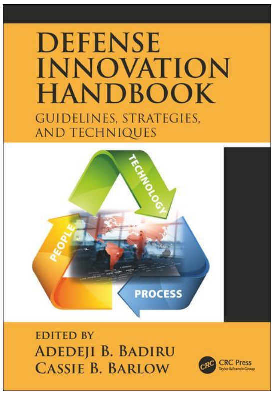

Defense Innovation Handbook
Guidelines, Strategies, and Techniques
Adedeji B. Badiru, Cassie B. Barlow

Globalization and defense manufacturing

Publication details
https://test.routledgehandbooks.com/doi/10.1201/b22181-9
Claude D. Vance
Published online on: 04 Sep 2018

chapter nine

Globalization and defense manufacturing

Claude D. Vance

Contents

Preamble

> "It is of importance that the kingdom depend as little as possible upon its neighbors for the manufactures necessary for its defense" (Adam Smith, *The Wealth of Nations*)
>
> "WE THE PEOPLE of the United States, in Order to form a more perfect Union, establish justice, insure Tranquility, provide for the common defense, promote the general Welfare, and secure the Blessings of Liberty for ourselves and our Prosperity, do ordain and establish this Constitution of the United States of America." (Preamble, Constitution of the United States of America)

Introduction

Offshore manufacturing trends threaten the national defense of the United States of America. It is an area Americans worry about jeopardized security; both individual and national. It has become a topic of debate and political agendas.[1] Offshore manufacturing is a component of globalization. While globalization generates positive impacts on the domestic and world economies, concerns about defensive risks are prevalent.[2] Strategic decisions require an understanding of the impacts offshore manufacturing has on readiness.

What is defense readiness? The Department of Defense (DOD) considers military capability the aggregation of four major components: force structure, modernization, readiness, and sustainability.[3] It defines readiness as "the ability of US military forces to fight and meet the demands of the national military strategy."[3] A civilian version of readiness is "the state of having been made ready or prepared for use or action (especially military action)."[4] In the *National Response Plan*, the Department of Homeland Security (DHS) uses preparedness to describe capability. DHS and DOD are both involved in executing the national security strategy.[5] Because *readiness* and *preparedness* are synonyms, a distinction must be made for this research to alleviate potential confusion created by the disparity between definitions.

Capability is the interdependent relationship between preparedness and readiness. After evaluating definitions from DHS and DOD, the United States Marine Corps (USMC) and General James L. Jones, USMC (retired), a definition for defense capability was created.[6] Defense capability is the ability of a nation to deter aggression, protect sovereignty, deploy into areas of responsibility (AOR), sustain operations as situations warrant, expeditiously redeploy from AORs, and rapidly recover and reconstitute for future incidents.

Defense preparedness is the endeavor of planning, training, and equipping.[6] Decision-makers need to anticipate immediate and future operations, and identify vulnerabilities.[3] Personnel require initial, refresher, and up-grade training to maintain their knowledge and proficiency levels. The most effective assets—equipment, resources, and systems—must be available for an organization to successfully complete its objectives.[6]

Defense readiness is the acquisition, modernization, and sustainment of assets. In the acquisition process, organizations procure assets based on identified requirements and shortfalls.[7] Sustainment is the continuous maintenance of operational and reserve asset levels to support routine and incident operations efforts.[3] Through modernization, relevant assets remain viable through state-of-the-art upgrades, and advanced technologies replacing antiquated technologies.

Defense readiness ultimately supports national security. An old military adage states, "if you train the way you fight, you'll fight the way you're trained" [author unknown]. That piece of wisdom applies to all persons engaged in national defense. Defense preparedness depends on the assets made available through readiness. Defense readiness is less effective when personnel are unprepared to utilize assets, or assets are unavailable. That interdependency determines a nation's defense capability. When defense capabilities are degraded, national security vulnerabilities increase.

National defense organizations rely on manufactured goods to maintain readiness for daily and contingency operations. According to the United States Department of Commerce, manufacturing "is a cornerstone of the American economy."[8] It encompasses every aspect of finished goods from creation to consumption.[9] Although not all research literature focused on manufacturing overall, authors focused on one to four key areas either directly or indirectly. Those areas of people, innovation, production, and logistics.

Manufacturing depends on people. They are linked to every aspect of the value chain.[10] Some contribute directly through research, touch labor, goods delivery, or as customers. Other persons provide indirect labor such as administrative support and management. Internally, corporate success depends on the quality of employees and hierarchical relationships within the company.[11] Externally, customers are crucial to corporate success. A nation's defense capability relies on the manufacturing workforce to provide national security customers with finished goods for readiness and preparedness.

Innovation provides creative starting points for manufacturing. New goods, processes, and improvements come from "seeds of thought" through study and experimentation.[10,12]

The three elements of innovation are education, research and development (R&D).[10,13] Education is the continual attainment of knowledge. Studying concepts and experimenting with how to convert them into useful products, processes, and/or improvements is the purpose of R&D.[14] Relationships among the three spawn innovation. Innovation provides manufacturing with future vitality.[15] In turn, innovation supports a relevant and reliable national defense.

Production is the heart of manufacturing. By definition, it is the "combination of materials, parts, or subassemblies to increase their value" as finished goods.[9] Within the manufacturing supply chain, the workforce, innovation and logistics link together to create finished goods. Defense agencies acquire commercial and agency-specific goods to sustain asset levels, improve capabilities, and for modernization. In turn, preparedness can continually exist at acceptable levels. Therefore, production is linked to national security through readiness.

Logistics provides the means for delivering goods to agencies involved in national security. It is the management of how resources move through a supply chain for the creation and delivery of goods to customers.[16] Logistics pertains to material handling, distribution, storage, and information. Connections to innovation, production, and people make logistics the fourth facet of the economic pyramid (Figure 9.1).

The DOD specifically identifies "focused logistics" as a key part of the defense industrial base.[17] Logistics are essential for meeting customer demands and remaining competitive.[8] Major facets of logistics include procurement, provisioning, maintenance, movement, and planning.[18] Those facets are similar in definition to the aspects of defense preparedness and readiness.

Multinational connections and stakeholder perceptions cloud the definitions of domestic and foreign manufacturing. Domestic generally relates to the people, entities, ideas, and geography indigenous to a nation. Because this research addressed the national defense of the United States (US), domestic refers to anything associated with the US, being "American," or occurring within the sovereign boundaries of the United States of America (US) and its territories (US borders). Foreign alludes to all things indigenous to or occurring in other nations. For example, the Ford Motor Company (Ford) assembles Fusion automobiles in Mexico.[19] Because Ford is considered an "American" automotive company, those Fusions are foreign-produced domestic vehicles. Conversely, Nissan North American Manufacturing (NNAM) assembles the Titan pickup truck in Canton, Mississippi.[20] NNAM is owned by a Japanese company, Nissan Motor Company, Ltd. Thus, the Titan is a domestic-produced foreign vehicle.

