas Chamorro-Premuzic (2013), professor and CEO of Hogan Assessment Systems has identified five characteristics successful innovators share (Shane & Venkataraman, 2000; Martin, McNally, & Kay, 2013; Brandstätter, 2011; Hülsheger, Anderson, & Salgado, 2009). First, successful innovators have an opportunistic mindset, and they are more adept at recognizing opportunities to solve problems than most people. Second, successful innovators have formal education or training. Some of the most prolific innovators, including Steve Jobs and Bill Gates, dropped out of college, but they are the exception rather than the rule. Third, successful innovators are proactive and exhibit a great deal of persistence. Fourth, successful innovators are cautious, risk averse, and more organized than the average person is. Finally, successful innovators leverage their network of coworkers and colleagues during the innovation process—it is a misconception that innovators work alone. While not all innovators exhibit these five characteristics, the research indicates that most successful innovators exhibit them (Chamorro-Premuzic, 2013).

Angela Duckworth's (2016) "grit" concept seems to align with Chamorro-Premuzic's observation of persistence in creative people. Duckworth has devoted much of her professional life to studying successful people. Her studies have suggested that successful people possess one universal characteristic, grit.

Duckworth has defined grit as the combination of passion and perseverance a person has for a specific goal for a long period. Perseverance is the critical element here because people get passionate relatively easily but few people maintain their passion over an extended period.

In numerous studies across many different activities, Duckworth has administered a grit scale to measure passion and perseverance, and found that grit predicts success better than talent does. In multiple studies of West Point cadets, Duckworth's grit scale better predicted who made it through Beast, an intense seven-week training program during a cadet's first summer, than did any other measure. In another study, Duckworth administered the grit scale to 273 participants in the Scripps National Spelling Bee and found that the grittier spellers went further in the competition. Interestingly, she also concluded that talent and grit were unrelated, meaning that gritty people are not necessarily the most talented.

Throughout her book, Duckworth (2016) shows that in the equation of success, effort has twice the weight of talent. She contends that success is a product of skill and effort, and skill is a product of talent and effort. Duckworth found that grittier people put forth more effort and exhibited greater follow-through.

Joy Guilford proposed the concept of divergent thinking as a way to measure an individual's level of creativity. Guilford (1971) identified four characteristics associated with divergent thinkers:

1. Fluency: measures the number of responses
2. Flexibility: measures how many different types of responses
3. Originality: measures the uniqueness of responses
4. Elaboration: measures the detail of responses

The general idea behind divergent thinking is that creative people tend to score higher in the four characteristics than people who are not creative. Divergent thinking leads to many solutions to a problem, whereas convergent thinking leads to one solution. Figure 3 provides an example of a divergent-thinking test and its results. As shown, creative people perform better in generating a variety of solutions in a divergent context than people who are not creative (Guilford, 1971).

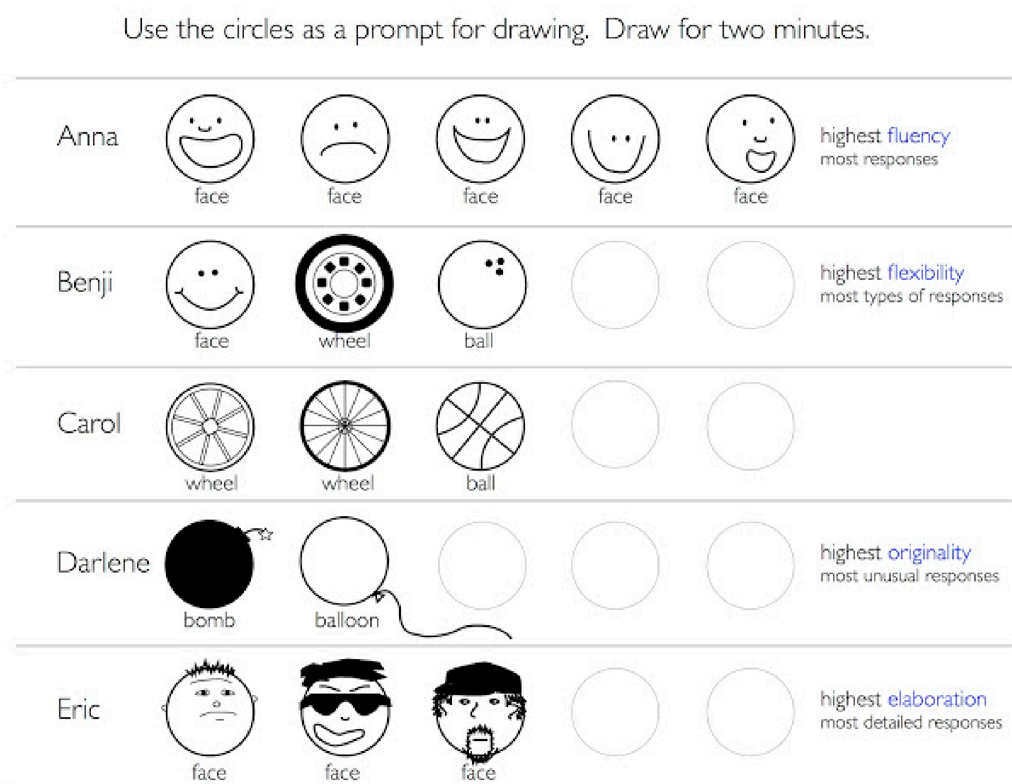

Figure 3. Example of a Divergent-Thinking Test. Source: Nilsson (2012).

Scholars and researchers have held Ellis Paul Torrance, an American psychologist, in high regard for his work on human creativity. During his time teaching and conducting research involving psychology of survival with the United States Air Force, Torrance learned that the foundational element of survival is creativity. His research has also noted that risk-taking is essential for attaining unusual achievements and constructive behavior. Torrance's development of the Torrance Test of Creativity (TTCT) gained worldwide attention. The TTCT combines verbal and figural components to measure individual creativity (Herbert, Cramond, Neumeister, Millar, & Silvian, 2002).

Herbert et al. (2002) describe the verbal and figural components of the TTCT as follows:

> The verbal component consists of five different types of activities: Ask-and-Guess, Product Improvement, Unusual Uses, Unusual Questions, and Just Suppose. The stimulus for each task consists of a picture to which individuals respond in writing. The figural component consists of three different activities that take 10 minutes each: Picture Construction; Incomplete Figures; and Repeated Figures. All of these activities require respondents to draw additions to shapes and incomplete figures to give meaning to the shapes. (p. 15)

The TTCT and divergent-thinking tests are similar except that the TTCT incorporates a verbal component.

Treffinger, Young, Selby, and Shepardson (2002) have developed four behavioral categories of creative people. The first category consists of generating ideas and includes cognitive characteristics such as divergent thinking and metaphorical thinking. The second category consists of digging deeper into ideas and includes cognitive characteristics usually referred to as convergent-thinking. The third category consists of exhibiting openness and courage to explore ideas and includes personality traits, in other words, interests, experiences, self-confidence, and attitudes. The fourth category consists of listening to one's inner voice and contains traits pertaining to identity, goals, and motivation or grit (Treffinger et al., 2002).

Treffinger et al. (2002) have also recognized that creativity does not occur in a vacuum but requires the interaction of essential elements. They have developed the Characteristics, Operations, Context, and Outcomes (COCO) model to explain how the four elements needed for creativity interact. Characteristics include the categories discussed in the preceding paragraph. Operations encompass the strategies and methods individuals use to solve problems, make decisions, and generate ideas. Context includes a person's situational dynamics, culture and climate as a way to describe the physical environment. Outcomes include the results of a person's effort, which are often products or ideas. Creative productivity is complex and dynamic within the COCO model. The interaction within the model either helps or hampers an individual's creative productivity (Treffinger et al., 2002).

Teresa Amabile, Head of the Entrepreneurial Management Unit at Harvard Business School, has developed a simple model to explain how creativity arises (Adams, 2005). Amabile has suggested that creativity results from the confluence of expertise, critical-thinking skills, and motivation. First, she has described expertise as the complete knowledge and understanding an individual brings to a creative effort. Second, she has described critical-thinking skills as ways individuals approach problems depending on their personalities. Third, Amabile has described motivation as the drive to succeed and assesses that intrinsic motivation is the most important type. Figure 4 depicts Amabile's model for how creativity arises (Adams, 2005).

There has been a great deal of research concerning human creativity and innovative behavior since the 1950s. Some of the newer studies support previous studies. A good example of this is Duckworth's findings that suggest grit is very much similar to persistence, as Chamorro-Premuzic has described it. Other research, like Guilford's divergent thinking, has stood the test of time and is still relevant today. Still, other studies stand out because they have utilized large sample sizes to derive results. Duckworth, for example, has administered her grit scale or variations thereof to thousands of people across many different occupations. Similarly, Feist has conducted meta-analysis using large samples to determine that creative people demonstrate similar personality characteristics regardless of profession. In conclusion, these studies broadly suggest creative individuals possess a set of specific characteristics, although there is less agreement on *which* set of characteristics.

