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Industry Study

Final Report
Manufacturing Industry



The Industrial College of the Armed Forces

National Defense University
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MANUFACTURING 2009

ABSTRACT: The U.S. Manufacturing Industry is at a dangerous inflection point. The dominant global manufacturing leader since the 1940's, the U.S. now finds its leadership position threatened by global competition and adverse domestic behavior. The 2009 Manufacturing Industry Study Group at the Industrial College of the Armed Forces analyzed the U.S. Manufacturing Industry in a global context to determine if the U.S. can maintain competitive pre-eminence, create high value-added manufacturing jobs and lead innovation in manufacturing at the level and pace necessary to satisfy the needs of both its defense industrial base and the country's broader, strategic goals and vital interests. Analysis indicates trends in the global manufacturing ecosystem are leading U.S. Manufacturing toward the wrong side of that inflection point. This report recommends the U.S. correct this divergence by adopting more supportive manufacturing policies reflective of both current global competition and U.S. needs. It further recommends these policies be based on a comprehensive national economic strategy which incentivizes better collaboration between government, industry and academia.

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PLACES VISTED

Domestic

BAE Systems Manassas, VA
 BAE Systems Rosslyn, VA
 Kaydon Ring & Sealing, Baltimore, MD
 Northrop Grumman, Baltimore, MD
 Toyota Motor Manufacturing, Georgetown, KY
 Kentucky Association of Manufacturers, Frankfort, KY
 University of Kentucky, Lexington, KY
 Woodford Reserve, Lexington, KY
 National Center for Defense Manufacturing & Machine (NCDMM), Latrobe PA
 Westmoreland County Community College
 The Ex One Company
 Curtiss-Wright
 Advance Manufacturing Technologies
 Impact-RLW System Inc.
 Penn United Technologies
 Miller-Holzwarth Inc.
 Kennametal Inc, Latrobe, PA
 Hamill Manufacturing., Latrobe, PA
 Latrobe Specialty Steel, Latrobe, PA
 Caterpillar, Clayton, NC
 Research Triangle Park Foundation, Raleigh, NC
 Research Triangle Region, Raleigh, NC.
 University of North Carolina School of Pharmacy, Raleigh, NC
 North Carolina State FREEDM Engineering Research Center, Raleigh, NC
 IBM Research Triangle, Raleigh, NC

International

Dublin, Ireland	Dublin Institute of Technology DAON Industrial Development Authority (IDA) Ireland Science Foundation Ireland (SFI) Enterprise Ireland Forfas Wyeth
Budapest, Hungary	U.S. Embassy ThalesNano Budapest University of Technology and Economics National Office for Research and Technology Innovation Protection and Security Company
Munich, Germany	Bavarian Chancellery GE Global Research Center BMW Plant EADS Headquarter Ottobrunn Technical University Munich Bauhaus Luftfahrt Bavaria

EXECUTIVE SUMMARY

The United States is currently the world's leading producer of manufactured goods, but global trends reveal significant challenges to its leadership position. Developing countries are transforming their agrarian-based economies into manufacturing-based economies, joining the rest of the industrialized world's quest for the myriad benefits of high value-added manufacturing. Additionally, internal U.S. behavior is making it difficult and economically unattractive to sustain a domestic manufacturing base. The 2009 Manufacturing Industry Study Group (MISG) of the Industrial College of the Armed Forces studied the impact of these trends to determine their impact on U.S. national security. Through consideration of fourteen industrial characteristics, two international exemplars (China and Malaysia), and discussions with domestic and international leaders across the global manufacturing ecosystem, the MISG concluded the U.S. can—and in fact *must*—maintain competitive pre-eminence, create high value-added manufacturing jobs and lead innovation in manufacturing at the level and pace necessary to satisfy the needs of both its Defense Industrial Base and the country's broader strategic goals and vital interests.

The MISG found manufacturing remains critical to U.S. diplomatic, information, military and economic power, comprising 14% of the U.S. GDP and serving as a force multiplier for many other industries. Unfortunately, analysis shows U.S. Manufacturing to be on the wrong side of an emerging inflection point, from which it may not be able to recover without concerted action. To correct this trajectory, the MISG recommends the U.S. take the following actions:

- 1. Develop and resource a National Economic Strategy that will feed into the existing National Security Strategy.** An NES would further integrate consideration of economic issues into broader policy decisions about how the U.S. deploys its instruments of power to advance national security interests.
- 2. Use the aforementioned National Economic Strategy preparation process to continually examine key issues affecting America's manufacturing sectors.** Examinations would bring needed focus to the role of manufacturing in the health of the defense industrial base and illuminate the dynamics at play between trade imbalances and domestic productive capacity.
- 3. Develop and expand pathways for collaboration between academia, industry, and government.** Pathways would create synergies across organizations to support each tier of the manufacturing environment.
- 4. Create an independent panel to review the impact of taxation, regulatory compliance, and benefits burdens on domestic manufacturers.** Review would bring focus to ways that government policies might be tweaked to limit unnecessary impediments to onshore production.

America's ability to continue its leading role in the world rests with continuing its tradition of unparalleled innovation and the ongoing creation of knowledge-based and high value-added manufacturing opportunities. Reversing current trends is directly relevant to securing vital U.S. interests. The MISG believes a long-term strategy reflecting the criticality of a strong Manufacturing Industry is essential to long-term U.S. economic health and national security, a factor critical to maintaining global stability and increasing global economic prosperity.

INTRODUCTION

I have learned something about my country. I run a global company, but I am a citizen of the U.S. I believe that a popular, 30-year notion that the U.S. can evolve from being a technology and manufacturing leader to a service leader is just wrong. In the end, this philosophy transformed the financial services industry from one that supported commerce to a complex trading market that operated outside the economy. **Real** engineering was traded for financial engineering. In the end, our businesses, our government and many local leaders lost sight of what makes a nation great: a passion for innovation. – Jeffrey Immelt¹

As Mr. Immelt expresses in his uncharacteristically candid letter to General Electric's shareholders in the Corporation's 2008 Annual Report, the U.S. has been sidetracked by the promise of short term—and subsequently fictional—market gains. Three decades of financial engineering fed unsustainable growth at the expense of the “real” engineering and ingenuity that had catapulted a largely agrarian nation into the world's only superpower underpinned by an unparalleled manufacturing base.

Likewise, national leadership has been distracted by the false promise of quantifiable metrics. These metrics may reflect the current U.S. *status* as dominating many indicators—economic size, manufacturing output, productivity, innovation, etc., but actually mask the far more critical *trends* which reveal the deterioration of U.S. industrial capacity in an increasingly globalized—and ruthlessly competitive—environment. These negative trends are particularly disconcerting given the invaluable contributions the U.S. Manufacturing Industry has historically provided across all instruments of national power—providing diplomatic clout, critical information assets, military capability, and economic strength from the nation's inception.

But is the U.S. Manufacturing Industry still critical in an increasingly networked, global economic environment, one rapidly populated by larger service and knowledge sectors and increasing competition? If so, can the U.S. maintain competitive pre-eminence, create high value-added manufacturing jobs and lead innovation in that Industry? Given the Industry's traditional criticality to U.S. national power, the 2009 Manufacturing Industry Study Group (MISG) at the Industrial College of the Armed Forces (ICAF) considered these questions by researching manufacturing challenges spanning historical, current and future periods and across domestic and international geographical lines. It overwhelmingly concluded² the U.S. Manufacturing Industry indeed remains critical to U.S. national power and its vital interests. Furthermore, the MISG concluded the U.S. can—and must—achieve these three goals—pre-eminence, high value-added jobs, and innovation—substantiating its thesis with four key recommendations capable of securing the Manufacturing Industry's irreplaceable contribution to U.S. vital interests.