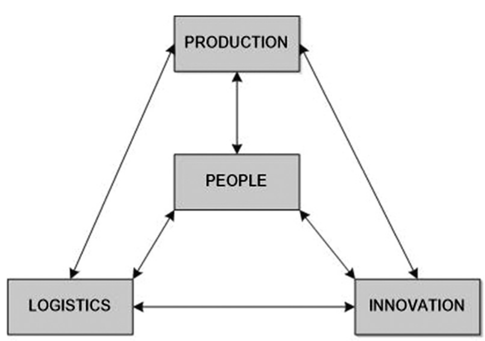

Figure 9.1 Economic pyramid.

Table 9.1 Defense manufacturer merger examples

Company	Former competitors acquired or merged
Boeing	McDonnell Douglas
Lockheed-Martin	General Dynamics Martin
McDonnell Douglas	McDonnell Douglas
Northrup Grumman	Northrup Grumman

Onshore and offshore refer to where activities take place or facilities are located. For this research, the US borders are the dividing lines for identification. Facilities and processes circumscribed by those borders were identified as being onshore. Therefore, Nissan Titans are assembled onshore. Offshore signifies that a location lies outside the US borders, including Canada and Mexico. Hence, Ford produces Fusions at an offshore facility. Offshore manufacturing is the innovation and/or production of goods outside US borders. A corporation may have onshore and/or offshore locations regardless of what consumers perceive as being domestic or foreign.

National defense depends on manufactured goods. As other nations experience growth in their manufacturing sectors, American manufacturing is in decline.[14] Domestic corporations compete with foreign competitors in commercial markets to remain viable. In the case of semiconductors, the military sector accounts for one percent (1%) of the market.[2] That number does not reflect the amount of non-military unique items used in daily defense operations. The reduction in defense contractors limits available options for acquiring domestically produced weapons systems (Table 9.1). In recent years, domestic-foreign partnerships have emerged as contractors attempt to satisfy the nation's defensive needs. The objective of this research is to show that offshore manufacturing trends are detrimental to the defensive readiness of the US.

Literature review

Federal legislation and policy affect national defense. Congressional concerns regarding procurement of offshore goods predate World War II.[21] Historically, domestic manufacturers have been inadequately prepared to supply and sustain military operations.[22] Under the Buy American Act, enacted in 1933, Federal agencies are required to purchase domestic goods for use in the US.[21] This statute applies to Federal agencies, outside the DOD, engaged in national defense and security. In 1941, enactment of the Berry Amendment mandated the use of domestic agricultural goods for national defense.[21] The Trade Act of 1962 authorized import limitations "for national defense purposes."[23] During the mid-1980s to early 1990s, foreign policy established under that authority successfully shored up declines in the domestic machine tool industry.[23] The Defense Authorization Act for Fiscal Year 2004 included legislation to incentivize defense contractors utilizing domestic capital assets.[23] Inclusion of such language was the result of concerns regarding domestic industries—particularly those supporting the defense industrial base—losing their market shares to foreign competition.[23] Legislation and policy, with respect to domestic production, will remain important national defense aspects as the nation moves into the future.

Activities within and without the domestic industrial base threaten national defense. The number of domestic companies with core competencies critical to national defense has diminished since the 1970s.[22,24] Reasons for the decreases include lack of work, leaving the defense industrial base completely, acquisition by domestic competitors or foreign interests, or ceasing to exist.[22,24] Foreign manufacturers exploit such opportunities to improve their capabilities and compete against the remaining domestic companies.[24] In turn, decreased domestic competencies and market shares translate into increased foreign dependency.[22]

As domestic companies move into systems integration and away from production, manufacturing is outsourced to lower tier suppliers.[25] At the start of Operation IRAQI FREEDOM, a European supplier withheld shipment of a munitions component critical for US military ordnance.[26] In the mid-1980s, an embargo against two Japanese electronics suppliers, for selling US technology to the Soviet Union, would have caused private industry layoffs and affected weapons production in the US.[22] Defense related issues can spill over into the private sector when procuring materials and capital assets from similar sources.

The innovation process is inherently linked to manufacturing, energy, and national security.[14,15] Innovation generates advanced manufacturing technologies. Domestic manufacturing invests the most capital into domestic R&D.[15] Domestic suppliers may be unable to implement advanced technologies (e.g., finances, labor with the necessary skills) while foreign competitors heavily invest in them.[25] As technology advancements push energy generation and distribution capabilities, strong innovation processes are needed to meet increasing requirements for clean, reliable sources.[14] The US relies on innovation to execute the national security strategy.[14] The percentages for government research spending have shifted in favor of meeting immediate needs via long-term basic R&D.[14] Innovative strength impacts the nation's economy, security, and prosperity.

Collocating manufacturing and innovation centers benefits both centers and their location. Close proximity facilities knowledge sharing, knowledge transfer, and innovation diffusion into adjacent centers.[15] Innovation centers proportionally grow with associated manufacturing centers.[2] The physical distance between centers and the amount of associated benefits are inversely related.[15] Globalization and the internet provide locations to virtually collocate centers in cyberspace.[13] Loss of domestic core competencies and dependence on offshore foreign products may create a reliance on offshore innovation for national defense.

Innovation relies on a well-educated people to conduct R&D. A large number of the domestic science and technology workforce, especially in defense, is close to retirement without a sufficient talent pool for passing on corporate knowledge.[2] Compared to primary and secondary students abroad, aptitude and interest in science and mathematics among US students is declining.[14] College students shun manufacturing careers based on negative stereotypes regarding work conditions, job uncertainty, and career growth.[11] As fewer domestic college students pursue science, technology, engineering, and mathematics (STEM) degrees, the number of foreign students earning STEM doctoral degrees is growing. Many DOD STEM occupations require US citizenship. A skilled labor shortage and knowledge gap could exist if the disparity between hiring and retirement continues to increase.

Domestic industries are able to compete globally. The terrorist attacks of 9/11 disrupted shipments from offshore. Before 9/11, manufacturers like Parker Hannifin competed against foreign competitors by improving processes and taking advantage of two important assets; people and superior logistics.[11] Companies can use people, logistics, and process improvement to stay competitive while supporting national defense. In 2001, Dr. Sheffi at the Massachusetts Institute of Technology presented four challenges companies should address for success. His challenges include preparing for future man-made and natural catastrophes, developing robust supply chains that take into account uncertainty and vulnerabilities across the entire value stream, establishing cooperative relationships with the federal government, and maximizing the strategic balance between corporate goals and security.[27] Meeting these challenges benefits the company and the nation.