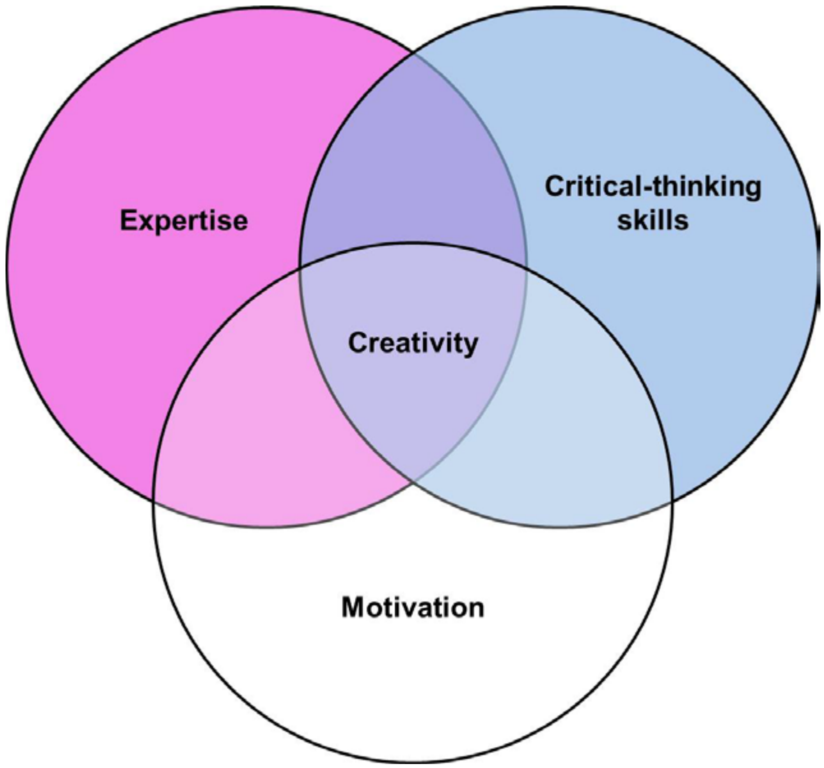

Figure 4. Three Components of Creativity. Adapted from Adams (2005).

B. PATENTS AS A MEASURE OF INNOVATION

Studies on creativity have focused on different metrics to evaluate whether a person is creative such as measures of impact for artists and writers, number of new start-up firms for individual entrepreneurs, and other inventive activities. Patents offer one such measure of creativity that economists have used extensively.

One method for measuring innovation is simply tabulating the number of patents assigned or granted to an organization or individual. Because so many studies suggest patents can measure a company's or organization's level of innovation, patents are often the de facto metric for organizational creativity. Using patents as the measure for inventive activity is so ubiquitous that much of the research now focuses on how best to understand patents as proxies for innovation. For instance, Faith (2013) has suggested that the technology classification system for patents might offer a better measure of innovativeness than merely a count of patents issued. Currently, the United States Patent and Trademark Office (USPTO) (2012) has 35 classes for design patents and more than 400 utility classes. Other studies, including one by Fallah, Fishman, and Reilly (2009), have shown that forward citations—the number of times a patent is referenced by newer patents—is a good measure for how important that patent is to industry.

Michael McAleer and Daniel Slottje (2005) have conducted a study that correlates the ratio of total U.S. patent applications to successful patent applications—the patent success ratio (PSR)—with the growth of real gross domestic product (GDP). The study found a Granger-causal relationship between growth in real GDP and PSR. Since innovation is a leading economic driver that fuels economic growth, it is not surprising to see this correlation. The results of this study suggest that patents can be used as a proxy for innovative activity.

Even though there are a number of studies that suggest patents are a good measure of innovative activity, there are potential pitfalls in using patents as proxies for innovation. One obvious problem is that patent data do not capture all innovative activity. When the DOD develops a technology that could jeopardize national security if made available through a patent, the USPTO does not issue a patent for that particular invention. There is no way of knowing how many innovations do not receive patents because such patents would jeopardize national security.

Additionally, some innovators use trade secrets instead of patents to protect their creations. Coca-Cola offers one of the best-known examples in which a company did use a patent to protect a major innovation. Coca Cola's executives have decided to retain the recipe as a trade secret because patents only protect the innovation for 20 years whereas trade secrets can theoretically protect an innovation forever. Moser (2013) has contended that most innovative activity takes place outside the patent system even in countries that have patent laws. If large companies like Coca-Cola are not patenting their innovations, using patents to gauge innovative activity could lead to biased results.

Using patents to measuring innovative activity in countries that have no patent laws is ineffective, but that does not mean people in these countries are not creative. Moser (2013) stated, “Countries without patent laws have produced as many innovations as countries with patent laws during some time periods, and their innovations have been of comparable quality” (p. 40). Moser’s observation underscores a critical problem faced by researchers who use patents as a proxy for innovation.

Hippel (1988) argued that companies might choose not to use patents to avoid patent infringement. He provided a hypothetical example in which a company decides not to patent as a better option. In the example, firm B decides not to patent an improvement to a patented process developed by firm A. If firm B patents its process improvement, it cannot use the improvement without first arranging an agreement with firm A. This type of scenario is common in fields where technologies develop quickly and many patents remain in effect because new patents may infringe on existing ones. This example illustrates why some companies elect not to patent. There is no way of knowing how many innovations go unpatented because of this phenomenon.

Certain biases within a patent system also affect the tendency of individuals or companies to patent. According to Pierre Desrochers (1998), these biases have included the type of invention, size of a company, and the industry in which the company operates. Researchers should carefully consider these biases because they can lead to incorrect conclusions and recommendations.

Although companies tend to prefer secrecy rather than patents to protect process innovations, companies tend to prefer patents rather than secrecy to protect product innovations. Desrochers (1998) stated, “Only 7 percent of the surveyed firms said that they frequently used patents for process innovations, whereas 57 percent said that only in very rare occasions would they try to patent process innovations” (p. 60). The study indicates that patent data does not capture most innovation associated with process improvements.

The size of a company can also affect how likely it is to patent. Ceh (1997) found that larger companies tend to patent more often than smaller companies do. This finding is not surprising because larger firms typically have greater financial and human resources available to patent more often. However, researchers could erroneously conclude that small firms are less innovative than large firms are simply because large firms patent more frequently. Conclusions of this sort ignore the importance of Ceh's findings.

The industry in which a company operates also has a significant effect on the propensity to patent. According to Desrochers (1998), the pharmaceutical industry in the 1990s had the highest propensity to patent of all industries. More than half of pharmaceutical firms tried to patent 80 percent of their innovations while three-quarters of firms in other industries tried to patent 20 percent or less of their innovations. His research suggests that researchers need to understand the context in which a company operates before drawing any conclusions regarding that company's creativity based on its patenting tendency. If researchers take patents at face value without accounting for the biases that affect the propensity to patent, they can make erroneous conclusions. According to Desrochers (1998) the pitfalls associated with using patents as a proxy for innovative activity should be seriously considered when conducting such research.

C. CONCLUSION

There are legitimate concerns over using patents as proxies for innovative activity because no patent system captures all innovative activity. However, conventional wisdom holds that wherever patent laws exist, individuals who utilize the patent system to protect their creations possess creative and innovative abilities. Therefore, even though the patent system does not capture all innovative activity it captures enough of it that a study designed to investigate the characteristics or traits of individuals who patent their inventions should provide some insight into human creativity. This is the subject of my thesis.

The Marine Corps has a lot to gain from a study that provides insight into human creativity. If the Marine Corps can identify the people within its ranks who have the most creative potential, it can target those individuals by retaining them and assigning them to billets that will help foster their creativity. The Commandant of the Marine Corps has called for disruptive thinkers to step forward and help solve difficult problems facing the Marine Corps. This study helps identify who these disruptive thinkers are.

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IV. DATA

In this section, I describe in detail the process of identifying individual inventors among Marine Corps officers. I began with a sample of all Marine Corps officers (9,291 officers) that accessed between 1990 and 2000. Then, using the complete first name, last name and first initial of the middle name, I identified a set of Marine Corps officers with the same first name, last name and first initial of the middle name that appear in the list of inventors in the USPTO. Since many of these name matches could be false positives because of common first and last names among the Marine Corps population, I used a set of assumptions as described below to rule out false positives.

Out of the 9,291 sample of officers, I filtered out nearly 90 percent of the officers based solely on name. Next, I filtered the matches by applying broad, yet well-informed assumptions based on an officer's duty status, known locations, and when an inventor filed a patent application. This set of assumptions quickly filtered out approximately two-thirds of the matches and rested entirely on patent application filing dates and patent assignees.

The second set of assumptions filtered through the remaining matches using locations and dates to determine whether an officer could have claimed a certain location as his address on a specific date. Given the strict criteria for identifying positive matches for inventors, it is likely the study may have missed some inventors. That said, my approach reduces any concerns of measurement error, and I am confident of the Marine Corps inventors identified in the data.

We focused on Marine Corps officers who accessed between the years 1990–2000 because these people fit the age profile of average inventors today. The average age for officers in our sample at accession is 24.9 years. Therefore, the average age of our sample in 2016 is approximately 46 years, as shown in Table 2. According to Taehyun Jung and Olof Ejermo (2014), the average age of inventors in the United States is 47.2 years. Therefore, the average age for our sample in 2016 approximately straddles the average age of inventors in the United States. This gives us a good chance of capturing younger, older, and average-age inventors.

