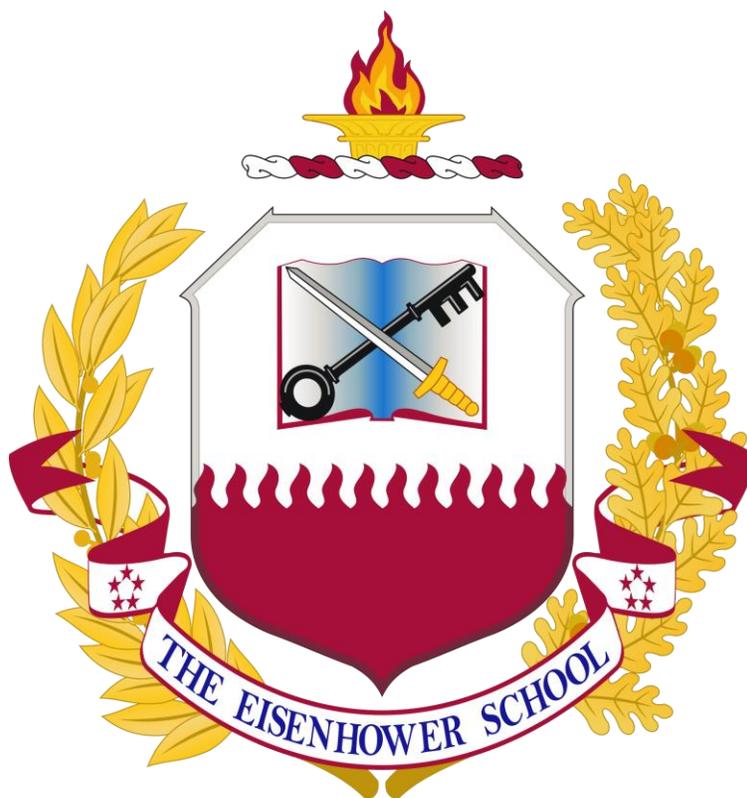


**Spring 2013  
Industry Study**

**Final Report  
*The Manufacturing Industry***



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# MANUFACTURING 2013

**ABSTRACT:** The Executive Branch of the United States Government has stressed the importance of manufacturing in America and recognized the important role of business and academia. This was highlighted in a July 2012 report from the President's Council of Advisors on Science and Technology (PCAST), *Capturing Domestic Competitive Advantage in Advanced Manufacturing*. Furthermore, Manufacturing was consistently emphasized during the 2012 election and the cornerstone of a subsequent State of the Union address. Across the board, government, industry and academia have found a common voice; manufacturing is vital to our economy and critical for our national defense.

The manufacturing sector, as defined by this study, is manufacturing in general, from the gathering of raw materials to final assembly and distribution. In this year's study, we narrow our focus to address specifically "Advanced Manufacturing" as defined by the National Council of Advanced Manufacturing (Paul Fowler):

The Advanced Manufacturing entity makes extensive use of computer, high precision, and information technologies integrated with a high performance workforce in a production system capable of furnishing a heterogeneous mix of products in small or large volumes with both the efficiency of mass production and the flexibility of custom manufacturing in order to respond quickly to customer demands.

Advanced manufacturing is not related to specific products. However, there are certain stakeholders that form a community-of-interest in areas where advanced manufacturing is thriving and growing, mainly: industry, academia, and government. Companies are locating in areas where local government creates a business environment that promotes economic development. Companies also look to Academia provide both a skilled and highly educated workforce plus the research and development facilities to support new product and process innovation. Our guest speakers and our local, domestic, international visits (foreign firms operating in the US) afforded us the opportunity to examine the strengths and weaknesses of the interactions between government, academia, and industry in regions supporting manufacturing. Over the past year, students became familiar with the multiple dimensions of these interactions and have considered how policies can have both a positive and negative impact on the viability of manufacturing.

This report builds on PCAST recommendations and provides prescriptive recommendations for fueling a resurgence of interest in manufacturing, generating the proper workforce to meet industry needs and providing a business atmosphere at the local, state and federal level that is conducive to manufacturing's growth. With the adoption and proper implementation of these recommendations, the United States can grow the manufacturing base and become a leader in advanced manufacturing.



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## **PLACED VISITED:**

### **Doemstic:**

Congressional Office of Representative Daniel Lipinski, Washington, DC  
National Association of Manufacturers, Washington, DC  
National Institute of Standards and Technology (NIST), Gaithersburg, MD  
National Defense Industry Association Conference, The Eisenhower School, Ft. McNair, D.C.  
Bureau of Labor and Statistics, Washington, DC  
Sikorsky Helicopters, Stratford, CT  
Pratt and Whitney Aircraft Engines, East Hartford, CT  
Concurrent Technologies, Johnstown, PA  
Harley Davidson, York, PA  
Kongsberg Defense Corp, Johnstown, PA  
Carpenter Latrobe Specialty Metals, Latrobe, PA  
Letterkenny Army Depot, Chambersburg, PA  
National Center for Defense Manufacturing and Machining, PA  
Carnegie Mellon University, Pittsburgh, PA  
Aerotech, Cheswick, PA  
Curtiss-Wright Electro-Mechanical, Cheswick, PA  
Youngstown Business Incubator, Youngstown, OH  
National Additive Manufacturing Innovation Institute, Youngstown, OH  
M-7 Technologies, Youngstown, OH  
Toyota Motor Manufacturing Kentucky, Georgetown, KY  
MAZAK Corporation, Florence, KY  
International Crankshaft Incorporated, Georgetown, KY  
Kentucky Association of Manufacturers, Frankfort, KY  
NIST Manufacturing Partnership Extension, Frankfort, KY  
Foundation for Kentucky Industry, Frankfort, KY  
Louisville Slugger, Louisville, KY

### **International:**

None.





# CHAPTER I: INTRODUCTION

## BACKGROUND

Beginning in early 2011, when the America Competes Act<sup>1</sup> was signed into law, through the July 2012 release of the PCAST report to the President on *Capturing Domestic Competitive Advantage in Advanced Manufacturing*<sup>2</sup>, the discussion of the future of manufacturing in America has been one of the most important topics in American politics. In that short time, leadership changes, new organizations, and foundational government strategy documents have been implemented to focus the nation and government resources toward recovering America's leadership role in advanced manufacturing and innovation. For the first time in recent history, manufacturing was highlighted during the 2012 State of the Union Address. The President revealed cooperative private-public collaboration similar to a mid-1980s initiative which recaptured America's role as the forerunner in microprocessors. The current initiative is much larger on an economic scale and proposes 15 regional centers for advanced manufacturing innovation. The Eisenhower School Manufacturing Industry Study (ESMIS) team studied a dynamic environment with a wide range of activity. ESMIS chose to focus on the July 2012 report mentioned above, examine its 16 recommendations, and provide an in depth analysis and road map for what industry, government and academia have stated.

ESMIS' review of the PCAST report and other foundational government documents found that the aggressive pace of pursuing a renaissance in manufacturing has created a collection of government strategy documents and numerous organizations that still require a substantial coordination effort. One glaring shortfall within the current framework is the lack of defined roles and responsibilities within the government. Missing is the identification of a lead agency, organization of specific areas of responsibility and a lack of prioritization within existing strategy and policy. Our report recommends several courses of action and methods for implementation.

In addition, the ESMIS team found the definition of advanced manufacturing difficult to extract from existing documentation and more importantly, the working definition and use of the term in industry does not match what has been documented. This conflict is discussed later in more detail with a recommendation to have an agreed upon, shared definition for all participants in the manufacturing community.

**Recommendation:** The executive branch must consolidate strategies and key definitions in support of advanced manufacturing. In addition, roles and responsibilities must be well defined, codified and communicated, presumably by the Interagency Advanced Manufacturing (IAM) Working Group which was congressionally mandated to organize a whole-of-government approach to advanced manufacturing.

### ***The Advanced Manufacturing Partnership Report***

In July 2012, the Advanced Manufacturing Partnership (AMP) Steering Committee, at the behest of the President's Council of Advisors on Science and Technology (PCAST), under the Obama Administration's Office of Science and Technology delivered a report entitled *Capturing Domestic Competitive Advantage in Advanced Manufacturing* to the President. The report was commissioned to study methods to revive our economy via the manufacturing industry. The



commission focused on a declining industry, which was once a historical strength of the United States economy. **This AMP report was the basis of the ESMIS field study.**

The AMP tasking was defined by the congressionally mandated Interagency Advanced Manufacturing (IAM) Working Group under the President’s National Science and Technology Council in the following manner: “AMP’s mission is to identify opportunities for investments in R&D, precompetitive collaboration, and shared facilities and infrastructure that have the potential to transform advanced manufacturing in the United States.<sup>3</sup>” In addition, the AMP group was created to fulfill the requirement in the America Competes Act that called upon the Executive Branch to “take into consideration the recommendations of a wide range of stakeholders, including representatives from diverse manufacturing companies, academia, and other relevant organizations and institutions.<sup>4</sup>”

#### **AMP Key Findings**

1. Use **advanced manufacturing** to fuel economic recovery.
2. Create a **sustainable** competitive advantage by repairing the innovative environment.
3. Utilize our industrial and national **strengths**.

The US is still a leader in advanced manufacturing and can retain that leadership by following *sixteen recommendations* divided into *three pillars of action*:

1. Enabling innovation
2. Securing the talent pipeline (for advanced manufacturing)
3. Improving the business climate

#### ***ESMIS Approach & Findings***

The ESMIS analysis examined the AMP committee’s findings, collected data from visits to the field and presentations by government, industry and academic experts. Next, the group analyzed gathered data, and made prescriptive recommendations with the committee’s report as a foundation. Fifteen of the AMP recommendations are covered in the sections that follow, while three general findings are included here:

1. The US has an opportunity to embrace advanced concepts to gain market advantage.
2. The AMPs identification of pillars are reasonable groupings for action, however they do not constitute analytic foundations of advanced manufacturing. Instead, they represent problems or gaps that have developed in the manufacturing market over the last few decades that will have to be overcome for advanced manufacturing success. This list may not be exhaustive, or may change over time. Our report retains the pillar structure and makes recommendations to fill these gaps.
3. Finally, the ESMIS team found what may already be obvious – government support to a specific market sector aimed at improving the nation’s economy will require careful, continual management. It will require close government-to-private sector collaboration to set common strategic goals, identify issues, and select clear and appropriate roles and responsibilities.