Caveats

A vast amount of information related to offshore manufacturing exists. As a topic of debate and agendas, most literature was directed toward particular industries or contained biases. Protection and government involvement were recurring themes in those writings. Recommended solutions for industry called for means to bolster domestic manufacturing sectors and protection from foreign competition, including onshore foreign competitors. Political authors either addressed support for domestic industries onshore or contradicted policies of the current administration during their time.

Writings hailed the movement and/or establishment of overseas operations as "win-win" situations. Authors touted the benefits of offshore activities.[28] Their major selling point was the ability to remain competitive. Some studies lacked support from discussion and sufficient evidence.[29] One such study, by McKinsey & Company, was refuted as advertising consulting services for starting offshore operations.[29]

Negative connotations were attached to the term *protectionism*. The "protectionist" label implied a group or an individual was willing to prevent foreign competition or reluctant to embrace globalization. Pacific Rim and European nations also feel offshoring effects outside their borders.[29] The term and label perspectives were American. Authors favoring offshore activities applied both to discredit opposing views.

Publications directed toward national security or defense manufacturing were scarce. Literature related to national security mainly addressed two issues. The first issue was economic security in the private sector. The discussions concentrated on high technology, machine tool, and transportation industries. The second issue was policy. The writers recommended federal changes to processes or favoring domestic capabilities in the defense industrial base. With little literature available, parallels between the private and public sectors must be drawn.

The topic of offshore manufacturing contains much controversy. Healthy debate examines pros and cons. Filtering out bias serves as an injustice. Points brought forth from all sides illustrate the need to determine a balance between a nation's best interests and the benefits of its presence in the global economy. How does a nation protect national interests, and still be a "good" neighbor?

Model development

Discussions in the literature continually keyed in on various combinations of four elements. They were innovation, investment, production, and the workforce. Further reading supported the idea that strong bonds exist among those elements. Research kept returning to a challenge against Sir Walter Petty's stages of development theory. The dominance of a society's economic sectors evolves from agriculture through manufacturing to services (Figure 9.2).[30] This theory works well when assuming generated wealth remains in the society.[11]

Figure 9.2 Stages of development model.

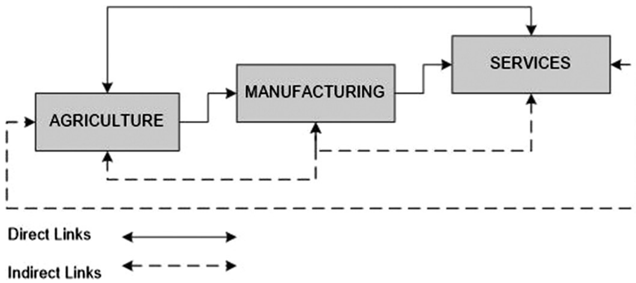

Figure 9.3 Modified stages of development model.

In challenging Petty's model, the Berkeley Roundtable on the International Economy argued prosperity, for a given economic sector, relies on direct and indirect interrelationships with the other two sectors.[30] Those relationships were added to the stages of development model (Figure 9.3). The modified model relationships indicate the potential for an economy to either regress toward a previously dominate sector or skip the manufacturing sector. Based on literature already researched, both scenarios were counterintuitive for Petty's theory. This generated two questions about relationships and benefits. First, is it possible that the three sectors are equally important? Second, do advancements in any one sector spill over as benefits to another?

The equal importance concept led to rearranging the modified model into an economic triangle (Figure 9.4). The economic sectors are in a horizontal relationship in this model. Growth in any sector is due to advances spilling over from the other two sectors.[11,30] A triangle was selected because of the relationships between fuel, heat, and air in the fire triangle. All three must be present, but lack a fourth element: combustion.[31] When all the

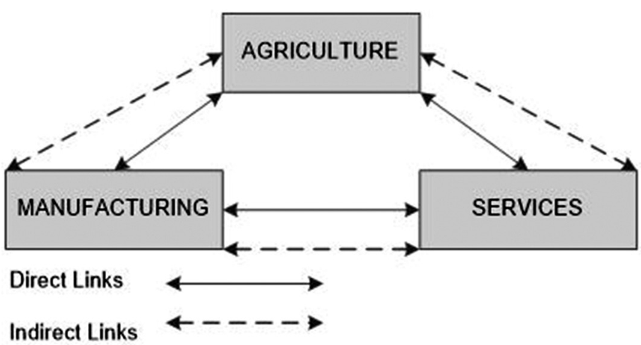

Figure 9.4 First economic triangle model.

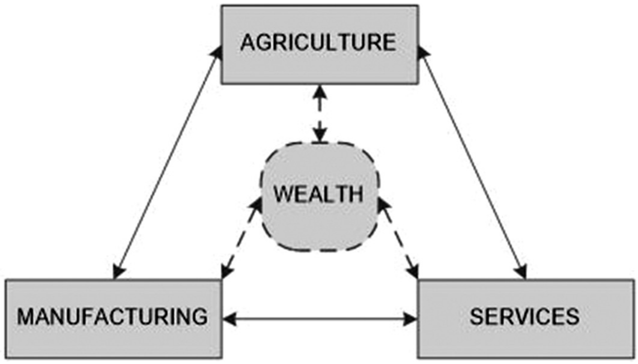

Figure 9.5 Second economic triangle model.

elements are present in correct proportions, something must occur for them to combine and generate growth.

The second iteration of the economic triangle depicts wealth as an indirect linkage among the three sectors (Figure 9.5). Wealth was viewed as a catalyst to spark an economy. Before providing wealth, a demand must be present. Therefore, the term *market* replaces *wealth* in the next model (Figure 9.6). This was because of the cyclical exchange of wealth and products between a market and the sectors which support it. For simplicity, direct and indirect linkages were combined in Figure 9.6 and subsequent models. Discussion about agriculture demonstrated significant sector growth was the result of advancements (e.g., technology) in related manufacturing and services. In turn, benefits spilled back into these sectors.[30]

As research moved toward manufacturing, technology became prevalent. It was seen as a driving force behind manufacturing advancements.[8,10,15] The benefits spawn more technology.[15,32] Further technology literature searches led to information concerning education and technology based service industries.[13,14] The importance of technology throughout the economy was the reason it replaced agriculture in the third economic triangle model (Figure 9.6).

With the market at the center of the third triangle, an examination of the four elements and their relationships took place. Services supply the other elements with

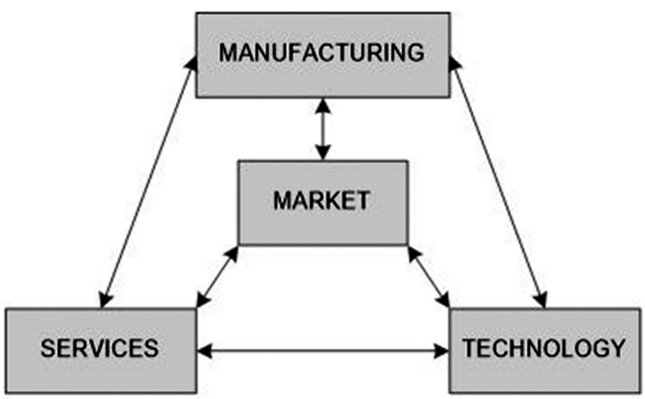

Figure 9.6 Third economic triangle model.

wealth and labor. Technology generates advancements. Manufacturing provides goods. The market is the exchange point. Questions quickly surfaced while determining interconnections. If services provide people and wealth to create technology, how does technology advance either one? What connections did technology have with the market? Because manufacturing was a source of wealth for laborers, was a direct link between goods and consumers more realistic than indirect links through the market? Why were exchanges circumventing the market? Erroneous interpretation caused the questions.

