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National Security Policy Constraints on Technological Innovation:

A Case Study of the Invention Secrecy Act of 1951

by

Dorothy K. McAllen

Dissertation

Submitted to the College of Technology

Eastern Michigan University

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY IN TECHNOLOGY

Area of Concentration: Technology Studies

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July 10, 2012

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National Security Policy Constraints on Technological Innovation: A Case Study of the
Invention Secrecy Act of 1951

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Many years ago, a friend and mentor advised me always to remember, “The Journey is the Reward.” I would therefore like to thank all of those many people who generously gave of their time, knowledge, and expertise during this interesting and challenging journey.

Abstract

Recent studies indicate that the United States is trailing other countries in technological innovation and competitiveness. This case study examined national security policy constraints on technological innovation, specifically the Invention Secrecy Act. It focused on the social constructs of collaboration and interdisciplinary knowledge in the aerospace industry. The methodology included historical research, data collection, and semi-structured interviews with experts from academia, general industry, government and public policy, aerospace/defense industry, and federal government. The results of the study suggested that since World War II, national security policies have not been clearly and consistently defined, interpreted, or implemented. This lack of clarity gave rise to actions by presidential administrations and federal agencies, creating a fractious atmosphere and further limiting access to and sharing of restricted or classified information by academia, industry, government, and private researchers. Government actions also directed funding allocations to specific research types or groups, which added to the veil of secrecy and selectiveness surrounding national security projects. Collectively, the actions constrained collaboration and interdisciplinary exchange of knowledge; two essential sources for technological innovation. This study identified five critical factors that likely impede technological innovation in America's aerospace industry: (a) power, control, and responsibility for national security, (b) the assumption that technological supremacy equals a secure nation, (c) policy constraints: the Invention Secrecy Act and Export Control Regulations, (d) funding constraints, and (e) organizational culture and ethnocentrism. Recommendations for future studies include explore and identify additional constraints on innovation by other national security policies, investigate and assess the impact of these restrictive policies on specific industries, and examine organizational culture as a barrier to technological innovation.

Table of Contents

Acknowledgements	iii
Abstract	iv
List of Tables	ix
List of Figures	x
Chapter 1: Introduction	1
Introduction	1
Background of the Study	1
Importance of the Study	4
Statement of the Problem	6
Objective of the Study	7
Research Questions	7
Assumptions	8
Limitation and Delimitations	8
Definition of Terms	9
Chapter 2: Review of Literature	11
Introduction	11
Defining Concepts	11
Social Constructs: Collaboration and Interdisciplinary Knowledge	14
Industry Selection for the Case Study	16
America as a Global Leader in Technological Innovation	18
America's Protection of Intellectual Property	23
Linking National Security Policies and Technological Innovation	25
Balancing Technological Innovation and National Security	30
Conclusion	31

Chapter 3: Research Methodology.....	33
Research Design.....	33
Sampling	34
Instrument Design.....	34
Data Collection.....	36
Managing and Recording Data.....	37
Data Analysis	38
Validation Strategies	40
Conclusion	43
Chapter 4: Presentation of the Data	45
Analysis of Documents and Historical Records.....	46
Information from Existing Databases: Secrecy Orders and University Research.....	59
Interviews	66
Emerging Themes	84
Summary	111
Chapter 5: Discussion and Recommendations.....	112
Question 1 - Invention Secrecy Act and Technological Innovation	112
Sub-Question 1: Collaboration on Technology Related to National Security	114
Sub-Question 2: Sharing/Learning through Inter-Disciplinary Knowledge	115
Sub-Question 3: Sharing Knowledge/Technologies Related to the Aerospace Industry	116
Sub-Question 4: National Security Policy Constraints on Technological Innovation	117
Conclusion.....	118
Recommendations for Further Research	119
Final Recommendations	120
References.....	123

Appendices.....	144
Appendix A: Informed Consent	145
Appendix B: Informed Consent	146
Appendix C: Research Interview Instrument	148
Appendix D: List of Documents and Archival Records	150

List of Tables

<u>Table</u>	<u>Page</u>
1 Ranking of Companies Based on Federally Awarded Contracts: IT, Defense, and Aerospace	18
2 Variation Equivalency Between Quantitative and Qualitative Data.....	41
3 Validation Strategies	43
4 Executive Order Policy Timeline Relating to National Security and National Defense	53
5 Total Secrecy Orders Filed by the U.S. Patent and Trademarks Office	633
6 Federal Research Funds - Science and Engineering for Top 20 Universities - FY 2008	66
7 List of Interview Participants	68
8 Major Export Control Laws and Regulations	97

List of Figures

<u>Figure</u>	<u>Page</u>
1 Article retrieved from Billboard, July 31, 1943.....	20
2 Cyclical and consistent analysis of collected data.	39
3 Presentation of Results for Data Collection.....	46
4 Total Secrecy Orders - 1988-2010.....	60
5 Secrecy orders filed, rescinded, and in effect – 1988-2010.....	64
6 Basic Research by Performing Sector, FY 2008	100
7 Human Subjects Review Committee Approval Document	145

Chapter 1: Introduction

Introduction

This qualitative, mixed-methods case study examined the Invention Secrecy Act of 1951 and its relationship to technological innovation in America's aerospace industry from the 1980s to today. The purpose of the study was to explore the relationship between national security policies and the process of technological innovation. The study specifically focused on two concepts: collaboration and interdisciplinary knowledge.

Background of the Study

Technological innovation is significant to the competitive growth of a globalized nation (Ezell & Andes, 2010). Additional research studies indicated that technological innovation also drives long-term economic growth (Andrew, Manget, Michael, Taylor, & Zablit, 2010; Ezell, 2009; Freeman & Soete, 2009). Shelton and Foland (2009) maintained that technological innovation is crucial to America's growth, stability, and viability for "maintaining world leadership in science, mathematics, and engineering."

America experienced a tremendous influx of intellectual and technical knowledge at the end of World War II, due in part to the wartime seizure of intellectual property from enemy nations (Gimbel, 1976). In addition to the seized patents and documents, more than 1300 German and Austrian scientists immigrated to America under Operation Paper Clip, a government program adopted in the aftermath of World War II to recruit European scientists for employment in the United States (Bower, 1987). These scientists were assigned employment, research work, and teaching positions within government sectors and at universities such as Columbia and Harvard. They were also directed to private industries like General Electric, Lockheed, and Martin Marietta (Bower, 1987; Medawar & Pyke, 2000; Walker, 1995). Since

that time, research from corporate, academic, and government laboratories was instrumental in developing numerous innovations for technologies such as transistors, mobile phones, personal computers, lasers, graphical user interfaces, weaponry, search engines, the Internet, and genetic code sequencing (Ezell & Andes, 2010; Innovation in America, 2010; Shelton & Foland, 2009). Traditionally, technology patents or patent applications were used as critical standards for measuring innovation. Since 1945, fueled in part by the seizure of intellectual knowledge, patents, and Operation Paperclip, America became a world leader in patent filings, which supported and strengthened America's position as a global leader in technology innovations (Gimbel, 1990; World Intellectual Property, 2011).

Today, however, only 65 years after World War II, studies by the Organization for Economic Co-operation and Development (OECD; Organization, 2009) and The National Science Foundation (NSF; National, 2010) indicated that America is trailing other nations in technological innovations and advancements. These studies were conducted using multiple indicators such as total patents, number of researchers, number of PhD graduates, total gross domestic product, R&D expenditures, R&D intensity (the ratio of a company's investment in research and development compared to its sales), and total scientific publications (National, 2010; Organization, 2009). Information and communication technology (ICT) was also considered a crucial driver of economic growth and widely used as a comparable standard for innovation between countries (Ezell & Andes, 2010). An analysis of OECD ICT data indicated that while the U.S. ranked high for total overall expenditures for R&D, they fell below several OECD countries when evaluating R&D intensity (Ezell & Andes, 2010; Organization, 2009). Another study, a survey conducted by the Boston Consulting Group in 2010, found that a "...new world order in innovation is taking hold, one in which rapidly developing economies, led

by China, India, and Brazil, will increasingly assume more prominent positions, while the United States and other mature economies continue to play major roles but gradually become less dominant” (Andrew et al., 2010). Their analysis of the R&D intensity for ICT manufacturing and ICT services from 1997 to 2005 showed that the U.S. ranked “dead last in terms of progress among 21 OECD nations” (Ezell & Andes, 2010). Additionally, the 2009 Information Technology and Innovation Foundation’s Atlantic Century report “ranked the United States sixth out of 40 leading industrialized nations in innovation competitiveness” (Ezell, 2009).

Several organizations, such as the OECD (2009) and the NSF (2010), conducted studies in an effort to understand America’s decline in innovation. However, in 2008, the National Science Board cautioned that while measurements such as published science papers, patent filings, and R&D spending can serve as rough benchmarks for countries to measure themselves against one another, they do not necessarily represent the total direct measures of innovation (Organization, 2010; Porter, Newman, Jin, Johnson, & Roessner, 2008). Harvard researchers Pisano and Shih (2009) also stressed that this phenomenon, technological innovation, could not be understood by only conducting quantitative research that measured various innovation indicators. They asserted that research must also analyze the phenomenon of technological innovation through additional methods or a collection of other indicators not previously utilized.

This research study focused on one such indicator: national security policies. At the conclusion of World War II, America implemented laws to strengthen and protect both the country and its newly acquired intellectual knowledge. One such law, the Invention Secrecy Act of 1951, was signed into law by President Truman and placed restrictions (termed “secrecy orders”) on research information and patent applications when the release of the specific information was deemed a threat to national security (Invention, 1952). Several amendments

were added since the law's signing, which lengthened duration of time secrecy orders could remain in effect. However, the Patent Commissioner continues to actively apply and enforce the guidelines outlined in the 1952 Invention Secrecy Act (U.S. Patent, 2011).

Traditionally, national security and intellectual property were thought to go hand in hand because war stimulated people's creativity through a need to protect their nation (Jackson & Morelli, 2007; Organski & Kugler, 1980). In addition to exploring this inclusive relationship, the research study also examined the exclusive relationship between national security policies and technological innovation.

Importance of the Study

It was, tragically, the bombing of Pearl Harbor on December 7, 1941, that was viewed as the first major catalyst to focus America's attention on national security (Betts, 2002). In the aftermath of Pearl Harbor, numerous presidential orders, acts, and laws, all relating to national security issues, were enacted to ensure the protection of America from outside dangers; many are still in effect today.

An important, though relatively unknown, act passed during this time was the Invention Secrecy Act. This Act provided security procedures to prevent the release of technical data that was deemed detrimental to the national security of America through secrecy orders served on the inventor and/or company (Invention, 1952). Today, secrecy orders are still issued by the U.S. Patent and Trademark Office (USPTO). As of 2010, there were 5,135 active secrecy orders in effect (see Table 5). While the secrecy order can later be rescinded after further consideration or review by the military or intelligence agency who originally requested the order (U.S. Patent, 2011), the law also allows the secrecy order to be renewed yearly, as deemed necessary, for national security reasons (Invention, 1952).

The number of secrecy orders filed is of major concern to American scientists. Steven Aftergood, director of the Federation of American Scientists' Project on Government Secrecy, cautioned that while their organization recognized that secrecy orders might be appropriate in some instances, government agencies tend to withhold more information than may be justifiable (Federation of American Scientists, 2011). Peter Katzenstein, Professor of International Studies at Cornell University, expressed similar concerns in 1996 on the withholding of knowledge and stated "... science is a social process that develops, refines, and rejects ideas. It is not a football game in which players protect turf – intellectual and otherwise" (p. xiv). Scientists and economists argued that the need to innovate and share new technology was vital to America's growth and expansion (Mukherjee & Stern, 2009; Wang, 2009; White & Bruton, 2007). Mukherjee and Stern (2009) further asserted that scientific progress depended on the ability to draw on multiple prior generations of knowledge and experience, and that the "step-by-step process of knowledge accumulation is at the center of the modern theories of endogenous economic growth."

The aerospace industry, critical to America's competitive edge in technological innovation, also falls under the same policies and processes regarding secrecy orders and classified research. Any policy constraints based on national security issues that negatively impact the U.S. defense and aerospace industries and their suppliers are potentially harmful because they play a significant role in America's industrial base, national defense, economic growth, scientific advancement, quality of life, global competitiveness, and education (Cheney, 2002; Coleman, 2012). At the 10th Annual Aviation Summit of the U.S. Chamber of Commerce, Jim Albaugh (2011), President and CEO of Boeing, stressed the importance of the aerospace industry in defining America in the 20th century. Albaugh stated, "It helped win World War II, it

brought the world closer together with commercial air travel, it changed the way we communicate with commercial satellites, and it changed forever how we look at the world around us when man first walked on the moon.” In an April 17, 2012, letter to Howard P. McKeon, Chairman of the House Armed Services Committee, and Adam Smith, Ranking Member, House Armed Services Committee, Dorothy Coleman, Vice President for the National Association of Manufacturers, reported that much of the technological innovation essential to America’s economic development comes from critical research and development in the defense and aerospace industries. “The capabilities of U.S. defense and aerospace manufacturing cannot be taken for granted – once they are gone they will be extremely difficult or perhaps impossible to rebuild” (Coleman, 2012). The aerospace industry was used in this study due to its overall importance to America’s advancements and competitive edge in technological innovation.

The above discussion indicates that the gap between America’s need for national security and the need for scientific innovation appears to be widening. This research project explored the following question: Is it possible that the same policies currently in place to protect America might also be detrimental to the innovation of technology and, thus, America’s economic growth?

Statement of the Problem

Previously outlined studies indicated that America was trailing other nations in technological innovation (National, 2010; Organization, 2009). These studies measured the decline through indicators such as patent filings, PhD graduates, R&D funding, published articles, and GDP. However, Pisano and Shih (2009) challenged researchers to explore different indicators to help analyze or explain this continuing decline. This study examined national security policies, specifically the Invention Secrecy Act, to explore its relationship with

technological innovation. National security and technological innovation were assumed to be inclusive (Jackson & Morelli, 2007). However, research studies have not thoroughly examined the exclusive relationship.

Objective of the Study

The objective of this research project was to explore national security policies and their relationship with technological innovation. This case study specifically examined the Invention Secrecy Act and its relationship to the aerospace industry from the 1980s to 2010, focusing on two constructs: collaboration and interdisciplinary knowledge. A secondary goal was to add to the body of knowledge regarding technological innovation.

The results of the study will assist managers and policymakers to attain clearer understanding in assessing and formulating policies and management practices. These results will increase future understanding of the respective influences national security and technological innovation exert upon each other. The outcome of this study might also generate additional hypotheses, which would suggest future research studies.

Research Questions

Cresswell (2007) recommended that a qualitative research design contain a “single overarching question and several sub-questions” (p. 108). Four sub-questions were included, which allowed the researcher to pursue additional issues deemed relevant to the central question (Stake, 2005). This research study addressed the following research question and sub-questions:

Central question (Q). Q1: What is the relationship between the Invention Secrecy Act of 1951 and technological innovation in the aerospace industry?

Sub-question (SQ). SQ1: How do researchers collaborate when the technology is related to issues of national security?

SQ2: How do researchers learn of new or innovative technologies in other disciplines?

SQ3: How do researchers share new or innovative technologies in the aerospace industry?

SQ4: In what ways do national security policies constrain technological innovation?

Assumptions

- It was assumed that all respondents would be objective and non-biased and would provide information honestly, accurately, and to the best of their abilities.
- It was assumed that during this study, the gender or race of the respondents or researcher would not significantly affect their perceptions.
- It was assumed that the lead researcher would collect and analyze the data objectively and without bias.

Limitation and Delimitations

- This study included secrecy orders issued by the U.S. Patent and Trademark office from 1988 through 2010. Starting in 1988, the Federation of American Scientists Organization filed yearly Freedom of Information Act requests with the U.S. Patent and Trademark Office to collect data regarding secrecy orders (Federation, 2011).
- Research results did not address industry-specific innovations due to restrictions by the U.S. Patent and Trademark Office. Industry information and patent details are classified for all patents subject to secrecy order (U.S. Patent, 2011).

- Due to the unique and purposeful samples used for the study, results might not be able to be generalized beyond the specific population from which the sample was drawn (Stakes, 2005).
- The data collected during the interviews were limited by the information provided by the participants.
- The study delimited the semi-structured interviews to those employed or associated through research with businesses, organizations, or governmental entities in the aerospace industry.
- All interviews were conducted in person by the researcher. However, due to restrictions on distance, time, and expense, several follow-up interviews were conducted over the telephone (Leedy & Ormond, 2010).
- The study delimited the research between the Invention Secrecy Act and technological innovation to the two areas of collaboration and interdisciplinary knowledge.

Definition of Terms

The following definitions will assist with the understanding of these terms and ensure uniformity throughout the study.

- Classified Information – “Information or material designated and clearly marked or clearly represented, pursuant to the provisions of a state or Executive order (or a regulation or order issued pursuant to a statute or Executive order), as requiring a degree of protection against unauthorized disclosure for reasons of national security” (War & National Defense, 1947).
- Constraint – “State of being checked, restricted, or compelled to avoid or perform some action” (Constraint, 2012).

- Innovation – Arthur (2009) defined innovation as four distinct components: (a) new solutions within given technologies; (b) novel technologies; (c) new bodies of technologies; and (d) new elements added to the existing collection of technology (p. 90). This term is discussed in more detail in Chapter 2.
- National security – “the protection or the safety of a country’s secrets and its citizens” (National Security, 2011). This term is discussed in more detail in Chapter 2.
- Secrecy Orders – An order issued by the Commissioner for Patents that the invention be kept secret (Secrecy Order, 2010).

Chapter 2: Review of Literature

Introduction

Chapter 2 is divided into six sections and provides a review of relevant literature in each of these areas: (1) description and explanation of concepts used throughout this study, such as “Technology” and “Innovation”, (2) constructs of collaboration and interdisciplinary knowledge, (3) selection of the aerospace industry for this study, (4) examination of studies related to America’s decline as a global leader in technological innovation, (5) discussion of America’s effort to protect its intellectual property and, (6) presentation of available publications regarding the relationship of technological innovation and national security.

Defining Concepts

Technology and innovation. The words *technology* and *innovation* are used frequently throughout our culture today. Particularly for industry, they connote images of modern, better, improved, relevant, new, futuristic, and other similar ideas. However, in reality, causal definition of these two terms produces widely divergent responses. Arthur (2009) stated that while we know a great deal about technology, in reality we know very little in the way of general understanding and agreement on its definition. Engineers and computer specialists study the specifics or design of machinery, sociologists analyze how technologies relate to each other and humanity, and historians study how technologies originated and evolved over time. The question remains, do these sciences successfully define technology or innovation?

Arthur (2009) cautioned that assuming a universal understanding of how *technology* is defined will create misunderstanding within the research unless this term is clearly outlined. The Merriam-Webster online dictionary broadly defined technology as (a) the practical application of knowledge especially in a particular area, (b) a manner of accomplishing a task especially using

technical processes, methods, or knowledge, and (c) the specialized aspects of a particular field of endeavor (Technology, 2011). White and Bruton (2007) proposed a broader definition and asserted that any definition of technology must include the following elements of technology that involve a process, that change is an outcome of technology, and that technology uses “a systematic approach to deliver the desired outcomes” (p. 16). Rogers (2003) discussed diffusion of innovation more simplistically and defined technology as hardware, or the tool that embodies a material or physical object, and software, the information base for the tool.

Innovation, as does technology, easily takes on different meanings. In *The Sources of Invention*, Jewkes, Sawers, and Stillerman (1968) defined innovation as the process by which an invention is put into commercial use. Rubenstein (1989) broadened their definition to include “the process whereby new and improved products, processes, materials, and services are developed.” White and Bruton (2007), while acknowledging that there are different types of innovation, expanded on that theme and defined it as “the process whereby new and improved products, processes, materials, and services are developed and transferred to a plant and/or market where they are appropriate” (p. 21). Arthur (2009) broke down innovation into four distinct areas:

- Novel solutions as a result of thousands of small advancements and fixes that cumulate to move practice forward.
- Radically novel technologies.
- Changing the internal parts or adding to them in the process of structural deepening.
- Whole bodies of technology emerging, building out over time, and creatively transforming the industries that encounter them.

For purposes of this research paper, the definition for innovation outlined by Arthur (2009) was used.

National security. The term *national security* is prevalent throughout modern documents, reports, and the current media, yet surprisingly there is no universally accepted definition. Research by Relyea (2002) indicated that national security began to appear with some frequency in federal documents during World War I and, though still undefined, appeared prominently again in official documents throughout World War II.

The concept of national security began to develop between the two wars when historian Charles A. Beard proposed to adopt a concept of national interest that promoted the well-being of the United States (Beard, 1934). The National Security Act of 1947 finally institutionalized the concept of national security as a resolve to maintain America's survival through the use of political and economic power, including military means (National Security, 1947). However, the term continued to change, depending on context. For example, the Pentagon currently defines national security as either a condition that provides military or defense advantage over any foreign nation(s), or a defense posture successfully able to resist hostile action (National Security, 2010). However, in May 2010, President Obama outlined a national defense strategy, the "National Security Strategy," in which he defined national security as the security of a nation, a strong innovative and growing economy, respect for values, and an international order advanced by U.S. leadership (Obama, 2010).

While there is no universally accepted definition for the term *national security*, for purposes of this study it was defined as "the protection or the safety of a country's secrets and its citizens" (National Security, 2011).

Social Constructs: Collaboration and Interdisciplinary Knowledge

Harvard professor and economist Joseph Schumpeter (1994, 2003) was one of the first to articulate that technologies develop from the technologies, education, culture, economy, politics, and other influences that precede them. While conducting his original studies in 1910 on how an economy develops, Schumpeter theorized that technologies do not radically appear but are developed from a collection of internal and external influencing factors (Arthur, 2009; Schumpeter, 1991, 1994). In the mid-twentieth century, historian Abbott Usher (1988) and sociologist William Ogburn (1988) supported Schumpeter's views, calling technology a combination or "constructive assimilation of pre-existing elements into new syntheses" (Usher, 1988, p. 11). Arthur (2009) referred to this amalgamation of technological building blocks over time as "combinatorial evolution" (p. 22). Key to this understanding is the view that technology is not a stand-alone object and that the process is not linear or algorithmic, but recursive and cyclical (Arthur, 2009; Ogburn, 1988; Usher, 1988).

Geert Hofstede (1984, 2001), an organizational sociologist from Holland, studied national and organizational cultures through their impact on work-related values. Hofstede argued that research on innovation focused solely on the technological aspect of the invention, but that innovation was really sociological, not technical, in nature. Arthur (2009) supported the social and cultural element of innovation put forth by Hofstede and added that if technology developed from technical and scientific knowledge and information alone, then any country that amassed engineers and scientists would be as innovative as any other (p. 159). Innovation in advanced technologies resulted not from knowledge, per se, but from a shared culture of information-exchange and understanding of complex issues and processes allowing that technology to emerge (Arthur, 2009).