Year	Number of Officers	Average Age then	Average Age (2016)
1990	869	25.6	51.6
1991	1,061	25.3	50.3
1992	1,065	25.7	49.7
1993	952	24.4	47.4
1994	883	25.2	47.2
1995	752	25.3	46.3
1996	880	25.2	45.2
1997	782	25.2	44.2
1998	613	23.7	41.7
1999	450	23.1	40.1
2000	597	23.3	39.3

Table 2. Average Age of Officers at Accession and in 2016

Collecting the names of inventors from five years before the date of the first datum point captures officers who patented before they joined the Marines. To provide the best chance of matching officers to inventors, I collected the names of all inventors to whom the USPTO granted patents since 1985.

The USPTO collects very little information about individual inventors. As such, we only collected first names, middle initials, and last names from the USPTO website. The Marine Corps collects significantly more information about individuals. For the officers in my sample, I collected four different types of data. The first type of data concerns demographics and includes age at accession, marital status, education level, race, and gender. The second type of data concerns dates and includes accession and separation dates, and validation dates of last known address. The third type of data concerns locations and includes home of record, last known address, and duty station assignments. The fourth type of data concerns data specific to serving in the military and includes physical fitness test scores, rifle qualification scores, pistol qualification scores, commissioning source, reason for separation, military occupational specialty (MOS), and whether an officer had prior enlisted service. Additionally, I also collect information regarding the patenting process for the United States Navy from the Office of Naval Research (ONR).

Certain trends in the sample closely matched trends of inventors in the United States as Jung and Ejermo (2014) found in their study. They found that 94.8 percent of inventors in the United States are male, and 93.75 percent of our sample was male. Additionally, they found that 93.6 percent of inventors in the United States have received at least tertiary education. 93.3 percent of our sample had earned at least a four-year college degree.

A. METHOD FOR COMPARING OFFICERS TO INVENTORS

Our sample consisted of 9,291 officers who commissioned between 1990 and 2000, and our list of inventors since 1985 consisted of more than one million names. The inventor list consisted only of individuals to whom the USPTO granted patents but ignores patent applications. We used the Python programming language to construct a search algorithm that compared the complete first name, last name and first initial of the middle name of officers in our sample to those of individuals on the inventor list. The search algorithm matched 1,068 officers to the names of inventors on the inventor list.

Many of these matches were false positives because these officers had very common names. Therefore, we constructed a two-step method for determining false matches, soft matches, and hard matches. The first phase quickly identified as false matches any officers who could not have been the inventor based on some well-informed assumptions. The second phase identified hard and soft matches while continuing to weed out false matches. We utilized Google Patents and the patent search function on the USPTO website to manually search for each of the 1,068 matches during both phases.

We categorized matches into three types. Officers who matched on name only were termed *false matches*. Officers who matched on name, location, and time were termed *hard matches*. We knew there would be some uncertainty surrounding several individuals in our sample as to whether they were good matches. This uncertainty centered on common names and lack of information about an officer's whereabouts after leaving military service. We termed the matches we could neither eliminate nor confirm definitively as *soft matches*. To reduce measurement error in the analysis, we do not explicitly study the characteristics of soft matches. In principle, future work can study these individuals in more detail.

Google Patents is a search engine that catalogs patents and applications from a number of different governmental patent databases including the USPTO. In 2006, Google collaborated with the USPTO to provide a patent search function. The partnership has grown since then, and in 2010, Google began offering patent and trademark bulk data at no cost to users (Lipman, 2010). Google Patents accesses all granted U.S. patents and published patent applications dating back to 1790.

The Google Patents search engine is intuitive and has a number of different criteria people can use to search for patents. We searched each officer match by entering his first name, middle initial, and last name in the inventor field. Unfortunately, Google Patents does not allow users to enter suffixes (e.g., jr., II, or III) in the inventor search field. About ten-percent of the sample had suffixes so we had to scrutinize the search results more closely for these individuals. Additionally, we used filters to show only patents granted since 1985 in the search results. These filters helped streamline the process of determining whether an officer was a legitimate match based on age, location, active-duty status, and patent assignment. We sorted the search results in Google Patents, so the most recent patent would appear at the top of the search results. What we found most useful about Google Patents was that it listed patent title, filing date, and original assignee in the search results. From a practical standpoint, searching with Google Patents was easy because I could enter names in the search field just as one would say a name.

The USPTO search function was not as user friendly as Google Patents because the search results provide links to individual patent documents while displaying only the patent number and title. For our research, this was not very helpful because we had to click on each link to access the filing date and patent assignee. Despite this downside, the USPTO provides users with more functionality than Google Patents because the database includes 55 different fields for searches. The search results for the USPTO automatically appear in chronological order with the most recent patent appearing at the top of the search results. One quirk about the USPTO search function is that users must enter the last name first followed by a comma and then the first name followed by a middle initial. Similar to Google Patents, the USPTO search function does not permit users to enter suffixes in its search fields. Despite some of the reduced user-friendliness of the USPTO search function; it was still a useful tool during our research.

B. ASSUMPTIONS

1. Phase One

In the first phase, we primarily used Google Patents to eliminate a significant number of false positive officer matches based on four assumptions derived from discussions with the ONR and knowledge about average inventors in the United States. These assumptions included the average age of inventors in the United States, patenting trends of particular inventors, workload of officers in their first year of service, and the filing date for a patent coupled with the original assignee.

Google Patents was exceptionally helpful in conducting phase one of our plan to eliminate false matches because it provided helpful information directly in the search results. By chronologically ordering the search results from newest to oldest, we could determine right away if any of the search results met our first and second assumptions because the patent application date appears at the bottom of each search result. Similarly, we could also see if any of the search results met our third assumption by looking at who the original patent assignee was and cross-referencing that information with the application filing date. Finally, we looked through each search result to determine whether an inventor had a patenting trend that fit with our third assumption by looking for who the original patent assignee was. Google Patents provided all the information we needed to eliminate 739 matches from the original list of 1,068 matches, simply by entering an officer's name and setting the appropriate filters.

Our first assumption was that any patent whose application filing date was before an officer's accession date did not belong to the officer unless the officer was at least 25 years old before accessing. In making this assumption, we believed that it was unlikely for a person to apply for a patent at a young age, especially considering that most of the officers were completing college in the years immediately preceding their accession. We classified as a false match any patent application filed before the officer accessed if the officer was younger than 25 at that time. We ruled out 36 officers because of this assumption.

Our second assumption was that any patent whose application filing date fell within the officer's first year of service did not belong to the officer. We assumed it would be unlikely for an officer to apply for a patent during the first year of service because of the time demands of the Basic School and initial MOS training coupled with three moves. We classified as a false match any patent whose application date fell within the first year of service for an officer. We ruled out 146 officers because of this assumption.

Our third assumption was that patents whose application filing dates occurred during an officer's time in service would have been assigned to the United States government or the inventor(s) listed on the patents would have retained ownership. ONR explained that certain laws, regulations, and Secretary of the Navy Instructions give the government the right to patent assignment under certain conditions (A. Ressing, personal communication, July 18, 2016).

The determination regarding the obligation to assign to the government involves a complex legal determination as outlined in Title 37 of the Code of Federal Regulations and is beyond the scope of this paper (Patents, Trademarks, and Copyrights, 2009). We classified as a false match any patent whose application filing date occurred during an officer's time in service and the inventor assigned the patent to anyone other than the government or himself. We ruled out 608 officers because of this assumption.

Our fourth assumption was that, during an officer's time in service, similar patents by the same inventor should not list the government or the inventor as the assignee on one patent and an organization other than the government as the assignee on a different patent. This assumption relates closely to our third assumption but goes a step further by assuming that the inventor who assigned the invention to himself or the government is the same person who assigned a similar invention to an organization other than the government. We classified as false matches any patents that were similar in nature and assigned to the government or inventor(s) and a private company during an officer's time in service. We ruled out 95 officers because of this assumption.

During phase one we recorded two notes that would be important to conducting phase two of our plan to eliminate false matches. First, we recorded the most recent and the earliest filing dates for a patent. During phase two, we used this information to determine what additional information about the officer we would use to determine a true or false match. Second, we recorded the link to the Google Patents search for quick reference during phase two.

2. Phase Two

We had to make some assumptions in phase two for eliminating false matches just as we had in phase one. We carried 329 matches forward to our second round of elimination but still believed many of these were false matches. Therefore, we made three assumptions to eliminate as many of the false matches as possible. All of the assumptions in phase two were predicated on the location listed on the patent for the inventor and whether an officer could have claimed that location as his residence when the patent application was filed. When an individual files a patent application, he or she must provide a mailing address and a city and state of residence if they reside in a place different from where they receive mail. The homes of record, a chronologically sorted list of duty stations, and last known addresses for officers in our sample made it possible to eliminate certain matches and identify others as hard or soft matches.