## MANUFACTURING INDUSTRY PERFORMANCE

Arguably, the single most important industry to maintain a strong national economy in the U.S. is the manufacturing. Manufacturing remains vital to U.S. economic security and prosperity, creates wealth, increases the standard of living and acts as a multiplier effect to other industry sectors. Within the industry, the defense industrial base is essential to national security. And yet, the manufacturing industry has suffered over the past decade primarily due to relocation of domestic production. In the past 20 years, the United States has seen a consistent decline in its manufacturing workforce. In 1997, the manufacturing sector directly supported 17 million jobs and today the National Association of Manufacturers estimates that number somewhere in the neighborhood of 12.2 million.<sup>5</sup> Despite the loss in jobs, America still maintains an incredible production capacity. Some of the reduction in labor force can be attributed to more efficient processes. However, the number of facilities that have closed leads one to conclude offshoring of certain manufacturing capability has hurt our economy and workforce. Countries such as China and India frequently attract manufacturing due to lower labor costs, lower tax rates and less government regulation.

Today the manufacturing sector contributes \$1.8 trillion to the American economy and accounts for 12.2% of Gross Domestic Product<sup>6</sup>. Statistics show that for every one dollar spent on manufacturing \$1.48 comes back into the economy, a 148% return on investment.<sup>7</sup> In addition to the 12.2 million jobs manufacturing directly supports, another five million are indirectly supported.<sup>8</sup> And yet, manufacturing still struggles. Will this trend continue or can the U.S. regain its manufacturing competitiveness through innovation, technological advances, productivity and efficiency?

### THE “ADVANCED” CHOICE

“Advanced” manufacturing covers both a market choice differentiating US manufacturers from global competitors and accentuates a government desire to recover an innovative, national-level environment that sustains an advantage. In the market sense, our field study observed that manufacturers found differentiation in advanced methods and tools for building things in line with the AMP report, but more often, they relied on advanced products for differentiation and long term profits. Several companies confirmed their ability to capitalize on the advanced market relied on US strengths (education, research laboratories, smart workers, and an entrepreneurial spirit). ESMIS noted examples of advanced processes and complex supply chains where companies controlled intellectual property and relied on unique knowledge capital as well as products of great complexity, advanced performance or high quality only replicated in the most developed nations.

In the government arena, the ESMIS team found “advanced” addressed a long-term strategic process bringing ideas from inception to market or introducing disruptive discoveries across the supply chain. Before globalization, firms were the driving force in the process. Post globalization, competition increasing technical discovery, and multi-national market creation, changes the template and inception can occur in one country, R&D in another, and production in yet another. The health of the innovative environment required to sustain success in advanced manufacturing became the domain of the government (federal, state, and local) primarily due to corporate changes and the very nature of crossing so many interest groups.



An important difference in the definitions of “advanced” between market choice and a government sponsored innovation environment is the disparate time horizons for each. Generally speaking, the ESMIS team found the outlook for most corporate strategies was no more than five years. However, the government innovative environment assumes timelines in excess of twenty years to bring university and government laboratory ideas through the development cycle into the market. This misalignment of timelines is a major driver in the need to coordinate strategy between public and private sector entities.

Recommendation: Further effort should be made to differentiate the different facets of advanced manufacturing. Close, continuous collaboration will be required to resolve the general timeline disparities.

### **THE GAPS THAT CHALLENGE**

The AMP pillars described above are the three most significant current challenges in the advanced manufacturing industry. The first gap is described above as a broken long-term, cross-community innovation cycle and is blamed for impeding technologies in their transition from prototypes to mass production. The other two gaps are problems in the market place echoed by industry.

The first market challenge repeatedly identified was a lack of highly skilled labor. Advanced products with advanced processes require highly skilled labor at a competitive price; however, there is a gap in this type of worker below the college educated level. This shortage is presumably due to a lack of domestic demand possibly driven by globalization. The government role here is less clear than in enabling innovation. Does federal government responsibility go beyond basic education? Has the federal government failed to provide quality high school graduates or are graduates drawn to other industries for employment?

The second market issue is a perceived imbalance in the global playing field, slanted specifically against U.S. firms. No detailed work was done in the AMP report on this area. The report suggests the government lower the cost of doing business, open trade options, and minimize schedule impacts as much as possible. Our research found little useful investigation into the “right” balance of federally provided public goods (i.e. EPA, OSHA, FAA, Soc. Sec., fair trade etc.) in exchange for corporate tax dollars and responsible business practices. In addition, there is a shortfall in the identification of specific inefficiencies in government processes or findings where the U.S. should revise its approach to fair trade. The Department of Commerce highlighted issues, which are captured in their 2012 report in response to Section 604 of the America Competes Act.<sup>9</sup>

What follows are our recommendations addressing the three main challenges to revive manufacturing in America. In our report we did not draw definitive lines between government and market responsibilities. We also did not attempt to define what the market "must do." Those answers are left to follow-on efforts and the tight collaboration required to ensure federal actions translate into economic gains for tomorrow's recovering economy.

## **CHAPTER II: INFORMATION AND COLLABORATION**



## INTRODUCTION

In order for advanced manufacturing to succeed, all of America must understand not only the importance of advanced manufacturing, but also the nature of the industry today. Advanced manufacturing is cleaner, more technological and efficient, and requires a skilled and educated workforce. Unfortunately, many Americans are unaware of today's advances, the abundance of opportunity and the excitement surrounding advanced manufacturing.

### PERCEPTIONS – STUDENTS, PARENTS, ACADEMIA AND GOVERNMENT

Today people still think 'declining, dirty, dark, dangerous, hard work, low pay, boring, and thankless' when they are asked about manufacturing.<sup>10</sup> A recent 2011 public opinion survey conducted by Deloitte and The Manufacturing Institute reported, "among 18-24 year-olds, manufacturing ranks dead last..." as a career choice.<sup>11</sup> That same study also reported that less than 20-percent of students say either their school or parents encouraged them to consider jobs in manufacturing.<sup>12</sup> The perception and facts that manufacturing jobs are being lost to overseas workers further discourages parents, guidance counselors and students.

**Recommendation:** Department of Commerce must develop a campaign plan targeting prospective employees, parents, and academia highlighting the excitement, challenge, benefits and security in manufacturing careers.

#### *Dispel Misperceptions of Dirty, Dark, and Dangerous*

Manufacturers have embraced continuous process improvement and empower employees by rewarding employee initiative. Lean manufacturing has become the norm. This translates to a skilled, effective, efficient and committed work force on the shop floor. It means the monotony of repetitive tasks have been replaced with shifting job tasks and the development of multiple skills as part of a work team. The productivity improvements required to remain competitive and retain a reduced labor force are safety, cleanliness, natural lighting, and ergonomically designed workstations. Employees are more productive, healthier and workplace injuries are significantly reduced. The Occupational Safety and Health Administration (OSHA) has reported steadily declining death and injury numbers in the manufacturing sector. "Since 1970, workplace fatalities have been reduced by more than 65 percent and occupational injury rates have declined 67 percent"<sup>13</sup>.

#### *Good Salaries and Challenging Positions*

In addition to the 12.2 million jobs manufacturing directly supports, another five million are indirectly supported.<sup>14</sup> These aren't low wage or low skilled jobs. The overall average estimated salary is \$77,060 for line workers with management often making over \$100K<sup>15</sup> and on the surface, there are many manufacturing jobs available. A review of online resources for finding employment, such as "manufacturing-jobs.com," "Monster.com," and "simplyhired.com" show, in some cases, over 900,000 job offerings in manufacturing.<sup>16</sup>

#### *Build Partnerships at the Regional Level but with a National Approach*

National leadership with a regional focus is required to ensure manufacturing educational and training programs are consistent nationwide and lessons learned are leveraged. The focus of these



partnerships, top down or bottom up in origin, is ultimately the purview of industry, with participation from governments, academia, associations, and students, as shown in Appendix A, Figure I.

## **MAKE IT IN AMERICA – CHANGING PARADIGMS**

### ***Develop a National Advertising Campaign***

The first action for the federal government is clearly stated in the PCAST report; “...creation of an aggressive, integrated “Image of Manufacturing” public service announcement campaign...”<sup>17</sup> A national advertising campaign should include promotion of the already established National Manufacturing Day, school exposure to the industry and standard advertising methodologies like product placement and brand imaging. Each initiative should be developed around central themes highlighting manufacturing as: 1) a critical contributor to national Gross Domestic Product (GDP), 2) a key factor in building strong and functional local communities, and 3) the most important industry to guarantee American national security by sustaining the ability to innovate, design, and build things that we need domestically and abroad for civil and military uses.

### ***Hollywood Relationships, Brand Imaging and Product Placement***

The entertainment industry practice of “product placement and brand imaging” should be strategically considered in films by manufacturing stakeholders to improve the image of the manufacturing workplace and highlight the technologically advanced processes and products. Additionally, partnerships with government trade, commerce and small business association representatives should be leveraged to place “Made in America” products and advanced manufacturing into the appropriate media channels. The communication and discussion between the entertainment industry and government of the importance of manufactured goods, and manufacturing tools and processes, ensures greater exposure of the public to interesting and exciting aspects of the manufacturing industry. Specifically, filming in manufacturing facilities provides opportunities for exposure of advanced manufacturing or specific company names and highlighted products. Manufacturing’s portrayal in popular culture will be a critical piece of capturing the interest of the young and modern work force.

## **ESTABLISH A NATIONAL ADVANCED MANUFACTURING PORTAL**

In addition to information for public consumption, the manufacturing industry itself requires an information technology platform providing a forum for the dissemination of critical information and opportunities for collaboration among stakeholders. The Advanced Manufacturing Partnership Steering Committee recommended, “...a searchable database of manufacturing resources created as a key mechanism to support access by small and medium sized enterprises (SME) subject matter experts to enabling infrastructure.”<sup>18</sup> The concern centers on the inability of subject matter experts “to prototype rapidly and virtually, produce small batches, customize products to individual consumers and clients, reduce inventories, and expand the range of products they can manufacture. The minimum investments required are too large to be cost effective for an individual firm, and there is often no effective way to buy shared services.”

To be successful and add true value, the portal must be viewed from the perspective of its intended audience, the SME. The portal must be intuitive, allowing users to find critical information, assess



affordability, and determine expertise available to solve their challenges. Most organizational websites, including existing manufacturing portals, such as <http://www.nist.gov/manufacturing-portal.cfm> and [http://manufacturing.gov/advanced\\_manufacturing.html](http://manufacturing.gov/advanced_manufacturing.html), do not focus on SME needs, but rather focus on the organization itself; discussing missions, awards, current projects, future focus, etc. The national assets available in Federal Labs, Research and Development Centers, Arsenal, Depots and other facilities can greatly expand the resources available to SME's from geographical, research and development and capability.