Historically, the evolution of technology was often viewed as linear, planning and designing an element from point A to point B (Hippel, 2005). Wang (2009), along with Hippel (2005), professed that technology and innovation did not function linearly but co-existed as an ecosystem with interrelated networks within and between disciplines. Attempts to understand technology or innovation from a singular discipline or technology led to misunderstandings, disagreements, and false conclusions. Studies showed that when a particular innovation or idea was set in motion in an environment of collaboration between disciplines, related innovations were more likely to be activated as well (Berger & Heath, 2005; Fiske & Taylor, 1991; Wang, 2009). In “Democratizing Innovation,” Hippel (2005) proposed a direct relationship between user innovation and what he terms *information communities*. Hippel (2005) defined information communities as “communities or networks of individuals or organizations that rendezvous around an information commons, a collection of information that is open to all on equal terms” (p. 164). Pinch and Bijker (1987) similarly argued that technology should not be considered a science but a social construct among broad communities of scientists and researchers. While researchers within specific fields or industries formed tight-knit interest groups and communicated among themselves, members of larger, open communities exchanged information and helped in informal ways that lent themselves to a more distributed innovation process (Brown and Duguid, 1991; Hippel, 2005).

A 2006 study by the National Aeronautics and Space Administration (NASA) was conducted on knowledge management and lessons learned from past NASA Space Programs, “Managing Innovative Space Missions: Lessons from NASA” (Paxton, 2006). The study concluded that for NASA to revitalize and re-direct its aerospace program, it needed to

implement a “cross disciplinary technology development and demonstration program” (Paxton, 2006).

This research study has not sought to analyze every aspect of technology and innovation, as both topics are large, diverse, and complex. However, the study has more narrowly explored the role of collaboration and interdisciplinary knowledge in technological innovation.

Industry Selection for the Case Study

As previously outlined, the Invention Secrecy Act was selected for this study due to its direct impact on patents and inventions, the date it was enacted, and its possible relationship to technologies that emerged in America at the conclusion of World War II. However, technological innovation encompasses processes within a broad spectrum of sciences and industries. Therefore, for purposes of this case study, the research focused on the aerospace industry for three reasons:

1. While the aerospace industry actually began in the early 1900s, it was not until the seizure of technologies from Asia and Europe and the immigration of scientists after World War II that America’s space program expanded and accelerated (Gimbel, 1990; Hunt, 1991).
2. The timeline for emerging technologies within the aerospace industry is closely aligned with the enactment and enforcement of the Invention Secrecy Act of 1951 (Gimbel, 1990; Hunt, 1991; Invention, 1952; White, 2007).
3. Many companies conducting research, participating, and competing in IT and the national defense industry are either the very same companies or are closely aligned with those competing in the aerospace industry. Table 1 shows a comparison of companies competing in the IT, aerospace, and defense industries based on federally awarded

contracts. As indicated in Table 1, the U.S. General Services Administration compiled the contract data and combined both defense and aerospace totals together (General Services, 2011). All of the companies listed in Table 1 have executives who are members or board members of the Aerospace Industries Association (AIA), the association representing the major aerospace and defense manufacturers. The AIA addresses issues that cover civil aviation, space, and national security collectively (Aerospace, 2011).

Table 1

Ranking of companies based on federally awarded contracts: IT, Defense, and Aerospace.

	IT products and services – 2010 (a)		Aerospace and Defense – 2009 (b)	
	Contracts (in billion dollars)	Ranking	Contracts (in billion dollars)	Ranking
Lockheed Martin Corp.	\$ 16.7	1	\$ 38.5	1
Northrop Grumman Corp.	\$ 11.1	2	\$ 19.7	3
Boeing Co.	\$ 10.5	3	\$ 21.9	2
Raytheon Co.	\$ 6.7	4	\$ 16.1	5
SAIC	\$ 5.5	5	\$ 7.5	9
General Dynamics	\$ 5.4	6	\$ 16.4	4
KBR Inc.	\$ 4.5	7	\$ 6.4	12
L-3 Communications Corp.	\$ 4.1	8	\$ 7.5	7
BAE Systems Inc.	\$ 2.0	15	\$ 7.5	8
United Technologies	\$ 1.5	17	\$ 7.5	6

***Note.* Data used in Table 1 obtained from (a) Lokey, 2011; (b) General Services Administration, 2011.**

America as a Global Leader in Technological Innovation

Abundant literature has been written regarding America's role as a global leader in technological innovation. The literature examined focused on two major areas: the premise of America's role as a global leader in technology innovation and the measurements used to

determine a nation's level of technological innovation. This section of the study gives an historical overview of events that took place in the 1940s; it identifies the facts, people, locations, and proceedings that transpired since World War II.

Historical overview: Actions during and after World War II. In 1944, during the critical days of World War II, America implemented a plan that would affect not only the course of the war but would also move America's industry to the forefront in technological achievements. Under the direction of General Dwight D. Eisenhower, American and British military and civilian teams were directed to "identify, secure, guard, and exploit valuable and special information, including documents, equipment, and persons of value to the Allied armies" (Gimbel, 1990, p. 4). Vannevar Bush, civilian director of the U.S. Office of Scientific Research and Development (OSRD), understood the importance of foreign technology beyond just military applications. Concurrent with the military's actions, Bush issued an additional directive to the commanders. The directive expanded the original mission agenda and ordered teams to seize information of an industrial nature, as well (Cornwell, 2003). Bush proposed that such information would not only assist in the current war effort, but as a more long-term objective, possession of intellectual knowledge would help American industries generate new technologies and move forward in global innovations, manufacturing, and trade. This influx of intellectual property would, in turn, expand industries, advance technology, stimulate the economy, and provide employment for discharged veterans (Cornwell, 2003; Gimbel, 1990; White, 2007). With the support of President Roosevelt and later President Truman, thousands of scientific documents were seized and transported to Wright-Patterson Air Force Base in Ohio (Walker, 1946). Additionally, over 46,000 patents were seized from enemy nations (White, 2007), and approximately 1,600 European scientists immigrated to America (Cornwell, 2003). The

government eventually sold many of these technologies to privately held companies. As shown in Figure 1, these enemy-owned patents were sold to American companies for as little as \$15 a patent.



Figure 1. Article retrieved from Billboard, July 31, 1943.

Despite the economic and political volatility of the post-World War II period, for America this was a time of remarkable technological and economic growth due to the thousands of technologies brought over to America (Helpman, 2004). For over half a century, America held the position of global leader for technological innovation. For this research project, the historical relevance of how America came to achieve such dramatic technological innovation in such a short period is critical because it begs the question: Was America a true innovator of technology? Or, as outlined by Arthur (2009), was America only improving and altering existing technology and not actually creating new technology?

Decline in America's innovation. As early as the 1980s, the U.S. Department of Defense (DOD) became concerned with the migration and loss of critical technologies and

America's dependence on foreign technologies (Heginbotham, Almquist, Bertrand, Brown, & McHale, 1990; Niesz, 1990). The DOD initiated two major research studies: "Dependence of U.S. Defense Systems on Foreign Technologies" (Heginbotham et al., 1990) and "Defense Dependence on Foreign High Technology: An Assessment of U.S. Vulnerability" (Niesz, 1990). Both studies evaluated international migration of America's technologies and the extent of America's vulnerability and dependence upon foreign technologies. These recently declassified studies portray a bleak assessment of America's status on domestic capability. One conclusion from the Niesz (1990) study indicated, "The prospect of long-term decline of the U.S. base of knowledge and capability in critical technologies like microelectronics, manufacturing equipment, and optics is the most serious vulnerability identified in the course of this study."

In 2010, Dr. Robert Atkinson, president of the Information Technology and Innovation Foundation (ITIF), testified before the Senate Subcommittee for Commerce, Science, and Transportation and warned that America's economic viability and survivability depended on the innovation process. "At a time when America's historic lead in innovation has evaporated and its relative innovation competitiveness continues to shrink ... the United States cannot afford to remain complacent" (Innovation in America, 2010).

Stephen Ezell (2009), technology analyst and policy fellow at ITIF, suggested that confronted with ever-changing new technology, corresponding innovation must be analyzed against other nations as a key economic factor for stability, growth, and national sustainability. Their analysis of the R&D intensity for information and communication technology (ICT) manufacturing and ICT services from 1997 to 2005 indicated that the U.S. ranked "dead last in terms of progress among 21 OECD nations" (Ezell & Andes, 2010). Also, the 2009 ITIF Atlantic

Century report “ranked the United States sixth out of 40 leading industrialized nations in innovation competitiveness” (Ezell, 2009).

The aerospace industry was also concerned about their role in America’s future. In April 2011, Jim Albaugh, President and CEO for Boeing, spoke at an Aviation Summit sponsored by the U.S. Chamber of Commerce. In his speech, Albaugh stated, “I am convinced that aerospace will define the 21st century. The question is, will it be U.S. aerospace that does it?” (2011).

Measuring technological innovation. Technological innovation was originally measured by the number of patents or patent applications filed; this was eventually expanded to include additional measurements such as published papers, PhD graduates, and R&D spending. In 2008, the National Science Board cautioned that while measurements such as published science papers, patent filings and R&D spending serve as rough benchmarks for countries to measure themselves against one another, they do not necessarily represent the total direct measures of innovation (Organization, 2010; Porter et al, 2008).

Unfortunately, there exists no standard measurement for technological innovation. Most quantitative research currently conducted to determine national and international trends relating to technological innovation was primarily focused on the invention, acceptance, adoption, or implementation of technologies (Srite & Karahanna, 2006; Wejnert, 2002; White & Bruton, 2007). Qualitative research studies on innovation by sociologists and anthropologists tended to examine how technology or technology innovation influences organizational cultures and values. During a recent interview, David Kappos, director of the U.S. Patent and Trademark Office, acknowledged that the United States as well as other countries must develop new ways to address innovation; “Patent filings do not equal innovation, by any stretch” (Ferenstein, 2011).

For policymakers and researchers, however, the issues were not as clear-cut as outlined above. Numerous questions remained, sparking debate on the specific genre of innovation that will stimulate a national economy; and on whether more spending always led to more innovation, or even what industry sectors will produce more results (Wang, 2009). Despite the on-going debate on whether America was still the most innovative nation or falling behind in investing in innovation, most economists and technology industry leaders favored and supported the basic premise on the importance and need for innovation for the viability and sustainability of a nation (Ezell, 2009; Wang, 2009). This research study is not an attempt to determine whether America is or is not a leader in technological innovation, but proceeds forward with the premise that innovation is important to America.

America's Protection of Intellectual Property

Protecting Technology. America's focus on protecting its appropriated intellectual property began in earnest after World War II with mass seizure of scientific documents and patents from enemy nations (Gimbel, 1968; Gimbel, 1990; Walker, 1946). The Office of Alien Property Custodian, originally established in October 1917 under the provisions of the Trading with the Enemy Act to oversee the seizure of foreign technology, was reinstituted in 1942 by President Roosevelt through Executive Order 9095 (Executive Order No. 9095, 1942).

Simultaneously, under Operation Alsos and Operation Paperclip, European scientists and technicians were brought to the United States to assist military and civilian industries in developing technologies beneficial to America: weapons, optics, chemicals, rubber, and oil (Cornwell, 2003; Gimbel, 1990). Gathering and assembling the technology, documents, patents, and thousands of foreign scientists created a serious dilemma for the military and policymakers (Cornwell, 2003). The burning question remained: How will America ensure that this newly

found scientific and technological knowledge remain in the hands of America's military and industries for development? More crucially, how will America ensure that the resultant technologies developed from those seized are not, in turn, used by others against America?

In May 1945, Fred M. Vinson, director of the Office of War Mobilization and Reconversion, in a request to the Joint Chiefs of Staff, expressed concern over the restrictions and secrecy regarding seized technologies from enemy nations. Vinson asked that all scientific and industrial reports be declassified and available to everyone so "industry and businesses could use them to increase the variety, quality, and quantity of our peacetime production" (as cited in Gimbel, 1990, p. 173). The Joint Chiefs of Staff, concerned about national security issues related to the technologies, did not support Vinson's request. Thus, the protection of newly acquired technology fell to existing laws and policies (Gimbel, 1990).

The Invention Secrecy Act and secrecy orders. America's efforts to protect intellectual property dates back to World War I with the passage of the Trading with the Enemies Act (Trading, 1917). Intended to protect national interests, the Trading with the Enemies Act was limited to wartime national emergencies and became obsolete at the end of World War I. In 1940, in preparation for America's entry into World War II, this act was reinstituted. Eventually, however, the need to protect America's technologies became paramount, even in peacetime, and the Invention Secrecy Act was passed. This Act repealed those sections of the Trading with the Enemies Act that related to technology. Section 181 of the Act stipulated:

A secrecy order shall, (a) last one year and may be renewed for additional periods of one year upon notification by the head of the agency who requested the original secrecy order; (b) remain in effect in the event of war plus one year; or c) in the time of a national

emergency (as declared by the President), for the duration of the emergency plus six months. (Invention, 1952)

The Invention Secrecy Act also stipulated that the United States Patent and Trademark Office (USPTO) is responsible for issuing secrecy orders on any invention or patent application upon the recommendation of defense agencies, including the Army, Navy, Air Force, National Security Agency, Department of Energy, and National Aeronautics and Space Administration (U.S. Patent, 2011).

Since 1988, Steven Aftergood, director of the Government Secrecy Project at the Federation of American Scientists, has filed yearly Freedom of Information requests to the U.S. Patent and Trademark Office, seeking data relating to secrecy orders filed on patents and patent applications (Federation, 2011). Although the data related specifically to secrecy orders, this collection comprised the most comprehensive compilation of data collected by any organization. Aftergood was concerned about the increase in secrecy orders issued and renewed by the USPTO (Federation, 2011). He was also alarmed by the number of “John Doe” secrecy orders issued. A “John Doe” secrecy order was a term used for any secrecy order issued to an individual inventor or company who was not associated with a governmental entity (Pallitto & Weaver, 2007). Since 1988, 41.41% of all new secrecy orders filed were against John Doe inventors (Federation, 2011).

Linking National Security Policies and Technological Innovation

The research for this study relating to the relationship of technology innovation and national security focused on three main areas: (1) the legality of invention secrecy and the protection of individual rights, (2) excessive secrecy and restricted access to technology, and (3)

the control of research and technology by military and governmental agencies. These three areas, while overlapping, were also distinct and are discussed individually in this section.

Legality of invention secrecy policies and legislation. Congress's constitutional authority to enact the original invention secrecy legislation was based on three legal premises. First, the U.S. Constitution gave Congress the power to "provide for the common Defense and general Welfare of the United States" (U.S. Const. article I, § 8, cl. 1). Since the Invention Secrecy Act was primarily directed toward issues of national security, invention secrecy legislation was therefore authorized under the Constitution (Invention, 1952; Lee, 1997). Second, the Constitution stated that Congress shall have the power "[t]o promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries" (U.S. Const. article I, § 8, cl. 8). While this provision authorized the creation of a patent system, it did not grant absolute patent rights, and therefore invention secrecy can be viewed as part of the patent system's operation (Lee, 1997; Relyea, 2003). Last, Lee (1997) suggested that under *Kohl v. United States* (1875), the federal government can legally seize private property by the power of eminent domain. The Supreme Court ruled that the right of eminent domain may be exercised "as is necessary to the enjoyment of the powers conferred upon it by the Constitution" (*Kohl*, 1875). Lee (1997) argued that while the Invention Secrecy Act might be constitutionally sound, the use of secrecy orders was overused and negatively impacted private interests.

Constitutional challenges regarding the violation of individual rights focused on the First Amendment. Proponents of individual freedom argued that secrecy orders restricted or curtailed the disclosure of details of an invention in violation of the First Amendment. The First Amendment stated, "Congress shall make no law... abridging the freedom of speech, or of the

press” (U.S. Const. amend. I). Lee (1997) contended that in areas of patents and technological knowledge, this restriction on speech extended beyond the individual to others in the scientific community who might have benefitted from that knowledge. As previously stated by Brown and Duguid (1991), Hippel (2005), and Wang (2009), the open and collaborative sharing of information was important because it created the ideal environment for innovative processes.

Relyea (2002) also acknowledged the legitimacy of the First Amendment rights for researchers; though cautioning that certain technological information with inherent national security implications also created the need for scrutiny. In *Schenck v. United States* (1919), the Supreme Court established a *clear and present danger* test. The Court held that Congress had the right to prevent words if they were used in “in such circumstances and are of such a nature as to create a *clear and present danger* [and] bring about the substantive evils” (Schenck, 1919). For *Schenck v. United States*, proof of intent was not a necessary requirement to impose restrictions on speech in cases of national security. In 1969, in *Brandenburg v. Ohio*, the Supreme Court expanded its previous *clear and present danger test* and included discussion on the speaker-intent as well.

Studies that surrounded the legality of national security policies and their relationship to First Amendment rights focused primarily on case law to support their argument and were limited to the legal issues surrounding the topic. While these studies supported the need for collaboration, the authors also expressed concern for potential abuse due to limitations placed on inventions and patents (Lee, 1997; Relyea, 2003). The courts concluded, however, that while they understood the arguments against overly restrictive policies and possible abuse, the government had the legal right to establish restrictions on research related to national security (*Brandenburg*, 1969; *Kohl*, 1875; Lee, 1997; Relyea, 2003; *Schenck*, 1919).

Excessive secrecy and restricted access to research and technologies. Concerns around excessive secrecy and restrictions on technical knowledge are not a recent phenomenon. A report prepared in 1950, under the direction of the National Academy of Sciences, on the role of the Department of State in national and international science found “ample evidence that unnecessary restrictions exist on the flow of classified scientific and technology information” (U.S. Department of State, 1950). The summation concluded, “These restrictions are dangerous to the progress of United States’ science, affect adversely the conduct of our foreign relations in science, and are therefore damaging to our national security” (U.S. Department of State, 1950).

Critics argue that the issue was not whether there should be secrecy, but instead, how much secrecy was necessary and who made those determinations (Foster & Lerch, 2005; Gast, 2004). In “Government Secrecy: Policy Depths and Dimensions,” Relyea (2003) outlined the legitimate need for secrecy and restrictions for reasons of national security; however, he also warned that those same government officials who cloaked their actions in secrecy must “hold themselves accountable to the people who made up the nation they serve.” May (2004) cautions, “Research will be inhibited if we continue down a road of scientific isolationism,”

In a speech at the National Archives in Washington, D.C., on national security and terrorism, President Obama assured the nation that he was aware of the problems and difficulties in balancing security and openness. He remained firm, however, on the need for these restrictions, stating, “Our democracy depends on transparency, but some information must be protected from public disclosure for the sake of our security” (Obama, 2009).

A review of the literature related to the secrecy and restrictions placed on research found that most studies focused on the actions and results of individuals, governments, academia, or industry rather than the actual policy the actions were based upon. However, as indicated in this

chapter, most studies that were conducted on national security policies challenged the legality, not the legitimacy of the policy.

Understanding classified vs. unclassified information and security clearances. In 2009, President Barack Obama signed Executive Order 13526 that established a uniform system to classify and declassify national security information (2009). This order replaced previous executive orders signed by earlier presidents and modified the federal regulation for Classified National Security Information (2001, 2003). It “prescribes a uniform system for classifying, safeguarding, and declassifying national security information” and classifies sensitive information into one of three levels: Top Secret, Secret, and Confidential (Executive Order No. 13526, 2009). The authority to classify information resided with the President, Vice President, agency heads, and officials designated by the President, and other U.S. government officials delegated this authority (Executive Order No. 13525, 2009, Sec. 1.3a). The Information Security Oversight Office (ISOO), an agency of the National Archives and Records Administration, is responsible for developing, coordinating, and issuing directives and instructions regarding the orders relating to classified information under policies related to both Executive Order 13526 (2009) and Classified National Security Information (2001, 2003). The ISOO oversees and monitors the different classification programs and policies for approximately 65 executive branch departments and independent agencies (Information, 2011).

Classified information is usually broken down further into categories or compartments based on the type of project, program, or national security topics; this additionally restricts methods of handling, sharing, or releasing information. For example, if a person has a Top Secret security clearance and wishes to view a Top Secret classified document from a specific project, unless that person has been cleared to discuss or read documents for that particular project, his

request would be denied. This is often referred to as the “need to know” principle (Information, 2011).

Balancing Technological Innovation and National Security

The achievement of balance between freely exchanging ideas and protecting a nation against those who would do it harm is a longstanding challenge. Many Americans became concerned about these issues in the wake of terrorist attacks in September 2001 and the subsequent passage of new legislation, such as the Patriot Act and the Homeland Security Act (Foster & Lerch, 2005). Others, however, such as Flagel (2005), Foster & Lerch (2005), and Gast (2004), suggested that it actually began with the attack on Pearl Harbor in 1941 and Roosevelt’s address to Congress, declaring the previous day as “a date which will live in infamy” (Roosevelt, 1941). Following this speech, Roosevelt subsequently directed all national resources to the war effort, which in turn fueled significant advancements in technology (Gast, 2004). In his analysis of World War II, Flagel (2005) proposed that, although Germany made significant and revolutionary strides in technology, those advancements were largely negated because “the Third Reich failed to emulate the Allies in teaming scientists with soldiers” (p. 251).

After World War II, concerns surrounding the security restrictions placed on federally funded research and private industry were abundant. In 1957, 84% of federal research funds were appropriated for military purposes. Vannevar Bush, director of the U.S. Office of Scientific Research and Development (OSRD), attempted to broaden a research agenda beyond military capabilities through a national science policy open to academics, private inventors, and industry as well as the military (Geiger, 1993). However, with the encroaching events of the Cold War, funding and research were again directed toward weapons research in government laboratories

(Geiger, 1993). Since that time, national security has continued to serve as a basis for limiting public scrutiny of restricted information (Gast, 2004; Relyea, 2002).

In a detailed study on the role of military innovation in the rise and fall of great powers, Taylor (2011) suggested that problems regarding technological innovation were a result of an imbalance of power and priorities within the military and civilian sectors. He proposed that the most successful power maintainers were those who “created a feedback loop – where the innovativeness of society directly supported the innovativeness of the military [and] in return, the innovative military protected, expanded, and diffused innovation to the society” (Taylor, 2011). Relyea (2002) presented historical arguments that supported Taylor’s theory and proposed that the terms *national security* and *homeland security* inherently created a perceived, though real, distinction between military and civilian matters; this, in turn, fed into an atmosphere of divisiveness. Taylor, a 1999 graduate of the U.S. Military Academy and currently a major in the U.S. Army, concluded that in order to create the competitive synergy necessary for innovation, “not only must integration occur between the civilian and military leadership of a country, but also among the various forms of national power in order to capitalize on the strength of the country” (2011, p. 107). Gast (2004) also favored a shared research agenda and cautioned that too much government control and limitations on research (through funding cuts, economic sanctions, or policy restrictions) created an atmosphere of distrust and contempt within the community of scientists and researchers. This same negative atmosphere could also result in a decline in technological innovation.

Conclusion

While existing studies indicated that research into problems related to national security and technological innovation were widely variant, their central tenets continued to be the need

for cooperation, open collaboration, expanded funding to private and academic researchers, and a strong national research policy that balanced the needs of the country (Gast, 2004; Relyea, 1994; Relyea, 2002; Taylor, 2011). The specific factors that contributed to the problem of America's decline in innovation and the approaches needed to accomplish any recommended actions are diverse and, at times, conflicting (Ezell, 2009; Ezell & Andes, 2010; Innovation in America, 2010; National, 2010; Organization, 2009). Past research into economic, political, and educational factors produced copious data; however, America's global standing for innovative competitiveness continued to decline (Organization, 2009).