SECTION I: OVERVIEW

The North American Industry Classification System (NAICS) defines the Manufacturing Industry as

“...the establishments engaged in the mechanical, physical, or chemical **transformation** of materials, substances, or components into new product. ... [Such] establishments [(e.g. plants, factories, or mills)] may process materials or may contract with other establishments to process their materials for them. Both types of establishments are included in manufacturing.”³

This definition requires some elaboration. The corresponding factory floor activities of direct production are colloquially referred to as “little m” manufacturing (i.e. “bending metal”). Far more critical to U.S. national security, however, is its complement, “Big M” manufacturing, the industry view the MISG researched. “Big M” manufacturing is broader than mere production. Specifically, it:

“...expands [the scope of “little m”] scope to include many of the decisions, processes, and activities that occur both upstream and downstream of factory floor activities...[e.g.] e-business, product design, process development, supply chain management, plant design, capacity management, product distribution, product costing, performance measurement, plant scheduling, quality management, workforce organization, equipment maintenance, strategic planning, and interplant coordination, [and] direct production...”⁴

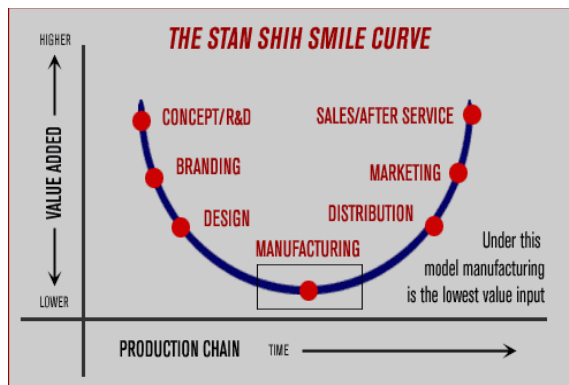


Figure 1. “Big M” view of Manufacturing

Stan Shih, the founder of Acer Computer and creator of the Shih Smile Curve in **Figure 1**, plotted the value added at each stage of the production chain. He posits “little m” manufacturing produces the least value added of any step in the process.⁵ As a result, “little m” manufacturers continue to be challenged to reduce their costs of production to compensate for the relatively low proportion of value they add to the final product. However, “little m” manufacturing is not the same across all product markets. It can provide critical insights into the other

elements of that curve, lost through shortsighted value chain analysis. Immature products and complicated systems often require unique manufacturing processes which may serve as barriers to competition. In such situations, the curve may be inverted, or at the very least flattened. This latter model represents high value-added manufacturing, the ultimate prize coveted by industrial leaders across domestic and international manufacturing industrial bases, and one once dominated by the U.S.

Maintaining competitive pre-eminence, leading innovation and creating high-value jobs is not only critical to securing U.S. vital interests, but securing global stability as well. As Dr. Leslie Gelb⁶ aptly notes in his treatise on U.S. responsibilities, the international community needs U.S. leadership to perpetuate both a liberal world order and global economic growth, noting, “...no single country...group of countries [or] international institution can provide such leadership,” except the U.S.⁷ But such responsibilities require the U.S. have assured access to a robust manufacturing base to underpin the power base required for such global development. That in turn requires the U.S. adapt to this new, far more competitive and fast-paced world order in accordance with Immelt’s concerns—realigning U.S. strategies, priorities, attitudes, and execution of its corresponding manufacturing policies to secure U.S. vital interests. This Industry Study Report provides a means to address these concerns.

The Report describes the Industry’s criticality, characteristics, and the challenges and trends supporting four recommendations. Recommendations, in turn are derived from analytical research focused on 14 industry characteristics and two international exemplars (Malaysia and China). The MISG also relied on empirical data gathered from visiting with

key contributors in the domestic and international Manufacturing Industry to develop its assessment.

Figure 2 graphically represents the relationships critical to the health and stability of the Manufacturing Industry. Although the MISG initially focused principally on the criticality of the Defense Industrial Base (DIB) and its corresponding “Iron Triangle” (comprised of Industry, the DoD, and the Government), the MISG’s analyses and discussions identified two other, equally critical triads. Many of America’s international competitors appear to better recognize the importance of these two additional relationships, substantiated by observations from international travel and best summarized by Robert Malone⁸:

“[t]he extraordinary effort made by so many foreign governments to limit and even reduce their manufacturers' costs, in turn, points to a major political problem hobbling domestic U.S. manufacturing: For most of our biggest trade partners, promoting domestic industry is a very high national priority. For the U.S. government, it is at best an afterthought.”⁹

This first additional relationship defines the linkage between academia, technology and industry which stimulates research, development, and innovation. The corresponding second relationship describes the linkage between academia, industry and government policy

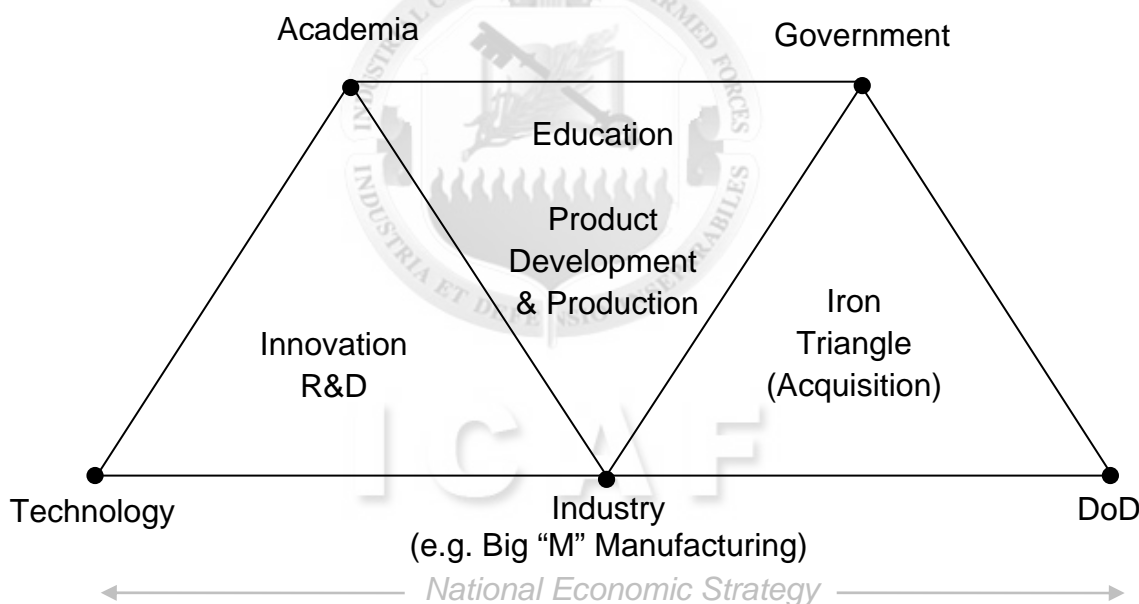


Figure 2. Critical Manufacturing Bridge Supporting National Security

which supports education, product development and production. This second linkage provides a critical “bridging” function tying academia to real-world needs via industry through supportive government manufacturing policies.

U.S. challenges reflect in part a relative decline of manufacturing in the economy as consumer demand, professional and educational choices, and macroeconomic policies have encouraged the rise of the services sector relative to production. But a major component of what ails U.S. manufacturing is foreign competition, where national governments incentivize collaboration between academia and industry, subsidize (or provide in whole) that academic education, develop national policies to support their national industrial bases, and incentivize

research and innovation. Their actions result from being forced to optimize their traditionally limited resources to compete with the previous U.S. monolith, one quickly being overtaken by Asian competition.¹⁰ Such optimization and competitive advantage in this new globalized economy now threaten the U.S. Manufacturing Industry, and subsequently, the U.S. vital interests on which they depend.

The challenges and trends emerging in this new world economic order and their corresponding threats indicate the U.S. Government can no longer rely on the country's previous substantial lead and capacity to best satisfy U.S. national priorities in internal and external environments of pure competition. The Manufacturing Industry, particularly the portion of that Industry comprising the DIB, no longer has the capacity, resources, or time to do so. Although the U.S. currently leads the world in the three individual triads in Figure 2, trends indicate that leadership is threatened. More importantly, the U.S. does not have the requisite integration across these critical triads. The Industry only requires the Government better understand—and communicate—its needs and establish corresponding, integrated policies to strengthen the elements which satisfy those needs through fair and equitable market competition. As such, this report's final recommendations center on this necessary bridging function given the Industry's criticality to national security, described in the next section.

SECTION II: WHY THE U.S. MANUFACTURING INDUSTRY MATTERS

Adam Smith famously warned that "...[i]f any particular manufacture was necessary, indeed, for the defense of the society it might not always be prudent to depend upon our neighbors for the supply..."¹¹ U.S. vital interests are thus best secured by a domestic manufacturing base able to meet the needs of its defense. The Manufacturing Industry is of critical importance to U.S. national power given its size, its symbiotic relationship with many dual-purpose¹² industries and its direct contribution to the military instrument of power through the materiel it provides to secure and defend the nation. The emergence of global value chains may shift part of that burden to allies or other trusted sources, but history shows the U.S. should foremost determine the requisite domestic manufacturing base necessary to secure U.S. national security.

The U.S. Civil War demonstrated the industry's criticality to national defense where the industrialized North was able to out-produce the often tactically superior Southern Confederacy. A half century later, a demobilized defense industrial base could not equip its forces or those of its allies until the closing months of "The Great War." Market forces transformed the resultant post-WWI *defense* industrial capacity into a burgeoning *commercial* industrial base, supporting U.S. economic growth in the late 1930s. However, at the onset of the WWII that industrial base was again not adequately prepared to support wartime demands of itself and its allies, compared to a German manufacturing sector focused on wartime, vice commercial, production.¹³ American leadership was eventually able to mobilize its geographically protected industrial base, overcoming the often technically superior Axis technology by superior U.S. production capability. American factories then carried the manufacturing burden for both itself and its war-torn allies, mass producing the aircraft, ships, land combat vehicles, and other vital support equipment instrumental in the Allied victory.