Our first assumption was that an officer's home of record should match the location listed on the patent if the invention occurred before the officer joined the military. Some officers changed their home of record while they were in service, so in these cases, we had to compare the city and state listed on the patent against both homes of record. We did not know when the officer changed his home of record. For patents filed before an officer accessed, the home of record alone was enough information to determine whether the match was good. For patents filed after the officer accessed and the home of record did not match the location on the patent, we moved on to a second assumption. We classified as a false match any patent application whose filing date occurred before service but the home of record did not match the location listed on the patent. We ruled out 28 officers because of this assumption.

Our second assumption was that if an officer changed his state of legal residence (SLR) from his home of record, he might have entered his new SLR as the location on the patent application. Military service members are unique in that many—perhaps most—have a SLR that is different from where they live during their time in service. However, in some cases, a service member's SLR matches the state where he or she lives while in service. This assumption held true for nearly all of the 329 matches we carried forward from the first round of elimination.

Under this assumption, we first looked at the patent application filing date and cross-referenced it with the duty stations an officer was assigned to at the time the application was filed as well as all the duty stations before the application was filed. We understood that the officer could have claimed as his SLR any states from duty stations prior to the patent-application filing date. With this information, we could see whether the location on the patent matched the location of any duty stations prior to the patent application date. We classified as false matches any patent applications whose affiliated addresses did not correspond with the known home of record or duty stations. We ruled out 97 officers because of this assumption. However, we classified as hard matches any patent whose affiliated addresses corresponded with the known homes of record or duty stations when the application was filed. We identified nine hard matches because of this assumption.

There is some general confusion even among military service members about the difference between the home of record and the SLR. In many cases, the home of record is synonymous with the SLR, especially early in a service member's career. The home of record is simply the location from where a person joins the military. In nearly all cases, people join the military in a state that is also their SLR. The SLR is a location where a service member intends to return after military service. However, a service member may change his SLR during service by being physically present in a new state and demonstrating intent to remain in the new state. A service member can only change his home of record to correct an error or if he leaves service and then rejoins (Fort Bragg Office of the Staff Judge Advocate, 2016).

Our third assumption dealt with patents filed after the officer left service. When an officer leaves service, usually he no longer claims a state where he is not living as his SLR. Therefore, previous duty stations and homes of record are no longer relevant for determining whether the match is good because the officer would not have listed these locations on his patent application. In these cases, we used the last known location as provided by Headquarters Marine Corps Manpower and Reserve Affairs (HQMC M&RA) to determine whether the match was good. Importantly, the last known address included a validation date. We first looked at the patent application filing date, and if it occurred after the officer left service, we compared the location on the patent to the last known address and validation date. We classify as hard matches those patents where the location on the patent matched the last known location and the last known location was validated before the patent application filing date. We identified 11 hard matches because of this assumption.

Most of the matches on which we tested our third assumption ended up being soft matches for two reasons. First, if there was a gap between when the officer left service and the validation date for the last known address, and the inventor filed his patent application during this gap, we could not confirm whether the match was good or bad based on the location provided on the patent. It is possible for an officer to leave military service, move to a location, file a patent application, and then move to the last known address. For example, one officer in our sample separated from service in 2005 but her last known address was updated in 2016. This officer matched an inventor who filed a patent application in 2010. Without knowing the officer's whereabouts in 2010 we could not classify the match as hard or false. Our level of uncertainty increased about the probability of the match being good as the time between an officer's end of service and last known address validation date increased. Second, if the inventor filed a patent application after the validation date associated with last known address, but the location on the patent differed, we could not determine whether the match was good. As an example, the validation date of one officer's last known address in our sample was 1993 and he matched an inventor who filed a patent application in 2012. Without knowing the officer's whereabouts in 2012, we could not confirm or discard the match. Our level of uncertainty increased about the probability of the match being good as the age of the validation date increased. The average validation date range of the last known address for the 329 officers carried forward to phase two was 5.6 years. We classified as soft matches those patents where the location on the patent did not match the last known location. We ruled out 11 officers and identified 173 soft matches because of this assumption.

Throughout the study, we looked for creative ways to confirm hard matches. For one of the matches, the patent had two inventors listed and they appeared to be related based on identical surnames. The category of invention, officer’s marital status, and fact that both inventors listed the same location on the patent application indicated that the two inventors were husband and wife. We confirmed the individual as an inventor using the individual’s marital data from HQMC M&RA. Unfortunately, no other hard matches presented opportunities to confirm the match beyond name, date, and location data of the officer.

After sorting through a sample size of 9,291 officers who accessed between 1990 and 2000, we identified 1,068 officers as potential matches to inventors in the USPTO database. We then utilized an iterative two-phased method coupled with several well-informed assumptions to sort through these potential matches. Ultimately, we found 20 hard, 173 soft, and 875 false matches. In the next chapter, we provide qualitative and quantitative analysis of these hard matches namely the military inventors.

C. VARIABLES

I constructed two dependent variables, an indicator for being an inventor and the number of patents granted by the USPTO. I used demographics and military factors to construct independent variables. What follows are descriptions of the independent variables.

First, I split race into six indicator variables including African American, White, American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, and no response. Next, I segmented education level into nine indicator variables ranging from high school diploma to post master’s degree. In the regression analysis, however, I just included an indicator for an undergraduate degree as the highest education level attained by an individual at accession and another indicator for high school diploma as the highest education level attained at accession. For education level, I created another variable to indicate if an officer had utilized a government-funded education program. Military academies, and the Enlisted Commissioning Program are government-funded education programs and government-funded scholarships are available to many who participate in the NROTC program. For the purpose of this study, we considered these commissioning programs government funded. Lastly, I created indicator variables for marital status and gender.

Headquarters Marine Corps M&RA provided age at accession in the data but some of the age data were missing or inaccurate. For age at accession, 387 officers, including two hard matches, had missing values. I did not drop individuals with missing ages from the regression analyses because doing so would have dropped 10 percent of the inventors. Instead, these individuals were not included when calculating average age at accession. Two of the inventors had ages that reflected current age instead of age at accession. I used accession dates to estimate a reasonably accurate age at accession for these two individuals.

There were more indicator variables to create for the military factors. I began by generating a variable for months in service. Seventeen percent or 1,629 officers in the sample had missing accession or separation data. For these individuals, I assigned a missing value in place of an accession date or a separation date. To calculate months in service, I subtracted the accession date from the separation date. If officers had not separated by May 2016, which is when HQMC M&RA pulled the data, months in service was the difference in months between May 2016 and an individual's accession date. Two hard matches had incorrect accession dates. For both of them, I was able to use the dates associated with their first duty station, the Basic School, to estimate a reasonably accurate number of months in service.

For rank at accession, I divided the sample into three segments including second lieutenants, warrant officers, and first lieutenant and above. Most of the sample was second lieutenants and all individuals in the sample had rank at accession data.

For pistol qualification scores, I constructed variables to correspond with qualification levels as defined in Marine Corps Order 3574.2J W/CH 1, the Marine Corps marksmanship manual from 1999 to 2007. Scores of 344 or higher were considered expert, 305 to 343 sharpshooter, 245 to 304 marksman, and less than 245 unqualified. I dropped two pistol scores because the values were non-numeric. Twenty percent of the sample, or 1,839 officers, were missing either initial or final pistol qualification scores.

The process to sort through 9,291 officers required the consistent application of the assumptions described in this chapter. All of the hard matches are matched on three criteria including, name, date, and location. If I could not match an officer on all three criteria, the officer was not included as a hard match. When a unique opportunity presented itself, as it did with an officer who patented an invention with his spouse, I took advantage to match him on a fourth criterion. The next chapter uses the data and variables described in this chapter to discuss summary statistics, construct linear probability models, and describe information associated with the patents for each inventor.

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V. RESULTS

This chapter examines the different categories of data collected on officers in the sample and analyzes them as they pertain to hard matches identified in this study. As mentioned before, I only focus on the 20 hard matches as the inventors comparing them to the rest of the Marine Corps officer population that accessed between 1990 and 2000.

A. SUMMARY STATISTICS

The summary statistics, as shown in Table 3, detail the differences between the means of variables associated with inventors and non-inventors. I calculate the statistics using the variables described in the previous chapter and include only variables used in the linear probability models presented later in this chapter. Many of the summary statistics appear to be notably different between inventors and non-inventors.

All inventors were male which differs from the sample only slightly where nearly 94 percent were male. This finding also closely aligns with a study by Jung and Ejermo (2014) that found 95 percent of inventors in the United States are male.

Inventors represented only two races, African American and white. Fifteen percent of hard matches were African American. This percentage is higher than the 6.5 percent of the sample that was African American. Eighty-five percent of hard matches were white which closely resembled the sample where eighty-seven percent of the officers are white.

Inventors consisted of both married and single officers. Sixty-percent of inventors were married, which is, less than the 77 percent of officers who were married in the sample. Forty percent of inventors were single. For comparison to Marines today, 56.3 percent of company-grade officers and 90.4 percent of field-grade officers in the Marine Corps today are married according to Headquarters Marine Corps Marine & Family Programs (2015).