This reasonably comprehensive review of literature related to national security and technological innovation indicated that an important gap remained in the body of knowledge. Pisano and Shih (2009) proposed that to understand complex or problematic issues, researchers must analyze the phenomena through new or different methods than those previously conducted. Therefore, this research project focused on a particular national security policy, the Invention Secrecy Act. This case study explored the relationship of the specific policy to technological innovation through semi-structured interviews, historical research and documents, and analysis of existing data.

Chapter 3: Research Methodology

Research Design

A case study research approach was selected to explore and examine the relationship between national security policy, technology innovation and, more specifically, the Invention Secrecy Act. Leedy and Ormrod (2010), Strauss and Corbin (1990), and Taylor and Bogdan (1998) suggested that case study methods are ideal for collecting and analyzing qualitative information relative to a single program for the purpose of understanding or generating theories on a little-known or understood situation. Case studies also allow the researcher to analyze a particular topic or experience at a deeper level. A major weakness, however, to both qualitative studies and case studies, is that when only a single case is studied in detail, it is not always generalizable to other situations (Cresswell, 2007; Leedy & Ormrod, 2010; Maxwell, 1998; Taylor & Bogdan, 1998). Thus, when conducting a single case study, Cresswell (2007) stressed the need to collect rich data through a variety of methods, such as triangulation.

The methodology outlined for this study will answer the following research questions:

Q1: What is the relationship between the Invention Secrecy Act of 1951 and technological innovation in the aerospace industry?

SQ1: How do researchers collaborate when the technology examined is related to issues of national security?

SQ2: How do researchers learn of new or innovative technologies in other disciplines?

SQ3: How do researchers share new or innovative technologies within the aerospace industry?

SQ4: In what ways do national security policies constrain technological innovation?

Subsequent sections provide detailed information on industry selection rationale, sampling, instrument design, data collection, data analysis, validation strategies, personnel, resources, budget, and timeline.

Sampling

The semi-structured interviews focused on specific individuals employed or associated with the aerospace industry, academic research, general industry, and government, and public policy. Two types of sampling were used: purposive and theoretical. Leedy and Ormrod (2010), Mason (2006), and Maxwell (1998) suggested this strategy when a participant's knowledge and expertise provides important information considered unattainable to the researcher through literature review alone. As theories or categories were developed, theoretical sampling was employed (Charmaz, 2006; Creswell, 2007; Leedy & Ormrod, 2010). Theoretical sampling, or choosing specific data sources, assisted in developing theories and understanding issues pertaining to the research questions. Discriminant sampling, returning to those same participants, was employed later to help validate the theories developed (Leedy & Ormrod, 2010).

Instrument Design

For the purpose of this research, semi-structured questions were used to gather data from the participants. The questions were asked in face-to-face interviews between the researcher and the individual participants. The questions used for this study were chosen based on a review of existing qualitative or mixed-methods research studies published in peer reviewed journals (Bubela & Caulfield, 2010; Macho-Stadler & Perez-Castrillo, 2010; Siegel, Waldman, & Link, 2003; Siegel, Waldman, Atwater, & Link, 2003) .

The questions addressed seven topic areas: (a) demographics, (b) firmographics, (c) internal research processes, (d) external research processes, (e) collaborative efforts, (f)

intellectual property management, and (g) funding. These topics were all directly related to the research questions and were formulated to elicit pertinent information necessary for data gathering and analysis. According to Maxwell (1998), semi-structured questions were more appropriate and useful in case analysis research because this open-ended, inductive approach was beneficial for soliciting underlying meanings and influences on the research issue. The interview questions for the one-on-one interviews can be found in Appendix C.

The first topic area, demographics, allowed questions specific to the interviewee and their position within the respective industry. The second area, firmographics, gathered data relative to the particular industry where the interviewee was employed. The third area, internal research processes, explored both collaboration and interdisciplinary knowledge to determine how the interviewee's company conducted R&D within their own organization. The fourth area expanded beyond the interviewee's company and included questions relative to external research processes to help determine how companies conducted research with other industries, government agencies, universities, or international consortiums. The fifth area allowed for questions regarding collaboration and interdisciplinary knowledge, both operationally as well as scholarly. The sixth area was composed of specific questions on intellectual property management and the filing or non-filing of patents by the company. The seventh and final question addressed funding sources for R&D in their company.

The interview questions were pilot-tested on two scientists who were not involved in the program. The pilot test was used to validate the accuracy, wording, and relevance of the questions.

Human Subjects Approval. The *Request for Human Subjects Approval* was approved by the Eastern Michigan University Internal Review Board (see Appendix A).

Data Collection

Information was collected through five methods and sources, or triangulation: (a) semi-structured interviews, (b) observation, (c) review and collection of historical documents, (d) data from existing primary sources or databases, and (e) a reflective journal maintained by the researcher. Triangulation was used to support and substantiate information collected during the different research processes. Triangulation also allowed the researcher to “gain a deeper and clearer understanding of the setting and people [and issues] being studied” (Taylor & Bogdan, 1998, p. 80).

Semi-Structured Interviews. The researcher conducted semi-structured interviews to effectively collect data from people employed in five different sectors or industries: (a) academia, (b) general industry producer, (c) government and public policy, (d) defense industry producer, and (e) federal government. Charmaz (2006) stressed that face-to-face interviews were ideal tools to gather data in qualitative studies. Charmaz (2006), as well as Strauss and Corbin (1990), encouraged the use of interviews to generate concepts and theories in qualitative research. These concepts are then used to explore the observed relationships and to clarify any issues in question (Charmaz, 2006, Creswell, 2007). Taylor and Bogdan (1998) and Strauss and Corbin (1990) both asserted that through interviews and theory-building, researchers did not seek to prove their theories but merely to demonstrate plausible support for these theories. The key to their argument was ensuring that the proposed theory was supported by the data and that the theory plausibly explained the behavior studied. Therefore, triangulation was crucial to provide support for theories developed during the interview process.

Sixteen people were eventually identified to participate in the semi-structured interview process. Constant comparative methods, moving back and forth between data collection and data analysis, were employed until theoretical saturation was reached (Charmaz, 2006; Leedy & Ormrod, 2010). The number of interviews conducted for the study was dependent on categorical saturation, or "...when gathering fresh data no longer sparks new theoretical insights" (Charmaz, 2006, p. 113). The interviews were tape recorded, when permission was granted, and transcribed verbatim for later analysis. If permission to audiotape the interview was not granted, the researcher took detailed notes and later transcribed the notes for analysis. The researcher later contacted the interviewees, either by telephone or in person, to validate the accuracy and completeness of the researcher's notes.

To ensure the confidentiality of the participants and records, all participants were assigned a pseudonym used for records, transcripts, and this report. All paper-based documents and audio tapes associated with the interview were kept in a locked and secure file cabinet maintained by the researcher. Appendix B is the Consent Form signed by all participants. Appendix C is a list of the questions that directed the semi-structured interviews. Exploratory questions were used "to deepen the response to a question, increase the richness and depth of responses, and give cues to the interviewee about the level of response that is desired" (Patton, 2002, p. 372).

Managing and Recording Data

All original tapes were stored in a locked and secured file cabinet to protect the identity and confidentiality of the individuals interviewed. The tapes were kept in a separate secure location from the record documenting the actual name of the individual interviewed and the

assigned pseudonym. After the tape recordings were transcribed, the transcription was compared with the original tape recording to ensure accuracy.

Documents and records were assigned a project number to maintain document tracking. A list was kept that included the name of the document, the publication source, and the date of its publication. Appendix E is a list of the documents and records examined in this study. The researcher kept a journal for the project with notes on observations, impressions, occurrences, and thoughts. Upon completion of the study, the researcher destroyed the consent forms, audio tapes, and any other identifying information.

Data Analysis

As a qualitative research project, the data collection and data analysis overlapped in order to customize the data collection to specific needs of the study (Leedy & Ormrod, 2010). This flexibility allowed the researcher freedom to adjust the analysis in parallel with data collection (Taylor & Bogdan, 1998; Charmaz, 2006; Morrow & Smith, 2000). While the analysis process may appear linear, qualitative research analysis was actually circular, ongoing, and continued until saturation was reached (Charmaz, 2006; Strauss & Corbin, 1990). Jackson and Penrose (1993) recommended consistent analysis and reanalysis of all information collected throughout the research process, as shown in Figure 2.

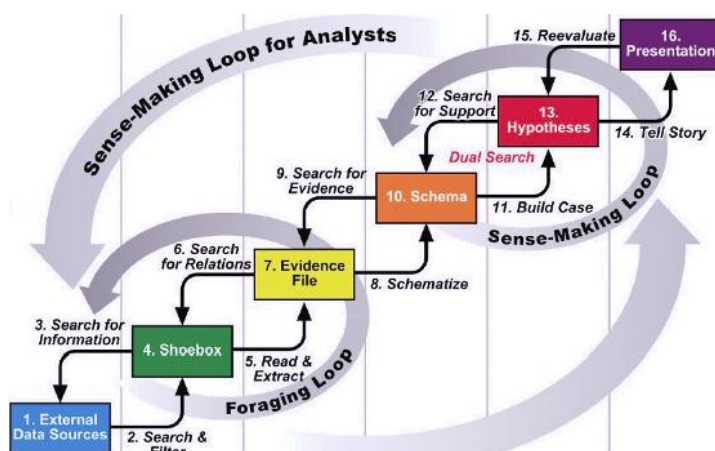


Figure 2. Cyclical and consistent analysis of collected data.

Source: (Jackson & Penrose, 1993).

This study included detailed information gleaned from historical records and documents, databases, and semi-structured interviews. This information was used to explore national security policy constraints and focused on collaboration and interdisciplinary knowledge. The interviews were analyzed to identify issues, interpret relevant meanings, and identify patterns and/or themes (Patton, 2002). The following strategies were used when analyzing results from the data collected: (a) organizing the data, (b) perusal or data immersion, (c) initiating overall categories or themes, (d) coding the data or classification, (e) generating initial interpretations of the data, and (f) developing interpretations or relationships based on the data collected (Leedy & Ormrod, 2010; Marshall & Rossman, 2006).

One strategy used to analyze case study evidence was reliance on comparison with standards and principles (Patton, 2002). The analysis also utilized pattern matching, explanation building, and chronology methods. The findings yielded conclusions and recommendations for future research.

Categories and emerging themes. The goal of categorizing was to “fracture” (Strauss, 1987, p. 29) the data and rearrange them into categories that facilitated comparison between

elements in the same category and, also, between categories (Cresswell, 2007; Glaser & Strauss, 1967; Leedy & Ormrod, 2010; Maxwell, 1998). This categorizing assisted in developing a basic understanding of the overall environment, generated themes and theoretical concepts, and organized and retrieved data to test and support the general ideas (Bogdan & Biklen, 1992; Marshall & Rossman, 2006). However, identifying contextual relationships based on contiguity or contradictions, rather than just similarities, was just as critical as categorization (Charmaz, 2006; Coffey & Atkinson, 1996; Maxwell, 1998).

Interpretation and development of relationships or theories. Marshall and Rossman (2006) cautioned that data interpretation should be effected at every step of the research study, not just the analysis stage. Therefore, consistent notes and memos were generated to document emerging ideas, as well as to foster creativity and new thought.

The evolving nature of categories, concepts, patterns, and trends cultivated through data-collection led to theory-development that addressed and answered the research questions (Leedy & Ormrod, 2010). Marshall and Rossman (2006) refer to this stage as “telling the story” (p. 161). This phase of the analysis evaluated the data for its usefulness and support to the questions explored in the research study.

Validation Strategies

Qualitative research demands validation strategies to ensure credible and rigorous studies (Cresswell & Miller, 2000). Cresswell (2007), however, also cautioned against attempting to use quantitative validation indicators when analyzing qualitative research. Table 2 details equivalent validation definitions between quantitative and qualitative data. For the purpose of this research study, qualitative validation techniques were used.

Table 2

Validation Equivalency Between Quantitative and Qualitative Data

Quantitative	Qualitative	Definition
Internal Validity	Credibility	Credible or believable from the perspective of the participant.
External Validity	Transferability	Generalized or transferred to other contexts or settings.
Reliability	Dependability	Researcher must account for all variables and changes within the research and documents.
Objectivity	Confirmability	Degree to which results can be confirmed or corroborated by others.

Note. (Guba & Lincoln, 1994; Leedy & Ormrod, 2010).

Data used for the study were collected from multiple sources; thus, multiple strategies were used to make the research study credible and rigorous (Cresswell & Miller, 2000). Table 3 details specific strategies that support each area of validation. The following methods employed for the study are shown to establish research credibility and trustworthiness:

- Triangulation – Triangulation, or the collection and comparing of multiple data sources to support the validity of the findings, was used throughout the research study (Leedy & Ormrod, 2010; Taylor & Bogdan, 1998). As outlined in the data collection section above, the researcher used five different forms of data collection for comparison and analysis.
- Extensive Field Work – Research for this study began in 2009. Five research field trips were conducted during which primary data was collected and interviews were conducted:

1. Seattle, Washington – 2009
 - Boeing's Defense, Space, and Security Division
 - The Museum of Flight
 2. Dayton, Ohio – 2010
 - Wright Patterson Air Force Base
 - National Museum of the U.S. Air Force
 3. Washington, DC – 2011
 - Federation of American Scientists
 - National Archives
 - U.S. Patents and Trademarks Office
 4. University of Michigan, Institute of Social Research – 2011
 - Advanced Studies: Qualitative Research and Conducting Semi-Structured Interviews
 5. Washington, DC – 2012
 - Conducted Interviews
 - Library of Congress
 - National Archives
- Negative case analysis – Leedy and Ormrod (2010) suggested that another validation method was identification of cases or interviews that contradicted existing hypotheses. Therefore, in addition to interviewing individuals employed in the aerospace industry, the researcher also conducted interviews with professionals or scientists from the general industry under exploration.
 - Feedback from others – Seeking the opinion of other colleagues assisted the researcher in determining appropriate interpretations and conclusions from the data (Leedy & Ormrod, 2010). Colleagues experienced in case study research and thematic coding assisted the researcher in analyzing the data collected.

Table 3

Validation Strategies

Validation	Definition	Research Strategy
Credibility	Credible or believable from the perspective of the participant.	<ul style="list-style-type: none"> • Record interview/transcribe • Field Notes/observations • Unbiased • Respondent validation
Transferability	Generalized or transferred to other contexts or settings.	<ul style="list-style-type: none"> • Detailed Research • Assumptions • Instrument-Pilot Study • Limitations/Delimitations
Dependability	Researcher must account for all variables and changes within the research and documents.	<ul style="list-style-type: none"> • Triangulation • Extensive field work/ rich data • Detailed collection/analysis • Fact/Fiction-Primary sources
Confirmability	Degree to which results can be confirmed or corroborated by others.	<ul style="list-style-type: none"> • Triangulation – data audit • Feedback: ‘devil’s advocate’ • Validation – Coding • Negative case analysis

Note. (Guba & Lincoln, 1994; Leedy & Ormrod, 2010).

Conclusion

This chapter described the methodology used to collect data and the techniques used for analysis. The specific data was obtained from historical records and documents, existing databases, and semi-structured interviews. Measures taken to prevent participant responsiveness

to outside stimuli and researcher bias included a search for discrepant evidence, triangulation, member checks, and rich data (Patton, 2002).

Chapter 4: Presentation of the Data

The purpose of this case study was to examine national security policy constraints on technological innovation. The researcher achieved a validation strategy through use of multiple-data sources that identified relationships and linked information. The strategy facilitated subsequent discussion and analysis. Although the data collection and analysis may give the appearance of a linear process, the phases were concurrent and iterative (Stake, 2005; Yin, 2009). As shown in Figure 3, a concurrent triangulated design was used to effectively leverage the extensive collection effort and to offset any methodological weakness of relying solely on either quantitative or qualitative methods (Cresswell & Plano Clark, 2007). This method also contributed to the trustworthiness and dependability of the information collected, enhanced the theory-generating capability of the case, and added to the strength and validity of the final discussions (Berg, 1995; Glesne, 1999; Stake, 2005; Taylor & Bogdan, 1998).

The data collection examined in this chapter stemmed from three categories of source information: (a) analysis of documents and historical records, (b) information from existing databases, and (c) semi-structured interviews. The findings in each category were organized by themes that emerged as they related to the research questions. This procedure followed a case study method of narrating a research report in this manner (Cresswell, 2007; Stake, 2005). The chapter concludes with emergent themes relative to the aggregate of data collected. Figure 3 shows the overall presentation of data for this chapter.

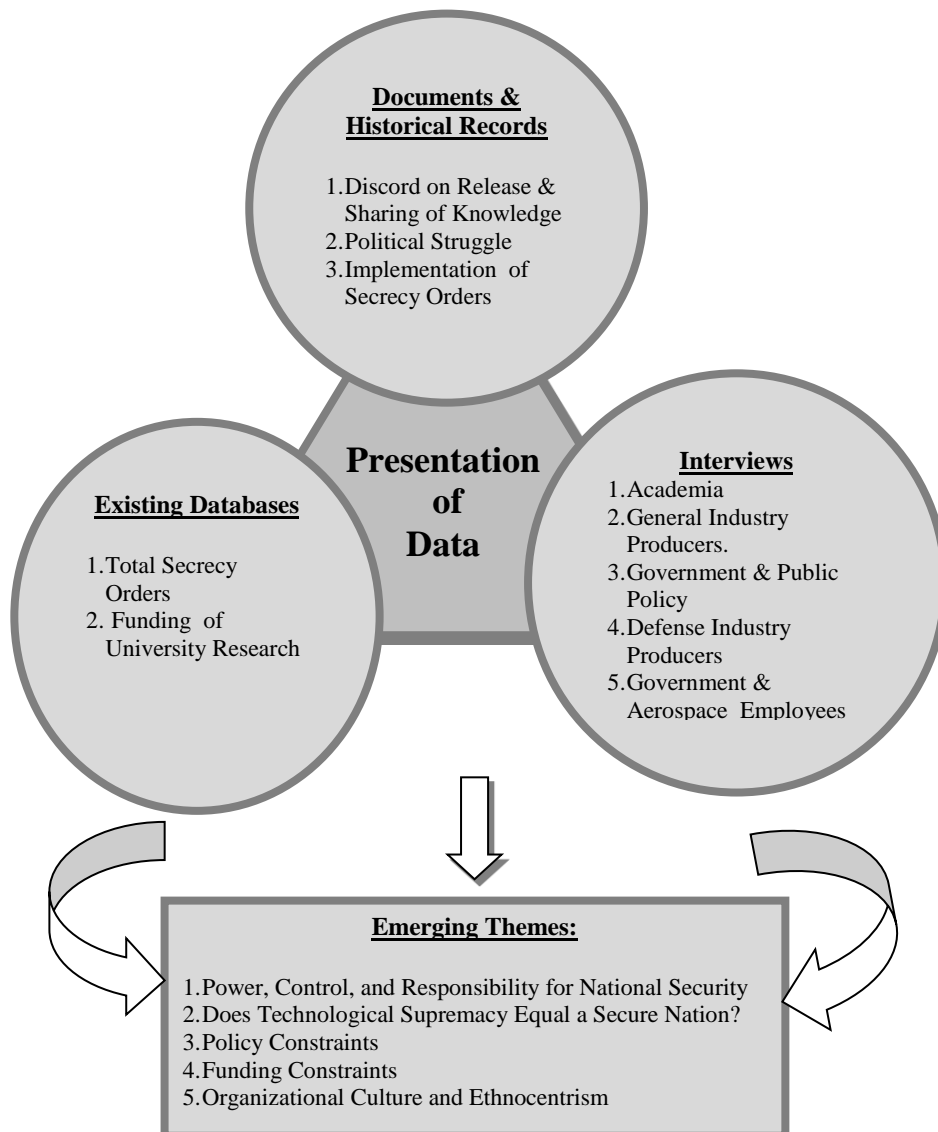


Figure 3. Presentation of Results for Data Collection

Source: Adapted from Cresswell & Plano Clark, 2007.

Analysis of Documents and Historical Records

While this case study focused on the Invention Secrecy Act and its impact on technological innovation, existing policies and strategic plans cannot be studied in situ. Historically, presidents, political figures, military leaders, scientists, and researchers played an

important role in the emergence of technological innovation in America; particularly the role of collaboration and dispersion of inter-disciplinary knowledge as well as events surrounding the Invention Secrecy Act. Therefore, rich data, in the form of historical documentation, was gathered as solid material for understand and conduct significant analysis in the study. The data were collated into the following three thematic areas: (a) Discord on the release and sharing of scientific knowledge, (b) The political struggle over national security and classified information, and (c) The implementation of secrecy orders.

Discord on the release and sharing of scientific knowledge. The question around collaboration and sharing of information on new or innovative knowledge or research was not a recent phenomenon. Since the 1940s, much of this confusion has centered on the philosophical differences between the civilian researchers, the military, and the President regarding control of scientific research and resulting expertise.

After World War II, America emerged as a world leader in scientific and technological achievements, particularly in the area of atomic research (Walker, 1995). The seizing of a sizable cache of foreign patents and scientific documents, as well as immigration of European scientists allowed America to move forward with an agenda of global superiority. The Invention Secrecy Act became an important tool of America's technological momentum. On August 6, 1945, after President Roosevelt's radio address to the American people announcing that an atomic bomb had been dropped on Hiroshima, Japan, the Secretary of War, Henry Stimson, issued a press release praising the coordinated efforts of scientists, researchers, and military officials that led to the design and manufacture of the bomb. In the press release, Stimson also included a reference to America's need to restrict intellectual knowledge stating, "It was early recognized that ...action should be taken to control patents in the field. Substantial patent control has been accomplished

in the United States” (Stimson, 1945). However, soon after the Hiroshima and Nagasaki bombings, disagreements took place among the Manhattan Project scientists (many who were on loan from their respective universities) and governmental officials regarding the release and sharing of scientific information. Many of the scientists believed that the knowledge and information acquired during research on the atomic bomb should be made available for use by other researchers and industries, while the government and military officials argued that the information should remain classified (Kelly, 2010).

However, even prior to the decision to drop atomic bombs on Japan, the relationship between military leaders and civilian scientists over the control of research and technology was already strained due to the creation of the Office of Scientific Research and Development (OSRD; Relyea, 2008). Over the objections of Henry Stimson, Secretary of War, this federal agency was created in 1941 by President Roosevelt to coordinate scientific research for military purposes (Executive Order No. 8807, 1941). Adding to an already volatile atmosphere, the newly appointed civilian director, Dr. Vannevar Bush, reported directly to the president, bypassing the military leadership (Relyea, 2008). An intense struggle over strategic military research ensued almost immediately between Vannevar Bush and Henry Stimson because American and German scientists were conducting intense research on the possibility of using atomic energy for military purposes; the Manhattan Project. Finally, in 1942, President Roosevelt backed down from civilian control of all military projects and transferred a major portion of the Manhattan Project as well as other related research to the War Department (Stimson, 1945). All research deemed necessary for national defense was then controlled by the War Department under the command of Maj. General Leslie R. Groves. This schism between the War Department and the OSRD set

the stage for an ongoing battle, not between nations, but between military and civilian control of national defense and the technologies needed to protect a nation.