A new approach was needed as errors rapidly invalidated the triangle models. Market was incorrectly placed in the center. Forcing all transactions through the market meant no direct linkages among the other elements. Market was removed as a model element, and assumed to be the model itself. Using the term *wealth* created confusion. Its definition refers to anything of value. For this thesis, manufacturing wealth is capital. It may be working capital (i.e., money, investments), capital goods, or human capital (i.e., labor, knowledge). Replacing market with capital enabled connections to other markets.

Renaming market to capital initiated an epiphany. A recent change in the fire triangle added "the uninhibited chain reaction" of combustion.[31] It explained fire sustainment and the chemical reaction process. The relationship was changed to a pyramid; the fire tetrahedron.[31] Similarly, capital aided in the understanding of market processes. Hence, the economic triangle was converted to a pyramid.

The economic elements were perceived again in tetrahedral relationships. Manufacturing produces capital and consumer goods. It also generates wealth.[10] The agricultural and services sectors also produce goods. Assuming that an economic model should represent all sectors, manufacturing was renamed production (Figure 9.7). Services represent a sector instead of a market element. People and services were interchangeable during evaluations after the first economic triangle. People invest human and working capital into the other elements. Indirectly, they contribute goods through production. Hence, services was changed to people. Capital flows to the other markets in one or more of the previously stated forms. As a conduit to other markets, capital remained a separate element. Additional research about technology brought changes. Technology and innovation were tied to education, development, and research.[13,14] Research and development drive innovation.[13] Applying technology to manufacturing and education indicated it is a product of innovation.[10,15] Literature support for innovation, as an economic element, caused it to replace technology in the pyramid.

Capital, as an element, continued to present challenges. This is similar to the questions regarding market as an element. One or more types of capital served as direct links

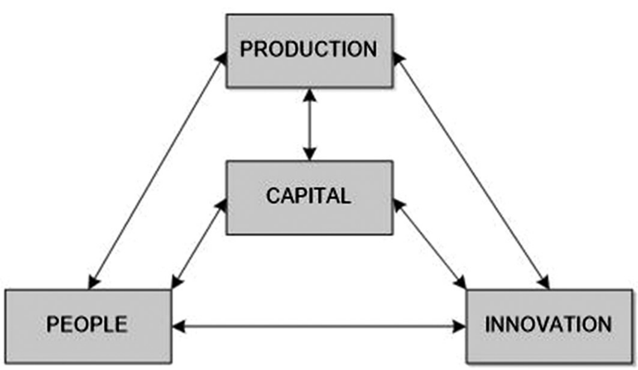

Figure 9.7 First economic pyramid model.

between other elements. That inferred that capital links elements rather than stands alone as one. Capabilities existed for people to provide human and working capital to other markets. Besides the flow of capital goods, the model no longer supported capital as a legitimate element.

Transferring capital between markets generated a replacement element: logistics. Logistics consists of two aspects. First, it involves the movement of capital.[18] Logistics links production to other markets.[27] Second, logistics focuses on operational process management.[16] Literature emphasized the importance of logistics in manufacturing.[8,27] Hence, logistics replaced capital in the economic pyramid (Figure 9.1).

Previous models were unstable because of erroneous justifications for market and capital. Innovation, people, and production were considered stable elements. Without all elements stable, those models collapsed. Could logistics support the model? It was necessary for indirect linkages between other elements. Producers need methods for shipping goods to consumers. In supply chains, they rely on suppliers for goods and technology from outside sources.[33] Logistics has direct links with the other elements. Growing complications mandate new innovations in logistics management.[27] Logistics requires labor, direct and indirect, and capital goods (e.g., tractor-trailers). Logistics shored up and completed the economic pyramid (Figure 9.1).

Security connection

While model development appeared to digress, it became the basis for further research. The initial hypothesis, effects of globalization on national security, was vague and unfocused. The unavailability of defense-specific information contributed to the broad approach. A holistic approach without the military was a failure. Civil agencies with national security responsibilities were identified during further reading and contemplation. Parallels between the pyramid, in the private sector, and those agencies were easier to draw.

Including civil agencies provided a better picture of defense readiness. The United States Coast Guard (USCG) has a dual role. During peacetime, it operates under DHS. In wartime, the United States Navy (USN) assumes authority of the USCG. Local law enforcement and fire departments are quasi-military organizations. These organizations are trained in (preparedness) and equipped for (readiness) emergency response (civil defense). Civil emergency management can be part of a military organization. The Tennessee Emergency Management Agency is part of the state's military department.[34] In recent years, new DOD doctrines incorporated civil support for homeland security.[35]

Readiness was a common theme in civil and military defense. While preparedness and readiness had similar definitions, both terms were used interchangeably. Distinctions were made to differentiate both terms. Preparedness pertains to people. Readiness refers to physical assets. Defense capability is dependent on both. Understanding the importance of all three—preparedness, readiness, and defense capability—to national security importance led to the definitions for each term.

Way forward

The economic pyramid elements were compared to capability, preparedness, and readiness. Direct links to people, innovation, and logistics were found. The defense industrial base provided connections to production. Literature for the initial hypothesis was reread several times. Those with overt national security and defense manufacturing connections were retained after the first read. Additional readings yielded four categories; indirect, inferred, supportive, and unrelated. Literature in the first two categories contained either indirect linkages or linkages that could be inferred. Supportive information and examples came from industry standards, dictionary definitions, and government reports. Literature unable to fit into any of the first three categories was classified as unrelated. Unrelated works were discarded.

Creating an annotated bibliography aided in narrowing the scope of this thesis. Six main topics exhibited a combination of relationships among manufacturing, government policy, and national security. The first topic was the effects of legislative actions on defense and the defense industrial base. Defense readiness strategy changes since World War I was the second topic. The third topic included attitudes toward and perceptions about manufacturing from society and legislation. The fourth topic was issues in domestic manufacturing giving rise to increased foreign competition. The fifth topic was concerned with increased dependence on offshore sources. Proximity relationships between manufacturing and innovation were part of the sixth topic. Researching onshore and offshore manufacturing led to identification of the topics.