Although the U.S. will not again face the kinds of generational warfare in the examples above—i.e. first-generation warfare (e.g. American Revolutionary War), second-generation warfare (e.g. U.S. Civil War)—and may not ever again face strictly third-generation warfare (e.g. WWII, Desert Storm), the corresponding manufacturing bases that supported U.S. forces

in past conflicts, must still be able to support U.S. forces to prosecute future generations of warfare, whatever form they may take.

In addition, over its history, U.S. Manufacturing significantly contributed to the economic and diplomatic components of national security. On the back of its uniquely unscathed post-WWII industrial base, the U.S. quickly rose to super-power status, achieving global manufacturing supremacy and eclipsing every other nation in terms of productivity and output. The U.S. Manufacturing Industry then built and rebuilt, tooled and re-tooled its base, singularly producing up to 32%¹⁴ of the world's manufactured goods while simultaneously fueling U.S. living standards to unprecedented heights during the last half of the 20th century.

The Manufacturing Industry alone comprises nearly 14% of U.S. GDP, itself eclipsing the total GDP of all but seven other countries.¹⁵ It provides the durable goods the U.S. (and in many cases the world's) population consumes, the processed food it eats, the medicines on which it relies, and the capital assets it uses to produce even more goods. "Big M" manufacturing provides significant benefits to local, state and national economies as well, supporting 1 in 6 U.S. jobs,¹⁶ in part a result of its 1.37 "multiplier effect," the largest multiplier of any U.S. industry.¹⁷ Thus manufacturing provides an extraordinary level of secondary benefit to the U.S. economy and prosperity. Finally, Manufacturing fuels the U.S. informational power base, providing the IT hardware, software, and processes necessary to gather, synthesize, and transport that information.

Simply put, without a robust Manufacturing Industry, the U.S. cannot—and will not—sustain its present global advantage. The following sections on industry characteristics and trends describe the corresponding concerns to U.S. national security.

SECTION III: MANUFACTURING INDUSTRY CHARACTERISTICS

The MISG performed broad-based, bottom-up research, augmented by domestic and international travel, to determine the ability of the U.S. to maintain competitive preeminence, lead innovation, and create high value added manufacturing jobs in the competitive 21st century global economy. The research considered the integrated effect of 14 key interdependent characteristics affecting the Manufacturing Industry. The 14 characteristics are:

U.S. National Government Policy and Programs	DoD Industrial Base Policy
State and Local Government Policy	Offshoring
Intellectual Property Rights	Trade Regulations
Productivity	Global Value Chains
Global Supply Chains	Industrial Operational Excellence
Information Technology	Manufacturing R&D
Frontier Technologies, and Science, Technology, Engineering, and Mathematics Education	

In addition to these characteristics, the MISG also considered two exemplars, China and Malaysia, to add an international perspective. **Figure 3** on page 10 provides a framework illustrating the interrelationship of these 14 industry elements. Notably, U.S. national government policy and programs have a unique opportunity to impart significant impacts on the other 13 elements. Broadly speaking, manufacturing firms must incorporate the effects of national policies with corresponding state and local government policies (e.g., federal and

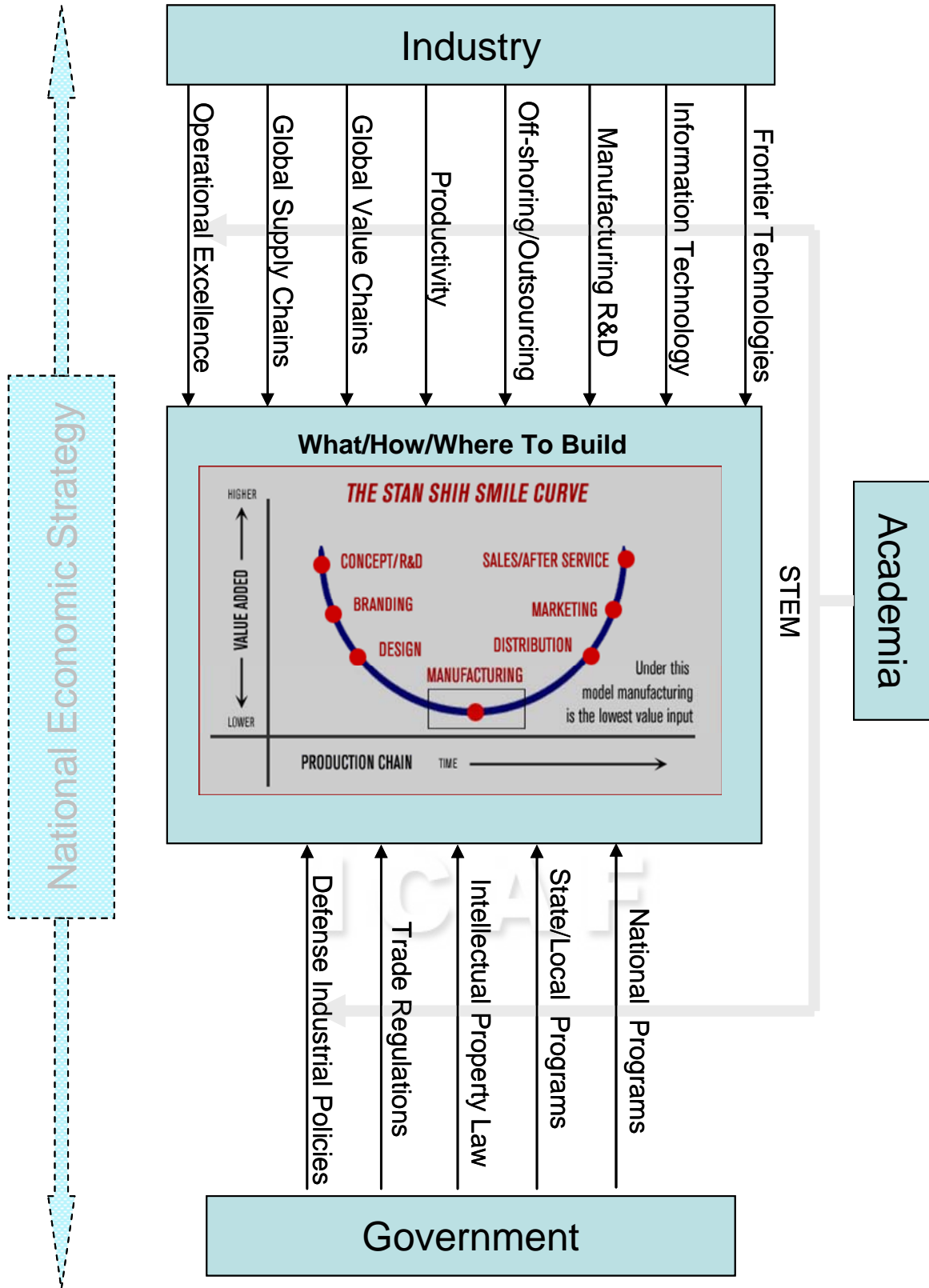


Figure 3. An NES Will Integrate Key Characteristics of the Manufacturing Industry

local tax rates) when making global investment and operational decisions. For example, firms weigh the potential benefits of lower taxes and less restrictive regulations outside the U.S. against the risk of losing control of proprietary technology in an environment that cannot sufficiently protect intellectual property. Given myriad government policies and programs, firms are faced with complex optimization problems as they attempt to maximize their competitive advantage.

The current set of U.S. government policies is outdated, poorly coordinated and insufficient for the networked 21st century global marketplace. Current policies remain steeped in a 20th century, industrially-based, free market economic model. They are inappropriate for the needs of today's economic structure where the combination of products, services, knowledge—and increasingly the policies of other countries—enables specialization and competitive advantage across sectors, especially manufacturing. The intensely competitive nature of global manufacturing and manufacturing's criticality to national power elevates the importance of government policies. Likewise, lack of strong coordination weakens their effectiveness.

U.S. government policies and programs, including environmental regulations, corporate tax law, and both monetary and fiscal policy also provide incentives and disincentives to steer behavior. These policies are often myopic, failing to effectively incentivize the bridging necessary to carry the considerable competitive advantages the U.S. holds in R&D and entrepreneurship across the innovation and application gap. Instead, these policies often support individual pieces of a system, e.g., education (Pell grants), R&D (renewable energy), and small business development, but fail to secure the system itself (e.g. the manufacturing sector). Given the criticality of the DIB, the U.S. Government did develop a separate DoD Industrial Base Policy (IBP) targeting the “Iron Triangle” of Congress, DoD, and industry.

The **DoD Industrial Base Policy** is codified in Title 10 of the U.S. Code. The DoD relies on a private defense industrial base to provide the majority of the goods and services it consumes. As the buyer in a defense materiel monopsony, the DoD possesses significant buyer power over suppliers. However, it does not have the financial resources to single-handedly ensure the health and viability of the defense industrial base. To compensate, the DoD develops policies to guide and communicate its behavior in the defense materiel market to maximize its contribution to DIB health and ensure access to defense items to meet the security needs of the nation. Title 10 directs the DoD to seek an industrial base that is “reliable¹⁸, cost-effective¹⁹, and sufficient²⁰ to meet strategic objectives.”²¹ Furthermore, the DoD requires the DIB to meet product integrity requirements (e.g., free of tampering and counterfeiting) and support the entry of smaller competitors and sub-system suppliers,²² where state and local policies are best positioned to stimulate these providers.