In 1945, just prior to stepping down as Director of OSRD, Dr. Vannevar Bush wrote a lengthy article published in *The Atlantic Magazine* in which he declared that as the war came to a close, men of science should focus their attention on making the wealth of knowledge collected as a result of wartime efforts more accessible (Bush, 1945). Many civilian scientists agreed with Bush's action plan, and at the conclusion of World War II, President Truman came under intense pressure from the scientific community, particularly those who had worked on the Manhattan Project, to release previously classified research and make it available to other scientific disciplines. In a 1946 press release, these scientists asserted:

The needless withholding of new developments is bound to delay progress in technical fields, and hence to have serious consequences for our national welfare and security, while the disclosure of a great store of new and useful information will stimulate the growth and development of science and industry. (White House, 1946).

Maj. General Groves convened a panel of scholars and scientists from Cornell University; Washington University; University of California, Berkley; California Institute of Technology, Pasadena; Iowa State College, the University of Chicago, and California Institute of Technology (White House, 1946). Included in the same White House press release were comments and recommendations made by the scholars and scientists on the panel:

We believe that the time has now come for the War Department to take the next step and release additional information in order to foster the development of a strong and healthy science and of a vigorous and inventive industry. The release of such information should proceed as rapidly as feasible in order to promote a return to those conditions of free intellectual interchange under which scientific education can be carried on with dignity and success. Only under these conditions of unimpeded growth can science have its most healthy and flourishing development. (White House, 1946)

Based on these recommendations, several areas of research were transferred to the private sector; examples of this transfer were the Manhattan Project to the civilian Atomic Energy Commission and the Los Alamos and Livermore research labs to the University of California (Patterson, 2006).

For the next twenty years, some of these wartime efforts continued to expand and transform America's technological endeavors in both military and civilian research projects. However, in his famous 1961 farewell address, President Eisenhower, expressed his growing alarm with the military-industrial complex and the scientific-technological elite. He lamented:

The potential for the disastrous rise of misplaced power exists and will persist. Only an alert and knowledgeable citizenry can compel the proper meshing of the huge industrial and military machinery of defense with our peaceful methods and goals, so that security and liberty may prosper together. The prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is every present – and is gravely to be regarded. (Eisenhower, 1961)

Six years later, in a response letter to Stanley Karson, Chairman of the Special Committee on Military-Industrial Complex, American Veterans Committee, President Eisenhower expounded on his 1961 message and the need for a more stable balance between military and civilian scientific endeavors. He stated “Our struggle against world Communism involves military, economic and spiritual factors. Each is equally important and it is up to us to see that we maintain the necessary strength in each and the proper balance among the three” (Eisenhower, 1966).

Today, over fifty years later, as America slips farther behind other nations in technological innovation, the question can be asked: Did America heed President Eisenhower's warning?

Political struggle over national security and classified information. National security was not only an important concept in protecting America, but is now a gateway used to control funding, policies, and information; all key factors for advancements in technological innovation. Since the 1940s, Americans have used the term *national security* more frequently, particularly in reference to military actions. However, the events of September 11, 2001, expanded the concept of national security into many new areas such as transportation, education, domestic policies, foreign relations, and the national economy.

Yet today confusion abounds regarding what constitutes national security and who oversees this critical area encompassing classified information, intellectual knowledge, and technology related to these domains. The confusion, which began during World War II, was reflected in actions taken by both the military and the American presidents and set the stage for internal power struggles. The following information gives a brief overview of the historic struggle for control of national security.

Current studies regarding this debate were covered in Chapter 2; however, a review of historical records on past American presidents reveals a clearer picture of fluctuating actions by White House administrations; resulting in complex entanglement. Analysis of key Presidential Executive Orders (E.O.) issued since Franklin D. Roosevelt brought to light the vacillating policies enacted under different presidential administrations; it was clear that these contractions added to the confusion regarding national security definition and classified information. Table 4 displays a timeline of key Executive Orders issued from 1940 to today. Critical to the policies issued by different presidents was their focus on either national *defense* or national *security*. National defense policies were considered more restrictive and overseen by the military, while national security implied broader powers overseen and regulated by the president or executive

branch of government. This table clearly illustrates equivocation by presidential administrations on policies related to national defense and national security.

Table 4

Executive Order Policy Timeline Relating to National Security and National Defense

Date Issued	Order Number	Signatory	Policy Emphasis
1940	E.O. 8381	Pres. Roosevelt (D)	National Defense
1950	E.O. 10104	Pres. Truman (D)	National Defense
1951	E.O. 10290	Pres. Truman (D)	Nation Security
1953	E.O. 10501	Pres. Eisenhower (R)	Nation Defense for National Security
1978	E.O. 12065	Pres. Carter (D)	National Security related to National Defense
1982	E.O. 12356	Pres. Reagan (R)	National Security
1995	E.O. 12958	Pres. Clinton (D)	National Security for National Defense
2003	E.O. 13292	Pres. G. Bush (R)	National Security
2009	E.O. 13526	Pres. Obama (D)	National Security relating to Defense of Terrorism

Note. All Executive Orders can be found in the References; (D) Democrat, (R) Republican

Prior to 1951, classified information was regulated by War Department General Order No. 3 of February 1912 and General Order No. 64 of November 1917 (Relyea, 2008). A March 1940 directive issued by President F. Roosevelt, E.O. 8381, strengthened the need to classify military information and technology related to national defense and left this issue in the control of the military (Executive Order No. 8381, 1940). However, shortly after the conclusion of World War II, President Truman issued E.O. 10290 in September 1951, which for the first time, classified information in the interest of “national security” rather than “national defense” and extended the classification authority beyond the military to include non-military entities throughout the executive branch. Although this order now included the term *national security*, no

definition was given. The order expanded authority for national security (including research and technology) beyond the military to the broader, implied powers and control of the presidency. It is important to note that this order was signed five months after President Truman relieved General Douglas MacArthur, Commander-in-Chief of the Far East and veteran of World War II, of his command for making statements in opposition to the White House administration. During an interview with President Truman, author and biographer Merle Miller (1973) asked President Truman why he fired General MacArthur. President Truman responded:

I fired [MacArthur] because he wouldn't respect the authority of the President. I didn't fire him because he was a dumb son of a bitch, although he was, but that's not against the laws for generals. If it was, half to three-quarters of them would be in jail.
(p. 287)

Truman, in his 1965 memoirs, complained that the military was neither willing to accept the policies of his administration nor respect his authority as the Commander-in-Chief of the military. In fact, General MacArthur openly refused to salute him and would instead only shake his hand. Truman stated, "If there is one basic element in our Constitution, it is civilian control of the military" (Truman, 1965, p. 142). President Truman's Executive Order 10290 was a major change to existing policy. This new order gave his administration broad, discretionary power to impose sanctions, under the auspices of national security, to other areas of government beyond the military. It was immediately attacked and criticized by the public and the press for "... creating broad discretion to create official secrets" and "... imposing a form of censorship, unwarranted in peacetime" (Relyea, 2008).

Shortly after taking office in 1953, President Eisenhower, a five-star General during World War II, revoked Truman's Order and returned to the previous national defense standard for applying secrecy by signing E.O. 10501, "Safeguarding Official Information in the Interest of

the Defense of the United States” (Executive Order No. 10501, 1953). In a 1953 speech before the Radio-Television News Directors Association in Washington, DC, Attorney General Herbert Brownell, Jr., explained the rationale behind the new Executive Order and stressed that President Eisenhower “considers the free flow of information from the Government to the people to be basic to the good health of the Nation ...” (Brownell, 1953). In objecting to Truman’s Executive Order and its regulations (from the philosophy of a stable and effective public policy) Brownell stated:

By using vague and broad descriptions of security information, they allow government officials to withhold many types of information which could be publicly disclosed without endangering the national safety. There is a tendency to follow the dangerous policy heretofore used by dictator nations of authorizing government officials to use the term ‘National Security’ indiscriminately, and thereby throw a veil of secrecy over many items which historically have been open to the public in this country. (1953)

Although President Eisenhower returned the nation’s defense back to military control, he remained committed to ensuring that intellectual knowledge was available to both military and civilian researchers (Relyea, 2008). National defense and intellectual knowledge were not synonymous.

For more than 30 years and with few amendments, President Eisenhower’s policy and procedure was considered the standard. President Carter signed E.O. 12065 in 1978 using the term *national security*; however, the order continued President Eisenhower’s policy and actually strengthened the existing protocol on information related to national security by including stronger policies related to declassifying information for release to the public “...as early as national security considerations permit” (Executive Order No. 12065, 1978). However, in 1982, President Reagan reversed these policies, signing an Executive Order that changed the focus back to national security, expanded the categories of classifiable information and material

(including research), and eliminated automatic declassification policies (Executive Order No. 12356, 1982).

President Clinton was elected into office in 1993 and, while the term *national security* remained, the classification policies and their application to new research were returned to those supported by President Eisenhower. This order, for the first time, defined national security as "...the national defense or foreign relations of the United States" (Executive Order No. 12958, 1995). This order also effectively reinstituted the balancing test established under President Carter's E.O. 12065 for "weighing the need to protect information vis-à-vis the public interest in its disclosure" (Relyea, 2008).

After the terrorist attacks on September 11, 2001, President Bush issued E.O. 13292 in 2003, which increased the breadth of federal agencies and services falling under national security protection (funding, policies, research) and postponed mandatory declassification of protected information (Executive Order No. 13292, 2003). Most recently, in 2009, President Obama issued E.O. 13526, which revoked President Bush's Executive Order regarding national security. Among the changes found in this directive was a rewording of the focus on classifying and declassifying information to "... information relating to the defense against transnational terrorism." The order further stated, "...our Nation's progress depends on the free flow of information both within the Government and to the American people" (Executive Order No. 13526, 2009). This order reinstated strong declassification policies.

Continual shift in focus by presidential administrations dramatically influenced the stable and equitable implementation of policies within and among governmental agencies. Finally, in 2008, the Office of the Director of National Intelligence (ODNI) initiated an intensive review of all federal agencies and their policies following inconsistencies and confusion

regarding national security, national defense, and the restrictions imposed by their classifications of information and technology. The review found:

...significant interagency differences and contradictory policies impaired cooperation and performance...and do not promote information-sharing and collaboration among the Community's agencies and mission partners... The definitions of 'national security' and what constitutes 'intelligence' – and thus what must be considered classified – are unclear ... There appears to be no common understanding of the classification levels...nor consistent guidance as to what constitutes ... 'exceptionally grave danger to national security.'" (Office of the Director, 2008)

The fluctuating policies, evidenced in Table 4 and supported by the 2008 ODNI study, indicated a lack of clarity and consistency between agencies to understand, interpret, and implement the numerous policies related to national security.

Implementation of Secrecy Orders – Patent Advisory Boards. The definition and background of secrecy orders was thoroughly outlined in Chapter 2. However, a critical element regarding these orders was the implementation or recommendations regarding secrecy orders. It is important to understand the process involved, as well as the group or agency responsible for determining when a secrecy order was applied to a patent application. This understanding will contribute to and facilitate further discussion in the analytical phase of this study.

Secrecy orders are issued under the authority of the Commissioner for Patents in the USPTO, a civilian agency of the Department of Commerce. Although the Commissioner has oversight for all secrecy orders relating to patents and patent applications, the Invention Secrecy Act provides that “whenever the publication or disclosure of an invention by the granting of a patent, in which the Government does not have a property interest, might in the opinion of the [Patent] Commissioner, be detrimental to the national security” (Invention, 1952), the application will be reviewed by certain specified defense agencies. If one of the defense agencies considers

that “the publication or disclosure of the invention ... could be detrimental to the national security,” the Commissioner orders that the invention be kept secret (Invention, 1952). This group of defense agencies is called the Patent Advisory Board. The Patent Advisory Board has gone through several major changes since its inception in 1917, and has added to the confusion regarding the Invention Secrecy Act and secrecy orders.

The original Patent Advisory Board, termed the Army and Navy Patent Advisory Board, was established in October 6, 1917 (Act to Prevent, 1917). The name was later changed to the Armed Services Patent Advisory Board (ASPAB) “to reflect the addition of U.S. Air Force representatives” (Armed Services, 2011). This semi-autonomous board operated under the administrative control of the Army Judge Advocate General’s intellectual property division (Administration, 1991). The Judge Advocate General Corps (JAG) is the legal division of a specific branch of the military and serves as legal advisors to the Secretary of the Army or the chief of Staff of the Army, or the command to which they are assigned (Judge Advocate, 2008). The ASPAB was a conduit for the referral of all patent applications from the USPTO to the Department of Defense. If any of the defense agencies determined that the disclosure of the application would be detriment to the national security, the ASPAB would recommend that the Commissioner of Patents for the USPTO impose a secrecy order. The recommendation is usually binding (Administration, 1991).

In 1997, the responsibilities of the ASPAB were transferred from the legal branch of the military, JAG, to a newly created agency in the Department of Defense, the Defense Threat Reduction Agency, and assigned to the Defense Technical Information Center (DTIC) (Termination, 1997). Today, all issues from patent applications related to national security concerns are now reviewed and decided upon by a technology advisory committee in the

Department of Defense – DTIC. Recommendations are submitted to the Commissioner for Patents at the USPTO, whereby if requested, a secrecy order is issued.

Information from Existing Databases: Secrecy Orders and University Research

Data were collected and analyzed from two key areas: secrecy orders issued and government-funded university research. The data collected on secrecy orders were limited to information obtained through Freedom of Information Act (FOIA) requests submitted by the Federation of American Scientists (FAS) to the United States Patent and Trademark Office (USPTO). The researcher obtained copies of the original documents from the FAS Director for the Project on Government Secrecy, Steven Aftergood (personal communication, June 28, 2011). The USPTO would release only limited information on the total number of secrecy orders filed due to the restricted and classified nature of patent application information. However, sufficient data were available to establish a pattern of activity. The data used for the charts in this section are located in Appendix D. The following discussion on data relevant to secrecy orders addressed four areas: a) Total Secrecy Orders Filed, b) John Doe Secrecy Orders, c) Rescinded Secrecy Orders, and d) Total Secrecy Orders in Effect.

Total secrecy orders filed. Each year since 1988, the Federation of American Scientists (2011) obtained annual reports on the number of secrecy orders through Freedom of Information Requests. Figure 4 represents data from 1988-2010 on the total number of secrecy orders filed each year by the USPTO, the total number secrecy orders filed on John Doe applications or patents, and the presidency under which the secrecy orders were filed. The presidential administrations are included in this chart in order to reference previous information outlined in this chapter regarding executive orders issued by the different administrations, as well as changes to the Patent Advisory Board.

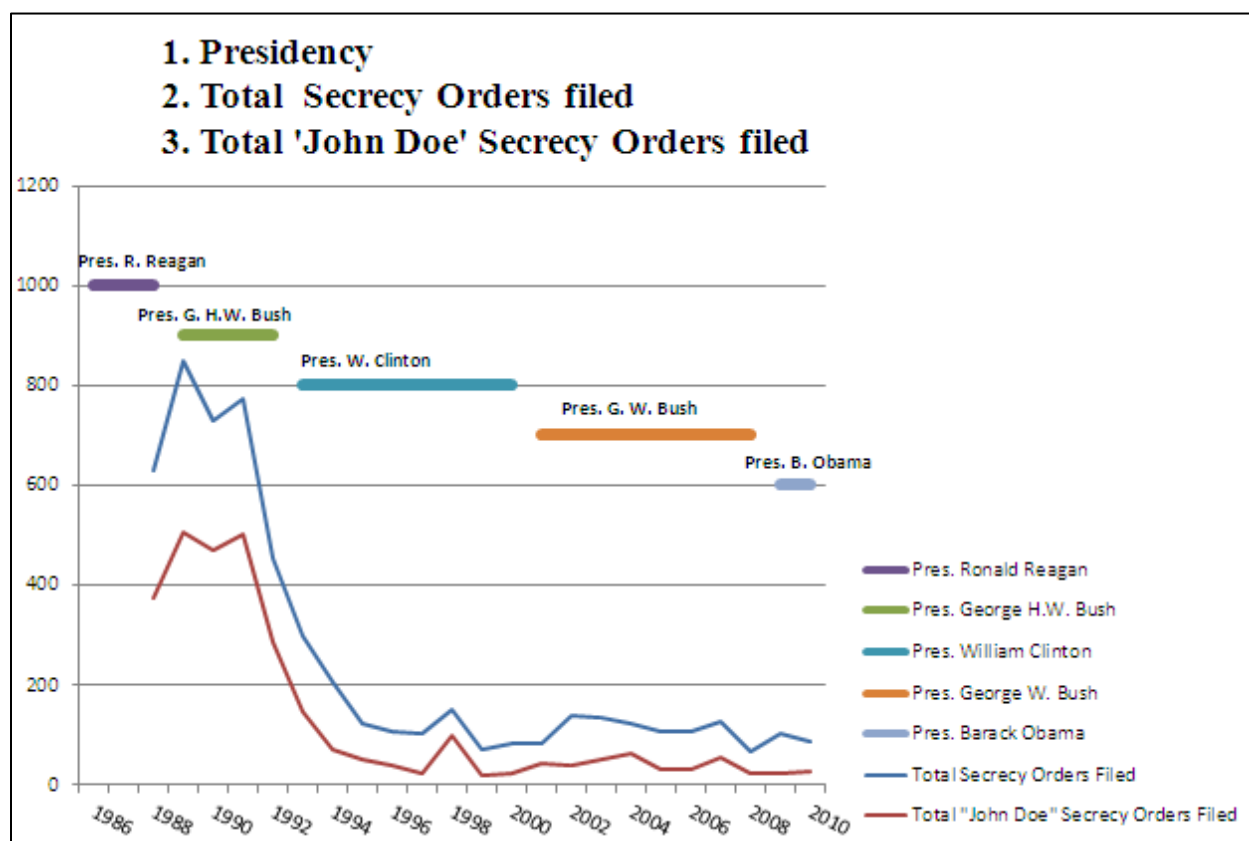


Figure 4. Total Secrecy Orders - 1988-2010.

Source: Federation of American Scientists, Steven Aftergood, 2011.

The total number of secrecy orders filed each year has dramatically decreased from 630 in 1988 to 86 in 2010. While this might be interpreted as an abatement of the policies regulating patent applications, interviews conducted with two government workers employed in the aerospace/defense sector indicate an alternative explanation. These employees explained that approximately 25-30 years ago, an internal policy was issued by their agency to announce cessation of patent application submission unless there was future commercial value to the invention. While the directive could not be located, this timeframe did coincide with the executive order signed by President Clinton in 1995 that demanded aggressive action to “set limits for the duration of classified information, prohibited the reclassification of properly declassified records, authorized government employees to challenge the classification status of records, and created review panels to oversee these actions and to advise on similar policies” (Executive Order No. 12958, 1995; Relyea, 2008).

John Doe secrecy orders. Where warranted, secrecy orders were automatically recommended on patent applications filed by either a sole government agency or a corporation working jointly with a government agency. Secrecy orders referred to as John Doe Orders are protective orders issued to patent applications made by corporations or private citizens and in which the government has no property interest (Pallitto & Weaver, 2007). These John Doe Orders, based on national security criteria as determined by Department of Defense policies, deny the publication, use, or access to these inventions (Invention, 1952). Opponents to this policy argue, “From a constitutional perspective, this is an astonishing power. An invention or process generated solely from the imagination of a citizen may be suppressed – and the inventor subject to imprisonment and fine for divulging the content of his or her own thoughts” (Pallitto & Weaver, 2007).

To date, discussions, divergent positions, and legal arguments relating to John Doe Orders have addressed the topic only through individual case studies or by analyzing the total number of John Doe secrecy orders filed. Table 5 displays the total John Doe Orders filed since 1988 and indicates that more than 41% of all secrecy orders filed are John Doe Orders. The graph in Figure 4 shows a comparison of the John Doe Orders filed with the total Secrecy Orders filed and indicates a similar percentage each year from 1988 to 2010. Unfortunately, the confidentiality surrounding actions taken on behalf of the Invention Secrecy Act prohibited a more detailed breakdown or analysis of the technology, industry, or other information relevant to secrecy orders.

Table 5

<i>Total Secrecy Orders Filed by the U.S. Patent and Trademark Office</i>					
Year	Total Secrecy Orders Filed	John Doe Secrecy Orders Filed	Total Secrecy Orders Rescinded	Total Secrecy Orders in Effect	Net Increase/decrease
2010	86	26	32	5135	54
2009	103	21	45	5081	58
2008	68	22	47	5023	21
2007	128	53	68	5002	60
2006	108	29	81	4942	27
2005	106	32	76	4915	30
2004	124	61	80	4885	44
2003	136	51	87	4841	49
2002	139	37	83	4792	56
2001	83	44	88	4736	-5
2000	83	24	245	4741	-162
1999	72	18	210	4903	-138
1998	151	99	170	5041	-19
1997	102	23	210	5060	-108
1996	105	39	277	5168	-172
1995	124	52	324	5340	-200
1994	205	69	574	5540	-369
1993	297	148	490	5909	-193
1992	452	288	543	6102	-91
1991	774	503	372	6193	402
1990	731	469	496	5791	235
1989	847	504	413	5556	434
1988	630	375	237	5122	393

Note. Obtained from Freedom of Information Request No. 05-007, Steven Aftergood, Federation of American Scientists on June 24, 2011.

Rescinded secrecy orders and total orders in effect. Secrecy orders can be rescinded by the Commissioner of Patents in three ways: (1) at the request of the federal agency who requested the secrecy order, (2) through a request of the inventor with approval by the federal agency who originally recommended the secrecy order or, (3) through a federal court order. A review of the total secrecy orders rescinded indicated a dramatic decline since 1988. In 1988,

237 secrecy orders were rescinded, compared to 2010, where only 32 secrecy orders were rescinded, resulting in an 86% decrease in the number of secrecy orders rescinded. Figure 5 shows a comparison of the secrecy orders filed and secrecy orders rescinded.

Total Secrecy Orders in Effect. Thus, while the total secrecy orders filed show a decrease of 86% (see Figure 4), because of the corresponding decrease in rescinded secrecy orders, the total secrecy orders in effect has remained almost constant, from 5122 in 1988 to 5135 in 2010, a .25% increase. Figure 5 shows the relationships between the total secrecy orders filed, total secrecy orders rescinded, and the total secrecy orders currently still in effect.