The second major need is to advertise the existence of the portal and its capabilities and solicit users' thoughts on continued improvements. To facilitate this marketing, NIST should leverage the Manufacturing Extension Partnership (MEP) program to serve as the primary and initial POC educating the SME companies on the availability and usefulness of the portal and its connected resources. NIST should also provide necessary training and support to the MEP for this purpose and develop an exportable marketing and educational tool to be provided to other federal, state, and local organizations such as R&D centers, the SBA, Universities, the National Association of Manufacturers, local business incubators and others. Finally, NIST should improve the visibility of the portal to the public through web based search engines by using the search engine guidance found on website: <http://www.howto.gov/>.

**Recommendation:** Usefulness of the technology must be measured. The main portal can initially begin measuring the value and return on investment by adding a web part type access counter to measure the number of independent users accessing and using the site, adding a short on-line survey for assessing value and receiving feedback on improvements, and conducting an annual on-line survey of key advisors in the relevant industry such as the MEP and industry consortiums.

### **CHAPTER III: ENABLING INNOVATION**

#### **INTRODUCTION**

The United States has been facing a manufacturing crisis for decades and must make significant investments in innovative technologies for the future of our domestic economy. The world has invested in R&D resulting in the erosion of the United States' competitive advantage in critical areas. R&D provides a future for advanced manufacturing in the United States with breakthrough technologies to drive competitiveness in a global marketplace. Technology, people, and cheap energy to enable a new industrial revolution for the 21st century are investments the United States must make today to secure our economic future. The critical path forward is to increase resources, keep the best talent, and ensure the business climate is conducive for growth. The most significant role is the United States government as a conduit for granting R&D investments, policies promoting growth, and vigorously protection of domestic intellectual property.

**Recommendation:** Immediately Implement Long-Term R&D Tax Incentives.

The additional R&D funding and tax credits should be permanent and long-term so individuals, laboratories, universities, and corporations can plan accordingly and provide stability. Long-term funding will provide certainty for employers and continuity to sustain in an uncertain political environment.



**Recommendation:** Congress should create a Pathway to Citizenship for the World’s Best and Brightest.

Broad immigration policies are a cornerstone of the United States as seen through historic success and growth. The nation must continue to attract and retain the world’s best and brightest talent to sustain global dominance. Consequently, there must be a pathway to citizenship for the best and brightest talent to stay in the United States and add to the domestic human capital for future US GDP growth.

**Recommendation:** The U.S. Department of Commerce should pursue sanctions with the World Trade Organization and the International Monetary Fund against any country found to actively participate in intellectual property theft, or found to fail to actively enforce activity relating to theft of intellectual property within their borders.

Continued widespread theft of intellectual property cannot continue. Billions of dollars of intellectual property is stolen in the international community annually. This undermines the economic viability of the nation and discourages continued investment in future R&D as the potential loss may be too great a risk. Finally, such theft jeopardizes U.S. security. If other countries are tied to theft of intellectual property, the U.S. Department of Commerce should take the lead on developing the factual case and presenting it to the U.S. State Department for pursuit of international sanctions. If action is not pursued by the international community within one year, the U.S. should authorize its own trade sanctions with such countries.

**Recommendation:** Congress must make the business climate in the United States more attractive by reducing structural costs for manufacturers by investing in energy technologies and providing linkages for manufacturing and energy corporations to have access to cheap domestic energy.

By making the business climate more attractive for firms the ROI for shoring back to the United States becomes more attractive, which will further lead to additional economic growth and prosperity. Many of the new manufacturing technologies could provide domestic firms a competitive advantage when combined with trends towards cheaper domestic energy costs, reduced transportation through near sourcing, and subsequently reducing overall supply chain costs. The PCAST report suggests several areas for R&D investment, but it is unclear as to which of these will fit best with future industry and the future of advanced manufacturing.

### **ESTABLISH A NATIONAL NETWORK OF MANUFACTURING INNOVATION INSTITUTES (MIIS)**

The federal government has funded research and development (R&D) for a wide range of initiatives to meet the needs of our government and nation. However, as successful as these programs are, the appearance of piecemealed investments to spur innovation, has had limited results, not focused on restoring the manufacturing sector or jobs and has been non-synergistic. In the 2012, President Obama announced an initiative to bring together large, medium, and small industrial enterprises, universities, national labs, community colleges, non-profit organizations and government agencies forming regional and national partnerships. The goals are to attack the



downtrend in innovation, re-establish the United States as a leader in advanced manufacturing and bridge the proverbial “valley of death”, the gap between R&D and commercial production of goods. On 9 March 2012, at Rolls Royce Cross pointe in Petersburg, VA, the President announced a \$1 billion investment into 15 regional hubs across the US, creating synergy between academia, private sector and government.<sup>19</sup> The 15 regional hubs will establish an interdependent network, initially funded by government with the goal of self-sustainment in approximately seven years.

In the 2013 State of the Union address, the President committed to three more Institutes for Manufacturing Innovation (IMIs) and on 9 May 2013 launched three new manufacturing innovation institutes. Federal co-investment by the Departments of Defense (DOD) and Energy (DOE) will be matched by the private sector. The DOE Manufacturing Institute will focus on next generation power electronics manufacturing addressing critical national energy needs. The DOD Manufacturing Institutes will focus on digital manufacturing, design innovation and lightweight and modern metals manufacturing.<sup>20</sup>

**Recommendation:** Draft Institute charters to encourage government involvement and approval in the research life cycle and decision process earlier rather than later.

#### ***Overabundance of Government Programs***

PCAST recommended a national network of MIIs, not smaller programs that do not complement each other. In this austere fiscal environment, “spreading the wealth” is detrimental to the achieving the strategy. In October 2012, the President announced another program, \$20 Million for 10 Public-Private Partnerships to Support American Manufacturing and Encourage Investment in the U.S.<sup>21</sup> This replicated much of the NNMI vision. The Department of Commerce, through NIST, needs to work together to align similarities or consider merging programs. During an interview with a spokesperson from the Kentucky Association for Manufacturers, who is knowledgeable of state and regional federal programs for the manufacturers of Kentucky was unaware of the initiative to develop a National Network for Manufacturing Innovation.<sup>22</sup>

**Recommendation:** Ensure programs are coordinated and communicated to prevent overlap or duplicative efforts and inefficient use of resources.

Building a “guiding coalition” of congress members, industry and academia is essential to providing the leadership to transcend the current administration’s term. The stakeholders need to be accountable to the administration, ensuring the right strategy is followed and provide the linkage between Legislative and Executive branches to streamline productivity. A “guiding coalition” needs to be in place before as soon as feasible. The coalition should be based in Washington, DC, however easily accessible to industry and academia.

### **FOSTER A MORE ROBUST ENVIRONMENT FOR COMMERCIALIZATION OF ADVANCED MANUFACTURING TECHNOLOGIES**

Efforts need to be made encouraging partnerships between academia, including community and technical colleges, private industry, and local through federal governments. While a national manufacturing policy is needed, innovation begins at local levels. No group or organization should be excluded from efforts to revitalize enhanced manufacturing ideas.



**Recommendation:** Establish a national clearing-house for ideas that lead to commercialization opportunities. If one small community has a need for innovation or new technology, most likely, others do as well.

Regional support of advance manufacturing is strong while national oversight and collaboration is not. Ideas and best practices must to be shared. Cross-pollination can lead to similar innovation in other sectors. The U.S. is currently in a manufacturing crisis and cooperation at all levels is necessary to secure our place as a global lead for advanced manufacturing. A single entity, preferably one of the national manufacturing organizations should take the lead in establishing a national identity. From here most of all cooperative efforts can be categorized and similar issues can be vetted by representatives from academia, private industry and the government. Conceivably, working in a partnership, problems and solutions, including national policy can be synchronized.

**Recommendation:** Realign academic pursuits from patent rights or property ownership to partnership and sharing of ideas.

Public and state institutions receiving federal funds should rethink their pursuit of patents for revenue and profit. Academia should look for collaborative efforts in research and development that lead to commercialization of technology that will benefit the nation as a whole. This is not suggesting academic institutions need abandon partnerships with private industry to develop and patent new ideas, but the pursuit of the ideas and technology funded by the tax payer should be for the benefit of the nation first, above consideration for revenue and profit.

## **CHAPTER IV: SECURING THE TALENT PIPELINE**

### **INTRODUCTION**

If the United States is to become an advanced manufacturing leader, people will make or break the endeavor. A skilled workforce is a key to success. That workforce should come from a system that embraces national standards through educational program accreditation, an emphasis on the importance of community and technical colleges, enhancing the university experience, encouraging industry/academic partnerships and utilizing the strength of America's Veterans.

#### ***An Aging Workforce and the Skills Gap***

There is a general consensus that there exists a shortage of skilled workers in the United States, especially in manufacturing. Reports differ as to the magnitude of the shortage; a Deloitte Consulting survey from 2011 places the number at 600,000 while a Boston Consulting Group estimate from a 2012 is lower at 100,000. Regardless of the amount of the shortage, it is predicted to increase over the next ten years as older workers retire. And, there is a need for employees to have the latest skill sets, as advanced manufacturing requires workers trained in technology, computers, and mathematics.<sup>23</sup> The Boston Consulting Group Report also points out that companies have cut back on training for entry-level workers, and the skills gap is reduced if workers arrive with math skills and are capable of learning how to run computer-controlled machines.<sup>24</sup> Manufacturers prefer that these skill sets be integrated into programs of study to complement traditional science, technology, engineering, and math (STEM) courses of study.<sup>25</sup> In



addition, English and other basic literacy and workforce skills are in demand to ensure workers are career ready.

### ***Management Level and Lack of Experience***

Advanced manufacturing requires innovative leadership and managers with people, technical, and business process skills. To find these “white collar” workers, manufacturers look to an entry-level workforce educated and trained in U.S. universities, draw upon experience in other professions such as the military, or recruit talent from overseas. No longer are manufacturing jobs just about hard physical labor, many open management positions in manufacturing are for professionals trained in design, programming, machine repair, retooling, and business. Larger companies with a significant labor force are interested in hiring team leads and process managers. Management skills are necessary in the service and sales sectors as well as traditional human resources, finance and administration.

## **BUILDING AN EDUCATION FRAMEWORK**

PCAST’S Recommendation 10, “Develop Partnerships to Provide Skills Certifications and Accreditation” calls for a “national focus on education and training that can produce workers capable of operating and troubleshooting modern factory equipment.” Key components of implementing this recommendation are a focus on partnerships between industry and academia; accreditation of programs and standardized curricula; and skills certifications. The PCAST Report and the March 2013 Manufacturing Institute Roadmap for Manufacturing Education identify success criteria of advanced manufacturing educational programs as having assessments to evaluate worker skills; an assessment of the program to ensure quality, programs that adapt to changes in the industry; and certifications that are portable and industry-recognized.<sup>26</sup>

**Recommendation:** Promote accreditation through existing programs recognized as reputable and having passed strict evaluation criteria from a credible third-party validator.