While **State and Local Government Policies** are both *dependent on* and *independent of* the national policies and programs mentioned above, they play an integral role in the success of U.S. manufacturing capability. For example, whereas reduced labor cost is often cited as the most important factor in outsourcing manufacturing jobs to places such as China, India, and Malaysia, there are many variables manufacturing industries consider before relocating to other cities, states, or countries. Access to an educated and trained work force, adequate infrastructure, competitive tax structures, and a robust R&D capability are critical, inspiring some states to develop research, innovation, or technology incubation parks to stimulate high value-added manufacturing. For example, North Carolina's Research Triangle

Park successfully recruited manufacturing firms, convincing them to relocate to realize the regional benefits. The alternative to intrastate emigration or installing production capacity domestically is offshoring.

Offshoring refers to the contracting out of goods production or service sector activities to businesses located abroad. The rise of Japanese and European multinationals is credited with spurring offshoring in the 1970s and 1980s.²³ Offshoring typically involves one of two scenarios leading to reduction in U.S. jobs. The first scenario involves the movement of work abroad by a corporation to a foreign subsidiary or joint venture, such as when General Motors replaces an American-made model in its Saturn line with one manufactured by its German subsidiary, Opel.²⁴ The second form of offshore outsourcing involves the procurement of a new product or service from an unrelated entity abroad, essentially replacing work done in the U.S., e.g., Dell employing Taiwanese manufacturers to build computers once built in the U.S.²⁵ Manufacturers generally seek substantial net savings (e.g., 50% or higher²⁶) to offset the increased logistics and transportation costs and resulting communication and management challenges. Offshoring also raises considerable concerns with respect to intellectual property rights in that offshoring could provide workers access to invaluable and vulnerable U.S. intellectual property (IP) in an environment lacking sufficient protection.

Intellectual Property Rights (IPR)²⁷ are legal rights granted by a government to protect the ideas of individuals or firms in order to encourage innovation and creativity by allowing creators to economically benefit from their work. IPR typically cover intellectual property associated with patents, trademarks, copyrights, and trade secrets. Intellectual property is a key contributor to U.S. leadership in the global economy, estimated to underpin more than 50% of all U.S. exports, generating an enormous export income, and responsible for 40% of U.S. economic growth.^{28,29} Individual governments grant—and protect—IPR to protect intellectual property against piracy, counterfeiting or infringement. IPR violations constitute a significant threat if not prosecuted under the stipulations of the trade rules designed to protect it internationally. As identified during travel, American, German, Irish, and Hungarian companies endeavor to protect their IPR when moving manufacturing to foreign countries, specifically restricting some of their more valuable intellectual property. China's widespread and egregious intellectual property violations remain a significant concern, while Malaysia has largely corrected its IPR deficiencies, fostering a considerable increase in foreign direct investment and trade.

Nations trade when it benefits them to do so. **Trade Regulations** are critical to assuring those benefits in a naturally anarchic system. Regulations support communication and the flow of imports and exports between countries, in turn increasing national and global prosperity. Nations prefer to trade under the guarantee of a rule-based architecture and equitable means of redress, both provided by trade regulations which normalize many different national politico-socioeconomic systems to ensure fair trade pervades the system. Manufacturing-related trade rules revolve around three key elements: 1) Dumping—acts by a foreign entity which harm a sector of the importing nation's economic base by selling a product at a price below fair market value³⁰; 2) Subsidies—direct or indirect acts by which an exporter's cost is offset by government contributions which interfere with the ability of the "hidden hand"³¹ to shape the marketplace; and 3) Safeguards—acts by which an exporter floods the marketplace with a particular product.³² Aggrieved importers can file a complaint with the World Trade Organization or directly against the nation in violation and impose punitive tariffs, countervailing duties, or anti-dumping levies to normalize the price.

While the aforementioned components of the manufacturing environment describe the broad impacts of legal considerations, the Manufacturing Industry should account for other “Big M” elements to synthesize national policies with market forces. The MISG considered competitive advantage, competition abroad (e.g. China, India, Mexico, Malaysia), the supply chains and their related value chains, operational excellence, R&D investments, and productivity. Consider first productivity.

Measures of **Productivity** growth constitute core indicators for the analysis of economic growth. Since 1959, labor productivity indices and related measures for broad economic sectors, including manufacturing, have been published by the Bureau of Labor Statistics. Productivity is commonly defined as a ratio of a volume measure of output (e.g. product value) to a volume measure of input (e.g. labor hours). While there is no disagreement on this general notion, a look at the productivity literature and its various applications reveals very quickly that there is neither a unique purpose for, nor a single measure of, productivity. Productivity measurements cover indicators such as technology readiness, efficiency, cost savings, benchmarks, production processes, and living standards so firms and agencies can gauge the effectiveness of strategies and programs.

Productivity provides a good comparative measure across different manufacturers—within their domestic domains—in that they are similarly impacted by the same inaccuracies inherent to the data, and to some extent to the level of outsourcing, offshoring, company merging and product quality. Manufacturers consider the impacts of these indicators to fully ascertain productivity values and understand how productive a company or country is within a given market or in the aggregate. The MISG found productivity metrics invaluable, as these metrics objectively demonstrated the loss of manufacturing jobs in low-value manufacturing was offset by automation and outsourcing, enabling significant increases in U.S. output. Productivity metrics also enable firms to optimize global supply chains and global value chains to maximize efficiency and minimize cost.

Global Supply Chains (GSC) comprise the inclusive trail of materials that come together into a final product sold as a unit. The supply chain of a single product begins in many different areas as raw or recycled resources and moves toward the final product as firms add value at each stop on the way. The culmination of this process results in a finished product that can be sold to a consumer. Enabled by information technology (IT), global manufacturers employ parts and labor from global suppliers. Some manufacturers derive significant advantages by ensuring adequate supplies are domestically (or even locally) available within a small radius. For example, all BMW first tier suppliers are located within a 600 km radius of BMW’s main plant in Germany. Other manufacturers leverage geographical advantages to both manufacture and sell their goods; Hungary and the Bavarian region of Germany both rely on their strategic central European locations to support their R&D and manufacturing bases, while Ireland markets itself as the gateway to the European Union for the U.S. Manufacturers continually trade border transaction costs (e.g., tariffs), labor costs, capital costs, logistics (e.g., shipping), external business costs (e.g., ease of doing business, regulations, etc.), and various risks (including security, IPR, financial and political risk) against each other to maximize profit, employing value chain analysis to determine advantages.³³

Global *Supply* Chains and **Global Value Chains** (GVCs) work together to maximize value and efficiency. GVCs provide a systematic method by which manufacturers isolate individual activities in the manufacturing process to determine the value (e.g., profit) of each

activity. Whereas the industrial age of manufacturing relied on an in-house, “factory-centric” business model, information age manufacturing models are based on global value chains.³⁴ GVCs reflect a new understanding of the distribution of added or relative value of a product at each stage of its production process from raw materials to retail sale, increasing globalization. They enable greater information sharing—critical to transparency throughout the chain—including interactive product development and synchronized production. For example, the production elements of manufacturing in many cases provide little interest to firms now relying on the higher value elements of the overall process to generate increased profit. U.S. “little m” manufacturing costs can be prohibitively expensive relative to their ability to generate income. Therefore, much of this work has been offshored to countries with lower labor costs, less regulation and more supportive government policies. The resulting erosion of manufacturing capacity driven by corporate profit strategies is diverging from the nation's vital interest of retaining a robust manufacturing base. GVCs are tied to GSCs and to other elements of the manufacturing process through information technology (IT).

The Manufacturing Industry employs **IT** extensively to reduce transaction and coordination costs in product design, manufacturing and marketing activities, within and across firms through concepts such as just-in-time, mass customization, total quality management, flexible manufacturing systems, global outsourcing, integration among functions, electronic data interchange, electronic commerce, supply chain management, and network organization. Manufacturers leverage IT for its ability to reduce labor, improve quality, differentiate products, improve customer service, and respond faster.³⁵ IT comprises databases to improve quality control (e.g. bar codes), digital displays and electronic controls to improve precision and speed in the manufacturing process, Radio Frequency identification systems for inventory tracking and ordering, and virtual prototyping (e.g., Computer aided design (CAD) and computer aided manufacturing (CAM)) to test new processes and products. Because these tools produce digitized output, the output can also be integrated across other IT elements, including globally available application software. IT thus provides manufacturers insight into where profit is best achieved through trade-off of competitive advantage, enabling them to optimize industrial operational excellence.