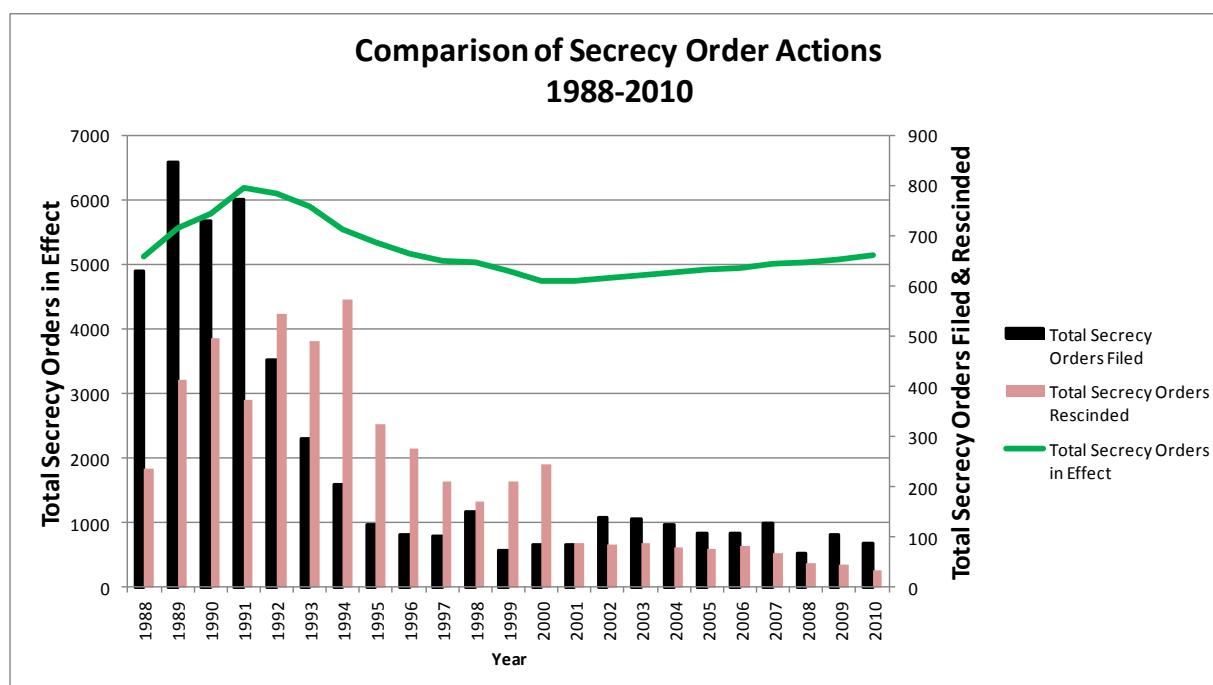


Figure 5. Secrecy orders filed, rescinded, and in effect – 1988-2010.

Source: Appendix D.

Government Funding - University Research. Since World War II and the time of Vannevar Bush, academic research has been important to the nation's economy (Matthews, 2011). While acting as the science advisor to both President Roosevelt and President Truman, Bush supported major investments in research for the nation's universities, advocating that this was significantly important to long-term national growth (Bush, 1945). Today, proponents contend "...the long-term competitiveness of the nation is linked to the strength of the academic research infrastructure (Matthews, 2011). Others claim that the relevance of academic research is broader and is merged with the local economy, supports industrial applications, and provides overall growth and fiscal benefits at both a local and national level (Berdahl, 2009; Bush, 1994; Mendez, 2011).

As of March 2012, the most recent data collected on federal support (FY 2008) of research for science and engineering within universities and colleges indicated that the total obligated amount of \$28.4 billion appears to represent an increase of .09% over previous years. However, Yamaner (2012) cautioned that factoring in adjustments for inflation, the total amount actually represents a decrease of 1.4%. Table 6 portrays the top 20 universities ranked by total science and engineering research funds contributed by specific federal agencies. The impact of this funding and its relationship to technological innovation is discussed at the end of this chapter in Emerging Themes: Constraints on Technological Innovation.

Table 6

Federal Research Funds – Science and Engineering for top 20 universities – FY 2008
(Dollars in millions)

Institution	Total Funds	HHS	NSF	DOD	USD A	DOE	NASA	Other agencies
John Hopkins University	28,424.7	623.9	24.6	405.3	0.7	3.3	51.2	4.3
University of Washington	613.4	417.6	81.4	49.7	3.6	22.1	10.7	28.3
University of Michigan (all)	587	430.4	68.2	53.5	0.8	13.4	18.6	12.1
Univ. of Calif., San Francisco	522.5	514.1	1.2	4.6	0	1	0.8	0.7
University of Pennsylvania	518.7	451.7	28	25.5	0.4	9.1	1.8	2.2
Univ. of Calif., San Diego	518	347.6	90.6	42.8	0.9	14.2	5.4	16.4
Univ. of Calif., Los Angeles	512	375.9	58.5	40.1	0	22.7	13.2	1.6
University of Wisconsin	453.1	254.2	89.2	12.4	27.8	51.1	8.3	10.3
Harvard University	437.4	370.1	37.3	15.7	0	4.5	6.8	3.1
Columbia University	433.1	317.6	74.1	10	0	9.3	8.6	13.5
Duke University	430.9	368.9	35.1	11.2	0	9.4	1.3	5
University of Pittsburgh	429.9	386.1	20.1	16.8	0.5	3.3	1.1	2.2
Washington Univ., St. Louis	425.6	390	20.8	2.6	0	4.7	7.4	0.1
Yale University	419.6	372.6	27.4	5.7	2.2	10.9	0.6	0.2
Stanford University	419.2	297.5	50.4	32.4	0	15.9	20.4	2.7
University of North Carolina, Chapel Hill	410	360.9	28.2	6.4	0.4	3.5	0.5	10.1
Massachusetts Institute of Technology	405.8	210.7	57.1	49.4	1.8	58.8	20.8	7.2
University of Minnesota (all)	390.1	269.8	64.1	6.2	29.3	7.3	5.1	8.2
Cornell University (all)	373.8	173	128.2	16.4	36.3	8.1	5.6	6.2
Pennsylvania State University (all)	366.3	91.1	51.2	157	32.4	17.2	11.6	5.8

Note: Retrieved from (Yamaner, 2012).

Interviews

The researcher conducted sixteen face-to-face interviews. One additional interview was retrieved from an oral history record maintained by the National Aeronautics & Space

Administration archives (Kranz, 1999). The oral history by Eugene Kranz, a project director for NASA, was important to this study as it added the historical context to what transpired in America's aerospace program from the 1960s to the 1980s. For purposes of this study, the oral history interview will be included with the appropriate functional group (see Table 7). The interviewees were categorized into five groups by their functionality and relevance to this research: Academia, General Industry Producers, Government and Public Policy, Defense Industry Producers, and Federal Government Aerospace/Defense Employees. All names used in this study, other than the oral history, are pseudonyms. Table 7 outlines the list of those people interviewed, their position, and the industry they represent.

Table 7

List of Interview Participants

Group	Pseudonym	Position	Industry	Interviewed
Academia	George	Professor/Researcher	Public University – Midwest U.S.	2/10/2012
Academia	Vincent	Professor/Researcher	Public University – Midwest U.S.	2/13/2012
Academia	Nancy	Professor/Researcher	Private University – Eastern U.S.	2/29/2012
Academia	Susan	Director: Research Policy	Public Research University – Midwest	2/27/2012
Academia	Kathy	Director: Research Policy	Public University – Midwest U.S.	2/7/2012
General Industry Producer	Alan	Director of Research & Development	Electronics Manufacturing - Global	3/17/2012
General Industry Producer	Martin	President	Automotive Manufacturing - Global	2/25/2012
General Industry Producer	Steven	Entrepreneur/Engineer	Design Engineering	3/3/2012
Government & Public Policy	Dennis	Director – Government Relations	Public Policy Research Center – eastern U.S.	2/28/2012
Government & Public Policy	Laurence	Director – Government Relations	Public Policy Research Center – Midwest U.S.	3/30/2012
Government & Public Policy	Sarah	Professor/Researcher	Public University – Midwest U.S.	4/12/2012
Defense Industry Producer	Donald	CEO	Tier 1 Global Supplier	3/2/2012
Defense Industry Producer	Timothy	Research Engineer	Defense Contractor - Global	3/7/2012
Defense Industry Producer	Tony	Research Scientist	Defense Contractor - Global	3/22/2012
Federal Government	Adam	Research Engineer	Aerospace/Defense	2/9/2012
Federal Government	Scott	Research Engineer	Aerospace/Defense	2/29/2012
Federal Government	Gene	Research Engineer	Aerospace/Defense	Oral History
** Oral History				
<i>Note: All names are pseudonyms. **Gene, Federal Government employee is actual name.</i>				

Summary of Interviews: Academia

Faculty and staff from three different universities were interviewed for this study. This included three tenured professors and two directors for university research and development offices. The interviewees represented private and public universities, medium to large sized universities, and teaching and research universities.

Interviewees: George, Vincent, Nancy, Susan, and Kathy. George was a professor and scientific researcher at a public university located in the Midwest. George's depth of perspective on research, collaboration, and interdisciplinary knowledge was gained from vast experience in private industry, as well as many years working at universities in different parts of the world. His approach and characterization of research was typical of those shared by the other interviewees in the Academic area. The following vignette provided highlights from the interview.

I am a strong believer that as members of the academic community, we have an obligation to generate new knowledge and to spread and share that knowledge with students and others, whether or not that is in our own area of expertise. But I can see both sides because I've worked in the private sector as well as academia.

When discussing collaborative research, George questioned whether research was true research if it was not collaborative.

How do you define research? Is it true research if only a small group of people are aware of it and it is not shared? Or, is it true research if there is no peer review? In the case of certain federal agencies, the review process is a closed process, not open for review by other scientists or those in other fields. How do they know their research is valid...because the reviewers who are from the same agency say it's valid? I would challenge that process and their assertion that they are conducting valid research.... What would I call it? I would call it experiments that produce a product.

The researcher posed questions to George about the need for secrecy and restrictions based on classified information and national security concerns. George stated that while he understood

these needs and concerns, he wonders whether the issue is actually the need for secrecy, or how the secrecy is applied.

I am not against people protecting this country, its people, and the technologies...and I understand why certain things need to remain confidential. But there needs to be a reason or standard for why this secretiveness is applied. Companies who work closely with the military and government might want to suppress information not because of national security concerns but because of proprietary information or competition with other companies. So under the umbrella of national security, research information is suppressed. Who benefits and is this in the best interest of our country?

Vincent, also a professor and researcher at a Midwest public university, echoed George's sentiment on the need for openness and collaboration in research. When asked about the sharing of knowledge or information between disciplines, Vincent proposed the following experience as an example:

Several years ago, I was invited to a small conference or symposium with other specialists; some were from my field of study, and others were from different disciplines. I felt very honored to be included in this group and to have been invited. At one point, we sat around a large table and with a moderator leading the discussion, we each discussed our current research and projects we were working on. At first, it was awkward, but as each of us began to discuss our work, we became more open and sharing with the information.

When asked if the members of the conference were members from industry, academia, or government, Vincent stated that it was predominantly academia and industry, though there were several people from different government research facilities. Vincent related that while he is not familiar with the Invention Secrecy Act per se, he is aware that research that moves into areas of national security may be considered classified and thus the results not publishable. He has conducted contract work for the government, but none that would be considered classified. Vincent stated that he had confidence in the federal government to make the right choices regarding classified research specifically relating to national security.

Nancy, a professor and researcher at an east coast private university, was more pragmatic regarding the use of federal funding for academic research and restrictions on classified research. Prior to becoming a faculty member at the university, Nancy was a member of the military for 15 years and, thus, specifically believed herself capable of seeing both sides of the issue. Regarding federal funding and classified research, Nancy stated during the interview:

Having been in the military, I understand the need for classified or restricted research specifically for national security. That's what the military does; it protects America and the American people so they can live the life they want with the freedom they expect. And if that means they can't share some of their information regarding research with everyone, well, that's the way of the military. But do I think it can go too far? Absolutely. There were some military projects I was aware of and I would think...wow, wouldn't that be great if people in the civilian sector could use some of that?

When asked if her views changed after joining the faculty at her university and whether this move influenced her actions towards sharing knowledge and collaborating on research projects, she replied:

Yes, it was an eye-opener when I came to the university... One minute I'm in the know, I'm part of the team, and the next minute I'm an outsider ... it was a hard adjustment to make. But I also believe that it has made me more motivated to work with others and share knowledge and information where I can, particularly at conferences with other people in related fields. But don't get me wrong, I still understand and agree with the need for some research to remain confidential and restricted. It's not the same as when I was in the military and, in looking back, I'm probably contributing more now... but I have to say, it's not the same feeling ... before I felt that I was a part of a family.

Susan, the director for classified research at a major research university, echoed George's statements regarding the responsibility of universities for research and knowledge. She added, however, that it was important to understand the intrinsic culture of both sectors; just as the military attracts certain people because it represents similar values and they are drawn to a military culture, the same is true for universities.

The university is a culture and people are drawn to teach and conduct research at the university because of a shared culture of teaching, learning, and working together for the common good. If that were taken away from them, they would find another institution that would allow those same values to exist.

Susan was asked about the type of government research conducted at the university. She stated that in 2011, their university made the decision to no longer conduct classified research. This was a difficult decision to make because the university had been involved in classified research projects since World War II and is renowned for its expertise in the scientific fields of medicine, chemistry, physics, and astrophysics. Susan explained:

The decision to work on a government project is at the discretion of each researcher. We found over the past 5-7 years, that fewer and fewer of our researchers were accepting classified projects because of the restrictions and limitations placed on the projects. One of the problems is that the Export Control laws restrict certain foreign nationals from assisting with the projects. Also, for most classified research projects, you cannot publish or disclose your findings. A professor's tenure at this university is based on their [sic] ability to conduct research and share those findings through publications or conferences. So while he or she might bring in research funds, that doesn't help them if they can't publish the results.

Susan went on to discuss some observed changes since the Regent's decision to no longer conduct classified research.

Surprisingly, the faculty were 100% behind the decision not to continue research in this area. Although we are a research university, collaboration and sharing knowledge between disciplines is part of our culture...I would guess it is a part of any academic culture. Universities attract a certain type of person who believes in these shared values, so we didn't think they would oppose the decision. Interestingly, however, we received a letter from the federal government [did not share which agency] stating that because we will no longer conduct classified research, we will be given a two-year window to change our mind. If in two years the university does not accept classified research, their faculty members will no longer be eligible to attend conferences designated as 'restricted.'

Kathy, the director of research and development at another public university, supports Susan's views regarding an academic culture. She commented during the interview:

Although I am in charge of research and development, I do not dictate to any of the researchers or faculty what they will or will not do. That is part of the culture of a university – they make that decision based on what they believe is best for themselves, the students, the university, and the country. Make no mistake, all of these people here are patriotic, they all believe in the military and national security...they just believe there is a different way to conduct research, share their research, and find new and innovative ways to move things forward.

When questioned about who makes the decision on whether or not to conduct research for the military or government projects, Kathy stated:

Again, that is their [the faculty or researcher's] decision, not mine. My job is to facilitate and help them in any way my office and the university can, not to hinder them in any way. We do not do classified research here, however. To conduct classified research is a very labor intensive and tedious process and that is a major commitment on the part of the university. Here at this university, we don't have the infrastructure to support that type of research...By infrastructure, I mean the security, policies, specialized laboratories, office facilities, and other requirements. Faculty conduct research for the government or the military; however, it is considered contractual and without the restrictions placed on classified research.

Summary of Interviews: General Industry Producers

Interviews were conducted with executives from two different global companies and the owner of a third company who refers to himself as a private inventor and entrepreneur. Early in the research study, interviewees were selected due to their work in industries related to government and aerospace research projects. However, to offer an opposing viewpoint and challenge the validity of information shared by people employed in the defense or aerospace sectors, interviews were conducted with key individuals involved in general manufacturing.

Interviewees: Alan, Martin, and Steven.

Alan, the director of Research and Development for a large global electronics company, was very familiar with the Invention Secrecy Act. However, Alan confided that policies related to Export Control laws dramatically affect his company because they need to collaborate with

subsidiaries in other countries. The Export Control Laws control information, technologies, and commodities that can be transmitted overseas to anyone. This includes the exchange of information with foreign nationals working or attending school in the United States.

The Invention Secrecy Act doesn't affect us because we avoid any type of research that could be construed as impacting national security. This isn't because we don't have the knowledge or expertise in this area, which we do. We employ brilliant scientists...I have a PhD in Physics and conducted research in one of America's premiere national laboratories. But for a company like ours, if we apply for a patent on a design we spent 5-8 years researching and testing, we can't afford to have a secrecy order shutting down our patent and its commercial value. If someone on a federal committee characterizes one of our patents as having national security implications, we could potentially lose millions of dollars if we weren't able to move forward with our ideas. Even if one of our patent applications is held up for a period of time while it is being reviewed, it could cost us money.

Alan was asked about collaborating or sharing information with the military, federal agencies, or companies that work in the area of aerospace or the defense industry. He replied:

Because we don't work on federal contracts, most of our people do not have security clearances. Therefore, anything we work on with those agencies would be one-way....meaning that the information would only go one way....from us to them. I worked in a national laboratory for several years and know the type of research that is conducted at that level. I understand the need for secrecy and confidentiality. I also saw times that some of the research we were working on might benefit those in other areas, such as the medical field. But because the need for secrecy was so ingrained in our everyday lives, it seemed like we no longer looked beyond our own projects. That's one of the reasons I moved on and am working for a private company.

Martin, president for a large global manufacturing company, concurred with much of Alan's sentiment. Martin also stated that they have an aggressive research and development division in their company, but are careful to avoid any products, designs, or research that could be identified with national security. Like Alan, Martin said their company could not afford to have any patent applications delayed.

The loss in commercial value could be astronomical. We are in a highly competitive market and if we cannot supply what we promised to our clients, there are many companies all over the world who can.

Regarding collaboration, Martin stated:

We have outstanding scientists and engineers working here and overseas. What we do and have learned might assist some of these government research projects. But I know how they are, I was in the military, and our company doesn't have time to play "you show me yours first" games. I respect them for what they do in protecting our country and allowing us to live the way we do....I don't know if the excessive secrecy is necessary because I'm not on the inside any more so I will have to trust their judgment. But do I think that this lack of sharing is hurting our ability to compete with other countries? Absolutely!

Steven, owner of his own technology company, also shared the same concerns of Alan and Martin. Steven began his career as a private inventor, designing small components for specific industries. After successfully commercializing several of his patents, he expanded his business and began manufacturing his own designs.

I am very careful what I design because I can only make money when I either manufacture my own invention or commercialize the patent. I don't know the exact law to stay away from ... I don't know it's name ... but I know that if anything I invent is scrutinized by the government or military ...because of what they call national security, I can pretty much kiss that invention goodbye.

During the interview, Steven was very secretive about his technologies. He referred to his inventions as his "life-blood" and his "life" because he stated that his life revolved around his ability to invent, design, and be independent. Steven was very involved with other independent inventors through email, chat rooms, and organizations or conferences for private inventors. In the interview, Steven repeated several discussions he had with other private inventors who expressed the concern that their invention might be "shut down" because someone in the government believed the invention could be tied to national security. While Steven did not know

of a specific example where this happened, he stated that because of that fear, most private inventors openly avoid any type of research into technology that is related to national security technologies.

Summary of Interviews: Government and Public Policy

Three different people currently working in areas of Government and Public Policy were interviewed for this study. One, Sarah, was a faculty member of a university who lectured and conducted research related to this domain. Dennis was a director for government relations at a public policy research center located in the eastern United States. The third interviewee, Laurence, was also a director for government relations for a public policy research center based in Midwestern United States. All three related the difficult balance needed between the public, government, industry, and academic sectors regarding research.

Interviewees: Sarah, Dennis, and Laurence. Sarah, a self-proclaimed history fanatic, stated that while everyone understood the need for balance, rarely does this occur.

For a multitude of reasons, many of them political, tough decisions must be made which in the public's eye, does [sic] not make sense because of the secrecy that shrouds presidential actions.

Dennis's views however, while similar, are more critical of the federal government and their need for secrecy.

Since 9-11, national security has been used as the basis for many decisions, most made in secret. People distrust secrecy, particularly when it comes to their safety. These isolated pockets of information that are controlled by certain groups involved in research, particularly the Department of Defense, is hurting our nation. I understand the need for protecting our country, but an open, honest, and transparent government that instills the trust of its citizens is crucial for America's future.

Laurence, who is also employed with a public policy center, was more conservative in his views on government and secrecy.

If we need to shroud our research in secrecy to protect our nation, then that is why we elect the president, to make those decisions. While we can't be blind, we need to trust that they will make the necessary choices to keep us safe. There have been many examples where people, Americans, have shared or sold classified information to other countries that can then be used against us. We don't want another 9-11. If we need to, we must err on the side of caution.

Summary of Interviews: Aerospace/ Defense Industry Producers

As previously discussed in this study, private companies and federal government contractors play a critical role in the aerospace industry of America. Three people were interviewed from the aerospace and defense industry sector: a CEO of a private company, and two engineers who each work for different aerospace/defense contractors.

Interviewees: Donald, Timothy, and Tony. During the initial interview with Donald, an attorney and the CEO of a Tier 1 supplier to the aerospace industry, the researcher began by sharing some background information about the research project and discussed America's decline in global technological innovation. Donald scoffed angrily and declared that the research was flawed and that America was the greatest nation on the planet. Donald went on to say:

Those reports don't mean a thing. I have worked in this industry for over 40 years and I know for a fact that we are number one. The problem is that everything we come up with here is stolen by the damned [named two countries]. Look at the mobile phones, iPads, televisions, almost everything. We designed it and they stole it!

Because Donald was an attorney, his company owned multiple patents, and he was very knowledgeable about the patent laws including the Invention Secrecy Act, he was asked about those John Doe inventors who unwittingly applied for patents and their inventions were found to fall under the auspices of national security. Thus, secrecy orders were placed on their patent applications. Donald again defended the secrecy orders, stating:

If they have a secrecy order placed on their invention then they shouldn't have been screwing around with it in the first place...I have no sympathy for them. They have no

business working on anything that is related to national defense; that is what we do. There are plenty of other businesses and industries that they can do research in; they don't need to be sticking their nose in areas that are none of their business.

A final question was asked about whether he felt some of the government or classified research could be beneficial to researchers in other sciences and whether there should be more collaboration between disciplines. Donald looked at the researcher with a horrified expression and emphatically stated, "Hell, no!"

Timothy, an engineer with a major defense contractor, was very informative about his company's role in the aerospace industry. Timothy's company was one of the leading defense contractors in the country and very active in the aerospace industry. While they have an extensive research program and work with many other agencies, Timothy cautioned that they were also very careful when determining the direction of their research.

Since our main supplier is the federal government, which includes the military, if we design an innovative product that no one will buy, we're out millions of dollars and we can't stay competitive, much less in business that way. Most of our research is targeted research, research on products we know there is a market for. The key is to design an innovative and futuristic product that someone will buy...that's where the money is. And since most of our work is for the military, that is who we work with.

Timothy was asked about sharing knowledge or collaborating with anyone outside of the military or federal government. He stated that, because they are a private company with shareholders and most of their information is patented or proprietary, they only share information if they are working jointly with another company.

When we work jointly with another company on a project, many times that company only knows that particular area that relates to their expertise, such as electronics. Plus, each company has signed confidentiality agreements and nothing gets out. In this industry, because we pretty much know and work with each other on different projects, if a company or employee reveals confidential information, they're pretty much done because no company will work with them.

Tony, an engineer with another defense contractor, agreed with Timothy's statements.

Tony affirmed that, because their main customer was the federal government (both civilian and military agencies), everything they work on is considered restricted or confidential. Even within their organization, research and information is compartmentalized on a need-to-know basis.

Tony has worked for the company for over 15 years and confided that employees tended to work with the same people or groups in either the federal government or other defense contractors.