The thesis contains five stages. First, a foundation was laid through research. Second, a hypothesis was built upon that foundation and finalized. Third, discussion will occur to either prove or disprove the hypothesis. Fourth, conclusions will be drawn and presented. Finally, recommendations for further research will be provided.

Perceptions and legislation

Negative perceptions concerning domestic manufacturing exist in the US. Plant closings and lost jobs are attributed to offshore competition.[1] Instead of associating manufacturing with high technology and innovation, college students used prison and slavery analogies to describe manufacturing careers in two major studies.[10] Consequently, few students pursue manufacturing related majors.[11] Traditional economic theories suggest that manufacturing has reached its apex and the service sector is becoming the dominant sector.[30] It is assumed that displaced manufacturing workers can simply retrain for new careers in other sectors.[13] Defense acquisition decisions, from 2001 to present, fuel notions about military dependence on components and subassemblies produced offshore (Table 9.2).[21] Lack of appreciation undermines the domestic industrial base.

Administrative and legislative connections to national security have existed since the US became a nation. Defense responsibilities and rights were included in the US Constitution and Bill of Rights.[36] Between World War I and the US officially entering World War II, important legislation supporting domestic production was enacted. In 1933, the Buy American Act (BAA) required the Federal government to procure assets, resources, and services from domestic [onshore] sources.[21] Even today, the BAA applies to civil agencies such as DHS.

The Berry Amendment is unique to the DOD. During World War II, concerns about the effects of war on the nation were brought forth in Congress. In 1941, the Berry Amendment was enacted to ensure service members were provided domestic agricultural goods (e.g., food, cloth for uniforms).[21] Since then, the number of items required to be produced onshore has grown. The Berry Amendment became part of the US Code in 2001.[21]

The Soviet launch of Sputnik ushered in new concerns for the US. The fear of the US losing its dominance in defense and scientific innovation prompted new legislation and programs. In 1958, Congress enacted the National Defense Education Act (NDEA).[14] The purpose of the NDEA has to bolster science and mathematics education in the US.[17] The Defense Advanced Research Projects Agency (DARPA) was established

Table 9.2 Federal acquisition competition examples

			Base aircraft			Assembly location	
Program	Agency	Competitor(s)	Model	Supplier	Nation(s)	Initial	Final
Deepwater[42]	USCG	Lockheed-Martin (LMA)	HC-235	CASA	Spain	Madrid, Spain	Unknown
UH-72A Helicopter[43]	US Army	American Eurocopter	EC-145	Eurcopter	European Union (EU)	Columbus, Mississippi	Columbus, Mississippi
Joint Cargo Aircraft[44]	US Army	L3 Communications	C-27J	Alenia North America	Italy	Turin, Italy	Jacksonville, Florida
	USAF	Boeing Raytheon	C-295	CASA	Spain	Madrid, Spain	Unknown
		LMA	C-130J	LMA	US	Atlanta, Georgia	Atlanta, Georgia
Law Enforcement[45]	DHS DEA FBI	American Eurocopter	EC-120 AS-350	Eurocopter	EU	Unknown Unknown	Unknown Unknown
Aerial Refueling Replacement Program[47]	USAF	Northrop Grumman	A330	Airbus	France	Toulouse, France	Mobile, Alabama
		Boeing	767	Boeing	US	Everett, Washington	Everett, Washington

within the time frame.[14] DARPA creates innovation advantages for defense.[37] Other than declared wars, the "Space Race" was a period in American history when substantial effort was placed on national defense.

Legislature and foreign policy can provide assistance to domestic manufacturing segments. The Trade Act of 1962 places importation limits for national security reasons.[23] The machine tool industry, a crucial defense industrial segment, has struggled.[25] Significant decline in domestic market share, thirty to fifty percent (30% to 50%), and possible loss of wartime surge capabilities caught the attention of the Reagan Administration.[23,26] Based on the Trade Act of 1962, Voluntary Restraint Agreements with Japan and Taiwan facilitated resurgence of domestic machine tools in the global market during the late 1980s and early 1990s.[26] By 2003, a report cited that twenty-five to thirty percent (25% to 30%) of machine tool skill and production moved offshore.[10] No sign of recovery since then was found.

Offshore dependence

The number of domestic defense manufacturers has decreased. Fifty years ago, an individual could count the number of prime defense contractors on more than two hands. That number has dwindled to a handful. Some companies, such as Vought, moved out of aircraft production. Those still in the aviation industry now supply components and subassemblies. Two of the remaining aircraft manufacturers, Boeing and Northrup Grumman, are combinations of former competitors (Table 9.1). Both companies have competed with foreign-based aircraft for major DOD contracts (Table 9.2). The increasing number of foreign-based aviation programs indicates two things. First, foreign dependence is present in US national security. Second, domestic defense manufacturing capabilities are declining.

A weak defense industrial base places the US at a political disadvantage. After a Japanese electronics firm provided the Soviet Union with military technology in 1986, Congress sought to prohibit sales of the company's products.[22] The negative effects on domestic electronics and weapons production countered the enactment of a ban.[22] Swiss-made components shipments, bound for onshore munitions production, were held up because of Swiss opposition to US policy and military actions in Iraq.[24,38] The US offered diesel submarines, a non-existent domestic production capability, to Taiwan.[24] Because Dutch and US foreign policies on China conflict, the Netherlands, a country with diesel submarine capabilities, refused assistance.[24] Dependence on foreign allies and companies shed doubt on defense readiness.

National security relies on foreign resources. The DOD defines essential industries as those "that transform the crude basic raw materials into useful intermediate or end products."[3] Raw materials are imported for defense and mobilization.[15,22] Berry Amendment waivers have been issued for Russian titanium in military aircraft.[21] As previously mentioned, the Berry Amendment pertains to the domestic procurement of military uniforms as well. The DOD requirements for wool berets create two problems. First, domestic wool sources are scarce.[21] Second, foreign companies with offshore production received beret manufacturing contracts to meet demand.[21] While offshore procurement and production of military uniform items may seem trivial, understanding the extent of foreign dependence is essential to readiness.

The energy powering security and the defense industrial base comes from natural resources.[14] In 2005, sixty-five percent (65%) of the petroleum consumed domestically came from overseas.[15] That does not include petroleum used by US military and government entities overseas. In response to the Energy Policy Act of 2005, the DOD is embracing domestic and renewable energy.[39,40] Such sources include scrap wood, wind, solar, and geothermal.[39] The unsuccessful attempt by a Chinese company to acquire Unocal, a domestic oil company, caused national security issues to surface.[17] Minimizing foreign energy dependence is necessary for national security.