To achieve **Operational Excellence**, manufacturers look at the whole process, integrating R&D, innovation, and the lessons learned from the actual build (e.g., “little m”). A concise definition of operational excellence describes a holistic approach to integrating operations management methodologies in order to optimize people, assets and processes including research and development, maintenance, sales and service, warehousing and distribution, quality, and production⁹ to exact continuous process improvement. Continuous process improvement can also be broadly translated into what is colloquially known today as “lean thinking.” It is heavily wed to research and development, characterized as Manufacturing R&D when applied directly to the field of manufacturing.

Manufacturing R&D is comprised of “basic and applied experiments and investigations (as well as associated technical activities that include testing, prototype development, and other early-stage work).”² It focuses on process-type technologies, such as measurement, milling, and machining, which allow for efficient, repeatable production leading to lower costs. Manufacturing R&D is critical to discovering new or emerging technologies or to make the next big leap in manufacturing processes or methods. These improvements may yield new processes, machines or systems to enable more efficient or effective production capabilities, resulting in fewer defects, greater yields, and lower costs. Furthermore,

innovation is critical to the manufacturing process for both improving existing products, achieving competitive advantage, specializing, and developing new product markets.

Small businesses are the mainstay of innovation as they are often unencumbered by the comparatively high overhead rates and bureaucracy of larger corporations. Therefore, small businesses are often beneficiaries of supportive national, state and local policies incentivizing innovation. During international travel, the MISG was briefed on numerous comprehensive strategic policies to synchronize investments in new technologies across academia, research, and development to spur innovation. Because some of these new technologies are embryonic at best, yet may hold great promise, they are termed “**frontier**” **technologies**.

Rapid Manufacturing is one such frontier technology tied to the field of Industrial Operational Excellence described above. Rapid Manufacturing covers a wide array of intelligent tool technologies such as self diagnosing analytical instrumentation, nano-scale precision tools, product life-cycle management (PLM) tools,²³ three-dimensional (3-D) printers,²⁴ and rapid prototyping to include automated robot-based nano-manipulation.²⁵

Nanoscience, the study of matter’s behavior at the atomic and molecular level, is another so-called frontier technology. Nanotechnology, as defined by the U.S. National Nanotechnology Initiative (NNI), involves “understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications.”³⁶ Consequently, it requires arranging the structure of materials and the precision placement, measurement, manipulation and modeling of matter less than one billionth of a meter.³⁷ Nanomanufacturing is an enabling process that cuts across many industries and products – nano-fabrication, nano-metrology and nano-particles—and is already creating entirely new industries such as nano-medicine and nano-materials.

Biology-based technology, or biotech for short, is another frontier technology involving everything from biomanufactured foods and medicines to fuels and materials. The combination of biotechnology and nanotechnology presents further possibilities. But new manufacturing opportunities such as rapid manufacturing, nanomanufacturing, biomanufacturing, and other frontier technologies can only be achieved through a robust science foundation, provided from within the industry as well as through academia, specifically its focus on Science, Technology, Engineering, and Mathematics (STEM) resources.

The National Science Foundation considers **STEM** the “...core technological underpinnings of an advanced society...the strength of which is viewed as an indicator of a nation's ability to sustain itself.”³⁸ It forms the cornerstone of U.S. manufacturing in legacy industries, substantial growth industries, and emerging technologies industries. This includes developing resources that span the product life cycle from basic and applied research to product development and manufacturing. STEM also provides a means for targeting resources to support each node of the “Big M” model of the manufacturing environment: Tier 1) research and development at the basic research level and applied research level for exploratory and applied applications, respectively; Tier 2) product design and development where designers are able to take the knowledge from applied research and apply to products that can be commercialized; Tier 3) production and maintenance, where products get produced and machines get fixed; and Tier 4) manufacturing support, where administrative functions, purchasing, inventory control, and shipping activities are executed.

Finally, the MISG considered the effect of these 14 characteristics on the U.S. Manufacturing Industry vis-à-vis Chinese and Malaysian manufacturing. With respect to

China, the MISG identified the key advantages of trade with China—e.g., a potential market comprising a consumer base of several hundred million people.³⁹ By outsourcing or offshoring components and hardware to China, U.S. companies have sharply boosted profits and return on capital,⁴⁰ but likewise have lost manufacturing jobs that will likely not return to—or may have never been created in⁴¹—the U.S. U.S. manufacturers face significant challenges competing with China due to low labor costs, lax environmental regulations, subsidies, and currency manipulation. China’s ongoing currency devaluation has artificially lowered prices on Chinese built goods and forced other Asian economies to devalue their currencies to remain competitive with the Asian monolith. These actions result in artificially inflated prices of competing U.S. products, hurting the U.S. manufacturing base, which subsequently may directly or indirectly affect national security.

U.S. trade with **Malaysia** does not face such significant challenges. One of the “Asian Tigers” along with Hong Kong and Singapore, Malaysia is a superior example of the global manufacturing industry—and offers an excellent counterpoise to China—as it too rapidly emerged from an agrarian society to become a leading global manufacturer. Malaysia, like China, now relies on an export-driven economy, where it is ranked as the 22nd largest exporting nation in the world with more than 5,000 foreign companies resident within the country. The Malaysian manufacturing industry alone contributes 80.3% to its total exports, and accounts for 32% of Malaysia’s GDP.¹⁰ The country achieved this rapid, stable growth through a national strategic economic policy first announced in 1986, which first considered its national competitive advantages, specialization, and strengths and weaknesses *before* it consciously developed its manufacturing industry.

SECTION IV: KEY TRENDS

The Manufacturing Industry has undergone two major perturbations over the last quarter century. First, the end of the Cold War opened global labor and natural resource markets. Second, the maturation of the Internet enabled the rapid exploitation of these newly available resources. These shocks significantly altered the global manufacturing landscape, creating both challenges and opportunities for firms. The industry is not likely to return to equilibrium as present trends are likely to continue.

The MISG identified two categories of such trends, termed macroeconomic and microeconomic, influencing America’s ability to attract and retain manufacturing in this evolving environment. Macroeconomic trends reflect broader conditions in the U.S. and the world. Examples include employment, productivity, and the persistence of the U.S. trade deficit. Microeconomic trends impact corporate decision making processes and the corresponding competitiveness of the firm. These include the availability of technological and commercial opportunities arising from research and development (R&D), the effectiveness of collaboration among industry, academia, and government, the skill levels of domestic workers, particularly with regard to STEM education, and the economic and regulatory attractiveness of a particular location. Both trends reveal threats to the sufficiency of the national industrial base in general and the defense industrial base specifically as it pertains to its ability to provide for national security requirements.

Macroeconomic Trends. The U.S. remains the world's top manufacturer, and its output as a proportion of global production has remained steady at around 20% since 1982.⁴² The U.S. has, however, been shedding manufacturing jobs for decades. In the early 1940's,

the Manufacturing Industry employed nearly 32% of American workers. By the year 2000, the Industry only employed 13% of American workers.⁴³ Manufacturing employment has become a particular concern in the wake of its slow rebound during the broader economic recovery after the 2001 recession. The recession itself contributed to the loss of 2.9M manufacturing jobs, about 17% of the total at that time.⁴⁴ In contrast to previous post-recession periods, manufacturing employment never recovered and fell an additional 600,000 in the period up to November 2008.⁴⁵ There are two long-term structural issues driving the broader decline in manufacturing employment: productivity gains and offshoring.

U.S. worker productivity has grown steadily for decades at about 2% annually between 1950 and 2000; this is, broadly speaking, highly desirable. Increased output per hour worked translates to increased living standards. Manufacturing productivity gains have grown even more quickly, averaging 2.8% annually for the same period. This implies that overall output per worker grew *threefold* in fifty years while manufacturing output per worker grew *fourfold*. Even more impressive is the acceleration of manufacturing productivity growth to 4% from 1995 to 2000 and 4.8% from 2000 to 2003.⁴⁶

Productivity gains partially explain declines in manufacturing employment, but also illustrate the danger simple metrics can pose. For example, one analysis concluded 8.6M new manufacturing jobs would have been required to produce the levels of output achieved in 2000 if productivity levels had remained at 1990 productivity rates. The number of manufacturing jobs would have increased 2% (thus comprising 19% of total U.S. employment) but instead fell to 13%.⁴⁷ This analysis illustrates the hazard in only using the number of manufacturing jobs as a metric of Industry health when capital investments and process improvements create productivity gains enabling increased output at reduced employment. Productivity gains are also credited with fueling a broad decline in global manufacturing employment. Between 1995 and 2002, global manufacturing eliminated 22M jobs, an 11% decrease.⁴⁸ Key trading

partners like Japan lost a sixth of its manufacturing jobs from 1995 to 2004 and China lost 15% over the same period.⁴⁹ As shown in Figure 4, employment changes are not uniform. If productivity increases were the sole reason for job loss and increased output, there would be little concern regarding the ability of the industrial base to support U.S. national security needs.