When asked about collaboration beyond these groups, he elaborated:

You have to understand that our work is specialized and, after working in this field as long as I have, we pretty much know each other, both in my company as well as between companies. But, while we work together, that doesn't mean that even I can share information automatically with others. If I am working on specific project with one guy, I can only talk to him about that project...but not about other projects I am involved with unless he has also been cleared for those other projects. For example, I am working on a project with someone from the Navy who I've worked with many times in the past. But I can only discuss this one project with him, not any other projects.

The researcher asked Tony what he would do if he had information based on his project that could help others, whether in his area of expertise or outside that area. Tony replied:

That's not for me to decide...the rules are the rules. I can pass that up to my manager, but all of the contracts between our company and any of the federal agencies who are funding our projects require confidentiality and non-disclosure agreements. Therefore, unless it is something critical, the information would stay in-house. We can't afford to violate any of our contracts; those are our life-blood.

Tony was asked about secrecy orders or the Invention Secrecy Act. He admitted that, while he wasn't personally familiar with the Act, he was aware, depending on the project, that their company does apply for patents.

I know that there are some projects we work on that will only be used by the military; there will never be a commercial value to those projects. However, for other projects, while we are designing something for use today by the military or a specific agency, we know that in 10, 15, or 20 years, there may be a commercial application for that product.

In those cases, after we've developed a product, we apply for a patent and a secrecy order is immediately placed on the application. Later, when the agency we are working with approves the release of information from that project, the secrecy order is released and a patent is issued. We then can look at ways to commercialize the product.

Summary of Interviews: Federal Government Employees – Aerospace/Defense

Two federal government employees who work in the aerospace industry were interviewed for the study. They are senior engineers and researchers who have work for the same federal agency for over 20 years each. Their areas of expertise are different, however, and they rarely worked together on the same project. A third interview perspective was an oral interview recorded in 1999 with a NASA employee very familiar with the aerospace program in the 1960s through the 1990s.

Interviewees: Adam, George, and Gene. Adam, a twenty-year government employee for a federal agency conducting research related to aerospace and defense issues, was relatively open and forthcoming about the processes used in his work environment. At the onset of the interview, Adam questioned the researcher whether she had a security clearance or if she had been “read in” on any existing research projects. Being “read in” indicated that a person had the proper security clearance and “need to know” about a specific project. Adam explained that if a person were asked to participate in a project, the individual would sign a confidentiality agreement specific to that project. If a researcher were working on five different projects, he or she would sign five different confidentiality agreements and would only be allowed to discuss the research with those people on each specific project. Adam was asked by the researcher if that wasn't restricting their own ability to collaborate or share knowledge learned from their research, and he stated:

That is the way it is; it is the only way we can guarantee that classified information does not get out to those who may not have a use for that information. We compartmentalize our projects, but we collaborate with each other within the team. The team could be made

up of personnel outside of our own agency, such as the military, national labs, or private defense contractors; however, everyone has signed the agreement.

When asked about collaborating outside of their team or on project coordination, Adam continued:

We have an internal review board that periodically reviews our project to ensure we are not duplicating efforts. I would assume that if they believe something we are working on is relevant to another project, we would be notified. However, so far, that hasn't happened to me.

Adam insisted that they collaborated with other researchers outside of their governmental organization. He was asked to give an example.

There are times when we need to know what is taking place in different areas such as at universities or private industry in various sciences and then we hold conferences and invite these people to participate. For example, we find that what works best is when it is a conference that targets a specific field of research, such as astrophysics. We will host a conference, invite the various participants, and have a moderator work with the different people so each of them share the type of research they are currently working on.

When asked whether any of their own governmental scientists participated and shared the type of research they are working on, Adam stated that although some of their scientists will participate, they only share a small amount of information because the projects are classified.

We call it "feeding," where we share some basic information about what we are working on to see if that generates an open discussion on what other types of research are taking place in the private industry or at universities.

The researcher commented that it appeared to be a one-way type of information-sharing, not true collaboration. Adam vehemently defended their actions, stating:

Most people don't understand what we do. Our work is top secret and we are the difference between living in America or a third-world country. We never know who [sic] we can trust and who will share the information with foreign countries, whether intentionally or unintentionally. That's why we always have to remain on guard and protect our information. We are the leaders of the world and our advanced technology

will keep us as leaders. By working with the military and defense contractors, we are guaranteed that our projects are state-of-the-art, high-tech, and in most cases will not be used against us. I trust my team to keep me, my family, and my country safe.

When Adam was asked about secrecy orders on patent applications, he stated that his agency doesn't have to worry about that because they rarely file for patents.

About 20-25 years ago, shortly before I joined the agency, we curtailed filing for patents...why should we? We are the government and don't need to. What we work on are projects related to technology for America, we are not going to commercialize our work. Now, if we work with a private defense contractor, they might choose to file for a patent and we would be included jointly, in which case a secrecy order would immediately be placed on the application. But otherwise, it involves a lot of unnecessary paperwork and there is no benefit to us. Just recently, they instituted a new policy where we can file for a patent and receive a bonus if it is accepted; however, I am not aware of anyone who has filed for a patent this way.

Scott, another engineer in the same agency, echoed Adam's statement regarding patents.

Scott stated that he has worked for the agency since the late 1970s and vaguely remembered when they stopped filing patent applications. The logic was that because they were a governmental agency and would not be commercializing the results of their research, a patent was unnecessary. In addition, Scott added:

Everything we do is secret, so why would we file for a patent. Most, if not all of the patent applications we previously filed had secrecy orders immediately placed on them, so it seemed redundant to file for a patent in the first place.

Asked whether he felt that the process used by their agency restricts collaboration with others outside of their organization or in other sciences who might benefit from their research, Scott answered:

Absolutely not. I have worked for the government for close to 30 years and almost everyone that works on our projects or in research related to national defense is who should be there. I've seen many of the same people from other federal agencies, branches of the military or private industries, and I know who [sic] I can trust. All of us know that what we work on is critical to the future of America, both to move us forward in

technology, whether in space exploration or defense related technologies, as well as our safety as a nation. We are proud of what we do and proud of each other. While people don't know who we are individually, we know each other, trust each other, and America knows they can trust us if we ever have another 9-11.

The third person who worked in the federal aerospace agency was Gene (actual name) and his information was obtained from an oral interview recorded in 1999 and digitally archived at the NASA Johnson Space Center. Gene was the Director of Mission Operations for the Johnson Space Center and participated in some of the most crucial missions undertaken by NASA, Gemini, Apollo, Skylab, and our current space lab. Prior to that, Gene was a pilot in the Air Force, later worked for a defense contractor, and finally began working for NASA in 1960, where he stayed for almost 35 years.

NASA and related agencies do more than just space exploration. We give young people a place to go, a place to envision the future, to see what is possible. On many of our flights, we incorporated research that impacted astronomy, medical experimentation, psychology, earth resources, and even manufacturing in other environments. We benefitted many different areas of research, but that information was not for public knowledge.

Having witnessed many changes in America's presidencies regarding space exploration, as well as projects related to national defense, Gene was very vocal about the government's role in technology and research.

We were the best, the brightest, and the future for this country. But what took place in many of our programs was politics, pure and simple. The abrupt termination of the Skylab was for purely political reasons. We need to challenge a new generation of people, to do something rather than be something. But we are lacking in national leadership, our leaders are more concerned with politics than making those tough decisions.

Summary of Interviews. Each of the interviews lasted approximately one hour. The participants also shared additional information related to later discussions in this study. Excerpts

from these interviews will be included in the section on Emerging Themes as well as in Chapter 5, addressing the research questions.

Emerging Themes

Based on the extensive research conducted for this study, five major themes emerged as key components in exploring the constructs of collaboration and interdisciplinary knowledge within the parameters of national security policies. Theme development was achieved through pattern-matching and explanation-building to compare and contrast empirical and historical data collected. This study design identified patterns and explored emerging ideas that identified possible explanations for concerns related to technological innovation (Boyatzis, 1998; Cresswell, 2007; Yin, 2009). It is not intended to quantify, develop, or identify causal relationships between the different types of data. The themes identified are:

- power, control, and responsibility for national security
- whether technological supremacy equals a secure nation
- policy constraints: Invention Secrecy Act and Export Control Regulations
- funding constraints: basic versus applied research
- shared organizational culture

Early in the study, the concept of national security was identified as a vital component in exploring the constructs of collaboration and interdisciplinary knowledge. It was found that information is shared or withheld based on the information's relevance to national security as defined by federal policies and guidelines. Dennis, Director for Public Policy, succinctly summarized this when he stated:

Since 9-11, the concept of national security has become an umbrella that looms over most events in America, from transportation, industry, finances, and education. All information must ultimately pass through filters, or policies, to determine whether the information is

harmful to national security. These policies are implemented by people in positions of authority, obviously, government officials. Therefore, government officials eventually determine what information can and cannot be shared with others based on their interpretation of national security policies.

Power, control, and responsibility for national security. The agenda of past presidential administrations in establishing national security policies is frustrating and confounding to the people tasked with protecting America, its citizens, and their technological achievements. Since the 1940s, this philosophical tug-of-war over defining and controlling national security policies has quietly taken place as power changed hands during each successive presidency. For example, in 2002, a bold attempt by the Department of Defense to take over an independent group of scientists created a public outcry. The Defense Advanced Research Projects Agency (DARPA), a premiere research arm of the Department of Defense, cancelled its contract with the influential but little known, JASON group. President Truman created the JASON group in 1948 as an ad hoc group of scientists tasked with evaluating and recommending research relevant to America's military and defense (Southwick, 2002). This autonomous group, named after a character in Greek mythology, was made up of approximately 32 of the country's most brilliant scientists and was awarded permanent, established funding through ARPA [name later changed to DARPA] in 1960 (Finkbeiner, 2006; Southwick, 2002). For the past fifty years, member scientists in the JASON group have worked to establish strategic initiatives to move the country forward in areas of technological advancements by acting as advisors to each of the presidents and the military leadership. In 2002, under the leadership of Secretary of Defense Donald Rumsfeld, the Department of Defense insisted on replacing three of JASON's members with three scientists of their choosing. JASON's membership refused to accept their designees, and JASON's funding

was cancelled. This offensive move angered not only scientists but also lawmakers who successfully lobbied to reinstate JASON's funding (Holt, 2002).

Some view this issue as a power struggle between the military and civilian sectors or even the military and presidential administrations. However, many scientists view this ongoing conflict as a debate that will give them the ability to access broad disciplines of research and scientific information so that they might work to generate new knowledge for others. Susan, responsible for classified research at a major Midwest university, related her surprise at receiving notice from a federal agency [Susan declined to identify the agency] advising her and the university that because of their decision to cease participation in classified government research, "...the faculty will no longer be eligible to attend restricted or classified conferences." Susan shared, however, that even with that restriction, the faculty continues to support the decision to stop all classified research due to restrictions imposed by federal contracts that establish rigid parameters for funded research. Susan went on to say that some faculty have security clearances through outside consulting positions with major defense contractors, which will still allow them to attend those restricted meetings and seminars. Martin, president of a large, non-defense, global manufacturing company voices similar sentiments, stating that while their research is "cutting-edge" for the manufacturing industry, certain engineers were recruited from the defense industry because of their expertise. Currently, their engineers attend manufacturing trade shows or conferences sponsored by their respective societies (i.e. IEEE) but are not eligible to attend seminars or participate in research on areas considered specific to national security. Laurence, director of a major non-profit research center on public policy, believes that the motive for most researchers in areas of technology is not based on political agendas, but on the desire to move technology forward. During Laurence's interview, he stated, "It is important that all research

attract the top minds from a variety of disciplines. The collaboration of intellectual knowledge is what will move this country forward, keep us competitive with other countries, and ultimately keep us safe.”

Even with this historical tug of war over national security, the question remains: Who is ultimately in control of national security? During the interviews, the researcher did not specifically ask a question related to control or responsibility. However, each interviewee indicated, through their responses to other questions, their hypothesis of who ultimately is in control of America’s national security. In President Obama’s 2010 speech on the steps of the National Archives, he defined national security, using phrases such as the security of a nation, a strong, innovative, and growing economy, respect for values, and an international order advanced by U.S. leadership. In each of the interviews, none of those terms was used by the interviewees. Instead, words such as threat, fear, safety, military, weapons, and protection were used. It may appear to be a matter of semantics; however, while the president is ultimately responsible for national security, the perception by the majority of interviewees is that the military is in control.

The three interviewees in the area of government and public policy expounded on that topic in their interviews, stating that although a clear governance structure is in place regarding national security and ultimately who is responsible for making key decisions, they believe that currently, the military is perceived as the dominant force in ensuring the country’s safety. Sarah, a university professor in public policy, gave a clear summation by stating,

On paper, the president is ultimately the Commander in Chief. However, if you took a survey today, my guess is that most Americans believe the Army, Navy...[pause]... actually all of them are the one that will ultimately make the difficult decisions. This isn’t a reflection on President Obama or any one president, but after what took place on 9-11,

people don't want to hear political rhetoric, they want action...and the military is who they will ultimately turn to.

Dennis, who also works in government and public policy, related similar views to Sarah's but added:

As a result of 9-11 and the major changes which took place afterwards, such as the passage of the Patriot Act, there is a mistrust by many Americans of anyone sitting in the White House. There is a perceived lack of transparency by politicians, and this includes the secrecy orders placed on technology. At a time of crisis, they want decisive action that will benefit all Americans, not a select few. The White House is viewed as a political tool, whereas the military is generally viewed as non-political. When push comes to shove, if we have another 9-11 type situation, people will look to the Generals for leadership.

As previously discussed, this issue is critical to the implementation of any national security policy, particularly secrecy orders, which directly influence technological innovation. Official governance may fall under the authority of the president, but operational control may very well be controlled by the military. Thus, determining whether scientific information will be shared for use by others could fall under the auspices of a national security policy defined either as "building global partnerships," "transparency," and "upholding America's values" (Obama, 2010), or a "defense advantage over any foreign nation" and necessary to "resist hostile action" (Pentagon, 2011).

Does technological supremacy equal a secure nation? The intent of this study was not to question America's commitment to technological superiority nor the patriotism of its citizens. In fact, as evidenced in this study, since World War II, America has strongly supported and funded research and manufacturing in areas responsible for national security. However, the political struggle over the control of national security, the funding of research, and the restrictions on intellectual knowledge based on federal policies and guidelines, underscores a

critical question. Does global supremacy in technological innovation equal a secure nation? This question went beyond the parameters set forth in this study and corresponding discussion emerged as a sub-theme during the interviews, requiring briefly examination.

The interviews showed a wide divergence of opinions on the topic of technological innovation and its role on national security. Interviewees from academia spoke in general terms on the importance of collaboration and interdisciplinary knowledge to move the nation, the world, and its population forward. George, professor and researcher, believed that philosophically, the role of research "...is to generate new knowledge which will benefit not only our country, but the world as a whole." Vincent, also a professor and researcher, supported George's statement and added, "There needs to be a balance between our ability to defend our nation, and also our ability to work with other nations...one should not exist at the cost of the other...there must be a balance."

Taking the opposing viewpoint, however, defense industry producers insisted that their innovations and resulting products were what kept the country safe. Donald, CEO of a private, high-tech, aerospace company supported the importance of military research and technology as the means of national security and vociferously claimed that the military and defense industry were the only entities that could protect America. In explaining his position, Donald asserted, "You don't understand, most of you can't, we are the line that stops them [the enemy]. Our technology is the most advanced in the world and that is why you and all the other people in America are free to do what you do." Timothy and Tony, defense contract researchers, and Amy, an engineer for a government aerospace program, strongly agreed with Donald's assertion that their advanced technology is necessary for America's continued protection. Amy added,

We need to keep our research and technology restricted to only those involved in the actual projects. We can't afford for other countries to use this technology against us; it is far too superior.... For example, right now, private companies and venture groups are doing their own research and moving forward in the space program, showing that they can move faster and cheaper than our agency. But it will just be a matter of time before that information is leaked out to other countries because they don't have the restrictions in place to control the research and technological information. They don't realize that what we do cannot be replaced; our work is what is protecting America.

Scott, also a federal government employee in the aerospace/defense industry, strongly emphasized during his interview that the classified research his establishment conducted was "...state-of-the art, no other country can come close to what we do. That's why we are number one, we lead the world... People only know a small fraction of what we do; we cannot be replaced."

This research study consistently showed how actions taken during World War II influenced today's policies and events. It is interesting to note that during the interviews, some opinions expressed by employees in the aerospace and defense industry, as well as the federal government, appeared to echo those expressed by General Walter Dornberger, former Commanding Officer of Germany's Peenemunde Rocket Research Institute during World War II; they supported a strong need for military presence in national security matters. In his 1954 book *V-2*, written shortly after his Allied imprisonment, Walter Dornberger expressed support for the notion that Germany's great technological achievements were a result, not of peacetime research, but from military events that created the opportunity for research and funding of large-scale military projects. He wrote, "The most brilliant scientists in Germany and Austria were recruited into the military and assigned to Peenemunde for their prior knowledge and expertise to help develop weapons to not only support Hitler's offensive in Europe, but more importantly, to protect Germany from enemy attacks" (Dornberger, 1954, p. 234). Dornberger took pride in their

accomplishments and justified his actions, stating, “Never would any private or public body have devoted hundreds of millions of marks to the development of long-range rockets for purely scientific purposes” (Dornberger, 1954, p. 271). Dornberger believed that advanced technology could exist only because of the huge financial support and backing needed for strategic military operations. Many of the scientists who worked for Dornberger in Germany, such as Wernher von Braun, Arthur Rudolph, and Kurt Debus, later immigrated to America and helped establish and direct multiple projects for the National Aeronautics and Space Administration (NASA; Bower, 1987).

There were some, however, who disagreed with the premise that better technological innovation equated to social progress or national well-being. Leonardi and Jackson (2004) referred to this as technological determinism and stated, “Despite the evidence against its empirical accuracy, technological determinism remains powerful and persuasive” (p. 617). Since World War II, this notion of progress and security rested on a doctrine of technological development that, in turn, inaccurately projected technology as the “harbinger of social progress” (p. 618). Others supported the power of technological determinism and argued that technology, national security, and social progress are not interdependent and should be considered mutually exclusive.

Wadhwa (2009), director of research at the Center for Entrepreneurship and Research Commercialization at Duke University, challenged the doctrine of interdependence as archaic and one-sided. In “Protectionism vs. the Innovation Nation,” Wadhwa asserted that “...measuring a country’s security by tallying the kind and numbers of advanced products has become increasingly irrelevant.” In additional support of this viewpoint, Laurence, director for government relations at a public policy research center, posited during his recent interview:

No one will dispute that technology is not critical to America's defense; however, it should never be considered the most important. America's [presence] in the world must be strategic, well thought-out, and ... you can even say choreographed, by leaders who are skilled not just in military matters, but many other areas that are equally important.

Discussion of this topic emphasized an underlying question regarding the importance and role of technological innovation to national security. While this is a critical topic for research and understanding, it will be addressed again in Chapter 5 as a recommended topic for future research.

Policy constraints: Invention Secrecy Act and Export Control Regulation. Results from the interviews and data collection indicated that policies from two different entities directly affect or influence collaboration and interdisciplinary knowledge as they relate to technological innovation. The first area was the Invention Secrecy Act, and the second area was Export Control Regulation.

This research study originally focused on the Invention Secrecy Act, which served as a focal point for data collection and discussions with interviewees. As previously indicated in Figure 4, the total secrecy orders implemented dramatically declined since 1988, and proponents of secrecy orders used this reduction to demonstrate their compliance with federal guidelines and presidential decrees. However, opponents argued that using only the data showing a decline in secrecy orders filed was misleading and created a false sense of collaboration and transparency among researchers and industry sectors. They cited the corresponding decrease in the number of secrecy orders rescinded each year, claiming it resulted in a net effect indicative of a relatively constant, total number of secrecy orders from 1988 through 2010 (see Figure 5). Dennis, whose career was spent in government and public policy, stated, "Secrecy orders may be appropriate, depending on the circumstances. However, because the entire process is cloaked in secrecy, there

will always be suspicions that governmental agencies are withholding more information than is really necessary.”

Information gathered for this study indicated that the Invention Secrecy Act constrained technological innovation in three ways. The first constraint was by restricting the release or sharing of information. When an industry or university worked jointly with a government agency on a classified project, a secrecy order could be placed on the patent application, thus protecting the detailed information from being dispersed. At a future point in time, when the invention was no longer a threat to national security, the secrecy order could be lifted, the patent issued, and the invention commercialized. Tony, an engineer with a defense contractor, stated that this method was frequently used. Tony advised: “While the U.S. government is our main customer, we also need to maximize our ability to sell our products to other customers when the secrecy order is lifted.” Timothy agreed with Tony and stated that many of the technologies on the market today were developed and used by the military 10-15 years ago. However, once a newer technology replaced its predecessor, the older version was sometimes released from the secrecy order and commercialized to the public. One recent example involved a sub-nano technology developed by a private company, CALSEC, under a \$44 million grant by the Department of Defense. The original technology was for the detection of IEDs (Improvised Explosive Devices), drugs (Cocaine), and bio-agents (i.e., anthrax) (CALSEC, 2011). The secrecy orders and the patent application were initially marked confidential, but once the order was lifted, and the patent issued, a company was able to release the information regarding the secrecy order. On CALSEC’s home page, the company stated that their sub-nano technologies were under secrecy orders since 2001; however, the orders were recently rescinded, and the patents were issued. The

technology was now being marketed to major medical centers for early cancer diagnosis testing (CALSEC, 2011).

Although the method employed by CALSEC was legal, Dennis expressed concern that there appeared to be little oversight on the process regarding secrecy orders. Dennis stated, “There is obviously a need to protect inventions for national security reasons, but this process can also be used by companies who choose to hide their invention under a secrecy order until the information can be released and the invention commercialized” (personal communication, February 29, 2012). Unfortunately, because of covertness surrounding secrecy orders, no information is available to the public to validate Dennis’s concerns, other than the total number secrecy orders.

Steven, engineer and entrepreneur, pointed out that the process surrounding the Invention Secrecy Act is also used as a business strategy by industries, such as aerospace/defense contractors to protect proprietary information from competitors and, in some cases, extend the patent time requirements. Steven related,

Secrecy orders are filed on the patent application but the patent is not issued until the secrecy order is rescinded. Prior to 1995, the time limit for a patent started when the patent was issued. This allowed these companies to conduct research that was funded through government contracts, eventually apply for a patent with a guaranteed secrecy order placed on the application [joint research with the government], and eventually sell the final product to the military or government. When the technology was outdated for military or government use, the secrecy order would be rescinded, the patent issued, and the time limit [17 years] would start. The company would then be free to commercialize their products to other industries or for civilian use.

In 1995, the law was amended, changing the length of utility patent protection from 17 years from the time of patent grant, to 20 years from the date of filing (U.S. Patent, 2000). Coincidentally, this date corresponds with statements made by Adam on filing patents. Adam, a

government engineer, explained during the interview that their agency stopped filing for patents about 15-20 years ago. He assumed it was because, as a government agency, there was no need to file for patents on their research as most resultant products were not commercialized. Still other researchers, outside of the aerospace/defense industry, have sought use of secrecy orders to protect their inventions. In a 2007 case, *Farag v. DTRA et al.*, Tarek Farag, a nuclear physicist, sued the USPTO and the Department of Defense (DTRA) because they refused to issue a secrecy order on his invention. The government argued that the invention was not a threat to national security and furthermore, Farag attempted to use the secrecy order to cloak his invention “under a shroud of secrecy.” The court ruled that secrecy orders were not a tool to be used at the whim of the inventor, but as a means to protect a country from a patent that could be “detrimental to the national security” (*Farag*, 2007; *Invention*, 1952).