Most community colleges are accredited; this ensures credibility, eliminating the separate accreditation review recommended in the PCAST report. Accreditation of community college programs also enables transferability of programs if students wish to relocate to other regions of the state or country. Industry employers can be confident students are learning skills through approved educational institutions with academic rigor.<sup>27</sup>

### ***Shared Foundational Skill Sets***

The development of curricula is aided by the use of competency models. The U.S. Department of Labor has developed one specifically for advanced manufacturing.<sup>28</sup> The competency model for advanced manufacturing includes foundational skill sets at its core then building to manufacturing specific skills. The model incorporates core competencies in personal effectiveness, academics, and workplace skills, as well as industry-wide and industry-specific technical competencies. The model culminates in management and occupation-specific competencies. The competency model shares the first three rows in common with other career fields and programs of study often available as courses at community colleges.<sup>29</sup> The alignment of the competency model for foundational skills minimizes the effort required of manufacturing coalitions to create a framework of standards,



accreditation, and certifications. Manufacturing-specific coalitions can focus on standards and certifications for industry-wide and industry-specific competencies.

### ***Leveraging partnerships***

The National Strategic Plan for Manufacturing issued in 2011 advises that the path forward should “leverage and/or expand existing models that have proven successful.” The PCAST Report contains similar guidance and emphasizes the role of industry associations in advancing the process<sup>30</sup> through the successful establishment of accredited advanced manufacturing education programs and providing required certifications.

One of the primary objectives for the Federal government as outlined in the National Strategic Plan for Advanced Manufacturing is, “making the education and training system more responsive to the demand for skills.” In addition, the strategic plan calls for better alignment of funding by recommending that funding support cross-sector partnerships.<sup>31</sup> The Federal role is coordination, funding, standard setting, outreach and serving as a champion for programs. In addition, “Modest changes to agency solicitations to encourage partnering with community colleges could instantly create stronger regional community college partnerships with the industry, universities and national labs that routinely seek agency R&D funding.”<sup>32</sup> Ultimately, Federal stakeholders should effectively support academia and industry so they can proceed with innovation, workforce development, and increased productivity without the need for continued federal funding or extensive government oversight. Community colleges are utilizing to partnerships as an avenue to diminish the challenges faced in the current economic and education climates.<sup>33</sup> Partnerships will benefit from a national approach providing tools and resources for certification and standardization without creating new programs or making significant investments in foundational materials. Industry benefits from having education providers, and students available for hire, in the local area – saving time and resources on training and recruiting.<sup>34</sup> This benefit is especially important for small and medium-sized businesses without the capacity to build extensive training programs. In a review of the National Science Foundation Advanced Technology Education (NSF ATE) programs, analysts note, Research has shown partnership programs work better than technical programs colleges and businesses create independently.”<sup>35</sup>

By leveraging a broader base of resources, advanced manufacturing programs have a greater chance of success and sustainment. For example, partnering with programs that promote cyber security education provides a link to STEM education and places focus on critical skills needed in computing and technology enhancing the advanced manufacturing industry. The NSF ATE program also provides a model of a broader approach to technical education focusing not only on manufacturing, but also other highly technical skill areas imbedded in academic programs. Funded grant projects are expected to provide solutions to workforce issues that result from the dialogue of a partnership between institutions and employers.”<sup>36</sup>

**Recommendation:** Develop Standardized Curriculum and Programs.

The development of standard curriculum allows students and industry access to similar programs of study regardless of location, allowing for transfer of credits and consistency in educational material. Educators advocate the advantages of consistency across a State’s course offerings, and offer consistent pathways to two and four year degree programs.<sup>37</sup> The certification process, based



on professional association criteria, helps ensure the application of knowledge through testing and skills assessment. Certification programs also provide students with applied workplace skills, advantageous over traditional academic programs. Third-party certification providers can assist academic and industry partnerships by offering a national perspective, and provide best practices, consultation, education standards, and facilitation of the certification assessment process.<sup>38</sup>

## COMMUNITY COLLEGES - A WORKFORCE PIPELINE

### *Value and Impact*

A vital component of workforce development comes not only from U.S. universities but a community college system that is both conventional and technical in educational approach. While community colleges and vocational schools shared a diminished perception as manufacturing declined and a college degrees became the preferred option for America's high school seniors, today's factories are cleaner, automated, computerized, and require technical and technological knowledge that has created what has been termed a need for "New Vocationalism"<sup>39</sup> In response, Community Colleges and Technical Schools are offering low-cost, high-value programs.

Today there are 1167 public and independent community colleges. In the Fall semester of 2011, these institutions enrolled 13 million students, 59-percent part time and 41-percent full time.<sup>40</sup> Communities are designed to meet student needs regardless of wealth, heritage, or previous academic status. It is for this reason community college student population is comprised of more minorities, adult continuing education, night classes and the ability for high school students to achieve college credits through dual enrollment. In addition, community colleges are generally affordable. The average tuition at the community colleges is \$6,262 for a two-year degree versus \$158,072 for a bachelor's degree from a four-year institution<sup>41</sup>

In the 2012 PCAST report to the President, a recommendation was specifically made to "invest in Community College Education."<sup>42</sup> To that end the committee suggested modifying assistance to have focused solicitation on manufacturing fellowships and scholarships. The report also recommends the creation of a national network of manufacturing educators, and finally, alignment of solicitations for federally funded research programs to encourage partnerships with Community Colleges.

### *Current Federal Assistance*

In January 2013, the Obama administration announced \$500 million in Community College grants to expand job training through local employer partnerships.<sup>43</sup> The goal is to promote skills development and employment opportunities in advanced manufacturing, transportation, healthcare, and STEM through partnerships between academic institutions and employers. The \$500 million guarantees each state \$2.5 million plus 297 individual schools receive grants approximately \$400 million.<sup>44</sup>

**Recommendation:** To ensure a future for manufacturing in the U.S. 70 percent should target STEM and technical fields with 15 percent specifically dedicated to students working toward manufacturing certifications.

Today, the federal government heavily subsidizes community college funding. According to the American Association of Community Colleges, 34-percent comes from Pell Grants, 16-percent



from Federal Work Study, and 20-percent from Federal Support Grants.<sup>45</sup> The ratio of funding support does not need to change and the additional \$500 million from the Obama administration for innovation provides an excellent opportunity to change the government approach with regard to tying resources to technical programs, specifically manufacturing and certified skills curriculum.

**Recommendation:** Encourage high school teacher to earn certification to teach at the community college level; adjust teacher pay; fund innovative tech in the classroom and encourage dual enrollment for high school students.

The U.S. Department of Education can incentivize high schools to work with community colleges and willing teachers to certify adjunct faculty, creating opportunities for dual-enrollment. Already occurring in parts of our country, this could be a national standard. Disadvantaged students could apply for student aid just as their college counterparts do. In addition to student benefit, teachers should be financially rewarded for their additional certifications and work. Equipment purchases in conjunction with local businesses creating manufacturing centers at each Community College will further prepare students for careers in manufacturing with hands on experience. While local businesses and industry may provide a practical laboratory, the community college should serve as the hub for innovation. Community colleges should receive matching federal funds for any private money invested in computer aided design (CAD), additive manufacturing, robotics, welding, maintenance and electronics. Prioritization should be need and performance based.

## ENHANCING THE UNIVERSITY EXPERIENCE

### *Today's Programs/Curriculum*

The PCAST report recommended, “augmenting existing engineering curricula with manufacturing coursework, and creating new graduate-level programs that provide students with a comprehensive overview of manufacturing as well as technological and operational perspectives in a professional engineering context.”<sup>46</sup> This recommendation was based on the role research universities in the U.S. play in shaping the basics of advanced manufacturing and defining future educators and leaders in this industry. The report also describes universities as, “uncertain about where the discipline of manufacturing best fits in academia within the normal boundaries of degree programs, departments or even schools, and as a result, universities are marginalized.”<sup>47</sup>

**Recommendation:** Federal investment dollars should be allocated promoting a network of university-industry partnerships focusing on engineering-based innovation and capabilities leading to a more highly-skilled STEM workforce with hands-on industry experience.

University-industry collaboration is essential for a qualified workforce capable of engineering based innovation by translating theory in the classroom to applied research and development. It is necessary to establish additional university-industry collaboration whereby each stakeholder benefits from their relationship results in more student enrollments, greater workforce development, and well trained and highly skilled workers. The Federal government’s approach must be synchronized and collaborative to optimize limited funds available to universities and colleges.



**Recommendation:** Universities should invite industry leaders to serve on university advisory and accreditation boards.

Currently, university manufacturing undergraduate and graduate programs are adequate, but fragmented. Manufacturing resources and capabilities within departments and programs are sufficient for under-graduate and graduate students seeking career opportunities in the advanced manufacturing sector. However, universities should consider more hands-on training within manufacturing related curriculums. Universities recognize manufacturing related disciplines cut across several U.S. industries ranging from aerospace and defense to biotech and health and complement existing programs such as industrial and operations engineering, mechanical engineering and material science. Manufacturing institutes and research centers exist today at universities and include partnerships among universities, non-profit organizations, industry and government. Leveraging those partnerships requires an alignment of funding and recognition that hands-on experience ensures graduates are prepared with the skills most needed by industry. In addition, government and industry funds are available to support university manufacturing institutes and research facilities, R&D initiatives, projects, and partnerships, including support for co-ops and internships.

### **BUILDING EXPERIENCE – INTERNSHIPS AND COOPS**

There is an opportunity to enhance long-term competitiveness by introducing college students to the industry through partner and interns programs in coordination with higher education institutions. Cooperative Education is defined as, “an educational program that prepares the students for professional careers by combining academic training with practical work experience in industry, business, and government services. Co-op students typically alternate periods of full-time work with periods of full-time, on-campus study.”<sup>48</sup> The work experience gained from the co-op helps students both academically and financially since they are paid a salary during their working semesters, and it provides them a better understanding of how to apply fundamental engineering principles.

The World Association of Cooperative Education (WACE) is one US based organization embracing cooperative education. Their vision is “to be the premier international organization linking the world’s leading higher education institutions, employers and public authorities...preparing new generations for a lifetime of professional success...”<sup>49</sup> Fifty six of the several hundred colleges and universities with internship and/or co-operative education programs are members of the WACE.<sup>50</sup>

#### ***Program Success and Benefit to Students, Employers, and Schools***

**Recommendation:** To further encourage internships and co-ops, the government should place stipulations on federal funding to schools.