Logistics risks

Logistics is vital to national security readiness. The word itself originated as a military term.[16] Events on September 11, 2001 (9/11) exposed domestic manufacturers to global supply chain vulnerabilities.[27] In keeping with commercial best practices, defense prime contractors are becoming systems integrators.[8] They manage the flow of information and products through supply chain networks.[27,32] As supply chains lengthen, both in distance and number of participants, control and security decrease.[13]

Supply chains depends on continuous and correct information flow. Commercial off-the-shelf information technologies, used by the government and private industries, are susceptible to cyberattacks.[13] Policies, procedures, and resources should be in place for data protection and disclosure prevention from those without a need to know.[13] Communications must be unambiguous and clearly understood. A sub-tier supplier, a few levels below a prime contractor, could produce parts based on an incorrect specification. The length of time between the error and detection may impact the production schedule or affect system performance. In the commercial environment, time loss and poor information translate into revenue losses. In national security, it means decreased readiness.

More risks are inherent to supply chains with offshore links than to domestic supply chains. A "black hole" was the description for transportation between suppliers and customers.[27] While advanced technologies and software may track the routes goods take, few updates are provided before goods arrive.[27] Offshore shipments are more vulnerable to disruptions than those from onshore suppliers.[13] The Swiss munitions component delays are an example. Another example came after 9/11 when the US government held up shipments coming from outside US borders.[27] Onshore automobile manufacturers experienced inventory shortages until offshore replenishment shipments could proceed.[27] Strategies utilizing onshore suppliers, enhanced tracking, and commercial-government partnerships may mitigate future risks.

Innovation

A network of related activities promotes growth and propels innovation processes forward. This combination of activities—such as R&D investment, knowledgeable workforce, proximity, etc.—is known as critical mass.[15] As innovations become more significant and frequent, the "spill-over" effects permeate the economy.[15] The manufacturing base acts as both a catalyst and a conduit. It feeds the innovation process while providing pathways to enlarge the critical mass. A competitive advantage exists where manufacturing capabilities and strong R&D are together.[14] Offshore manufacturing base growth and the establishment of new R&D bases place US R&D dominance at risk.[15] Foreign economies are gaining the critical mass necessary to support R&D offshore. Even if domestic manufacturing remains constant, its global share is shrinking with respect to increased foreign competition.[15] The US must enlarge its global R&D share to overcome the disparity.

Innovation requires two types of investment for prosperity and vitality. The first investment is education and training for the nation's workforce knowledge base.[1] Historically, the US federal government had led the charge when offshore competition threatened national prosperity and security—such as the Cold War. The US still faces offshore competition for global R&D dominance. Free tuition, since 1986, is part of a strong emphasis Ireland places on secondary and higher education.[14] Two Canadian innovation strategies, at the federal, provincial and local levels, seek to strengthen the national economy by "promoting R&D in the sciences and engineering…" and improving education, beginning at the elementary school level.[14] Determining how to tackle such challenges is vital to future innovation.

The future of domestic manufacturing depends on innovation. The second type of innovation investment is R&D investment.[1] R&D funding comes from public and private sources. In the decade prior to 2004, the largest manufacturing research funding source—federal funding—was reduced by half.[1] Manufacturing programs at DARPA and the DOD Manufacturing Technology program have also experienced elimination or significant reductions.[1] While overall funding was reduced in that period, priorities and allocations shifted from technologies to life sciences.[41] In contrast, South Korea sought to double R&D spending between 2002 and 2007.[14] In 2003, seventeen percent (17%) of global industrial R&D spending—about US$122 billion—came from domestic R&D for manufacturing in the US.[15] Between 1999 and 2003, domestic manufacturers' investments rose forty-two percent (42%) for offshore R&D and fell two and one half percent (2.5%) for onshore R&D.[15] These trends may indicate a weakening of the innovation critical to the US economy.

The domestic manufacturing sector employs large percentages of R&D essential personnel. Twenty-five percent (25%) of the science-related workers are in manufacturing; forty percent (40%) of them are from engineering fields.[15] Providing a sufficient source of educated workers begins at the elementary school level. Most domestic primary and secondary students lack a sufficient educational foundation for science-related fields. In 2003, less than one-third of fourth and eighth graders were proficient in math and science.[41] Proficiency among high school seniors was below twenty percent (<20%) three years earlier. When ranked internationally against peers from twenty other countries, domestic seniors were near the bottom; 19th for math and 16th for science.[41] Coincidentally, post-secondary and graduate science-related education experienced declines. During 1996 to 2003, the number of science and engineering doctoral degrees awarded to US citizens and permanent residents fell twenty percent (20%).[15] President John F. Kennedy expressed the relationship between prosperity and education when he stated, "Our progress as a nation can be no swifter than our progress in education. The human mind is our fundamental resource."

Global competition and dominance relies on an educated and literate domestic workforce.[11] R&D workers must come from other sources if US educational systems are unable to provide qualified domestic candidates. Such candidates may be foreign nationals studying either in the US or abroad. At the turn of the twenty-first century, domestic institutions awarded over fifty percent (+50%) of engineering and math doctoral degrees to foreign nationals.[41] Foreign graduate programs in nations like China and India are improving.[13] Engineering programs at Mexican and Turkish institutions were accredited by the Accreditation Board of Engineering and Technology during 2006–2007.[46] Although foreign talent bolsters US innovation, chances exist for foreigners to seek education overseas or return home with the knowledge they have obtained.[15,41]

Geographic proximity is important to manufacturing and innovation. Within the US, research centers like Silicon Valley and the Research Triangle came about through research spill-overs from academia nearby.[15] Collocating R&D and manufacturing capabilities improves competitive advantage.[14] Whether domestically or globally, corporations look to research conducted by sub-tiers within their supply chains.[15] Overseas, research occupational opportunities are expanding, and federal research investment is increasing.[13] The growth in manufacturing capabilities offshore is proportional with the increasing number of R&D centers overseas.[17] Reasons for relocating production and R&D offshore include reduced costs, highly skilled personnel who are eager to work, new technology, and proximity to growing markets.[14] Regional living standards are related more to productivity, fueled by innovation, than economics.[15] Offshore investment and public-private ventures abroad threaten the innovation critical to the US economy as R&D funding declines onshore.[41] Meeting these challenges requires a national effort.[17]

Besides economic security, innovation is important for national defense. Developing foreign economies challenge US technical competitiveness and leadership. Both are vital to economic health and military superiority.[17] Maintaining close proximity between R&D and manufacturing threatens the US military advantage. Throughout the Cold War, US federal policymakers understood that domestic innovation investment supported military superiority.[41] Since 1997, the following Chinese public law reinforces military support by the private sector[17]:

Combine the Military and Civil
Combine Peace and War
Give Priority to Military Products
Let the Civil Support the Military

China publicly acknowledges military dependence on civilian innovation and manufacturing. Another innovation threat comes from foreign acquisition of onshore capabilities.[24] It degrades the ability to maintain a strategic advantage by depending on foreign and offshore components and technologies.[1] Increasing private R&D reliance, insufficient DOD guidance, poor public-private coordination, and offshore R&D and manufacturing could place national defense at a disadvantage.[17]

Conclusion and recommendations

Offshore manufacturing has relationships with national security. Connections can be overlooked when evaluating innovation, logistics, people, and production separately. A fifth element, government, should be added to uncover additional linkages. As globalization continues, aggregated examination of these five elements becomes necessary. No single element is responsible for declining American dominance. The combination of activities, over several decades, fuels an impending "Perfect Storm." Trends directly and indirectly related to national defense, such as those in the private sector, will continue to threaten readiness and the ability to accomplish strategic objectives. For now, the risks appear minimal. The potential for risks to increase exists as other countries gain the critical mass necessary to grow their economies and gain defensive advantages. Retention and expansion of the gap between the US and foreign entities requires public and private actions to minimize the effects of offshore manufacturing on national defense. While foreign and offshore dependence do affect national defense, the full extent is unknown.