The second way national security policies influenced technological innovation was through company or government agency avoidance of secrecy orders altogether through failure to file patent applications. This process was previously discussed in a vignette by Adam, who stated in his Clint Eastwood impression, “We’re the government; we don’t need to file no [expletive deleted] patents.” When asked about technology that may no longer be used by the military but might have value to the civilian sector, Scott, also a government employee, replied, “To be honest, most of the time we are moving forward at such a fast pace, we rarely have time to think of those things. I’m sure if it is something really important they would let another sector know about it.” He stated that many government agencies now have a Technology Transfer and Commercialization Office that oversees the dissemination of technologies for scientific, academic, industrial, and commercial use; however, he is not personally familiar with their policies. Susan reiterated that failure to file a patent is not necessarily intentional, but instead

might be a lack of internal coordination and understanding of the research and technology itself. She stated that most universities, particularly research universities, have a section or division that focused on technology transfer; however, many of these offices were overwhelmed, understaffed, and might not understand the value of the information in their files. Wadhwa (2009) contends that “less than 0.1 percent of all funded basic science research results in a commercial venture. And myriad promising discoveries lie dormant in file cabinets of university technology transfer offices, waiting for a white knight.”

Last, the Invention Secrecy Act could negatively affect innovation as a result of companies who refrain from conducting research with national security implications to avoid the potential limitation of a secrecy order placed on their invention. Using a negative case analysis approach (Guba & Lincoln, 1994), members from general industry producing companies who do not conduct research in the area of national security were also interviewed. Alan, director of research and development for an electronics company stated:

We avoid at all costs the possibility that any of our research and resulting patents would fall under secrecy orders. We have brilliant researchers and engineers, physicists, chemists, and many other specialists. However, we need to deal in reality and we cannot afford to have any of our research or patents tied up or delayed by some mysterious government group claiming national security. I’m not saying it’s right or wrong, but those are the policies we must work under and our bottom line is to produce a profitable product.

Alan was asked how they ensure that none of their research or inventions encroached in areas of national security, and he clarified this issue stating:

I’ve worked for the government and I’ve worked in national labs, so I know what they are looking for, that’s one of the reasons I was hired for this position. An error on my part could cost this company millions of dollars if one of our inventions is delayed in the patent process. I constantly review all current and proposed research and if any of them stray into a gray area that might potentially be in the area of national security, we deal

with it immediately. While I won't go into details on how we deal with it, let me just say that if one of our patent applications was tied up because of a secrecy order, we could potentially lose millions, if not billions of dollars in revenue. I make sure that doesn't happen.

The second set of policies discussed by many interviewees, involved Export Control Regulations. These regulations are a complex set of export laws that fall under different departments of the federal government: the Department of Homeland Security, the Department of Commerce, the Department of State, and the Department of the Treasury (see Table 8).

Table 8

Major Export Control Laws and Regulations

Regulation	Agency	Department	
AECA – Arms Export Control Act	U.S. Immigration and Customs	Department of Homeland Security	Controls the import and export of defense articles and defense services.
EAR – Export Administration Regulations	Bureau of Industry & Security	Department of Commerce	Governs export of most items in the U.S.
ITAR – International Traffic in Arms Regulations	Directorate of Defense Trade Controls	Department of State	Governs all military, weapons, and space related items.
OFAC – Office of Foreign Assets Control	Terrorism and Financial Intelligence	Department of the Treasury	Enforces the foreign policy of the U.S. government including all trade sanctions, embargoes, and financial interactions with prohibited or blocked individuals.

Note: Retrieved from

http://www.usa.gov/Agencies/Federal/Executive.shtml#Executive_Departments

Laurence, director of governmental relations for a public research center, explained the two critical aspects of these laws regarding restrictions on technological innovation. The first is

that certain information is considered an exportable item and it therefore fell under all of the export control laws. Second, the export laws restricted whom the information can be shared with by a person's country of origin. While many assumed export refers to products shipped to another country, it's worth noting that export laws are broadly defined and include international students working on research projects in American universities, as well as foreign nationals working for American companies.

Kathy and Susan both stated that these laws were more restrictive for faculty and researchers because they applied to all research, not just classified research. Susan advised that their university recently hired an additional person in their office whose sole responsibility was to oversee the research and ensure compliance with the various export laws. Researchers Vincent and Nancy from academia and Martin and Timothy, general industry producers, all mentioned the limitations placed on international students and workers by these export policies, not solely in their ability to conduct research, but also to collaborate with other experts within and between sciences. Vincent stated that depending on the country of origin, these government controls dictated the type of research that international students can work on:

The broader impact to a university is its ability to recruit international students, offer them Graduate Assistant positions to assist with research, and even discuss research with them if that information is deemed potentially threatening to national security. University professors have been prosecuted for discussing information with other faculty, researchers, and even international students, that the government feels is harmful. I can't take that chance and so I am overly cautious.

There were open debates between academia, industry, and the different departments regarding the imposed restrictions as a result of export control laws. A study at the Massachusetts Institute of Technology on "Balancing the needs for space research and national security in ITAR [International Traffic in Arms Regulation]" found that current export control

policies, most drafted during the Cold War, do not balance the interests of national security with those of technological innovation; they instead restrict “international collaboration and knowledge sharing” (Broniatowski, Jordan, Long, Richards, & Weibel, 2005). Government officials considered the burden on industry and universities minor when compared to national security (Kusiolek, 2008). Dr. Thomas Zurbuchen, Professor of Space Science and Aerospace Engineering at the University of Michigan, testified before a Capitol Hill hearing in 2009 on the adverse impact of export control regulations to industry and academia and argued that ITAR discouraged the best students from attending U.S. universities, which eventually impacted American industries. He went on to say that export restrictions forced those international students who have been recruited, educated, and trained to develop innovative technologies to seek employment overseas and eventually work for companies that compete against U.S. companies (Zurbuchen, 2009).

Funding constraints: Targeted research groups and types of research. Policies related to federal funding was an issue portrayed by many interviewees as a restriction, control, or barrier to advancements in research. These restrictions were viewed differently, however, by academia, general industry producers, defense industry producers, and government employees. One of the major topics identified in this study was the restriction placed on basic and applied research.

Those in academia expressed concern that control over federal funding limited scientists on the type of research they could conduct and whether the results could be shared with others in the scientific community. For example, Table 6 listed the top twenty American universities receiving research funds from various federal agencies. However, the total funds allocated for research do not give a true representation of the restrictions placed on universities when they

accept a federal contract or grant. For example, the National Science Foundation cautioned that while total research funds may appear to show a large commitment to higher education, “Historically, federal funding of research and development for universities has focused more on basic than applied research, while funding support for private industry has focused on applied research or development” (Matthews, 2011). Figure 6 shows the results of a 2010 study by the National Science Foundation, which found that universities performed approximately 56% of the nation’s basic research (National Science, 2010).

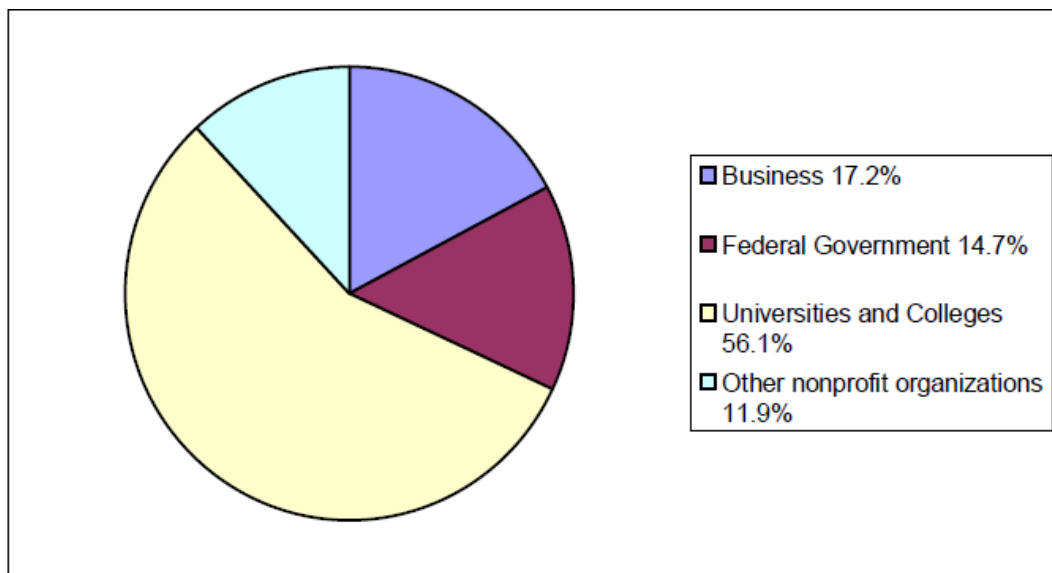


Figure 6. Basic Research by Performing Sector, FY 2008

Source: Retrieved from (Matthews, 2011)

Susan, director for university research, agreed that a large portion of the federally funded research conducted at their university was basic or fundamental research. However, she also pointed out that the university workplace culture was quite different from that of general industry.

Our professors and scientists support a culture of generating knowledge, information, and the advancement of new ideas, whether they relate to basic or applied research. However,

they also know that industry and government rely on the types of research conducted by universities. Our researchers have the time and flexibility to explore new areas; their concern isn't the commercialization of a product, or beating out their competition. Universities, particularly research universities, also attract some of the newest and brightest students from all over the world who not only bring in new ideas, concepts, and methods, but willingly challenge the old or established ideas. Government and industry do not have that type of flexibility or resources.

It was worthy of note that a 2009 independent study on the role of basic and applied research, conducted for the Department of Defense, concluded that isolating or restricting funding programs between universities, industry, or government agencies was not beneficial to the overall viability of technological innovation and resulted in lack of coordination and growth in technology (MITRE, 2009). George, a university professor and researcher, was conducting a research project funded by a contract with a branch of the military. He indicated that the parameters of his research would allow him to focus on basic research and that he was not permitted to take his research to the next step of the application process. When asked about the restrictive nature of his project, George responded:

This is what we do. Many universities receive contracts to conduct basic research and the applied research associated with that process is then either conducted by a national lab or contracted to private industry. While I would like to take my research to the next step, if I violate my contract, I jeopardize my ability to receive future federal or military contracts as well as my credibility in the research community. Also, while the basic research I am conducting is not classified, the applied research could be, and we do not conduct classified research at this university.

Nancy, professor and researcher, related another viewpoint on this issue based on the flexibility and requirements of the private research university where she is employed.

As a private university, we are encouraged to solicit funding and resources that involve federal projects, including classified research projects. Working on classified projects allows us to participate and share in studies for both basic and applied research, plus the university has the facilities to accommodate this type of work. While we are still restricted to the specific information or data of our research and the contractual

agreement for our specific project, I believe these broader parameters [conducting both basic and applied research] are necessary to explore more fully our own field of study as well as contribute to others. That's one of the reasons I chose to work for a private research university.

Regarding industry research, the MITRE study (2009) found that existing research projects were designed such that each federal agency controlled their individual programs through their own allocated funds. This resulted in a lack of coordination and synergy and “renders the basic research program susceptible to ‘drift’ away from long-term imperatives to short-term needs” (MITRE, 2009). The researchers for the study also concluded, “In the present program, evolutionary advances are the norm, and revolutions are less likely to be fostered than they should be” (MITRE, 2009).

Several of the people interviewed from the federal government and defense industry producers offered a different take on this issue. Donald, the outspoken and forthright CEO, stated that the issue was not that “clear-cut.”

I am the CEO of a major company with people depending on me to make sure this company develops a solid product, stays competitive in the market, and finally, makes money. I wish we had the time for ‘Skunk-Works’ type research, but we don’t. We need to create a product that we know is marketable and needed – immediately. Fundamental research is critical, but it doesn’t generate dollars and the research can take ten to fifteen years and still never find an answer. This company couldn’t survive that way. Plus, who would do the applied research and produce the products necessary for our space program or the military? A university like Harvard, Duke, or Cal Tech? Can you see them conducting research into advanced weapons systems? They wouldn’t survive the fall-out from the students and faculty if they found out.

Scott, a federal employee, agreed with Donald’s industry perspective and stated that it echoed what commonly occurs in the federal government.

Some of our national labs conduct fundamental research and some of these labs work with neighboring universities, particularly in California. However, for those of us who work for an agency of the government, we are expected to conduct research that

eventually leads to “something.” We cannot spend years and years working on a project that generates an idea, particularly if that idea can’t be immediately used in a project. People think that only private industry has to worry about competition, that as the government, we have the luxury of time. For example, today there are many private ventures springing up that are attempting to show the world that they can produce a spacecraft faster, cheaper, and at the same time generate revenues. If we don’t show that we can do the same, we’re out of business!

Obviously, research funding is an extremely complex process, particularly when associated with national security. However, the previous vignettes and reports demonstrated that funding policies and procedures could determine the direction and scope of research for technology projects as well as conclude who benefitted from patentable results. Dennis cautioned that the lack of oversight and secrecy surrounding the funding and patents “...is both a potent combination and an open door for abuse and manipulation of government policies, all in the name of national security.”

Organizational culture and ethnocentrism in national security. The last emerging theme was shared organizational culture and its role in collaboration practices and interdisciplinary knowledge. Americans are highly individualistic, which allows for a wide variation in activities, lifestyle, personal beliefs, and affiliations. They also belong to multiple cultural groups, such as national culture, ethnic culture, and organizational culture (Hofstede, 2001). Organizational culture is composed of guidelines and beliefs that are usually based in shared practices learned on the job or brought into the job based on one's own personal beliefs (Hofstede, 2001). Organizational culture is not necessarily limited to an individual company but can include several companies, organizations, or groups of people involved in similar types of work.

The interviews clearly outlined patterns of organizational behavior based on the culture in which the individuals resided. Those in academia unanimously described their culture as one of "openness," "learning," and "sharing" while "seeking and developing new knowledge." The secrecy surrounding certain patents was alarming to several members of academia, not because they do not believe secrecy orders are necessary, but due to the lack of transparency surrounding the orders. During the interview process, as the Invention Secrecy Act and secrecy orders were explained, George, Vincent, Susan, and Kathy all asked for additional information and facts regarding the secrecy orders and the type of inventions that were included. When advised that the detailed information was not available, even after the secrecy orders were lifted, they were shocked that this policy was allowed to continue. Vincent stated, "I believe that what they are doing is in the best interest of this country, but I would be more convinced if I could see some facts." Nancy summarized her concern with the statement, "For the Department of Defense to

oversee the secrecy orders, national security, as well as a large percentage of the funding for research, it's like the wolf guarding the hen house. Who's guarding the wolf?"

Susan previously described their university's decision to stop accepting all classified research as a joint accord by the regents, university administration, and faculty. Despite the fact that this resolution would limit federal funds allocated to the university, Susan stated that the restrictions regarding research, secrecy orders, and export controls, were no longer "in the best interest of the university and its students." Nancy agreed with Susan's statements but clarified that private universities do not have the luxury of state funding and must temper their openness with "fiscal reality." George, academic researcher, responded to a question on accepting classified research projects:

Would I conduct classified research even if I felt it was too restrictive and went against some of my beliefs on collaboration and sharing? Absolutely! The reason is that for the right price, I will conduct the government's research and accept all of their constraints. Because with that money, I can then conduct many more research projects of my own choosing and with the best students, no matter what their nationality. This isn't a matter of win or lose. This is a matter of doing what's best for our country, the university, and the students. The word 'I' does not fit into that equation.

The interviewees in the general industry producer group were similar in their overall beliefs regarding openness and sharing; however, because of the competitive nature of their industry and the need to generate profits, their support or lack of support for secretiveness and restrictions was based on business strategies. During the discussion, Martin, president and CEO of a manufacturing company, referred to his group as the "bastard child."

The aerospace and defense industry are thought of as one and the same because usually it's the same players. They work together, they share projects, they receive funding, and they're included in all of the conferences, meetings, and briefings related to this industry. They work on cutting-edge technology that those of us, who are considered 'outsiders', cannot participate in. They have their own sandbox and they don't play well with others.

The defense industry producer group, while aware of the need to also generate profits, tended to additionally voice support for government and military control of products, policies, and information related to national security. Martin noted that this was probably because the American government was their main customer. Donald, the most vocal interviewee, frequently spoke about his patriotism and desire to protect America. The three aerospace/defense industry representatives, Donald, Timothy, and Tony, all expressed immense pride that the work they do contributed to the protection of Americans and the country's borders. Tony, the youngest from this group, related how his parents bragged about the work he did:

While my family doesn't know much of what I work on, I know they are very proud of what I do because it helps this country. My parents were immigrants and love this country. They always instilled this sense of duty into all of their kids. Everyone in the family brags about me and while it's embarrassing, it also makes me feel good, like I belong.

The group of government employees also expressed this sense of belonging, or being part of a family that protected the country. Patriotism was a word used by federal employees, Adam and Scott; both were concerned about the privatization of their industry because "only we know what America needs, we do it because we care ... not to make a profit" (Scott). Earlier in this report, Nancy shared her experience while she was in the military working on defense-related projects and prior to her employment with a private university. She expressed that the military was a difficult environment to leave because in the Army, she was part of a larger family: "I belonged to this elite group called the Army, I was made to feel special and was included in some of the most advanced projects undertaken." She went on to relate her experience after leaving the Army. "I've run across several colleagues that I worked with in the Army, and while they are friendly with me, I know I'm an outsider ... they are secretive around me ... it hurts."

The military and defense-related industries also played an important role in this discourse because numerous research projects were joint operations between private contractors in the defense industry and the military. Donald advised that the military or a particular government agency was usually the major customer for most technology related to national security. Therefore, there was an inherently close relationship between the people and businesses in this industry. Donald also stated that defense industry producers frequently hired employees directly from branches of the military and this practice created a close relationship.

If you look at most of the large private companies that compete in the field of national security, you will usually find retired Generals, Colonels, ex-CIA officials, and other three-letter executives on their payroll. When you have a private company with executives from the military or government, and your customer is the military or government, it's just logical that everyone is on the same page.

Researchers warn, however, that this type of isolated organizational culture that encompassed the military, government, and those industries that supported them created an environment of ethnocentrism, which could have negative consequences. Gerras (2008), professor at the Army War College, posited, "The U.S. Army, because of its preeminence among the world's land power, has tended to develop an ethnocentric view that our way is the best way." Fastabend and Simpson (2004) believed that the military culture of 'group-think' was the antithesis to critical thinking and fostered an environment in which "subordinates simply mimic the thinking of their superiors." For a subordinate to think critically about a situation rather than simply obey a directive was considered "...a challenge to the egocentric and ethnocentric tendencies of Army officers" (Gerras, 2008). Adam, the engineer working for a government agency, previously expressed his belief that "No one understands what we do ... we can't be replaced ... we are what's keeping America safe." In discussing this "group-think" process for

those working in areas of national security, Sarah, professor of government and public policy, warned, “This is a closed culture that strongly believes what they do is at the heart of saving our country. They attract other like-minded people to join their organizations and reject those who may not agree. This recursive behavior serves to reinforce their already ethnocentric-type beliefs.” Kam and Kinder (2007) added that what makes ethnocentrism so powerful was that it included a person’s belief, as well as their feelings. “Ethnocentrism is not just an error in judgment, not just a matter of intellectual functioning; it involves emotions as well, both positive and negative.” This belief tended to divide the world into in-groups and out-groups, did you belong, or were you an outsider (Kam & Kinder, 2007; Levinson, 1949). This sentiment was also voiced by Nancy, who has experience both as a member of the military and in academia:

When I was in the Army, I felt very patriotic, very American. I believed that we needed to keep secrets from others, particularly in technology, which, as an engineer, is the type of project I worked on. We did not even think of filing for a patent, because there was always the risk of information getting out, even if a secrecy order was issued ... it just seemed like unnecessary paperwork. Plus, everything we worked on was for us [Army], so there wasn’t a need for a patent.

Steven, the entrepreneur, offered an alternative perspective. Steven filed and received eight patents related to a wide variety of technologies. Knowing the restrictions placed on patent applications that were deemed a threat to national security, Steven studiously avoided working on any technologies that could jeopardize the commercialization of any of his inventions.

My father was also an inventor and so I grew up knowing the types of things to stay away from. The people who work in those areas [aerospace and defense] are not going to share anything with someone like me, a lone wolf, even if I am an engineer with some impressive inventions to my name. Would I want to work on some of their projects, be in on some of their meetings, or even talk to some of their engineers? Hell, yes! I have a lot to give, I never slow down, my mind is always spinning. I come up with some of the most unusual ideas and designs, and I know I could really help them if given a chance.

The vignettes shared by some of the interviewees revealed widely diverse cultural beliefs that could affect technological innovation. Most of those in academia believed that the collaboration and sharing of knowledge generated innovation, while those in the aerospace or defense related industry believed that a culture of protectionism and secrecy was necessary for technological innovation. In “The 21st Century Battlespace: The Danger of Technological Ethnocentrism,” Roy van den Berg (2010) warned that relying on a cadre of specialists to develop technology to win wars or protect a nation did not guarantee ultimate victory. He stated that the battlefield was broad; strategic leaders and planners needed to include those outside of the military. “War is a human endeavor, and thus we should be careful when we remove the human element from it.”

Sarah, professor of government and public policy, stressed that both sides are right and both sides are wrong.

The real issue here is the need to find a balance that will move America forward, protect the country and its citizens, and a solution that everyone can live with. The gap that separates the two cultures could be narrowed, or even eliminated, by a cooperative effort to limit secrecy to its least ambiguous, most broadly accept purposes.

Susan also addressed the issue surrounding ethnocentrism,

Traditionally, most literature tends to associate ethnocentric attitudes, values, and cultures with the military. In fact, if you were to look at the research conducted in this area, you would probably find that much of it is conducted on the military or pockets within the federal government. However, those in academia also share traits and beliefs that can be considered ethnocentric. University faculty and researchers share cultural values that support openness and the belief that what they do is for the common good ... they believe they are right...just as those in the military believe that they are right to restrict information for the common good. It becomes harmful when a group cannot see a middle ground and they begin to ‘circle the wagons’. Their actions create an atmosphere of isolation and protectionism to protect those inside and shield themselves against others.

The discussion on culture, however, went beyond organizational culture and touched on issues related to national culture. Vincent, a university professor, while supporting an open environment for collaborative research, also believed that America needed to be concerned about its safety.

I wish we didn't have to choose and that there was a way for everyone to work together; but I also want to live in a country without fear for me or my family. If that means that some of what the military or government does must remain secret, then I trust them to make the right decision. What choice do I have? If we have another 9-11 type occurrence, who are we going to turn to ... the politicians ... the media ... who? I know that most of us will turn to the military and government to protect us.

Steven, entrepreneur, also expressed concern about his safety, even while arguing for less government secrecy.

I may complain about the closed-door policy of the government and military when it comes to sharing information and even about those secrecy orders on patents. But I also know that if something were to happen to this country, I would want ... no, I would expect the military and other government agencies to take immediate action. So maybe I'm a hypocrite, I want the best of both worlds...my freedom, but also to be safe. I'm not sure they can go hand-in-hand.