Regionally dependent, the government should require a certain number or percentage of schools to provide internships or co-ops partner with manufacturers. The University of Cincinnati (UC) has a successful model with over 100 years in existence. A WACE Global Institutional Partner, they are listed as one of the top twelve schools with stellar examples of internships/co-ops.<sup>51</sup> The UC cooperative education program was established in 1906 through their Division of



Professional Practice. This dedicated division with a staff of 35 faculty and administrators is focused on building partnerships with industry and businesses to enhance the cooperative education experience for students within the College of Engineering and Applied Science, the College of Design, Architecture, Art and Planning, and the College of Business. Among their population of engineering students enrolled in the cooperative education program, greater than 50% of them (200-500 students) are working with large and small manufacturers. A majority of the students are split between aerospace, defense, automotive, gasket and consumer product manufacturers across the United States, with the greatest concentration in the mid-west region.

**Recommendation:** Encourage the implementation of partnerships could be implemented at the state level by awarding scholarships to students.

The UC recently received a state grant of \$1.8 million dollars to fund scholarships for students participating in the internship or co-op program. The scholarship money is paid by the academic institution to the student would negate the need for employers to provide wages to the students. The employer has an incentive to participate because there is no burden of paying student wages. The co-ops and internships will strategically target growth industry clusters including advanced manufacturing, polymers, automotive and aerospace.<sup>52</sup>

### **HARNESSING TALENT – THE SKILLED VETERAN**

In March of 2013, the National Unemployment rate was 7.6 percent,<sup>53</sup> the lowest it has been in several years and indications are the trend will continue. However, the same cannot be said for our post-9/11 Veteran population. Their unemployment rate has fluctuated in the past two years between 10 to 12 percent.<sup>54</sup> The manufacturing industry is showing promise of increased employment opportunities in the United States and a shortage of skilled labor in the coming years. The convergence of a talent pool of unemployed veterans and an industry on the verge of losing skilled workers is upon us and as a Nation we must take advantage of this fortuitous opportunity.

Historically, manufacturing companies involved in the defense sector employed large numbers of Veterans in their workforce. Veterans have vast technical skills and certifications as mechanics, technicians and artisans. Veterans have innovative supervisory and management skills. Some, such as the aircraft industry, enjoy the talents and skills of former military aircraft mechanics on the shop floor, and former pilots in management positions. While there are examples of veterans transitioning to very successful workers and leaders in the manufacturing industry outside of the defense sector, the industry could benefit from an influx of veterans into their workforce. In order to best merge the two, the government and Veterans Administration should continue to develop relationships in a role similar to “Troops to Teachers,” which was so successful in the late 1990s and beginning of the 21st century.

#### ***Returning Heroes Program***

The solution to enriching the manufacturing workforce with veterans involves action by various agencies and organizations. Many good initiatives are in place such as the Get Skills to Work Coalition,<sup>55</sup> but as a Nation, there is much more we can and should be doing. On November 21, 2011, the President signed into law two new tax credits for corporations. The *Returning Heroes Tax Credit* is a new hiring tax credit that will provide an incentive for businesses to hire unemployed veterans.



**Recommendation:** Maintain the existing Work Opportunity Tax Credit for veterans with service-connected disabilities (currently the maximum is \$4,800). However, companies should receive a tax credit regardless of prior employment status

With this new credit of 40 percent of the first \$24,000 of wages (up to \$9,600) for firms that hire veterans with service-connected disabilities who have been unemployed longer than 6 months,<sup>56</sup> the Wounded Warrior Tax Credit will double the existing tax credit for long-term unemployed veterans with service-connected disabilities. Providing the tax credit only when Veterans are hired after 6 months unemployment is counterproductive to what is needed. Veterans need jobs upon transition from the military and companies need a skilled employee and should not be required to wait until they are unemployed for a period of time before they receive a tax credit.

**Recommendation:** Incentivize the GI Bill – STEM plus Manufacturing—Matching Veteran’s Skills with Manufacturing’s Needs. Maximizing GI Bill Benefits where our National employment needs are greatest will drive Veterans to focus degrees of study in areas offering maximum educational benefits and highest job potential.

The role of manufacturing companies must not be overlooked and there are already great strides being made. On March 15, 2013, The Manufacturing Institute, in partnership with GE, Cincinnati State Technical and Community College, Alcoa Inc., Boeing and Lockheed Martin, celebrated the accomplishments of the first group of eleven U.S. veterans to complete classes from the Get Skills to Work (GSTW) program. GSTW is joining together major manufacturers and educators to help close the skills gap through training and skills matching for U.S. veterans. The event marks an important milestone for the nationwide program, which launched in October 2012. The program also aims to empower employers with tools to recruit, onboard and mentor veterans.

**Recommendation:** Codify Military Skill Sets so Veterans and employers can recognize and translate the skills gained through military training and experience into civilian workforce skill sets.

The Manufacturing Institute, working with Futures Inc., has created a digital badge system to help translate applicable Military Occupational Specialty codes (MOS), the U.S. military’s system for identifying jobs, to civilian positions in advanced manufacturing. Skills matching and badge distribution will be supported by the US Manufacturing Pipeline, a centralized online hub that connects manufacturing employers with veterans and transitioning military personnel. Military veteran participants and employers can access these platforms at [GetSkillstoWork.org](http://GetSkillstoWork.org).

Until recently, most companies had no easy way to directly translate the specialty classifications of military applicants and determine a match to the skills and abilities needed in civilian jobs. That problem is about to disappear, thanks to new technology for a Military Manufacturing Badge. An internet based program aligns badges with occupational specialties within the military with the civilian manufacturing skills the veteran candidate demonstrated in the military. Candidates with priority skills such as welding and machining are now available at the click of a mouse. Manufacturers will connect directly with military bases and Badge-holders via an online match on [USManufacturingPipeline.com](http://USManufacturingPipeline.com), a new one-stop resource for jobs in the manufacturing. Increased awareness of these programs through the Veterans Administration and Transition Assistance



Programs (TAP) will ensure Veteran’s opportunities for employment in the manufacturing sector are maximized.

**Recommendation:** Modify Transition Assistance Programs.

Transition Assistance Offices on military installations, by way of career counselors, can encourage (by providing information and materials to) separating service members to pursue schooling or employment in advanced manufacturing highlighting the growth in the industry, age of current workforce and overall job satisfaction by people currently serving in that industry. TAPs, available on every military post, camp or station, can also reach out to manufacturing industries with invitations to attend job fairs, leave reading materials, leaflets, and pamphlets for transitioning service members. Ideally, materials should contain information highlighting veteran success stories and the potential growth in the advanced manufacturing field.

## **CHAPTER V: “IMPROVING THE BUSINESS CLIMATE”**

### **INTRODUCTION**

The U.S. manufacturing sector is currently in the midst of a global fight for economic survival and must take swift, decisive, and controversial measures to ensure the future prosperity of the American people. Our leaders must act now to place American manufacturers on a competitive playing field, specifically in the area of advanced manufacturing, which will allow U.S. businesses to compete against aggressive, motivated, and savvy foreign competitors. The three areas requiring immediate and decisive attention to improve our business climate are enacting tax reforms, improving our trade policy, and implementing an updated energy policy. These will be explored in more detail in the sections below.

### **ENACT TAX REFORM**

The PCAST Report listed three recommended actions to strengthen our domestic manufacturing competitiveness under the heading of “Enacting Tax Reform.” They are a reduction of the tax rate for domestic manufacturing activity, increasing the R&D alternative simplified credit to 20 percent and making it permanent, and creating an internationally competitive corporate tax system. The PCAST Report recommendations are important initiatives that should be implemented, but with some caveats.

**Recommendation:** Enact Tax Code Reform

The United States (U.S.) currently has “the highest combined federal-state statutory corporate tax rate among our major trading partners” and also among the Organization for Economic Cooperation and Development (OECD) member nations. One caveat is the U.S. has generous allowances, deductions, and exclusions that lessen the tax burden.<sup>57</sup> Figure II in Appendix A illustrates how the U.S. maintained a general consistently elevated corporate tax structure over the years while other nations have adjusted their rate for increased global competitiveness.



A reduction of the corporate tax rate for domestic manufacturing activity would help align our corporate tax rate with other OECD member countries. The challenge with our tax system is to understand how effective or ineffective this reduction would be, because the tax code contains many loopholes that already lesson the tax burden. Additionally, it is argued any reduction in the tax rate could further erode our tax base and revenue generation.<sup>58</sup>

Corporate taxes are just one of many cost considerations for businesses as they look at their overall business costs in the U.S. There is also the concept of a ‘trade-weighted average structural cost burden,’ which includes corporate taxes, employee benefits, tort costs, pollution abatement compliance, and energy costs. Using this metric “US manufacturing costs are 9.3 percent higher than their 9 largest trading partners on a trade-weighted basis.”<sup>59</sup> Figure III in Appendix A shows a breakdown of the U.S. corporate structural cost burden.

These “domestically imposed costs” add at least 20 percent to the corporate bottom-line and make it difficult for manufacturers to compete globally. Absent these costs, U.S. manufactures would enjoy a cost advantage over most of their industrial competitors. The most burdensome structural cost is the corporate tax rate that has remained unchanged for decades.<sup>60</sup>

In view of all of these considerations Congressional leaders should take steps to quickly lower the tax rate for domestic manufacturing in conjunction with eliminating some of the tax loopholes that may be abused by corporations. Additionally, the Congressional Research Service should immediately undertake a study that takes a more holistic view of the costs associated with manufacturing including structural costs and state and local costs. Lastly, at the next summit the Office of the U.S. Trade Representative and the Department of Commerce should work closely with OECD member nations in order to address the issue of tax base erosion and consider executing coordinated efforts to preclude a “race to the bottom.”

**Recommendation:** Strengthen the R&D Tax Credit with a requirement to review and renew annually.

Another important corporate tax consideration is increasing the research and development (R&D) tax credit. Increasing the R&D alternative simplified credit to 20 percent (from 14) appears to have the broadest appeal and can serve to encourage investment by introducing predictability into the corporate R&D framework. This was echoed by a recent study stating government should “Assure businesses that the R&D tax credit availability can be relied on so projects with long gestation periods and riskier outcomes can be considered more frequently.”<sup>61</sup>

An R&D tax credit was first implemented in 1981 and has been renewed over a dozen times. The credit expired in December 2011, but was renewed in January 2013 retroactively to 2011. The current credit is now set to expire at the end of 2013.<sup>62</sup> Unfortunately this makes corporate R&D planning difficult and uncertain. Although a U.S. R&D tax credit is helpful in supporting innovations in industry, the rate does not fare well when compared to the rates of other countries. In fact the U.S. ranks 27<sup>th</sup> out of 42 countries in terms of R&D tax incentive credit generosity according to one study.<sup>63</sup> On the other side of the argument is the concept that corporate tax incentives, like the R&D tax credit, may serve to undermine government efforts to generate tax revenue. This continues to be an important topic of discussion for OECD member nations.