Confronting the effects of offshore manufacturing on national defense requires further research. This thesis focused on five elements individually: government, innovation, logistics, people, and production. How interactions among two or more elements affected relationships between offshore manufacturing and national defense were unclear. It is improbable to assume the full understanding of the effects on a macroscopic level. The following research recommendations are meant to better understand the effects of offshore manufacturing or reduce the threats through strategic decisions.

- Research federal policies; especially DOD acquisition policies. The US government publicly furnishes general policy and acquisition information. Surveying personnel directly involved in acquisitions may provide non-programmatic information regarding offshore manufacturing. Examine the effects of restricting/disallowing foreign competition in acquisitions and the effects on domestic competition in global and foreign markets.
- Evaluate the current defense manufacturing state. Publications directed toward defense manufacturing were scarce. Focusing on one or more aspects of the defense industrial base (e.g., fixed- and rotary-wing aviation) may generate insight into the effects of offshore manufacturing.
- Address domestic education. Research already focuses on the current state. Future planning needs strategies for improvement, supplying qualified talent, and flexibility to meet known and unanticipated challenges.
- Study the effects of art and its interconnections with STEM and innovation. Although STEM was the education focus for this thesis, what advantages does innovation gain from the arts (i.e., critical thinking, creativity, communication)? Art education includes language (i.e., writing, speaking), performance (i.e, music, theater), and visual arts such as painting. Just as steam drove industrialization, does the addition of art provide STEAM power for innovation?
- Analyze and compare three supply chain approaches for defense logistics. The first approach is sole domestic support. The second approach is primary domestic support with supplemental foreign sources. The third approach is an expedient logistics system where cost, schedule and performance drive selection of a domestic or foreign source.
- Study green alternatives to reduce dependency on foreign materials. Reusing and recycling could offset diminished and/or non-existent domestic sources. Advantages exist in alternative and renewable energy. The USN moved in this direction with Admiral Hyman Rickover's push for nuclear-powered naval vessels.

List of abbreviations

9/11	September 11, 2001
AOR	Area of Responsibility
BAA	Buy American Act
DARPA	Defense Advanced Research Projects Agency
DEA	United States Drug Enforcement Agency
DHS	United States Department of Homeland Security
DOD	United States Department of Defense
EU	European Union
FBI	United States Federal Bureau of Investigation
Ford	Ford Motor Company
LMA	Lockheed-Martin
NDEA	National Defense Education Act
NNAM	Nissan North American Manufacturing
R&D	Research and Development

STEM	Science, Technology, Engineering, and Mathematics
STEAM	Science, Technology, Engineering, Arts, and Mathematics
US	United States of America, or United States
USAF	United States Air Force
US Borders	Sovereign boundaries of the US and its territories
USCG	United States Coast Guard
USMC	United States Marine Corps
USN	United States Navy

References

1. Lieberman, J. (2003). *Making America Stronger: A Report With Legislative Recommendations on Restoration of US Manufacturing*, 2003. Retrieved September 25, 2006 from http://lieberman.senate.gov/documents/reports/ManufacturingReport.pdf.
2. Belt, D., Fellows, J., Kameru, B., Nazaroff, A., Pauroso, A., Schulz, F., Ballew, B., Bond, T., Demers, S., Kirkpatrick, S., & Thomas, W. (2005). *Electronics Industry Study Report*. Washington, DC: The Industrial College of the Armed Forces, National Defense University.
3. US Department of Defense (2007, October). *Department of Defense Dictionary of Military and Associated Terms*, Joint Publication 1-02. Washington D.C.: Government Printing Office.
4. Readiness (n.d.). *WordNet ® 3.0*. Retrieved July 20, 2007 from http://dictionary.reference.com/browse/readiness.
5. Office of the President of the United States of America (2006). *National Security Strategy of the United States of America*, March 2006. Retrieved September 25, 2006 from http://www.whitehouse.gov/nsc/nss/2006/nss2006.pdf.
6. Gongora, T. (2002, June). *The Meaning of Expeditionary Operations from an Air Force Perspective*. Paper presented at the Seapower Conference 2002, Dalhousie University, Halifax, Nova Scotia, Canada. Retrieved July 21, 2007 from http://wps.cfc.forces.gc.ca/papers/other/gongora.pdf.
7. US Department of Homeland Security (2006, May). *National Response Plan*. Washington, DC: Government Printing Office.
8. United States Department of Commerce (2004, January). *Manufacturing in America: A Comprehensive Strategy to Address the Challenges to US Manufacturers*, January 2004. Retrieved September 26, 2006 from http://www.ita.doc.gov/media/Publications/pdf/manuam0104final.pdf.
9. Institute of Industrial Engineers (1998). *Industrial Engineering Terminology*. Norcross GA: Engineering & Management Press.
10. National Association of Manufacturers (2003). *Keeping America Competitive: How a Talent Shortage Threatens US Manufacturing*, 2003. Retrieved September 27, 2006 from http://www.nam.org/s_nam/sec.asp?CID=201721&DID=230273.
11. Meredith, J. and Shell, R. (1988). *The Withering of US Manufacturing. Industrial Management*, 30(5), 13–18.
12. Innovation (n.d.). *WordNet ® 3.0*. Retrieved July 30, 2007 from http://dictionary.reference.com/browse/innovation.
13. Association of Computing Machinery (2006). *Globalization and Offshoring of Software*, 2006. Retrieved September 26, 2006 from http://www.acm.org/globalizationreport.
14. Committee on Prospering in the Global Economy of the 21st Century (2005). *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. Washington, DC: National Academies Press. Retrieved November 14, 2006 from http://www.hq.nasa.gov/office/oer/nac/documents/Gathering_Storm.pdf.
15. Popkin, J. and Kobe, K. (2006). *US Manufacturing Innovation at Risk*. Retrieved September 27, 2006 from http://www.nam.org/s_nam/bin.asp?CID20251&DID=236300&DOC=File.PDF.
16. Logistics (n.d.). *Investopedia.com*. Retrieved February 19, 2008 from http://dictionary.reference.com/browse/logistics.