However, tying all job losses and increased output to productivity may be misleading because the statistics mask the offshoring of production at intermediate stages of the manufacturing process. An oft-cited paper by the Upjohn Institute's Susan Houseman cautions that while productivity gains may reflect better educated and higher performing workers, they can also result from cost savings generated by the offshoring of inputs. Thus, the domestic Manufacturing Industry base could be declining even as output grows, reducing the capacity to satisfy national security needs via a domestic DIB.

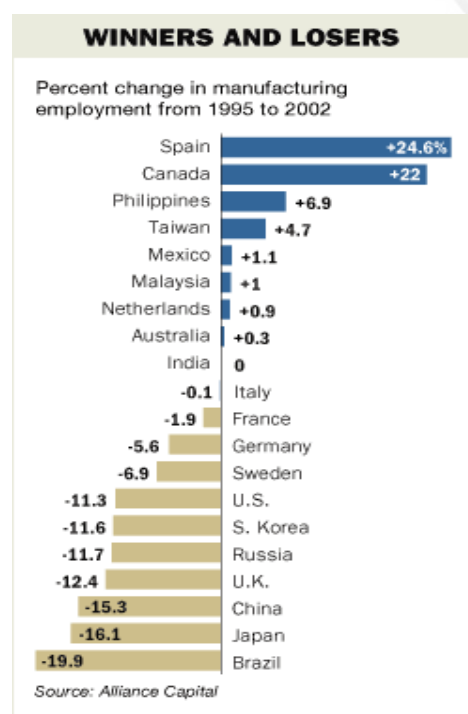


Figure 4. Global Manufacturing Employment Trends.

The data does not provide a clear answer to the productivity gains vs. offshoring debate. Most analysts agree U.S. job losses are primarily caused by domestic factors, e.g., contract completion, downsizing, bankruptcy and financial difficulty, and domestic outsourcing, with offshoring perhaps responsible for less than 5% of layoffs. However, there has clearly been a rise in production abroad that might have been attracted to the U.S. in earlier decades.⁵⁰ The relative growth in manufacturing output overseas is not in and of itself a damaging development since it provides U.S. consumers with cheaper products and U.S. manufacturers with lower cost inputs. This trend, coupled with Americans persistent tendency of insufficient savings has induced trade deficits, resulting in favorable conditions for creating non-tradable services jobs vice employment tied to U.S.-based production. The risk is a potential loss of the requisite manufacturing base needed to support U.S. vital interests and facilitate the maturation of frontier industries that can over time create high-value.

Microeconomic Trends. Given growing global competitiveness and the speed at which firms execute decisions, firms are attempting to differentiate themselves from competitors and stake out a more resilient position of competitive advantage. To that end, firms are combining R&D funds and human capital in economically advantageous locations. As shown in Figure 5, global R&D funding is on the rise. Firms are willing to spend R&D funding when and where research talent is both available and likely to provide the innovations necessary to penetrate or defend markets. Firms are also increasingly more open to collaboration with government and academia to improve the effectiveness of R&D spending.

According to the Council on Competitiveness, the U.S. still leads the world in most innovation metrics; R&D spending, research performance of U.S. universities, number of scientific researchers, number of patents, most innovative companies, etc.⁵¹ However, across all metrics, the U.S. is losing its lead and its innovation engine is at risk. While the U.S. is not reducing its commitment to domestic R&D (the U.S. still accounts for 37% of global R&D spending), U.S. firms are more likely to invest some R&D offshore. Another factor distorting actual R&D investment derives from surging R&D investment by other countries. China's investment in R&D increased at an average rate of 19.3% in the last decade and is viewed as the most attractive location for new R&D as the funding follows production to China and other emerging market economies.⁵²

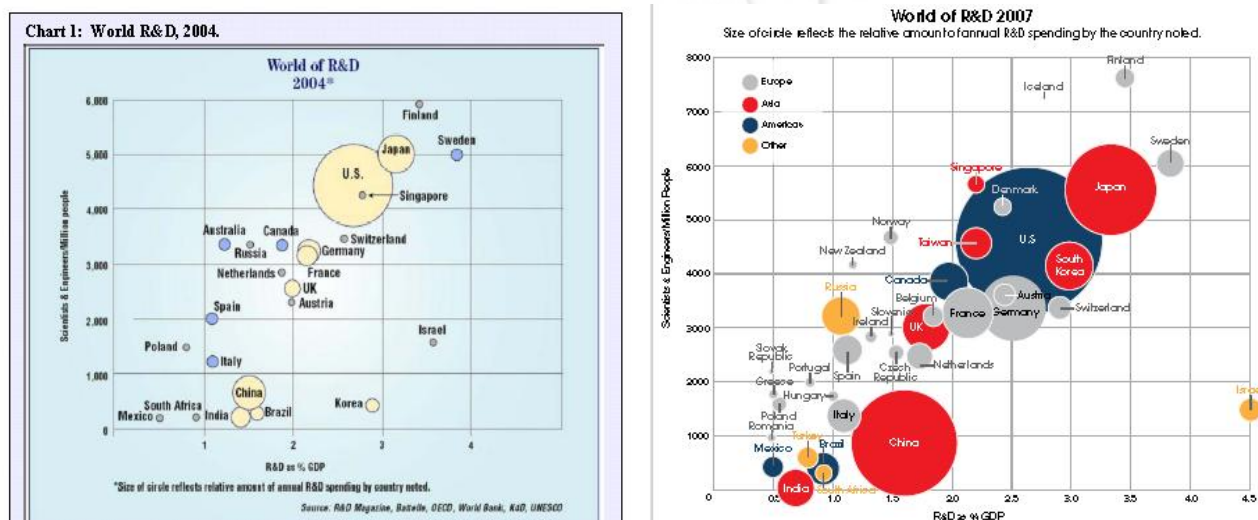


Figure 5. World R&D Expenditures 2004⁵³ vs. 2007.⁵⁴

Regarding the quality of the workforce, The Bureau of Labor Statistics and Georgetown University statistical sources indicate there is no shortage of STEM resources available to the U.S. manufacturing sector.⁵⁵ The supply of STEM resources holding science and engineering degrees actually *exceeds* the number of available STEM jobs.⁵⁶ Instead, the Industry is impacted as a result of the large number of STEM graduates choosing non-technical career paths. The ability to attract and retain these valuable human resources in the future is dependant upon the ability of the manufacturing sector to collaborate with academia on long-term resource planning.

Furthermore, data does not support the popular belief U.S. students are failing when compared to their peers in industrialized countries, including science and mathematics. Boe and Shin reviewed U.S. student test performance on six different international tests and compared U.S. students to students in 22 other industrialized nations.⁵⁷ They concluded U.S. students generally performed above average in comparison with students in other industrialized nations.⁵⁸ The actual shortcoming resides in public schools, which are not sufficiently equipped to address the challenge of preparing students for high tech innovative environments of an IT-intensive nature.⁵⁹

In a globalized world, companies choose locations based on customer needs and profit potential. Both domestic and international manufacturers consistently noted the negative influence of America's high corporate tax rate. Corporate tax rate remains a significant factor affecting corporate decisions on facility locations. The U.S. combined federal and sub-federal corporate tax rate of 39.3% is the highest among the world's leading industrialized countries.⁶⁰ Even if corporations ultimately pay less than the maximum rate, the tax code negatively distorts corporate behavior with regard to investment and production locations.

Lowering the benchmark tax rate would signal America's commitment to domestic production. Developing tax regulations incentivizing domestic R&D investment would not only leverage U.S. inherent strengths, illustrated in **Figure 6**⁶¹, but encourage new manufacturing capacity able to leverage the talents of knowledge-based research and technology clusters present across the country.

Another factor influencing the competitiveness of U.S. manufacturers is regulatory and compliance costs, which are almost twice the average for manufacturing as for other U.S. industries.⁶² Environmental protection, for example, is laudable in its own right but corporate representatives told the MISG the cumbersome process of complying with rules and then documenting that compliance is often unnecessarily expensive and thus anti-competitive. Likewise, the burden for U.S. corporations of providing health and retirement benefits to employees has become a matter of national competitiveness and alternative models,

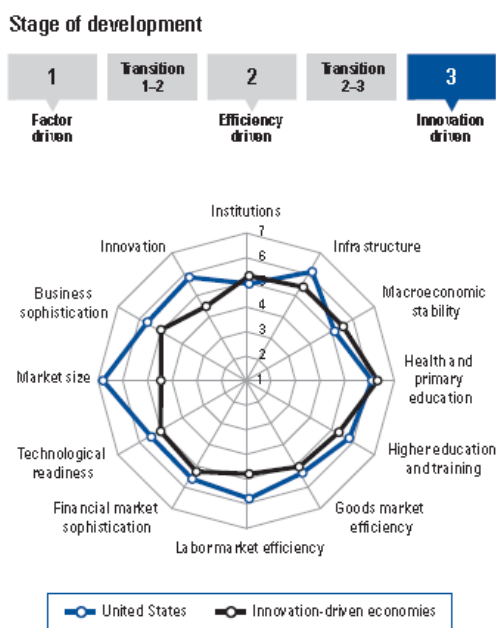


Figure 6. America's Level of Development.

whether based on public or private sector solutions, have the potential to strengthen the ability of the U.S. to retain and attract new manufacturing industries on its shores.