Variable	Inventors	Non-Inventors	Sample
	Mean	Mean	Mean
Male	100%	93.73%	93.74%
Black	15%	6.48%	6.50%
Asian	0%	1.34%	1.33%
Never Married	40%	22.90%	22.94%
Age	23.16	24.88	24.89
Warrant Officer	0%	6.89%	6.88%
1stLt-Gen	10%	8.60%	8.60%
Months in service	106.3	128.17	128.13
Undergraduate degree	85%	62.58%	62.62%
High school diploma	0%	5.31%	5.31%
Govt. Funded education	55%	43.08%	43.11%
Expert initial	75%	64.09%	64.12%
Sharpshooter initial	20%	26.18%	26.17%
Marksman pistol initial	0%	8.61%	8.59%
Unqualified pistol initial	5%	0.55%	0.56%
Expert pistol last	85%	70.54%	70.57%
Sharpshooter last	15%	21.96%	21.95%
Marksman pistol last	0%	6.52%	6.50%
Unqualified pistol last	0%	0.49%	0.48%

Table 3. Summary Statistics for Inventors, Non-inventors, and Sample

The education levels of inventors closely aligned with the trend that inventors typically have higher levels of education. Seventeen hard matches had obtained a bachelor's degree, two had earned a master's degree, and one had earned a professional degree. Again, this finding aligns with Jung and Ejermo's study (2014) that determined 93 percent of inventors in the United States had at least a tertiary education. Since the Marine Corps does not update education data after officers separate from the Marine Corps, the education data for the sample could be inaccurate. Most of the separation dates for inventors are more than 10 years old and these individuals may have obtained higher levels of education than the data show.

The average length of service for inventors was eight years and 10 months while the average length of service for non-hard matches was 10 years and eight months. These statistics are somewhat unexpected and may indicate the Marine Corps is not retaining innovative officers more than it is retaining non-innovative officers.

Unsurprisingly a majority of officers in the sample including inventors were second lieutenants when they accessed. The inventors included two individuals who accessed at a rank higher than that of second lieutenant. The officers who accessed at a rank above second lieutenant may have transferred to the Marine Corps from other services.

Fifty-five percent of inventors commissioned through government-funded commissioning programs whereas only 43 percent of non-inventors commissioned through government-funded education programs. The relatively larger percentage of inventors utilizing government-funded commissioning programs may indicate the Navy and Marine Corps are targeting creative people with these programs.

Inventors seem to perform better on initial and last pistol qualification scores. Another interesting aspect of the pistol scores is that both inventors and non-inventors generally showed improvement as the percentage of experts and sharpshooters were greater for last pistol score than initial pistol score.

B. REGRESSION ANALYSIS

In this section, I describe the results of quantitative analysis of the findings in this study. I used linear probability models to analyze the results of this study. The estimating equation used was as follows:

$$y_i = \beta_0 + \beta_1 Demo_i + \beta_2 Education_i + \beta_3 Military_i + \varepsilon_i$$

As described previously, the dependent variables y_i are indicator equal to one if an individual has a patent and the number of patents. $Demo_i$ is a vector of indicators for different demographic characteristics, $Education_i$ is a vector of individual education characteristics, and $Military_i$ is a vector of military-related characteristics for individual i.

Tables 4 and 5 show the results using simple linear probability models. The regression output in Table 4 shows coefficients and standard errors where being an inventor is the dependent variable. Demographics, education, and various military factors are independent variables in this regression analysis. Given concerns with linear probability models, Appendix A and Appendix B show probit regression models for comparison. They yield results similar to those of the linear probability models.

VARIABLES	Inventor vs. demographics	Inventor vs. demographics, education	Inventor full model
Male	0.0025*** (0.0006)	0.0024*** (0.0006)	0.0016** (0.0007)
Black	0.0035 (0.0030)	0.0035 (0.0030)	0.0033 (0.0033)
Asian	-0.0020*** (0.0005)	-0.0019*** (0.0005)	-0.0018* (0.0009)
Never married	0.0017 (0.0014)	0.0014 (0.0016)	0.0014 (0.0019)
Age at accession	-0.0001*** (0.0000)	-0.0001** (0.0000)	-0.0002 (0.0003)
Warrant Officer			0.0008 (0.0024)
1stLt-Gen			0.0030 (0.0051)
Months in service			0.0000 (0.0000)
Undergraduate degree		0.0013 (0.0011)	0.0022** (0.0011)
High school diploma		-0.0010 (0.0009)	0.0004 (0.0009)
Govt. funded education			0.0005 (0.0012)
Expert pistol initial			0.0026* (0.0016)
Sharpshooter pistol initial			0.0018 (0.0011)
Marksman pistol initial			0.0002 (0.0006)
Unqualified pistol initial			0.0181 (0.0187)
Expert pistol last			0.0002 (0.0012)
Sharpshooter pistol last			-0.0002 (0.0008)
Marksman pistol last			-0.0003 (0.0009)
Unqualified pistol last			0.0002 (0.0029)
Diff between 1st & last pistol			0.0000 (0.0000)
Constant	0.0024* (0.0013)	0.0013 (0.0011)	-0.0018 (0.0064)
Observations	8,904	8,904	7,101
R-squared	0.001	0.001	0.003
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1			

Table 4. Dependent Variable: Indicator for Inventor

With just 20 inventors, our ordinary least squares models are not very powerful. Most of the variables we included in the models are not significant at the 10 percent level potentially because the model is not powerful enough to detect differences. Additionally, the models do not explain very much of the total variation of inventors because the R-square values for both models do not exceed 0.003. Therefore, we consider the results of this regression analyses to be suggestive evidence on the individual characteristics of inventors.

Two independent variables, education and initial pistol qualification score, were statistically significant in the full model. When an individual has an undergraduate degree, they are more likely to patent, but the effect size is small because the coefficient is 0.0026. This finding agrees with Jung and Ejermo (2014) who have found inventors in the United States are more educated. I interpret this finding as inventors are more likely to be educated individuals rather than having an undergraduate degree makes a person more creative.

Surprisingly, scoring expert on initial pistol qualification was statistically significant at the 10 percent level. However, the coefficient for this variable is relatively small at 0.0016. The effect size may be small but the variable positively correlates with creativity. This finding probably does not mean that scoring well on pistol qualification will make someone more creative. Rather individual performance on pistol qualification is most likely a proxy for some measure of unobserved ability that is correlated with creativity. Since recent work has highlighted the importance of grit, I also looked at the difference between initial pistol score and final pistol score as a potential measure of grit. Interestingly the difference was not statistically significant. It appears that in this sample, pure ability as measured somewhat by initial pistol qualification score seems more important.

The regression output in Table 5 shows coefficients and standard errors where number of patents granted by the USPTO is the dependent variable in a linear probability model that uses ordinary least squares. Demographics, education, and various military factors are independent variables in this regression analysis.

VARIABLES	Num_Patents	Num_Patents	Num_Patents
	vs. demographics	vs. demographics, education	full model
Male	0.0034*** (0.0010)	0.0034*** (0.0010)	0.0019** (0.0008)
Black	0.0064 (0.0058)	0.0065 (0.0058)	0.0032 (0.0033)
Asian	-0.0027*** (0.0008)	-0.0025*** (0.0008)	-0.0020** (0.0010)
Never married	0.0025 (0.0024)	0.0019 (0.0026)	0.0006 (0.0021)
Age at accession	-0.0002*** (0.0001)	-0.0002** (0.0001)	-0.0002 (0.0003)
Warrant Officer			0.0008 (0.0024)
1stLt-Gen			0.0027 (0.0051)
Months in service			0.0000 (0.0000)
Undergraduate degree		0.0024* (0.0015)	0.0024** (0.0012)
High school diploma		-0.0008 (0.0010)	0.0002 (0.0010)
Govt. funded education			0.0004 (0.0014)
Expert pistol initial			0.0036* (0.0021)
Sharpshooter pistol initial			0.0020* (0.0012)
Marksman pistol initial			-0.0001 (0.0008)
Unqualified pistol initial			0.0172 (0.0187)
Expert pistol last			-0.0001 (0.0015)
Sharpshooter pistol last			-0.0004 (0.0009)
Marksman pistol last			0.0000 (0.0010)
Unqualified pistol last			0.0016 (0.0037)
Diff between 1st & last pistol			0.0000 (0.0000)
Constant	0.0040** (0.0018)	0.0021 (0.0013)	-0.0004 (0.0067)
Observations	8,904	8,904	7,101
R-squared	0.001	0.001	0.003
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1			

Table 5. Dependent Variable: Number of Patents

The results from Table 5 are nearly identical to those from Table 4 but the effect sizes were slightly bigger. Two independent variables, education and initial pistol qualification score, were statistically significant in the full model. When an individual has an undergraduate degree, he is more likely to patent, but the effect size is small because the coefficient is 0.0024. I interpret this finding as individuals who patent more than once are more likely to be educated individuals rather than having an undergraduate degree increases the chances that an individual will patent more than once.

When number of patents is the dependent variable, both expert and sharpshooter initial pistol qualification scores are statistically significant at the 10 percent level. The coefficients are 0.0036 and 0.0020 respectively. These coefficients are bigger than the coefficients presented in Table 4 for the same variables, which means initial pistol qualification has a larger impact on the number of patents issued. I interpret these coefficients the same as those in Table 4. Scoring well on a pistol qualification will not make a person more creative but here it appears scoring expert or sharpshooter on initial pistol qualification captures some ability that correlates with creativity. Similar to the pistol qualification scores presented in Table 4, the differences between initial and last scores were not statistically significant.