Laurence agreed that freedom and safety might not go hand in hand, but he also believed that someone must be the watchdog for these groups [military and federal agencies] to ensure that they stayed within their boundaries. He stressed, "While there can never be total transparency in government, they need to know that there are powerful groups, such as mine, that will make darned sure that they do what's right for the country." In an old yet relevant and well-cited Supreme Court case, the justices addressed the government and its right to impose secrecy in limited instances. They warned, "...decisions shrouded in secrecy, once made known to the citizenry, must be acceptable to them...The citizenry, in turn, must accept such secrecy in

limited instances in order to have the confidence that their representatives are making decisions and policies acceptable to them” (*Ex parte Milligan*, Relyea 2003).

Summary

This chapter presented data collected from historical and archive records, existing databases, and semi-structured interviews. Chapter 5 will discuss the research questions, summarize the project, and make recommendations for future studies.

Chapter 5: Discussion and Recommendations

The purpose of this study was to explore the national security policy constraints on technological innovation. This case study specifically focused on the Invention Secrecy Act and the social constructs of collaboration and interdisciplinary knowledge as they related to the aerospace industry. The questions were as follows:

Q1: Research Question: What is the relationship between the Invention Secrecy Act and technological innovation in the aerospace industry?

SQ1: Sub-question 1: How do researchers collaborate when the technology is related to issues of national security?

SQ2: Sub-question 2: How do researchers learn of new or innovative technologies in other disciplines?

SQ3: Sub-question 3: How do researchers share new or innovative technologies within the aerospace industry?

SQ4: Sub-question 4: Do national security policies constrain technological innovation?

This final chapter will summarize and interpret the major findings of this study, discuss the implications of this research, and recommend areas for further research.

Question 1 - Invention Secrecy Act and Technological Innovation

This study explored issues surrounding the Invention Secrecy Act to examine its relationship to technological innovation. The underlying premise of the Invention Secrecy Act was based on technological information and whether the information was detrimental to national security (Invention, 1952). Therefore, the data collected and interview discussions pertinent to the concept of national security were critical to answering the research questions. The legality of the Act and the government's right to enforce the Act, while key to understanding the historical

context, were not a focus of this study. Although challenged over the years in various federal courts, the legitimacy of the Invention Secrecy Act and the government's legal authority to execute the Act were firmly established as far back as 1875 with *Kohl v. United States* and *Schenk v. United States* (1919). The federal courts consistently supported the federal government's right to restrict information for reasons of national security, which included patent information (Brandenburg, 1969; Kohl, 1875; Schenck, 1919). However, opponents to the Invention Secrecy Act argued that the disparity in the Act's implementation, as well as other federal policies associated with national security, placed unfair limitations on research, collaboration, and funding, which directly impeded technological innovation (Foster & Lerch, 2005; Gast, 2004; Mukherjee & Stern, 2009; Relyea, 2008).

This research study indicated that as far back as World War II, the definition, interpretation, and implementation of national security policies served to justify limiting information, funding, and public scrutiny of restricted information, including secrecy orders issued as a result of the Invention Secrecy Act (Gast, 2004; Relyea, 2002). Many of these national security policies were not defined, interpreted, or implemented in a consistent manner. This lack of clarity gave rise to actions by various federal agencies that limited access to certain types of information and research for reasons of national security. These restrictions stifled, and, in some examples shown in this study, directly impeded collaboration and sharing of interdisciplinary knowledge between academia, industry, government, and private inventors. Industry-employees and academicians who supported classified or restricted government research appeared to collaborate amongst each other only on a project-by-project basis; other industries specifically abstained from conducting research for technology potentially encroached on areas of national security to avoid the threat and repercussions that resulted from secrecy

orders. Collectively, these actions placed restraints on intellectual knowledge that will ultimately influence technological innovation (Andrew et al., 2010; Danhof, 1970; Mukherjee & Stern, 2009).

Sub-Question 1: Collaboration on Technology Related to National Security

This study indicated that there was limited collaboration among researchers when the technology was related to issues of national security. The defense industry producers and federal government employees insisted that most of their research was associated with national security and was, therefore, either restricted or classified. Collaboration was discouraged even amongst themselves; unless working jointly on a specific project, one scientist might not be aware of the research taking place in the next room or lab. Scott, an engineer employed by the federal government, shared a story related to a complex and detailed project his team had worked on. Unbeknownst to them, another team in the same agency, but at another location, was working on a similar project. Scott lamented, “We were shocked at the lack of coordination between all of our projects. We just assumed this was coordinated or reviewed at the management level. Our team was angry because we had invested countless hours in this project. They set up an oversight committee after that, so it wouldn’t happen again ... we hope.”

In the field of academia, the interviews also demonstrated inhibited collaboration between colleagues in different sectors. During the interview, George related that he received a federal grant to conduct basic research on basic research but could not take it to the next step of applied research. When the researcher inquired if he knew who or what agency would be conducting the applied research on the project, he replied, “With the government, everything is on a need to know basis, and obviously I don’t need to know.” Susan, director of government research at a large research university, explained that once their university made the decision not

to conduct classified research, they were notified that their faculty could not participate in future conferences that discussed restricted or classified material. Although some of their faculty could still participate because they have security clearances due to outside consulting work with defense contractors, they would be limited on what they could share or discuss with colleagues at the university.

Sub-Question 2: Sharing/Learning through Inter-Disciplinary Knowledge

Scientists from the Manhattan Project were some of the earliest to argue for sharing scientific information, methods, and discoveries between disciplines (White House, 1946). However, interviews conducted with industry researchers indicated that even today, restrictions remain that prevent them from sharing interdisciplinary knowledge. Additionally, other selective actions, such as restrictions placed on the targeted funding to universities or industries for basic and applied research, limited the researchers' ability to expand their own research or share information with other disciplines. When Vincent, faculty member and researcher, was asked about sharing information between disciplines, he related his experience when invited to a government sponsored round-table discussion along with other researchers from similar fields to share information on current research projects. While Vincent was impressed with the collaborative exercise, unbeknownst to him, Adam, an engineering manager who worked for the government, relayed a similar scenario during his interview. When asked about collaboration and shared knowledge between disciplines, Adam stated that his agency periodically hosted small discussion groups in different parts of the country and that they invited researchers from various fields to participate in sharing information on the latest research. Adam added that they had members from their agency on the panel; however, the purpose of the exercise was to collect information related to other disciplines. Their research was usually classified so their own

members could only share information of a general nature. This way, Adam bragged, they were able to stay abreast of knowledge and research in other sectors that might potentially influence their own research.

The American Academy of Arts and Sciences (AAAS) was also concerned over the lack of collaboration and cooperation between academia, government, and industry. In 2011, they initiated a research project, still ongoing, termed ARISE II, to explore factors that affected America's productivity in science and technology (American Academy, 2012). The AAAS was concerned that "the policies guiding the use of federal research funds impacts [these areas] in ways not sufficiently considered by policy-makers and funding agencies" (American Academy, 2012). Additionally, Wadhwa (2009) argued, "We have a goldmine of potential innovation locked in the research labs of our universities. Over the last four decades, we've invested on the order of a trillion dollars on university research." However, because of the lack of shared knowledge between universities, industry, and government, this information lies dormant in university and industry research labs.

Sub-Question 3: Sharing Knowledge/Technologies Related to the Aerospace Industry

The aerospace and defense industry are closely aligned because much of the technological research and development conducted have applications in both sectors. Therefore, many of the top companies in America conduct joint research and supply technology to government agencies involved in aerospace programs and defense programs (see Table 1 for the list of companies based on federal contracts). Donald, CEO and Tier 1 supplier to both industries, stated, "Basically, companies are involved in the two areas; they're one and the same. We compete for the same projects, against the same companies, and many times offer similar technologies."

The matters regarding restricted and classified information previously discussed in SQ1 & SQ2 also applied to most research and manufacturing in the aerospace industry. Timothy, an engineer for a major defense contractor, stated,

Everything we do is considered classified or need-to-know. That is drilled into us from day one. Even if it's not classified, it is proprietary information and unless we are authorized to discuss it outside of the project team, it isn't discussed.

When asked about research for the aerospace industry, Timothy continued,

Although we are a defense contractor, there really isn't too much difference between some of our research for military projects and those for the aerospace projects – some of the technology is similar if not the same. I might be working on only a small component of a larger project and when it's completed, I don't always know how it will be used, how it fits into a larger project, or who's going to use it. Because of the type of work we do, our projects may be compartmentalized with only the larger project team understanding the big picture.

Sub-Question 4: National Security Policy Constraints on Technological Innovation

The results of this research study indicated that national security policies, specifically the Invention Secrecy Act, placed constraints on the collaboration and sharing of interdisciplinary knowledge. However, scientists and individuals employed in government and public policy sectors agreed that some technologies should be restricted through secrecy orders because of their limited scope and potentially harmful capabilities. Vincent, albeit a supporter of open collaboration, also acknowledged, “There are some technologies that are too destructive or dangerous, and we need to trust that our government and military leaders will do what is right.”

This study suggested that issues challenged by opponents were not the specific policies per se. As discussed in Chapter 4, these policies (many going back to the 1930s and 1940s) were adjusted, altered, and amended to adapt to changes in the government, presidential administrations, and even other advanced technologies. Instead, the implementation or processes

surrounding the policies appeared to be at the core of this argument. Similarly, Dettmer (2000) and Goldratt (1986) proposed that most policy constraints come down to the dilemma of deciding whether they are a result of the system or the process. Dennis, director of a public policy research center, summed up the issue when he stated,

No one wants to restrict the government's ability to protect our country and if that means placing secrecy orders on certain patents, we all understand. However, when there is a lack of transparency regarding the secrecy orders issued, those rescinded, and how the entire process takes place, this blankets the entire process in a cloak of covertness.

Dennis added that he was not criticizing the national security policies, but the processes surrounding implementation of those policies.

Conclusion

The results of this study indicated that since World War II, vague and ambiguous national security policies contributed to America's innovative decline. This lack of clarity gave rise to a historical pattern of actions by various federal agencies that limited access to certain types of information and research. The study identified areas in which national security policy constraints, particularly the Invention Secrecy Act, hindered and, in some examples, directly impeded the collaboration and sharing of interdisciplinary knowledge between academia, industry, government, and private inventors. Industries and academia who supported classified or restricted government research appeared to collaborate amongst each other on a project-by-project basis, while other industries specifically abstained from conducting research in areas of national security to avoid the threat of secrecy orders.

This study, supported by data from the National Science Foundation, also found that government-funding allocations directed the types of research performed (basic or applied) as well as the industry or group that received funding (Matthews, 2011). This, in turn, resulted in

less sharing of intellectual knowledge and further isolating the research and industries involved in technology related to national security. Collectively, these actions placed constraints on the collaboration and interdisciplinary exchange of knowledge, two critical sources for technological innovation (Kang & Kang, 2009; Shilling, 2008; White & Bruton, 2007).

While this study did not provide guidance for recommended action to address the constraints identified in the research, the information presented should be considered a first step in any process of change (Dettmer, 2000). The results of this study are intended to give managers and policymakers an improved understanding in assessing and formulating policies and management practices regarding the effect of national security policies on technological innovation.

Recommendations for Further Research

The study uncovered three areas for future research: (a) national security policies, (b) industries, and (c) culture. First, this research project was a single case study that focused on the Invention Secrecy Act. While this study should not be generalized, due to its limited focus, the research clearly demonstrated that the Invention Secrecy Act was a deterrent to conduction of innovative research and technologies in the aerospace industry. Additionally, this research study revealed other national policies, such as the Export Control Act, that were considered a hindrance to America's technological growth. A broader study, including interviews with individuals working in other domains affecting national security (such as the military), would potentially identify additional restrictive policies. By identifying several federal policies, a multiple-case study could be conducted that would allow analysis of the information not only within its case setting, but also across and between settings, which could lead to better

clarification of the issues (Baxter & Jack, 2008). Yin (2003) cautioned, however, that multiple or collective case studies can be time-consuming and expensive to conduct.

Second, the interviews focused on five categories: academia, general industry producers, government and public policy, defense and aerospace industry producers, and federal government employees working in the field of aerospace. The categories were selected for this initial study to explore the research questions and identify the issues that surrounded the Invention Secrecy Act. Additional research in the form of a single case study that focused on only one industry, such as academia, could also add more understanding and insight into these matters. Expanding the existing research, however, might also identify other sectors critical to the aerospace industry, such as the military.

Finally, this research project discussed organizational culture as a possible impediment to technological innovation. The interviewees were selected from five different sectors or industries, and many expressed strong discipline-bound views that were supported with similar statements by others in their industry. Sarah, professor of government and public policy, warned that in some domains, policies such as those that surround national security can be used as a mechanism to control the status quo of an organizational or industrial culture, such as in the aerospace and defense industry. Additional research on culture and values specific to this sector would contribute to overall understanding of the constraints and barriers resulting from cultural influences.

Final Recommendations

The study resulted from four years of extensive research that included information from numerous historical and archived documents, existing government and private databases, and

detailed interviews with government researchers, aerospace engineers, corporate executives, policymakers, entrepreneurs, and academic scholars. The final recommendations are:

1. Definition of National Security

- a. Establish a nationally recognized definition for national defense, applicable to all federal agencies (i.e., State Department, Department of Defense).
- b. Ensure that all existing and future policies, procedures, and legal mandates comply with the definition.

2. Existing National Security Policies and Legal Mandates

- a. Review existing national defense policies and legal mandates to determine if they are in line with the definition and direction set forth by the Executive Office for National Security.
- b. Identify and address all existing national security policies that could restrict America's overall technology strategies.
- c. Establish guidelines to ensure that all governmental agencies comply with national security policies, such as the Invention Secrecy Act.

3. Scientific Knowledge and Collaborative Projects

- a. Expand research and scientific knowledge through collaborative projects that include broader disciplines beyond those focused on the aerospace or defense industry (i.e., medical, fire service).
- b. Encourage Technology Transfer Offices in government, industry, and academia to identify areas of research or projects that could be useful and beneficial in other areas. Establish collaborative sharing of archived research projects.

4. Restrictive or Classified Projects

- a. Review projects identified as restricted or classified projects to determine whether these designations are appropriate, or if additional disciplines or fields of research could benefit from this knowledge (e.g. project designated as classified just to prevent information release to competitors).
- b. Encourage broader applications of aerospace research by opening conferences and seminars to experts in other fields, disciplines, or industries who might not have secret, or top-secret security designations.

5. Educate and Inform

- a. Disseminate information from this study through presentations at seminars and conferences to inform those people in technology and technology policy on the implications of their actions on technological innovation.
- b. Publish articles on the results of this study as well as future studies.
- c. Conduct and encourage additional research on this topic to identify other areas that impact innovation.

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Appendices

Appendix A: Informed Consent



EASTERN MICHIGAN UNIVERSITY
Education First

January 16, 2012

To: Dorothy K McAllen
School of Technology

Re: **UHSRC # 111205**
Approval Date:

Title: "National Security Policy Constraints on Technological Innovation: A Case Study of the Invention Secrecy Act of 1951"

UHSRC Initial
Application Determination
EXPEDITED APPROVAL

Category: Approved Expedited Research Project
January 16, 2012

The Eastern Michigan University Human Subjects Review Committee (UHSRC) has completed their review of your project. I am pleased to advise you that **your expedited research has been approved** in accordance with federal regulations.

Renewals: Expedited protocols need to be renewed annually. If the project is continuing, please submit the **Human Subjects Continuation Form** prior to the approval expiration. If the project is completed, please submit the **Human Subjects Study Completion Form** (both forms are found on the UHSRC website).

Revisions: Expedited protocols do require revisions. If changes are made to a protocol, please submit a **Human Subjects Minor Modification Form** or new **Human Subjects Approval Request Form** (if major changes) for review (see UHSRC website for forms).

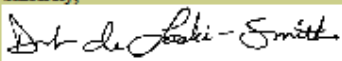
Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to human subjects and change the category of review, notify the UHSRC office within 24 hours. Any complaints from participants regarding the risk and benefits of the project must be reported to the UHSRC.

Follow-up: If your expedited research project is not completed and closed after three years, the UHSRC office will require a new **Human Subjects Approval Request Form** prior to approving a continuation beyond three years.

Please use the UHSRC number listed above on any forms submitted that relate to this project, or on any correspondence with the UHSRC office.

Good luck in your research. If we can be of further assistance, please contact us at 734-487-0042 or via e-mail at human.subjects@emich.edu. Thank you for your cooperation.

Sincerely,



Deb de Laski-Smith, Ph.D.
Interim Dean
Graduate School
Administrative Co-Chair
University Human Subjects Review Committee

University Human Subjects Review Committee - Eastern Michigan University - 200 Boone Hall
 Ypsilanti, Michigan 48197
 Phone: 734.487.0042 Fax: 734.487.0050
 E-mail: human.subjects@emich.edu
www.ord.emich.edu (see Federal Compliance)

The EMU UHSRC complies with the Title 45 Code of Federal Regulations part 46 (45 CFR 46) under FWA00000050.

Figure 7. Human Subjects Review Committee Approval Document

Appendix B: Informed Consent

National Security Policy Constraints on Technological Innovation: A Case Study of the Invention Secrecy Act of 1951

Informed Consent

Dear Prospective Participant:

Thank you for your willingness to participate in this interview.

I am currently conducting a research study at Eastern Michigan University to explore the possible constraints on technological innovation by national security policies, specifically the Invention Secrecy Act of 1951. Your participation in this study is voluntary and you may withdraw from the study at any time without negative consequences. While there is no direct benefit to the participant, your participation may benefit future research in the area of technological innovation and national security policies. The interview will take approximately one (1) hour.

To ensure confidentiality of the participants and records, each participant will only be identified by a number or code designation. Your identity will be kept confidential at all times unless indicated and authorized by you at the end of this document; therefore, participation would involve no more than minimal risk. The interview will be audio taped to help accurately capture the information and then transcribed for analysis. No identifying information will appear on the transcription. If you feel uncomfortable with the recorder, you may ask that it be turned off at any time. All paper-based documents and audio tapes associated with the interview will be kept in a locked and secure file cabinet maintained by the researcher. Upon completion of the study, the consent forms, audio tapes, and any identifying information will be destroyed.

When the study is complete, you may request a copy of the findings. Information collected may be used in presentations and publications, but your name will not be associated with any responses unless authorized by you. For questions about this research, please contact Dorothy McAllen, Eastern Michigan University (734.487.1161, dmcallen@emich.edu). This research protocol and informed consent document has been reviewed and approved by the Eastern Michigan University Human Subjects Review Committee for use from January 1, 2012 to

August 31, 2012. If you have questions about the approval process, please contact Dr. Deb de Laski-Smith, 734-487-0042, Interim Dean of the Graduate School and Administrative Co-chair of UHSRC, (human.subjects@emich.edu).

Exceptions to the above informed consent information:

Please indicate your choice by placing your initials next to any statement that applies to you:

_____ By initializing here, I agree to be identified by name in any written reports, presentations, or publications which result from this research.

_____ By initializing here, I agree that the company where I am employed may be identified by name in any written reports, presentations, or publications which result from this research.

Consent to Participate: I confirm that I understand the purpose and parameters of the research study outlined above. I am aware that participation is completely voluntary and that I may choose not to participate. If I do decide to participate, I can change my mind at any time and withdraw from the study without penalty or negative consequences. By signing my name below, I hereby provide consent for the use of my responses and wish to participate in this research endeavor.

Date: _____

Printed Name of Participant: _____

Consent Signature of Participant: _____

Participant's Phone Number: _____

Date: _____

Printed Name of Interviewer: _____

Signature of Interviewer: _____

Appendix C: Research Interview Instrument

National Security Policy Constraints on Technological Innovation: A Case Study of the Invention Secrecy Act of 1951

Research Instrument

Sample Interview Questions by Topic Areas

Demographics – Information on Interviewee

- What is your title or role in Company (decision making role)?
- How many years have you been with the company?
- How many years have you been in this type of industry?
- Are you, or have you been personally involved in research? If so, in what capacity?

Firmographics – Information on Organization

- What is the industry or functional role of company (Aerospace/National Defense Industry)?
- Is your company a governmental organization, non-profit, or for-profit organization?
- How many total employees does your company employ?
- How many employees are engaged in areas of research?
- Annual Revenue
- Expenditures for Research

Internal Research Processes

- What types of research does your company pursue?
 - Government Contracts
 - Restricted/classified Projects
- Does the size of the research project determine whether the project will remain internal or external?
- How are research projects chosen?
 - What are the factors that determine what projects are chosen?
 - Who makes the decision?
 - Does the potential for patent filings influence what projects are chosen?
- If the project is restricted or classified, what is the process regarding who to include/exclude in the project?

External Research Processes

- Are there specific types of research engaged in for external collaboration?
- How does your company decide when to collaborate on a research project?
 - Who makes that decision?
 - What are the factors that determine external collaborative projects?
 - Does a restricted/classified project influence the decision to collaborate on projects?

Collaboration – Business/Scholarly

- Does your company encourage collaboration on research projects? Internal/external?
- Give an example of a small/large, internal/external, multi-disciplinary project.
- Are you allowed to present research at conferences/scholarly journals? If so, what are the parameters?
- Will your company accept or initiate a research project if the results cannot be published or shared at a conference?

Intellectual Property Management – Patents

- Does your company actively pursue filing patent applications?
 - Approximately how many patent applications has your company filed over the past 10 years?
 - What types of patents does your company pursue?
- Who benefits financially from any patents or inventions by your company?
- What other benefits would be received by the inventor?
- Are you aware of the Invention Secrecy Act or restrictions by the USPTO on patents due to national security issues, called secrecy orders?
 - If so, how has that affected your company's ability to conduct proprietary research?
 - If you are a for-profit company, how does this affect your ability to market the patent or results of the research?

Funding Sources

- How much of your research funding is internal/grants/contracts/B2B/etc?
- Does your company actively solicit government contracts for research? If so, from what agencies have you received funds?
- Does your company actively solicit contracts or funds from non-government sources? If so, from what agencies have you received funds?
- Does your company solicit or participate in research projects if the project is restricted or classified?

Other

Do you have any other issues or concerns relevant to this study that you would like to discuss?

Appendix D: List of Documents and Archival Records

Transcripts of testimony given before the House of Representatives on Changes to the Laws

Relating to Patents and the Patent Office

Advertisements for Selling Enemy Patents

Letters and documents from the Truman Presidential Library

Letters and Documents from the Eisenhower Presidential Library

Correspondence between federal agencies and officials - retrieved from the National Archives

Archived White House Press Releases and documents - retrieved from the National Archives

Current White House Press Releases and speeches

Freedom of Information Requests submitted by Federation of American Scientists to the USPTO

retrieved from the Federation of American Scientists

Responses by the USPTO to Freedom of Information Requests – retrieved from the Federation of

American Scientists

USPTO Policies and Procedures retrieved from the USPTO

Patent Specific Information retrieved from Proprietary Databases at the USPTO

Department of Defense Directives

University Policies regarding Government and Classified Research

Emails between Researcher and Interviewees

Transcript of Oral Interview: Eugene Kranz

Tape recording of Interviews Conducted

Transcripts of taped Interviews

Researcher's Notes from Interviews

Researcher's Field Notebook