Despite the loss in tax revenue, Congressional leaders should act now to increase the R&D alternative simplified tax credit to 20 percent and make it permanent. This would reduce corporate investment uncertainty and encourage long-term investment planning. Other than losing some tax revenue, it appears that there are no other significant downside risks to implementing this initiative and are a minor price to pay for encouraging corporate investment and innovation. This is also directly aligned with the goal of maintaining an American manufacturing competitive edge.

**Recommendation:** Create an internationally competitive corporate tax system.

This involves the foreign earnings taxation issue of U.S. based companies keeping earnings estimated to be in the \$100s of billions outside of the country to avoid taxation. Adopting a partial or full corporate tax exemption would encourage companies to repatriate these earnings for investment and job creation. The counter argument is companies would instead use these funds to pay out dividends and conduct stock buy-backs similar to what happened during the 2004 tax holiday. “A tax holiday in 2004 resulted in U.S. corporations repatriating an astounding \$315 billion in earnings at a favorable tax rate of 5.25%.”<sup>64</sup> Lobbyists have argued this would lead to job creation although critics believe corporations would conduct only modest amounts of reinvestment and focus primarily on executing large dividend payouts and increasing shareholder value.

Another international tax issue that warrants further consideration is the concept of transfer pricing, which is essentially the ability of U.S. companies to establish a price for the transfer of items into the U.S. that keeps most of the profit in an international subsidiary; commonly known as a controlled foreign corporation (CFC). CFCs are generally placed in either tax havens or low tax countries in order to minimize a U.S. multinational’s tax liability. Along those same lines, U.S. multinationals will “often seek to maximize their tax-deferred foreign earnings by holding high-profit intellectual property in foreign subsidiaries (CFCs),” as well as off shoring their manufacturing capacity.<sup>65</sup>

A territorial tax system would obviate the transfer pricing issue, because most if not all repatriated foreign income would be exempt from taxation. Unfortunately, corporations seeking to minimize their tax liability can still exploit a territorial tax system. Others argue that the U.S. already has a de-facto territorial system in the sense that corporations just keep their money abroad to avoid paying corporate taxes.

Congressional leaders must act immediately to create a competitive corporate tax system. To this end the territorial tax system may be a viable model, but must be tailored in such a way as to minimize corporate tax avoidance. Additionally, Congress should enact a tax holiday as early as 2013, similar to the one in 2004. Undoubtedly some of the funds will be paid out as dividends and used to increase shareholder wealth, but the benefits of repatriating those funds far outweigh the negatives. This will bring needed funds back to American corporations and individuals at a time when companies should have ready reserves to offset the impact of a tough economy. Additionally, it is worth considering that even funds paid out as dividends are not just placed “under a mattress,” but are now available for American consumption, investment, or as a source of security during these challenging economic times. The caveat to this “tax holiday” is that the



root causes must also be addressed in order to avoid having another holiday in the next five to ten years. The Congressional Research Service should be tasked immediately with researching initiatives that would preclude subsequent tax holidays. Additionally, the Office of the U.S. Trade Representative and the Department of Commerce should also discuss the global challenges of tax havens and low tax countries with OECD member nations at their next meeting in order to develop a comprehensive solution that will benefit all member nations.

## IMPROVE TRADE POLICY

The ongoing export control reforms and the National Export Initiative (NEI) are a step forward in opening up foreign markets for American manufactures and are in-line with the PCAST recommendations on trade reform. While these reforms are a step in the right direction, there are additional changes which would further accelerate the process and continue to make U.S. exporters more competitive in foreign markets.

**Recommendation:** Unleash the full potential of the Export-Import Bank.

While the Export-Import (Ex-Im) Bank is already a success story in increasing U.S. exports, more can be done to increase market access to U.S. trade. First, Congress must decrease its level of oversight and governance of the Bank. There has to be a realization by Congress that if the American economy will only grow through increased manufacturing and the export of those goods, then Congress must do whatever is needed to promote that increase. This includes reversing some rules associated with the Ex-Im Bank, like the requirement for certain exporters to only use U.S. based shipping for their products.<sup>66</sup> This is not even feasible in the globalized market of today and only increases costs.

Congress also needs to lift the limit on the amount the Ex-Im Bank can have tied up in loans.<sup>67</sup> There is no reason to have a limit since the Bank is not federally funded, and the loan limit hurts manufacturers if they can't get financing because the Bank's funds are tied up in existing loans. While part of the limit is designed to ensure the Ex-Im Bank doesn't compete to too great an extent with commercial lenders, the time for that concern has passed. If the U.S. is serious about growing the economy through more exports of manufactured goods, then the commercial banking sector needs to stand on its own and become more competitive in this area. As mentioned previously, other countries do not have such restrictions on their export lending banks, why should the U.S. impose them and hurt American exporters?

**Recommendation:** The U.S. should focus its efforts on promoting the newer form of free trade agreements (FTAs), which not only open up free trade channels, but also have added benefits of intellectual property (IP) protection and increased non-tariff barriers (NTB) elimination for agreement signatories.

Three main areas should be examined for change. While the U.S. Trade Representative (USTR) is responsible for negotiating trade agreements, decisions on these possible change areas needs to be made by the Executive Branch with coordination from other applicable areas of government. First, consideration needs to be given to reducing U.S. work on, and involvement in, the Doha Development Agenda (DDA). Negotiations in the World Trade Organization (WTO) have been



ongoing since 2001 on this agreement with no real progress or estimation of when it might be concluded. Trade agreements of this sort are becoming a thing of the past and quickly become irrelevant since negotiations drag on so long that the issues change, and so the agreement must be further updated and renegotiated.

Additionally, the focus of the Trans-Pacific Partnership (TPP) and the Transatlantic Free Trade Agreement (TAFTA) should be reexamined. Both FTAs are very good for American manufacturers and exporters. But, the U.S. government seems to be deeply favoring the TTP initiatives over TAFTA. While emphasis on the TTP is in-line with the Administration's strategic realignment to the Pacific, and emerging markets in this area are significant opportunities for U.S. exporters, the U.S. can't forget Europe. Europe is the U.S.'s largest trading partner, and the potential for increased trade with the European Union (EU) exists.<sup>68</sup> This increase would be beneficial for economies on both sides of the Atlantic, thus boosting the global economy at a time when it is badly needed. The TTP should not be sidelined, but the resources currently working the DDA could be refocused to TAFTA, and the TTP and TAFTA could be given equal footing and importance in the U.S. government.

Finally, the U.S. needs to greatly increase the number of FTAs it has, while also giving more consideration to Bilateral Investment Treaties (BITs). While the push for more FTAs is nothing new, the concept of BITs has continued to gain recognition as another way to make American exports competitive. Globalization is here to stay, and opponents of it need to move past their objections and look for ways to make it benefit American manufacturers and exporters. Along with this is the realization that foreign direct investment (FDI) and BITs are not bad and can help U.S. exports, and thus the economy, grow.<sup>69</sup> The Administration and Congress must find ways to promote both of these concepts to the American public, while also putting in place measures or legislation to support them in the government. The Ex-Im Bank expansion could certainly help in this regard. All these trade agreement changes would have a huge positive impact on SMEs, as well as IP protection and NTB prevention. All that is required is forward momentum by the U.S. government to get these stakeholders started.

**Recommendation:** Immediately Reform Export Controls.

The reforms outlined in the current export control reform (ECR) plan are good, but must be accelerated.<sup>70</sup> American defense industrial base (DIB) companies need help immediately in increasing their export opportunities. With current and continuing cuts to the DoD budget, DIB manufacturers cannot afford to wait for the single control list to be implemented as part of the final long-term reforms. A push must be made immediately to consolidate the lists, streamline the licensing process, and complete the transition to a single point of contact for export control information. This process could be greatly expedited with the correct pressure from both the White House and Congress. Additionally, creating a single point of contact in the Department of Commerce for this program would also great assist the reform and program as a whole.

Additionally, DoD must not only simplify its piece of export control, but also be more realistic in its export control requirements. DoD traditionally errors conservatively when making decisions, but this can't continue when evaluating national security technology and products. To help the DIB and ensure it is available to continue to innovate and provide defense products for the future,



it must survive and the DoD must facilitate this by take a hard, and fair, look at products it recommends for the export control list.<sup>71</sup> By doing so, the export control process can better help exporters succeed, can protect national security, and can assist small and medium enterprises (SMEs) in being more competitive when exporting overseas.

## UPDATE ENERGY POLICY

One of the four recommendations under improving the business climate was to “update energy policy,” with four sub areas for improvement: focus on energy efficiency and conservation, increase and diversify domestic supplies, speed development of renewable sources of energy, and transition to a low carbon economy. If the purpose is to truly encourage the growth of the manufacturing sector in the United States with an emphasis on advanced manufacturing, it “seems” the priority in any energy policy should be to reduce energy costs and minimize new, more restrictive regulations.

Looking at the PCAST report, “increase and diversify domestic supply” has the most potential for decreasing energy costs for manufacturing. However, economic pressure on industry has created the opportunity for creative thinking and the development of alternatives to the standard energy solutions. Things like distributed generation, on-site combined heat and power (CHP), building efficiency practices, or individual company initiatives, are being implemented every day in an attempt to counteract the increasing price of energy. These initiatives will be covered in this section along with the imperative to upgrade the country’s electrical grid infrastructure and the development of U.S. natural gas reserves. With added incentives from Government and funding for research and development, these creative solutions could go a long way in improving the limitations of high-energy costs.

**Recommendation:** Increase and Diversify Domestic Supply through Distributed Generation.

The traditional practice of large, centrally located power plants providing electricity over a long distance on power lines is very efficient. The “transmission of electricity from a power plant to a typical user wastes roughly 4.2 to 8.9 percent of the electricity as a consequence of aging transmission equipment, inconsistent enforcement of reliability guidelines, and growing congestion.”<sup>72</sup> Small scale privately funded power solutions encouraged through state and federal subsidies or tax breaks could go a long way in decreasing the need for this outdated power distribution system. Examples of distributed generation can be things such as: wind farms, photovoltaic, mini reactors, or any future energy production technology that can be built and added to the grid with small to medium size production capability, and is scalable. For distributed generation to work, the technology used at individual sites will need to allow for capacity growth or decrease. For example, as a community grows and extra capacity is needed, the ability to add additional solar cells or wind turbines to meet demand must be an option for distributed generation to succeed.