As noted in the overview, the *trends* indicate the *true* health of the U.S. Manufacturing Industry, although its supporters are typically distracted by non-representative statistics (e.g. job loss). Other countries face their own set of unique challenges. However, some countries are more apt to consider their strengths and weaknesses, and develop a comprehensive strategy to accentuate inherent specialization and competitive advantage. In discussions with manufacturing leaders in Ireland for example, Dublin uses the objective ratings compiled in the World Competitive Index to develop national strategies consistent with its unique set of challenges, trends, strengths and weaknesses. The U.S. would do well to do the same, using **Figure 6** as a starting point in developing such a strategy, which when considered side-by-side with the triads in **Figure 2**, highlight inherent, unique U.S. advantages.

SECTION V: RECOMMENDATIONS

Based on visits to five states and three foreign countries as well as extensive study and research, the MISG concluded that the United States should take steps to secure the health of its manufacturing base, not only to preserve future prosperity but also to advance long-term national security interests. Consequently, the MISG believes the U.S. Government, America's corporations, and the country's academic institutions should institutionalize thinking about manufacturing from a *national security* perspective. Reframing U.S. views on Manufacturing would give rise to initiatives to both promote collaboration among government, corporations, and universities and remove obstacles to retaining manufacturing in the U.S. or attracting production to U.S. shores.

Key Recommendations

The MISG generated four key recommendations addressing the challenges listed in this report, summarized below with details following:

- **Develop and resource a National Economic Strategy (NES) that will feed into the existing National Security Strategy.** An NES would further integrate consideration of economic issues (including those of the Manufacturing Industry) into broader policy decisions about how the U.S. employs its instruments of power to advance national security interests.
- **Use the NES preparation process to continually examine key issues affecting America's manufacturing sectors.** Examinations would bring needed focus to the role of manufacturing in the health of the defense industrial base and illuminate the dynamics at play between trade imbalances and domestic productive capacity.
- **Develop and expand pathways for collaboration between academia, industry, and government.** Better pathways would create synergies across organizations to support each element of the manufacturing environment.

- **Create an independent panel to review the impact of trade rules, taxation, regulatory compliance, and benefits burdens on domestic manufacturers.** This would highlight unnecessary impediments to onshore production for potential removal.

The following is a detailed discussion of the MISG's four recommendations:

1) Recommendation: Develop and resource a National Economic Strategy (NES) that will feed into the existing National Security Strategy.

The U.S. should more effectively integrate economic and strategic thinking by formulating a National Economic Strategy (NES) that supports the preparation of the existing National Security Strategy (NSS), an annual report required by law since 1986.⁶³ The process of preparing an NES would more effectively inject the economic instrument of power into the national security planning process. This would complement existing efforts to bolster interagency economic policy coordination, such as the creation in 1993 of the National Economic Council⁶⁴ alongside the National Security Council

The MISG concluded that U.S. efforts to integrate economic policy into broader strategic planning are insufficient to optimize the advancement of long-term national security interests, including those of the Manufacturing Industry. The MISG witnessed the benefits other countries derive from having developed mechanisms which ensure their national economic interests are routinely examined in a wide strategic context. This was evident in travels to Germany and Ireland as well as research conducted on the policies of Malaysia, France, Russia, Japan, the Peoples Republic of China, and Taiwan.

National Security Strategy documents reveal a heavy focus on the *military* and *political* instruments of power, with *informational* and *economic* instruments included only as supporting elements.

Consideration of the military instrument of power is well integrated into the NSS process because the Department of Defense elaborates on DoD's support for strategic objectives through several mechanisms, including the Quadrennial Defense Review (QDR), the National Military Strategy, and the National Defense Strategy. Political and non-military security related activities are also well covered by virtue of specific strategy documents and plans prepared by civilian agencies that address issues such as intelligence, homeland security, foreign policy, and foreign assistance. There is no supporting interagency report or process that specifically addresses how national economic policy relates to national security strategy, and this is where preparation of a National Economic Strategy would prove most useful.

Responsibility for the preparation of an NES would likely fall on the National Economic Council, relying heavily on the Departments of Treasury, Commerce, Energy, and State, along with the U.S. Trade Representative (USTR), the Environmental Protection Administration (EPA), and other smaller federal agencies with roles in economic policy, as needed. Creating and vetting such a document would impose a discipline of interaction across economic-focused government departments and expand communications channels among these departments, other non-economic civilian entities in the government, and the military.

(2) Recommendation: Use the NES preparation process to continually examine key issues affecting America's Manufacturing Industry.

The specific contents of the NES would, of course, be determined by the President, based on informed debate throughout the Executive Branch. The MISG, however, believes a

comprehensive strategy document should address a number of issues related to manufacturing that have bearing on U.S. ability to advance its interests based on a vigorous economic instrument of national power. These issues include the following:

I. The Defense Industrial Base

An NES should address the significant and disturbing vulnerability identified by the MISG: the lack of analysis of national economic policy in the context of America's declining defense industrial base.

As defense spending as a percentage of GDP declines, the footprint of DoD spending on the national industrial base is shrinking. The result is a reduction in the DoD's influence on the composition of the industrial base and a corresponding reduction in the robustness of that base. An NES could address how DoD policy might stress and expand the use of commercial capabilities where feasible, but at the same time contemplate a more active role in structuring the defense industrial base when commercial options are not feasible. Furthermore, an NES would highlight those areas in which the U.S. must maintain competitive pre-eminence to ensure its vital interests are satisfied.

II. The Balance of Trade

The NES should evaluate whether the underlying causes of persistent trade deficits are creating long-term harm to the development of the U.S. economy. Short-term trade deficits are benign, reflecting cyclical differences in economic performance between the U.S. and its trading partners. However, the U.S. has run a trade deficit every year since 1975, with dramatic increases in particular over the past decade.

A trade deficit means the economy is in effect facing a shortage of production in goods and services relative to consumption. Since it is difficult to compensate for this shortage by importing services, the adjustment that occurs is naturally biased towards the provision of goods from abroad, so trade deficits that persist over the longer term tend to shift economic activity towards non-tradable services like construction, retail, and entertainment at the expense of manufacturing. This is a matter of national concern to the extent by which the mix of sectors gain and lose compromises the ability of the country to maintain its industrial base for strategic reasons or to grow new industries that are likely to produce high value-added jobs and spur innovation over the longer term—an issue naturally suited for the interagency debate process that would accompany production of an NES.

III. Trade Policy

The lack of balance in trade reflects macroeconomic conditions rather than trade policy issues. An NES would provide for the requisite monitoring and recommendations regarding the effectiveness of trade policy in maintaining a level playing field for U.S. industry. Representatives of numerous production sectors allege extensive harm from foreign trade practices, suggesting an unfair competitive edge accruing to foreign competitors from poor intellectual property rights enforcement, currency manipulation, industry subsidization, and barriers to market access. The MISG heard first-hand about these challenges from corporations and analysts at site visits in the District of Columbia, Kentucky, Maryland, North Carolina, Pennsylvania, and Virginia.

The U.S. already has a number of instruments at its disposal to address unfair trade practices, including WTO dispute mechanisms, anti-dumping levies, countervailing duties (against subsidies), and safeguards (against the flooding of the domestic market with imports).

The vigorous use and enforcement of such instruments are key to maintaining the domestic constituency for open trade. The NES could set a broad tone with regard to the employment of such measures.

NES preparation could be particularly useful in establishing an integrated interagency approach towards trade partners whose actions are of particular concern from a critical national interest perspective. The MISG found *China's* expanding trade and investment relationship with the U.S., for example, is sufficiently extensive and volatile to merit broad strategic consideration. This is clearly reflected in existing U.S. policy that encourages China to be a "responsible stakeholder" in the global economic order, recognition of the importance of China's orderly economic expansion with respect to U.S. interests.

IV. Constraints on Corporate Activity

The NES should analyze whether conditions at the firm level are impeding the broader creation of high-value production and service jobs in the U.S. One example might be skills shortages due to a lack of STEM education and information technology capabilities. A large proportion of government workers in information technology jobs are nearing retirement, suggesting the potential for future labor shortages in this area.⁶⁵

V. Critical and New Industry Support

The NES should recommend steps to be taken at the *national* level to ensure frontier industries do not develop primarily outside the U.S. Measures could include expanded R&D support, incentives for education, national efforts to coordinate the commercialization of research, and outright subsidies to industries whose role in the economy is critical to predominance in defensive capabilities (e.g., semiconductors, steel).

The MISG spoke with numerous private sector contacts who suggested America will have great difficulty capturing value from tomorrow's production if it does not make a concerted effort to view new industry development from a broad, strategic perspective. Future high-value industries will likely be at the nexus of technological advancement and emerging challenges, implying that areas such as biotechnology, nanotechnology, and environmental goods may well offer Manufacturing opportunities over the coming decades equal in magnitude to the explosion of IT over the past generation.