Even with relatively weak linear regression models, the data in this study supports findings from previous studies that inventors tend to be better educated. Additionally, the statistical significance of initial pistol qualification scores could indicate that scoring well with the pistol may indicate a person has creative potential. Although the model explains only a small fraction of the total variation of inventors, it does indicate the direction in which independent variables cause the dependent variable to move.

C. QUALITATIVE ANALYSIS

In this section, I begin by analyzing the military data for the inventors and finish by analyzing information from the inventions. Many of the observations that follow may indicate patenting trends of Marine Corps officers. Additional studies similar to this one could more fully develop the following analysis.

1. Military Factors

Inventors in our sample of Marine Corps officers are not concentrated in particular occupations as shown in Table 6. For example, the Military occupational specialties (MOSes) for inventors spanned the breadth of MOSes available to officers in the Marine Corps. Every Marine has a primary MOS (PMOS) assigned during his career. Generally, a PMOS is the MOS assigned to an officer after he completes initial MOS training but a PMOS can change as an officer progresses through his career. When an officer leaves one MOS he is assigned another MOS and the PMOS changes to reflect the officer's new MOS. Similarly, when an officer obtains a certain rank, his PMOS may change to denote a change in responsibility. For example, when an officer assigned to PMOS 7208, Air Support Control Officer, promotes to Major, his PMOS changes to 7202, Air Command and Control Officer. In this study, we examined both PMOS1 and PMOS2, as well as whether an officer's PMOS changed. Three inventors changed occupational fields during their careers, one experienced a PMOS change due to promotion, and six experienced a PMOS change based on new responsibilities within the same occupational field.

The most represented occupational field among inventors was pilot because seven of the 20 inventors were pilots as shown in Table 5 by the PMOS2 designators 75xx. This finding was somewhat expected since pilots have represented the largest segment of officer MOSs for a long time. According to the U.S. Marine Corps (2016), approximately 24 percent of officers serving on active duty in 2016 are pilots. Interestingly, logistics officers, 0402, were overrepresented in the results. Five inventors had logistics officer as their PMOS2 but logistics officers comprise only about 8 percent of the officers on active duty today (USMC, 2016).

An officer's commissioning source is another interesting element to consider in analyzing inventors. The Marine Corps has a number of different programs that individuals can use to earn a commission, but the majority of officers commission through Platoon Leader Class (PLC), Officer Candidate

Class (OCC), Naval Reserve Officer Training Corps (NROTC), or the U.S. Naval Academy. Commissioning sources for inventors were as follows: six inventors commissioned through NROTC, five through Platoon Leader Class PLC, four through a military academy, three through Officer Candidate Class OCC, one through the Enlisted Commissioning Program (ECP) and one through other. Inventors utilized government-funded education more than non-inventors.

Officer	PMOS1	PMOS2	Commission Source	Enlisted Service	Years of Service
1	2502	0602	NROTC	No	21
2	3502	0402	NROTC	No	8
3	7599	7562	ECP	Yes	20
4	7560	7566	OCC	No	9
5	7599	7566	ACAD	No	6
6	1302	1302	NROTC	No	2
7	7251	7562	ACAD	Yes	24
8	0402	0402	OCC	No	21
9	0302	8041	OCC	No	30
10	7561	7562	PLC	No	10
11	0302	0302	ACAD	No	4
12	4402	4402	OTHER	No	13
13	0802	0802	NROTC	No	4
14	0402	0402	NROTC	No	4
15	6002	6002	ACAD	No	4
16	0206	0206	NROTC	No	4
17	7556	7557	PLC	No	10
18	0302	0402	PLC	Yes	20
19	0402	0402	PLC	No	3
20		7599	PLC	No	2

Table 6. Military Information for Inventors

In the Marine Corps, Pilots generally have longer initial service obligations than do non-pilots. Since it is expensive and time consuming to train pilots, they typically have to serve on active duty for eight years after earning their wings. In contrast, non-pilots typically serve just four years before they can voluntarily separate. We found that six of the 13 non-pilots may have completed more than their initial service requirements and four served for 20 years or more. Two pilots stayed on active duty in the Marine Corps beyond their initial service obligation and they both completed at least 20 years of service.

The time inventors spent on active duty in the Marine Corps has another dimension apart from whether the Marine Corps effectively retains creative people. It is worth noting that six inventors served for 20 years or more. According to Kane (2015), just 17 percent of military service members complete 20 years of service, which is currently the service length required to earn a defined pension retirement. Clearly, most people who serve in the military do not persevere through 20 years of military service. In contrast, 30 percent of inventors served for at least 20 years. Since perseverance is a critical component of grit according to Duckworth (2016), this finding may indicate that creative people are grittier individuals.

2. Patent Information

Patenting trends of inventors such as how many patents they were granted or when they applied for patents reveal useful information. I extract a great deal of information from each patent as shown in Table 7. The following section analyzes the information I obtained from the patents associated with inventors.

To begin with, most military inventors do not patent more than once. The United States Patent and Trademark Office (USPTO) granted 27 patents to the inventors. The USPTO granted 16 inventors one patent, two inventors two patents, one inventor three patents, and one inventor four patents. There are several explanations why so many inventors only patented once. Maybe these inventors are early in their inventing careers and they will patent again in the future. Perhaps they have not patented more because they do not have more patentable inventions. Conceivably, these inventors did not realize a sufficient return on their initial patents to warrant additional efforts to patent again. It is worth pointing out that all inventors who patented more than once assigned their patents to private companies. When the patent assignee is an organization or a company, it is unlikely that the individual inventor(s) would shoulder all or even most of the cost associated with applying for the patent. This may suggest that individuals are more likely to patent multiple times when they do not assume all of the cost or bear all of the responsibility of doing so.

Eleven inventors retained patent assignment of their inventions, 14 assigned their inventions to private companies, and two assigned their inventions to the U.S. government. Nine inventors applied for patents while they were serving on active duty in the Marine Corps. The active-duty inventors account for nearly all of the self-assignment as they assigned seven inventions to themselves and two to the U.S. government. The officers who applied for patents after separating from the Marine Corps assigned four inventions to themselves and 14 to private companies. These findings suggest that officers tend to retain patent assignment when they are on active duty and not retain patent assignment after they leave military service.

On average, inventors waited for two years and three months between the time they filed patent applications and when the USPTO granted the patents. This average fits within the traditional total pendency wait time as reported by the USPTO (2016). Inventors who assigned inventions to themselves waited for approximately two years and four months on average. In contrast, officers who did not retain patent assignment for their inventions waited less time on average. Those who assigned their inventions to private companies waited two years and two months and those who assigned their inventions to the U.S. government waited one year and eight months.

Officer	# of Patents	Patent Assignee	Days Between Filing Date and Grant Date	# of Inventors	Forward Citations	Age at Filing	Patent U.S. Classification	Classification Description
1	1	U.S. Navy	846	1	26	29	375/316	Pulse or digital communications
2	1	U.S. Navy	397	5	14	30	141/369	Fluent material handling
3	1	Self	764	5	132	32	235/379	Registers
4	1	Self	588	3	15	35	340/945	Communications: electrical
5	1	Self	446	1	12	25	401/137	Coating implements with material supply
6	2	Private Company	711	2	12	31	42/36	Firearms
		Self	648	2	4	31	42/106	Firearms
7	1	Self	524	1	8	34	D3/289	Travel goods and personal belongings
8	1	Self	515	1	10	30	454/370	Ventilation
9	1	Private Company	803	1	39	47	44/308	Fuel and related compositions
10	1	Self	1,846	1	3	37	116/235	Signals and indicators
11	1	Self	1,133	1	22	31	220/507	Receptacles
12	1	Self	735	5	3	42	428/34.4	Stock material or misc. articles
13	4	Private Company	496	5	2	28	D34/1	Material or article handling equip.
		Private Company	364	5	5	28	D34/1	Material or article handling equip.
		Private Company	1,735	5	4	30	194/205	Check-actuated control mechanisms
		Private Company	1,352	7	3	29	194/211	Check-actuated control mechanisms
14	1	Private Company	637	1	15	31	210/393	Liquid purification or separation
15	1	Private Company	1,139	1	10	32	60/39.27	Power plants
16	1	Private Company	887	5	25	33	62/81	Refrigeration
17	2	Private Company	732	2	0	42	1/1	Not defined
		Private Company	561	2	27	40	707/748	Data processing
18	3	Private Company	579	1	2	36	362/105	Illumination
		Self	831	1	5	39	2/412	Apparel
		Private Company	704	1	0	43	1/1	Not defined
19	1	Private Company	1,148	4	5		235/380	Registers
20	1	Self	1,233	1	6		435/161	Chemistry: molecular biology and microbiology

Table 7. Patent Information for Inventors

Approximately half of the patents associated with inventors list more than one inventor on the patent. For the inventions assigned to private companies or the U.S. government, six have just one inventor and 10 have more than one inventor. For the inventions where inventors retained patent assignment, seven have just one inventor and four have more than one inventor. This finding suggests that inventors who work by themselves tend to retain patent assignment while inventors who work in teams tend to assign patents to other.