**Recommendation:** Increase and Diversify Domestic Supply: On-Site Combined Heat and Power (CHP).



CHP in another way companies can decrease energy costs while increasing efficiency. CHP, also known as “cogeneration is the process whereby a single fuel source, such as natural gas, is used to produce both electrical and thermal energy.”<sup>73</sup> This process can be as high as 90% efficient depending on the application. For example, Houweling’s Tomatoes installed natural-gas engines in their Camarillo, CA greenhouse. The CHP engines allowed them to operate their greenhouse as efficiently as possible by cutting the amount of power they consume, while also generating heat for the greenhouses and using captured carbon dioxide as fertilizer for the greenhouse’s plants.<sup>74</sup> Today CHP produce almost 12% of U.S. electric power; saving building and industry owners over \$5 billion per year in energy costs, decreasing energy use by almost 1.3 trillion BTUs per year, reducing Nitrous Oxide or Nitrogen Dioxide, NO<sub>2</sub> emissions by 0.4 million tons per year, reduce Sulfur Dioxide, SO<sub>2</sub> emissions by over 0.9 million tons per year, and prevention of the release of over 35 million metric tons of carbon equivalent into the atmosphere.<sup>75</sup> It is this kind of creative thinking and the use of unique applications employed by individual companies today that continue to expand the potential for this technology. Government incentives to promote such technology would help increase opportunities that bring significant savings in energy costs to companies, while at the same time promoting environmental responsibility.

**Recommendation:** Increase and diversify domestic supply by encouraging Individual Company Initiatives.

With little new large-scale energy production, most companies are left trying to find ways to shave energy costs on their own. Volvo Powertrain in Hagerstown, MD found a unique way to capture the energy output during the engine test runs of their large diesel motors. The engines are hooked to electric generators, and during the engine test runs that can last several hours, the electricity that is produced is fed directly back into the plant - reducing the amount of power needed off the grid. Volvo signed an agreement to provide land on site to a company to build a solar photovoltaic system. “In addition to the Maryland Clean Energy Grant Program, Solar Federal Income Tax Credits, and selected county Property Tax Credits, Maryland residents and businesses who have installed a solar photovoltaic system can also earn and sell Solar Renewable Energy Credits (SRECs) to help offset the cost of their system. Under Maryland’s Renewable Energy Portfolio Standard, companies that sell power in Maryland are required by law to source a certain percentage of their electricity generation from solar power and other renewable energy systems. In order to be in compliance with this law, generators may purchase renewable energy credits from residents and businesses that are generating their own renewable electricity.”<sup>76</sup> Although this will help Volvo meet Maryland’s requirement for renewable energy use and avoid penalties, it will not help to decrease the overall cost of energy purchased from the grid.

After looking at what companies are doing on their own in an attempt to lower energy costs, the question then becomes what should the government do? If manufacturing truly is a national interest, and increasing both manufacturing and manufacturing facilities is a national priority within America, what is next?

**Recommendation:** Increase and Diversify Domestic Supply with Electrical Grid Infrastructure Upgrades.



First, State and local governments need to update and expand the infrastructure distributing power across the United States. The electrical grid in the U.S. is horribly outdated and very inefficient, but there are possible solutions on the horizon. Smart grid technology is allowing for improvements to the grid as fast as the innovations can be deployed into the network. “Benefits include enhanced cyber-security, handling sources of electricity like wind and solar power and even integrating electric vehicles onto the grid.”<sup>77</sup> These kinds of enhancements to the grid will allow for the utilization of other energy efficiency concepts such as distributed generation and CHP. At the current time it is often difficult, if not impossible, to gain access to the grid in certain areas because the technology just will not allow it. As companies like Volvo and Houweling’s Tomatoes begin to generate their own power, local utilities need to be able to identify the change in power requirements and adjust accordingly. The increased available power on the grid and reduced need for massive generation should help to drive overall costs down and stabilize delivery by decentralizing the source.

**Recommendation:** Increase and Diversify Domestic Supply maximizing domestic Natural Gas resources.

If the Federal Government and state Governments want to implement energy policies to help American manufacturing, promoting a plentiful supply of affordable natural gas must be considered. A small gas powered turbine on-site engine can provide a flexible source of electricity, heat for the plant, and a source of hot water. Natural gas is use has a variety of uses of the manufacturing sector. “The Energy Information Administration (EIA) estimates that from 2009-2015, 96.65 gigawatts (GW) of new electricity capacity will be added in the U.S. Of this, over 20 percent, or 21.2 GW, will be natural gas addition. According to the EIA, natural gas-fired electricity generation is expected to account for 80 percent of all added electricity generation capacity by 2035.”<sup>78</sup> As additional gas is made available, gas prices will decrease driving down the cost of energy produced at gas fired power plants.

Although each of the previous options help encourage manufacturing in America by making energy cheaper and more accessible, the potential synergy of combining the two can increase the benefits. A vastly expanded and more efficient distribution system of natural gas would allow the addition of small-scale distributed generation capability throughout the country. Companies could put small generation systems inside factories and supply secure competitively priced energy for manufacturing. With a mature smart grid, all additional sources of energy could gain access to the grid through automatic monitoring and switching, and provide excess energy back to the grid to help reduce costs and increase reliability.

Government needs to take the lead and separate environmental policy from energy policy and promote a plentiful, inexpensive supply of power. America must provide cheaper energy in the short term to promote manufacturing growth and provide incentives to unleash American ingenuity in the long-term to encourage innovation and the use of more efficient and sustainable types of energy. American manufacturers strive every day to be good stewards of the environment and responsible members of their communities.

## **CHAPTER VI: CONCLUSION**



Due to the vast reach of manufacturing in the United States, it is difficult to confine a meaningful analysis to a single industrial sector. Even applying business tools to analyze advanced manufacturing, a subset of manufacturing, is a daunting task, especially when considering it is the bulk of what remains in the United States today. Manufacturing is a pervasive and strong part of our economy and culture, but without reversing its negative growth trend it will no longer be able to support the bedrock of our country, the American middle class. This is what motivated us to analyze this industry and delineate what our national leaders must do to create and sustain a renaissance in manufacturing.

The ESMIS team agrees that advanced manufacturing holds the most promise for achieving the best competitive edge for a U.S. resurgence. Advanced manufacturing comes from only the most developed countries and their technical ‘know how’ is as important as the product itself. Additionally the speed of change, due to ever expanding markets and advancing technologies, favors the entrepreneur who can leverage the tools of education and innovation. These increasingly complex products, processes, materials, and analytical tools minimize the leverage buyers and suppliers have to enter the competitive space in advanced manufacturing. The caution is that speed, special inputs (rare raw materials, specialized and flexible tooling, highly trained labor), and specialized products require flexibility throughout the supply chain in the public as well as the private sector. This is the challenge that lies before America--keeping up with the Information Age we helped create.

When looking at our nation’s strengths, weaknesses, threats and opportunities the team found that advanced manufacturing is our best opportunity. Since the 80’s US manufacturers have been focused on raising quality and performance standards to address increasingly difficult consumer problems (primarily in microelectronics, health care and military systems). Unfortunately the future promises fewer government programs that will take ideas from their infancy to marketable products that revolutionize the world (e.g. the internet, GPS, etc.).

Although we seem to fabricate less and less, the last few decades have seen the rise of the world’s leading integrators creating amazingly complex systems of systems. The ability for the United States to reinvent itself is a fundamental part of our history, and we now have the opportunity to do it once again. However there is no doubt that challenges lie ahead. To excel in advanced manufacturing we must restore our innovative environment, tailor our training and motivate our work force. Additionally we must find the right political balance to address our nation’s rising debt, global interdependence and relatively expensive structural business costs. Our biggest threat is the loss of control of the very intellectual and human capital that will fuel our success. Our biggest weakness is in our nation’s current ability to collaborate among academia, government, and industry. First, Americans are wary of government intervention in the market, and this renaissance will require significant government involvement. Secondly, we lack a unifying threat or effort in the face of a shrinking budget, diminishing international influence, and a prolonged economic downturn. This is a difficult situation to overcome for a government requiring consensus. Finally, our bureaucracies and habits have become large and entrenched making efficiency, flexibility and “re-invention” a more daunting challenge.

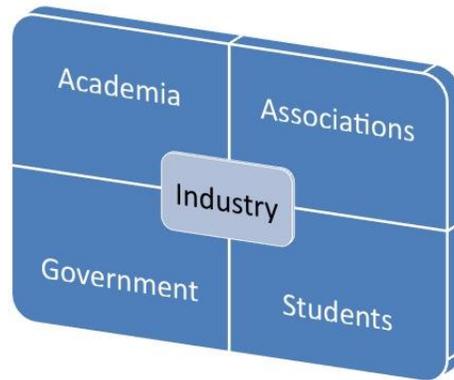
In the years ahead, government must work with industry and academia in order to fuel this much-needed renaissance in advanced manufacturing. Industry should conduct a sub-sector analysis that



identifies the essential components of manufacturing that need to be “made in America.” The free market and pertinent agreements will resolve the manufacturing location of everything else. In this environment care should be taken by government and industry to identify the risks associated with “letting certain things go.” Finally, government must reduce its inefficiencies, consolidate the advanced manufacturing foundational policy, and derive cross-sector collaboration as a teammate to industry and academia. With the current efforts underway across America, we are regaining the once great position of the US manufacturing machine most prominently demonstrated in the buildup for World War II. What stands in our way is failing to adapt our businesses, government and culture to meet the challenges created by a global marketplace with increasing aggressive and motivated foreign competitors.