(3) Recommendation: Develop and expand pathways for collaboration between academia, industry, and government.

U.S., State, and local leadership should establish and support policies to target resources and initiatives to support each tier of the manufacturing environment: R&D, product design and development, production and maintenance, and, finally, manufacturing support such as administrative functions, purchasing, inventory control, and shipping. Manufacturing jobs are particularly beneficial to the communities in which they are located, and the creation and retention of such jobs often rests on the ability of governments, universities, and corporations to coordinate activities that support the process of turning research and ideas into domestically produced goods.

The MISG was highly impressed with North Carolina's efforts to encourage universities, corporations, and all levels of government to collaborate in preserving and expanding high-value industries. North Carolina's Research Triangle Park is just one example in this regard of many successful efforts in the U.S. and abroad to forge "knowledge links"

that promote manufacturing sectors. Similar efforts, for example, have been instrumental in innovative economic development associated with the rise of California's Silicon Valley.

The MISG believes universities, industry groups, state governments, and the federal government should actively consider how they can further incentivize the necessary collaboration that enables the academia-technology-industry cluster formation key to high-value innovation. Social networking tools for example, are useful catalysts for integrating these three elements and will prove invaluable to U.S. pre-eminence in manufacturing and innovation.

(4) Recommendation: Create an independent panel to review the impact of taxation, regulatory compliance, and benefits burdens on domestic manufacturers.

The MISG believes key federal agencies should appoint an independent panel to review the impact of taxation, regulation, and employee benefits on American manufacturing with the goal of making recommendations that would strengthen competitiveness and eliminate unnecessary barriers to onshore production. The current combined corporate tax rate of 39.3% is a poor advertisement for investment into the U.S. economy. An overhaul of the tax code to incentivize domestic R&D and production may be necessary to retain the industrial base. Furthermore, regulatory compliance should not overly burden manufacturers and the government should help firms adapt to tighter regulations.

SECTION VI: CONCLUSION

U.S. Manufacturing is in a state of long-term relative decline, threatening the viability of our country's defense industrial base and U.S. longer-term prosperity. The loss of U.S. production jobs is to some degree a reflection of forces that cannot and should not be arrested. For example, productivity gains translate into fewer people needed to create more value. This trend creates temporary but painful dislocations for some workers but is conducive over time to higher living standards. Similarly, the addition of large numbers of workers and sophisticated supply chains tied to the globalizing world economy imply that it is no longer realistic to perform low-value, labor-intensive functions in the U.S.

However, the MISG believes the decline of manufacturing in the U.S. has gone further than these forces would or should suggest. This reflects domestic economic policies that favor service industry growth coupled with taxation and regulation approaches that drive activity offshore. Further, America's trade partners are employing their own strategies to attract high-value production industries that in prior decades would have come to the U.S. Some of these foreign efforts are admirable, such as improving the investment environment or promoting workforce skills acquisition, but others are patently unfair, including the neglect of intellectual property rights and unfair subsidies to industry in violation of global trade rules.

The MISG believes that the current trends can be turned around, but only through concerted action. ***YES, America can maintain competitive pre-eminence, create high value-added manufacturing jobs and lead innovation in manufacturing, but only with concerted action along the lines of this report's four recommendations -- and it is imperative this action begins now.***

ENDNOTES

¹ Jefferey Immelt. "General Electric 2008 Annual Report," General Electric, 2008. http://www.ge.com/ar2008/letter_5.html (accessed May 22, 2009.) [Emphasis added.]

² Report conclusions were achieved through consensus vice unanimity.

³ U.S. Bureau of Labor Statistics. "Industries at a Glance: NAICS 31-33," (BLS, 2009). <http://www.bls.gov/iag/tgs/iag31-33.htm> (accessed May 22, 2009).

Note: Manufacturing is often relegated to only the part of the building process that "bends metal," as noted in the Stan Shih curve in Figure 1. However, the manufacturing process has a significant prologue, consisting of the R&D, the branding and the design of the end product, as well as a significant logistics tail, i.e. selling, distributing, and maintaining the product. This report considered the entire manufacturing process, including those elements underpinning the process in the first place, e.g., education.

⁴ National Research Council of the National Academies. "New Directions in Manufacturing: Report of a Workshop," (National Academies Press, 2004), http://books.nap.edu/openbook.php?record_id=11024&page=R1 (accessed May 22, 2009).

⁵ Michael Nystrom. "The Stan Shih Smile Curve: Value Creation in the Knowledge Economy, (The Market Traders, April 25, 2007), <http://forum.themarketraders.com/read-m/26/7111/7111> (accessed May 22, 2009).

⁶ President Emeritus of the Council of Foreign Relations and author of Power Rules: How Common Sense Can Rescue American Foreign Policy.

⁷ Leslie Gelb, "Necessity, Choice, and Common Sense," *Foreign Affairs*, no. 3, Volume 88 (May/June 2009): 56.

⁸ Robert Malone is respected as a competition advocate, is a contributing editor to *Forbes Magazine* and the author of several articles and books, including Chain Reaction: How Today's Best Companies Manage Their Supply Chains for Superior Performance.

⁹ Robert Malone. "U.S. Manufacturing Slides Across The Board." (*Forbes.com*, January 29, 2007.), http://www.forbes.com/2007/01/28/manufacturing-declines-us-biz-logistics-cx_rm_0129mfg.html. (accessed May 22, 2009).

¹⁰ Michael E. Porter and Klaus Schwab, "The Global Competitiveness Report, 2008-2009," *World Economics Forum*, 2008, <http://www.weforum.org/documents/GCR0809/index.html>.

¹¹ Adam Smith. "The Wisdom of Adam Smith (1723 – 1790)," (The Adam Smith Institute, 2009), <http://www.adamsmith.org/smith/quotes.htm#jump5> (accessed May 22, 2009).

¹² Dual-purpose describes those products applicable to both commercial and defense markets.

¹³ William Schneider, "Why the Defense Industrial Base Matters," *Defense News*, May 18, 2009.

¹⁴ Harold G. Vatter, John F. Walker, *History of the U.S. Economy Since World War II*, (New York: M.E. Sharpe, 1995).

¹⁵ Elizabeth Wilson. "Build a Billion From the Ground Up," Interview with Harry E. Figgie Jr. (*Entrepreneur*, 2009). <http://www.entrepreneur.com/startingabusiness/successstories/article200240.htm> (accessed May 22, 2009).

¹⁶ Leo W. Gerard and David M. Rubenstein. "U.S. Manufacturing: The Key to Reviving the Economy," (The Hill's Congress Blog, 2009," <http://blog.thehill.com/2009/03/09/us-manufacturing-the-key-to-reviving-the-economy/> (accessed May 22, 2009).

¹⁷ "Manufacturing's Multiplier Effect Is Stronger Than Other Sectors," (National Association of Manufacturers, 2009), http://www.nam.org/~media/Files/s_nam/docs/237700/237698.pdf.ashx (accessed May 22, 2009). Note: The multiplier effect is the degree to which a dollar generated through one activity spawns value from other activities. Therefore, for every dollar generated by manufacturing another 1.37 dollars is generated in other industries.

¹⁸ The DoD defines reliable as meeting requirements plus on-time delivery.

¹⁹ The DoD defines cost-effective as delivering contracted products at or below cost by a competitive industry with at least two viable suppliers for every need.

²⁰ The DoD defines sufficient as meeting performance requirements while remaining flexible to react to changing requirements and priorities.

²¹ Office of Under Secretary of Defense Acquisition, Technology & Logistics Industrial Policy, Annual Industrial Capabilities Report to Congress,[2008], http://www.acq.osd.mil/ip/docs/annual_ind_cap_rpt_to_congress-2008.pdf.

²² Ibid.

²³ Linda Levine, "Offshoring (a.k.a. Offshore Outsourcing) and Job Insecurity Among U.S. Workers," Congressional Research Service Report RL32292, January 23, 2009: 3.

²⁴ Dave Vanderwerp, "Saturn's latest re-badged Opel replaces the Ion, keeps its European namem" Car and Driver (February 2007), www.caranddriver.com: 1

²⁵ Mark Landler, "These Days Made in Taiwan Often Means Made in China," The New York Times, (May 29, 2001): 1

²⁶ As mentioned in conversations on international travel.

²⁷ The idea of IPR is founded in the U.S. Constitution which states: "[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." Cornell University Law School. United States Constitution, (2008), <http://www.law.cornell.edu/constitution/constitution.articlei.html> (accessed May 22, 2009).

²⁸ <http://www.law.cornell.edu/constitution/constitution.articlei.html>

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⁴¹ E.g., LCD Flat panel displays and televisions.

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⁴⁶ Forbes. "U.S. Manufacturing: Challenges and Recommendations." Note: All productivity figures cited in this paragraph based on this source

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