Forward citations measure how many times newer patents reference an older patent. Generally, a patent with more forward citations is more valuable than a patent with fewer forward citations. Two of the patents associated with inventors do not have any forward citations because the USPTO granted the patents within the last few months. Most of the patents have fewer than 15 forward citations. However, two patents stand out as having a larger number of forward citations. One patent has 132 forward citations and another has 39. This finding may suggest that Marine officers are not inventing relatively valuable inventions but it does not diminish the creative ability of these individuals.

When inventors filed patent applications, they were more than 10 years younger on average than average inventors in the United States as determined by Jung and Ejermo (2014). Inventors were 33.8 years old on average when they filed patent applications. The oldest hard match to file for a patent was 47 years and the youngest was 25 years. This may suggest that inventors with military service background patent at a younger age than do inventors who do not have military service background.

The types of inventions associated with inventors vary considerably as shown in the patent classification column in Table 7. However, they are similar in that only three of the 27 patents are design patents; the others are utility patents. This finding aligns with the fact that most patents issued by the USPTO are utility patents. Based on patent classification, patent description, and officer’s PMOS1 or PMOS2, we conclude that officers one, two, four, and six likely used knowledge or interest gained during their time on active duty to create their inventions. Similarly, we believe officers nine, 14, 15, 18, and 19 may have used knowledge gained during service to create their inventions. The types of inventions associated with the remaining officers are so far removed from their likely duties as officers that we believe their military service did not help them create their inventions.

This study finds interesting differences between inventors and non-inventors. The summary statistics suggest that inventors are less likely to marry, younger at accession, serve for less time, and more likely to utilize government-funded education. However, this study does not identify enough inventors to construct powerful linear regression models. Even with relatively weak OLS models, initial pistol qualification scores and education levels are significant at the 10 percent level.

VI. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

This study examines the Marine officers who accessed between 1990 and 2000 to identify which officers have patented. We first use a search algorithm to match officer names with inventors in the United States Patent and Trademark Office (USPTO) database. We then use two rounds of elimination based on well-informed assumptions to determine which officers have patented. Ultimately, I find 20 officers who have existing patents with the United States Patent and Trademark Office (USPTO). I conduct mainly qualitative analysis but perform quantitative analysis where the data permits.

The summary statistics point to interesting differences between inventors and non-inventors. At accession, inventors are younger on average than non-inventors are. A larger proportion of inventors are African Americans compared to the population of Marine Corps officers and inventors are more likely to be married. However, these differences are not significant in the regression analyses. Two exceptions are initial pistol qualification scores and education level, which are statically significant at the 10 percent level.

This study is the first step in what should be a journey to determine which demographic and military factors researches can use to identify military service members with the most creative potential. For a long time, researchers have used patents as proxies for human creativity and applying this concept in a military context will produce meaningful results because the data available for military service members is so rich. The amount and type of data available concerning military service members coupled with the ability to determine which service members have patented provides a great deal of potential to make meaningful findings about human creativity.

Given the U.S. Navy's long history of innovation and mandate by the American people to help keep the United States safe from adversaries who are trying to exploit gaps within its capabilities, it will need to innovate in the future more frequently and more quickly than it has in the past. Accordingly, the Commandant of the Marine Corps has clearly stated his desire for Marines to step forward with creative solutions to the complex problems facing the Marine Corps. The challenges facing the U.S. military today clearly require innovative people to solve. This study should be continued until enough inventors are found to conduct quantitative analysis that will produce meaningful results.

B. RECOMMENDATIONS FOR FOLLOW-ON STUDIES

This research did not produce sufficient inventors to conduct meaningful quantitative analysis. Expanding the range of officer accession dates beyond those in this study would probably result in enough inventors to conduct more quantitative analyses. I recommend studying officers who accessed from 1985 to 1989 and from 2001 to 2010.

This study focused exclusively on Marine Corps officers. A study of officers from other services could potentially yield interesting results by way of comparing patenting trends among the services, determining whether officers have a tendency to patent in certain fields based on branch of service, or comparing demographical findings among the services.

Another study should interview inventors identified by this thesis to develop panel data in support of a longitudinal study. It would be interesting to investigate how the careers of these individuals have progressed since they separated from military service and what opportunities their inventions have provided them. It would also be helpful for the Marine Corps to understand why these officers decided to leave the active-duty force. Additionally, it would be useful to understand whether any inventors obtained a higher level of civilian education after separating from the Marine Corps.

This study looked at officers only so a follow on study of enlisted personnel has the potential to capture more inventors because the enlisted population is orders of magnitude greater than the officer population. We found that three inventors had served in the enlisted ranks before earning their commissions. This evidence suggests that the enlisted ranks will contain inventors. The study of enlisted personnel should be expanded to the other services as well.

Another study should conduct a quantitative analysis of the soft matches identified by this study. Researches who study patent holders often work in degrees of uncertainty because it is extremely difficult to know with certainty, aside from interviewing individuals, whether a name match is a true match. They have developed a method to work around the uncertainty by assigning probabilities to soft matches. A study designed to assign probabilities to the soft matches in this study based on the proximity of last known address to home of record as well as time between last known address validation date and patent filing date would be useful research.

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APPENDIX A. PROBIT RESULTS, DEPENDENT VARIABLE: INDICATOR FOR INVENTOR

VARIABLES	Inventor	Inventor	Inventor
	vs. demographics	vs. demographics, education	full model
Black	0.4040* (0.2241)	0.4030* (0.2245)	0.5005* (0.2938)
Never married	0.2373 (0.1603)	0.1950 (0.1896)	0.2036 (0.2190)
Age at accession	-0.0440** (0.0192)	-0.0380** (0.0190)	-0.0220 (0.0428)
1stLt-Gen			0.3113 (0.5134)
Months in service			0.0012 (0.0015)
Undergraduate degree		0.2357 (0.2282)	0.5301** (0.2284)
Govt. funded education			0.1231 (0.1960)
Expert pistol initial			2.7750*** (0.2667)
Sharpshooter pistol initial			2.6666*** (0.2109)
Unqualified pistol initial			3.7462*** (0.6038)
Expert pistol last			2.5139*** (0.2085)
Sharpshooter pistol last			2.3321*** (0.2438)
Diff between 1st & last pistol			0.0024 (0.0038)
Constant	-1.9148*** (0.4635)	-2.2048*** (0.4445)	-8.3222*** (1.1734)
Observations	8,248	7,806	5,300
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1			

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APPENDIX B. PROBIT RESULTS, DEPENDENT VARIABLE: INDICATOR FOR NUMBER OF PATENTS RECEIVED

VARIABLES	Num_Patents	Num_Patents	Num_Patents
	vs. demographics	vs. demographics, education	full model
Black	0.4040*	0.4030*	0.5005*
	(0.2241)	(0.2245)	(0.2938)
Never married	0.2373	0.1950	0.2036
	(0.1603)	(0.1896)	(0.2190)
Age at accession	-0.0440**	-0.0380**	-0.0220
	(0.0192)	(0.0190)	(0.0428)
1stLt-Gen			0.3113
			(0.5134)
Months in service			0.0012
			(0.0015)
Undergraduate degree		0.2357	0.5301**
		(0.2282)	(0.2284)
Govt. funded education			0.1231
			(0.1960)
Expert pistol initial			2.7750***
			(0.2667)
Sharpshooter pistol initial			2.6666***
			(0.2109)
Unqualified pistol initial			3.7462***
			(0.6038)
Expert pistol last			2.5139***
			(0.2085)
Sharpshooter pistol last			2.3321***
			(0.2438)
Diff between 1st & last pistol			0.0024
			(0.0038)
Constant	-1.9148***	-2.2048***	-8.3222***
	(0.4635)	(0.4445)	(1.1734)
Observations	8,248	7,806	5,300
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1			

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LIST OF REFERENCES

Adams, K. (2005). *The sources of innovation and creativity.* Retrieved from http://www.ncee.org/wp-content/uploads/2010/04/Sources-of-Innovation-Creativity.pdf

Bacon, L. (2016, March 4). Commandant looks to "disruptive thinkers" to fix Corps' problems. Retrieved from http://www.marinecorpstimes.com/story/military/2016/03/04/commandant-looks-disruptive-thinkers-fix-corps-problems/81279544/

Brandstätter, H. (2011). Personality aspects of entrepreneurship: a look at five meta-analyses. *Personality and Individual Differences*, *51*(3), 222–230. Retrieved from http://www.sciencedirect.com/science/article/pii/S0191886910003454

Ceh, S. L. B. (1997). The recent evolution of Canadian inventive enterprises. *The Professional Geographer*, *49*(1), 64–76. DOI: 10.1111/0033-0124.00057

Chamorro-Premuzic, T. (2013, October 25). The five characteristics of successful innovators. *Harvard Business Review.* Retrieved from https://hbr.org/2013/10/the-five-characteristics-of-successful-innovators

Crouch, D. (2014, September 30). USPTO breaks new ground with 300,000 patents issued this fiscal year. [Web log post]. Retrieved from http://patentlyo.com/patent/2014/09/patents-issued-fiscal.html

Defense Advanced Research Projects Agency. (n.d.a). ARPANET and the origins of the Internet [Web page]. Retrieved September 28, 2016, from http://www.darpa.mil/about-us/timeline/arpanet

Defense Advanced Research Projects Agency, (n.d.b). Where the future becomes now. Retrieved November 2, 2016, from http://www.darpa.mil/about-us/timeline/where-the-future-becomes-now

Defense Advanced Research Projects Agency. (n.d.c). World's first weather satellite. Retrieved September 28, 2016, from http://www.darpa.mil/about-us/timeline/worlds-first-weather-satellite

Danchik, R. J. (1998). An overview of transit development. *Johns Hopkins APL Technical Digest*, *19*(1), 18–26. Retrieved from http://www.jhuapl.edu/techdigest/td/td1901/danchik.pdf

Desrochers, P. (1998). On the abuse of patents as economic indicators. *Quarterly Journal of Austrian Economics*, *1*(4), 51–74. Retrieved from https://mises.org/library/abuse-patents-economic-indicators

Duckworth, A. (2016). *Grit the power of passion and perseverance.* New York, NY: Scribner.