17. US-China Economic and Security Review Commission (2005). *2005 Annual Report to Congress*, 2005. Retrieved September 27, 2006 from http://www.uscc.gov/annual_report/2005/annual_report_full_05.pdf.
18. Logistics (n.d.). *Dictionary.com Unabridged (v 1.1)*. Retrieved July 30, 2007 from http://dictionary.reference.com/browse/logistics.
19. Ford Motor Company (2007). *Ford Motor Company Sustainability Report 2006/7*. Retrieved July 28, 2007 from http://www.ford.com/en/company/about/sustainability/2006-07/overviewProfileGlobalDirectoryNAmerica.htm#mexico.
20. Nissan North American Manufacturing (2007, February 1). *At a Glance: 2007 Nissan Titan King Cab/Crew Cab*. Retrieved July 28, 2007 from http://www.nissannews.com.
21. Grasso, V. (2005). *Berry Amendment: Requiring Defense Procurement To Come From Domestic Sources*, 2005. Retrieved November 10, 2006 from http://www.fas.org/sgp/crs/natsec/RL31236.pdf.
22. Morrison, M. (1990). *The US Defense Industrial Base: Deterrence in Decline*. Marine Corps University Command and Staff College. Retrieved November 14, 2006 from http://www.globalsecurity.org/military/library/report/1990/MMR.htm.
23. Freedenberg, P. (2005, August 5). Are Machine Tools Important to Our National Security? *American Machinist*. Retrieved November 14, 2006 from http://www.americanmachinist.com/Classes/Article/ArticleDraw_P.aspx.
24. Hawkins, W. (2003, June 25). Homeland Defense: National-Security Resources Should not Be Manufactured in Foreign Lands. *National Review Online*. Retrieved November 14, 2006 from http://www.nationalreview.com/comment/comment-hawkins062503.asp.
25. Farrell, L. (2005). US Must Not Lose Manufacturing Edge. *National Defense Magazine*, 89(615), page 4. Retrieved November 14, 2006 from http://www.nationaldefensemagazine.com/issues/2005/Feb/US_Must.htm.
26. Freedenberg, P. (2005, January 1). Can Manufacturing Support a War? *American Machinist*. Retrieved November 14, 2006 from http://www.americanmachinist.com/Classes/Article/ArticleDraw_P.aspx.
27. Sheffi, Y. (2001). Supply Chain Management under the Threat of International Terrorism. *International Journal of Logistics Management*, 12(2), 1–11.
28. Chakrabory, K. and Remington, W. (2005). Offshoring of IT services: The impact on the US economy. *Journal of Computing Sciences in Colleges*, 20(4), 112–125.
29. Hira, R. *Implications of Offshore Outsourcing*. January 23, 2004. Retrieved September 25, 2006 from http://www.soc.duke.edu/sloan_2004/Papers/.
30. Hall, J. (1991). Sectoral transformation and economic decline: Views from Berkeley and Cambridge. *Cambridge Journal of Economics*, 5(2), 229–237.
31. National Fire Protection Association. *All About Fire*. Retrieved June 11, 2009 from http://www.nfpa.org/itemDetail.asp?categoryID=1330&itemID=30861&URL=Press%20RRoom/A%20Reporter's%20Guide%20to%20Fire%20and%20the%20NFPA/All%20about%20fire.
32. National Association of Manufacturers (2006, October). *The Facts About Modern Manufacturing, Seventh Edition*, October 2006. Retrieved October 4, 2006 from http://www.nam.org/s_nam/sec.asp?CID=210507&DID=229891.
33. Chopra, S. and Meindl, P. (2004). *Supply Chain Management: Strategy, Planning, and Operations, Second Edition*. Pearson, NJ: Pearson Education, Inc.
34. Tennessee Emergency Management Agency. *TEMA – The Agency, Its Missions and Goals*. Retrieved June 14, 2009 from http://www.tnema.org/index.htm.
35. US Department of Defense (2005, August). *Homeland Security*, Joint Publication 3-26. Washington, DC: Government Printing Office.
36. *The Constitution of the United States of America*. Article 1, Section 8. Article 2, Section 2. Second Amendment.
37. Defense Advanced Research Projects Agency (2008). *DARPA: Bridging the Gap*. Tampa, FL: Faircount LLC.
38. Freedenberg, P. (2004, January 1). Shoring Up the Defense Industrial Base. *American Machinist*. Retrieved November 14, 2006 from http://www.americanmachinist.com/Classes/Article/ArticleDraw_P.aspx.

39. United States Army (2009). *Army Energy Program: Renewable Energy*. Retrieved May 29, 2009 from http://army-energy.hqda.pentagon.mil/renewable/renewable.asp.
40. LOGAN Energy Corporation (2006, August 22). *US Army Schofield Barracks, HI PEM Demonstration Project Final Project Report*. Georgia: LOGAN Energy.
41. Kazmierczak, M. and James, J. (2005). *Losing the Competitive Advantage? The Challenge for Science and Technology in the United States*, 2005. Retrieved September 27, 2006 from http://aeanet.org/publications/idjj_CompetitivenessOverview0204.asp.
42. European Aeronautic Defense and Space Company (2007, May 2). *EADS CASA Will Supply Lockheed Martin Another Five (5) HC-235A Multi-mission Aircraft for the US Coast Guard's Deepwater Program*. Retrieved July 19, 2007 from http://www.eads.com/1024/en/pressdb/pressdb/Military%20Transport%20Aircraft/20070502_EADS_CASA_HC-235A.html.
43. American Eurocopter (2006, December 2). *First UH-72A Light Utility Helicopter delivered to the US Army. New helicopter is a military version of the successful Eurocopter EC145*. Retrieved July 19, 2007 from http://www.eurocopterusa.com/Media/News/NewsDetail.asp?ID=409.
44. Putrich, G. (2007, June 14). *C-27J Tapped for Joint Cargo Aircraft*. Air Force Times. Retrieved July 19, 2007 from http://www.airforcetimes.com/news/2007/06/defense_JCA_070613/.
45. American Eurocopter (2007, July 12). *US Customs and Border Protection Orders Additional AS350 B3s for Homeland Security*. Retrieved July 19, 2007 from http://www.eurocopterusa.com/Media/News?NewsDetail.asp?ID=465.
46. Accreditation Board for Engineering and Technology (2010). *Search All Accredited Programs*. Retrieved March 31, 2010 from http://www.abet.org/AccredProgramSearch/AccreditationSearch.aspx.
47. Hedgpeth, D. (2008, March 4). A Foreign Air Raid? *The Washington Post*. Retrieved June 28, 2010 from http://www.washingtonpost.com/wp-dyn/content/article/2008/03/03/AR2008030303194_pf.html.