Faith, K. S. (2013). Patterns of creation and discovery (Doctoral dissertation). Retrieved from http://www.rand.org/pubs/rgs_dissertations/RGSD321.html

Fallah, M. H., Fishman, E., & Reilly, R. R. (2009). Forward patent citations as predictive measures for diffusion of emerging technologies. Presented at 2009 Portland International Conference on Management of Engineering Technology, Portland, 2009. Portland, OR: IEEE.

Feist, G. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality and Social Psychology Review*, *2*(4), 290–309. Retrieved from http://doi.org/10.1207/s15327957pspr0204_5

Galenson, D. W. (2003). The two life cycles of human creativity. *NBER Reporter*, 12–15. Retrieved from http://libproxy.nps.edu/login?url= http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=11120761&site=ehost-live&scope=site

Galenson, D. W. (2010). Understanding creativity. *Journal of Applied Economics*, *13*(2), 351–362. Retrieved from http://libproxy.nps.edu/login?url= http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=62007952&site=ehost-live&scope=site

Guilford, J. P. (1971). *The nature of human intelligence.* New York, NY: McGraw-Hill.

Haber, S. (2016). *Patents and the wealth of nations* (Hoover Institution Working Group on Intellectual Property, Innovation, and Prosperity No. 16004). Stanford, CA: Hoover Institution.

Headquarters Marine Corps Marine & Family Programs. (2015). The Marine Corps demographic update. Retrieved from http://www.usmc-mccs.org/mccs/assets/File/Demographics%20Booklet%20June%202015.pdf

Herbert, T. P., Cramond, B., Neumeister, K. L. S., Millar, G., & Silvian, A. (2002). *E. Paul Torrance: His life, accomplishments, and legacy* (RM02152). Retrieved from http://nrcgt.uconn.edu/wp-content/uploads/sites/953/2015/04/rm02152.pdf

Hippel, E. von. (1988). The sources of innovation. *Science*, *243*(4897), 1497–1498. doi: 10.1126/science.243.4897.1497

Hülsheger, U. R., Anderson, N., & Salgado, J. F. (2009). Team-level predictors of innovation at work: a comprehensive meta-analysis spanning three decades of research. *The Journal of Applied Psychology, 94*(5), 1128–1145. doi: 10.1037/a0015978

The Institute of Electrical and Electronics Engineers. (2015). Patent power 2015: Social media and smartphones score big. Retrieved from http://spectrum.ieee.org/at-work/innovation/patent-power-2015-social-media-and-smartphones-score-big/constructing-the-patent-power-scorecard-2015

Jaruzelski, B., Schwartz, K., & Staack, V. (2015, October 27). *Innovation's new world order.* Retrieved from http://www.strategy-business.com/feature/00370?gko=e606a

Jung, T., & Ejermo, O. (2014). Demographic patterns and trends in patenting: Gender, age, and education of inventors. *Technological Forecasting and Social Change*, 86, 110–124. doi: 10.1016/j.techfore.2013.08.023

Kane, T. (March 2, 2015). Military retirement: Too sweet a deal?. Retrieved from http://warontherocks.com/2015/03/military-retirement-too-sweet-a-deal/

Lipman, M. (2010, June 2). USPTO, Google partner to offer patent, trademark bulk data. *Law 360.* Retrieved from http://www.law360.com/articles/172500/uspto-google-partner-to-offer-patent-tm-bulk-data

Martin, B. C., McNally, J. J., & Kay, M. J. (2013). Examining the formation of human capital in entrepreneurship: A meta-analysis of entrepreneurship education outcomes. *Journal of Business Venturing*, *28*(2), 211–224. Retrieved from https://ideas.repec.org/a/eee/jbvent/v28y2013i2p211-224.html

McAleer, M., & Slottje, D. (2005). A new measure of innovation: the patent success ratio. *Scientometrics*, *63*(3), 421–429. doi: 10.1007/s11192-005-0222-2

McCaney, K. (2015, August 3). Navy's reign in patent rankings continues. Retrieved from https://defensesystems.com/articles/2015/08/03/navy-onr-ipo-patent-rankings.aspx

McGarry, B. (2015, September 18). *JTAC calls in A-10 airstrike with android tablet*. Retrieved from http://www.defensetech.org/2015/09/18/jtac-calls-in-a-10-airstrike-with-android-tablet/

Moser, P. (2013). Patents and innovation: evidence from economic history. *Journal of Economic Perspectives*, *27*(1), 23–44. doi: 10.1257/jep.27.1.23

Nilsson, P. (2012, March 24). Four ways to measure creativity [Web log post]. Retrieved from http://www.senseandsensation.com/2012/03/assessing-creativity.html

National Environmental Satellite, Data, and Information Service. (2014). NOAA's geostationary and polar-orbiting weather satellites [Web page]. Retrieved from http://noaasis.noaa.gov/NOAASIS/ml/genlsatl.html

Patents, Trademarks, and Copyrights 37 C.F.R. § 501.6 (2014).

Roberts, A. (2015, August 5). The lives saved by the bomb. *The Wall Street Journal.* Retrieved from http://www.wsj.com

Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *Academy of Management, 25*(1), 217–226. doi: 10.2307/259271

Toll, I. W. (2008). *Six frigates: The epic history of the founding of the U.S. Navy.* New York, NY: W. W. Norton & Company.

Treffinger, D., Young, G., Selby, E., & Shepardson, E. (2002). *Assessing creativity: A guide for educators* (RM02170). Retrieved from http://nrcgt.uconn.edu/wp-content/uploads/sites/953/2015/04/rm02170.pdf

United States Department of Defense, Press Operations. (2016). Department of Defense (DOD) releases fiscal year 2017 president's budget proposal. [Press release]. Retrieved from http://www.defense.gov/News/News-Releases/News-Release-View/Article/652687/department-of-defense-dod-releases-fiscal-year-2017-presidents-budget-proposal

United States Patent and Trademark Office. (2002). The U.S. patent systems celebrates 212 years. Retrieved from http://www.uspto.gov/about-us/news-updates/us-patent-system-celebrates-212-years

United States Patent and Trademark Office. (2012). Overview of the U.S. patent classification system. Retrieved from https://www.uspto.gov/sites/default/files/patents/resources/classification/overview.pdf

United States Patent and Trademark Office. (2015a). General information concerning patents. Retrieved June 14, 2016, from http://www.uspto.gov/patents-getting-started/general-information-concerning-patents#heading-2

United States Patent and Trademark Office. (2015b). USPTO’s prioritized patent examination program. Retrieved August 26, 2016, from http://www.uspto.gov/patent/initiatives/usptos-prioritized-patent-examination-program

United States Patent and Trademark Office. (2016a). Types of patents. Retrieved August 26, 2016, from https://www.uspto.gov/web/offices/ac/ido/oeip/taf/patdesc.htm

United States Patent and Trademark Office, Fiscal year 2017 Congressional justification. (2016b). Retrieved August 26, 2016, from https://www.uspto.gov/sites/default/files/documents/fy17pbr.pdf

United States Patent and Trademark Office. (n.d.). Traditional total pendency. Retrieved November 22, 2106, from https://www.uspto.gov/corda/dashboards/patents/kpis/kpiOverallPendency.kpixml

United States Marine Corps. (2016a). Occupational field distribution. Retrieved October 8, 2016, from https://marinecorpsconceptsandprograms.com/almanacs/active-duty-officer/occupational-field-distribution

United States Marine Corps. (2016b). Racial and gender distribution. Retrieved October 8, 2016, from https://marinecorpsconceptsandprograms.com/almanacs/active-duty-officer/racial-and-gender-distribution

World Intellectual Property Organization. (2014). *World intellectual property indicators*. Retrieved from http://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2014.pdf

XVIII Airborne Corps and Fort Bragg Office of the Staff Judge Advocate Legal Assistance Office. (2016). Information paper – State of legal residence. Retrieved from http://www.bragg.army.mil/directorates/osja/Legal%20Assistance%20Documents/Information%20Papers/State%20of%20Legal%20Residence.pdf

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