## APPENDIX

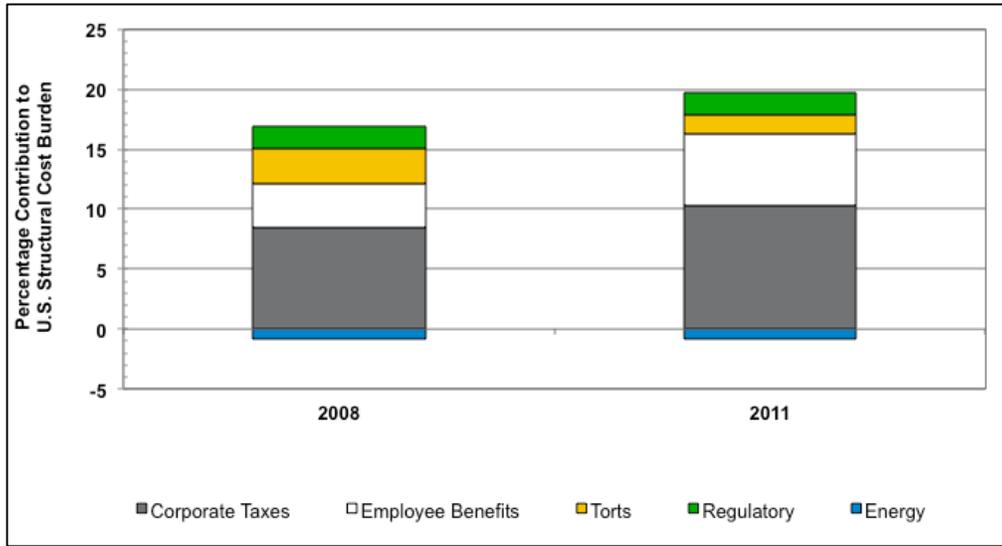


**Figure I:** Relationship of Partnership Participants to Industry

	Statutory (1997)	Statutory (2012)	Effective (2011)
United States	40.0	40.0	34.6
Japan	57.1	38.0	29.5
France	36.6	33.3	34.1
Mexico	34.0	30.0	17.5
Germany	57.4	29.4	23.8
Canada	44.6	28.0	20.5
China	33.0	25.0	16.6
Korea	30.8	24.2	29.5
United Kingdom	31.0	24.0	27.9
Taiwan	25.0	17.0	10.9

**Figure II:** International Corporate Tax Rates (from Manufacturers Alliance for Productivity and Innovation (MAPI)<sup>79</sup>)





**Figure III:** Corporate Structural Burden (from Manufacturers Alliance for Productivity and Innovation (MAPI))<sup>80</sup>



## ENDNOTES



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<sup>1</sup> *America Competes Reauthorization Act of 2010*, Pub. L. 111-358, 111<sup>th</sup> Cong., 1st. Sess. (January 4, 2011) United States Government Printing Office.

<sup>2</sup> *Report To The President On Capturing Domestic Competitive Advantage In Advanced Manufacturing*. Executive Office of the President, President’s Council of Advisors on Science and Technology. July 2012 (accessed, 4/15/2013)  
[http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast\\_amp\\_steering\\_committee\\_report\\_final\\_july\\_27\\_2012.pdf](http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_amp_steering_committee_report_final_july_27_2012.pdf)PCAST

<sup>3</sup> *A National Strategic Plan For Advanced Manufacturing*. Executive Office of the President, National Science and Technology Council. Feb 2012 (accessed, 6/3/2013) pp12  
[http://www.whitehouse.gov/sites/default/files/microsites/ostp/iam\\_advancedmanufacturing\\_strategicplan\\_2012.pdf](http://www.whitehouse.gov/sites/default/files/microsites/ostp/iam_advancedmanufacturing_strategicplan_2012.pdf)

<sup>4</sup> *America Competes Reauthorization Act of 2010*, Pub. L. 111-358 Sec. 102 (b)(7)(F), 111<sup>th</sup> Cong., 1st. Sess. (January 4, 2011) United States Government Printing Office.

<sup>5</sup> National Association of Manufacturers, Facts About Manufacturing in the U.S.,  
<http://www.nam.org/statistics-and-data/Facts-About-Manufacturing/Landing.aspx> (accessed March 31, 3013)

<sup>6</sup> Ibid

<sup>7</sup> Ibid

<sup>8</sup> Ibid

<sup>9</sup> [www.commerce.gov/sites/default/files/douments/2012/january/completes\\_010511\\_0.pdf](http://www.commerce.gov/sites/default/files/douments/2012/january/completes_010511_0.pdf)

<sup>10</sup> Informal interviews by author, various dates and locations. “Not for attribution.”

<sup>11</sup> Giffi, Craig A. and DeRocco, Emily S., Deloitte Development LLC and the Manufacturing Institute. “Unwavering commitment. The public’s view of the manufacturing industry today.” 2011. P3. Accessed online 02 April 2013: <http://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/us%20cip%202011PublicViewonManufacturingReport%20090811.pdf>

<sup>12</sup> Ibid. P9.

<sup>13</sup> OSHA, Severe Violator Enforcement Program, [www.osha.gov/dep/enforcement/svrp\\_white\\_paper.pdf](http://www.osha.gov/dep/enforcement/svrp_white_paper.pdf)

<sup>14</sup> National Association of Manufacturers, Facts About Manufacturing in the U.S.,  
<http://www.nam.org/statistics-and-data/Facts-About-Manufacturing/Landing.aspx> (accessed March 31, 3013)

<sup>15</sup> Ibid

<sup>16</sup> Representative manufacturing job search website with filters for manufacturing jobs.  
<http://www.simplyhired.com/a/jobs/list/q-manufacturing>

<sup>17</sup> PCAST Report, P32.

<sup>18</sup> *Report To The President On Capturing Domestic Competitive Advantage In Advanced Manufacturing*. Executive Office of the President, President’s Council of Advisors on Science and Technology. July 2012 (accessed, 4/15/2013)

<sup>19</sup> The White House, “We Can’t Wait: Obama Administration Announces New Public-Private Partnership to Support,” *The White House/Statements and Releases*, <http://www.whitehouse.gov/the-press-office/2012/08/16/we-can-t-wait-obama-administration-announces-new-public-private-partners>, 25 January 2013.



---

<sup>20</sup> The White House, “Obama Administration Launches Competition for Three New Manufacturing Innovation Institutes,” *The White House/Statements and Releases*, <http://www.whitehouse.gov/the-press-office/2013/05/09/obama-administration-launches-competition-three-new-manufacturing-innova>, 9 May 2013.

<sup>21</sup> The United States Department of Commerce, “Obama Administration Announces \$20 Million for 10 Public-Private Partnerships to Support American Manufacturing and Encourage Investment in the U.S.,” *October 2012 Press Releases*, <http://www.commerce.gov/news/press-releases/2012/10/09/obama-administration-announces-20-million-10-public-private-partnersh>, 18 April 2013.

<sup>22</sup> NDU’s non-attribution policy does not allow citing individuals.

<sup>23</sup> Washington Post, March 13, 2013 *Hired! Small Businesses Find Ways to Beat the Skilled-Worker Shortage*

<sup>24</sup> Davidson, Paul, *Study Says Shortage of Skilled Workers Not that Severe USA Today*, October 15, 2012

<sup>25</sup> NAM Roadmap

<sup>26</sup> *Ibid.*; The Manufacturing Institute, *Roadmap for Manufacturing Education*, (Washington, DC: The Manufacturing Institute, February 2013), 3.

<sup>27</sup> Accrediting Commission for Community and Junior Colleges Home Page, <http://www.accjc.org/> (accessed March 31, 2013).

<sup>28</sup> Executive Office of the President, President’s Council of Advisors on Science and Technology, *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing*, (Washington, DC: The White House, July 2012).

<sup>29</sup> Ennis, Michelle R. *Competency Models: A Review of the Literature and the Role of the Employment and Training Administration*, (Washington, DC: U.S. Department of Labor, January 29, 2008), 6.

<sup>30</sup> Executive Office of the President, President’s Council of Advisors on Science and Technology, *A National Strategic Plan for Advanced Manufacturing*, (Washington, DC: The White House, February 2012), 16.

<sup>31</sup> Executive Office of the President, President’s Council of Advisors on Science and Technology, *A National Strategic Plan for Advanced Manufacturing*, (Washington, DC: The White House, February 2012), 16.

<sup>32</sup> Executive Office of the President, President’s Council of Advisors on Science and Technology, *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing, Annex 3: Education and Workforce Development* (Washington, DC: The White House, July 2012), 9.

<sup>33</sup> Kile, Joanna, *Exploring Industry Perceptions of the Development and Sustainability of Academia-Industry Advanced Technological Education Partnerships*, (Waco, TX: Baylor University, August 2012).

<sup>34</sup> Edward Magee, General Manager, York Vehicle Operations, Harley-Davidson, interview by author, York, PA, April 1, 2013.

<sup>35</sup> Hull, Dan M., *Career Pathways for STEM Technicians*, (Waco, TX: National Science Foundation, OP-TEC, 2011), 13.

<sup>36</sup> Kile, Joanna, *Exploring Industry Perceptions of the Development and Sustainability of Academia-Industry Advanced Technological Education Partnerships*, (Waco, TX: Baylor University, August 2012).



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<sup>37</sup> Weil, Brent, The Manufacturing Institute Webinar Series Roadmap for Manufacturing Education, <http://www.themanufacturinginstitute.org/Skills-Certification/Webinar-Series/February-2013-Four-Year-Report/February-2013-Four-Year-Report.aspx> February 2013 (accessed March 31, 2013).

<sup>38</sup> National Coalition of Certification Centers, Benefits Homepage, <http://www.nc3.net/about/benefits/>, (accessed March 17, 2013).

<sup>39</sup> Bragg, Debra D., The New Vocationalism in Community Colleges. New Directions for Community Colleges, [www.eric.ed.gov/PDFS/ED468379.pdf](http://www.eric.ed.gov/PDFS/ED468379.pdf), n115 Fall 2001 (accessed April 4, 2013)

<sup>40</sup> Skills for America's Future, Community College Facts, The Aspen Institute, [www.aspeninstitute.org/policy-work/economic-opportunities/skills-america's-future/what-we-do/community-college-facts](http://www.aspeninstitute.org/policy-work/economic-opportunities/skills-america's-future/what-we-do/community-college-facts) (accessed March 31, 2013).

<sup>41</sup> Community College Grads Out-earn Bachelor's Degree Holders, CNN Money, <http://money.cnn.com/2013/02/26/pf/college/community-college-earnings/>, February 26, 2013 (accessed April 4, 2013).

<sup>42</sup> Executive Office of the President, President's Council of Advisors on Science and Technology, "Capturing Domestic Competitive Advantage in Advanced Manufacturing," AMP Steering Committee Report, (2012): 35, [www.whitehouse.gov/ostp/pcast](http://www.whitehouse.gov/ostp/pcast).

<sup>43</sup> U.S. Department of Labor, Obama Administration Announces \$500 million in Community College Grants to Expand Job Training through Local Employer Partnerships, News Release, <http://www.dol.gov/opa/media/pres/etc/ETA20121885.htm> (accessed April 4, 2013).

<sup>44</sup> Ibid.

<sup>45</sup> American Association of Community Colleges, Fast Facts From our Fact Sheet, [www.aacc-nhc.edu/AboutCC/Pages/fastfactsfactsheet.aspx](http://www.aacc-nhc.edu/AboutCC/Pages/fastfactsfactsheet.aspx).

<sup>46</sup> Executive Office of the President, President's Council of Advisors on Science and Technology, "Capturing Domestic Competitive Advantage in Advanced Manufacturing," AMP Steering Committee Report, (2012): 35, [www.whitehouse.gov/ostp/pcast](http://www.whitehouse.gov/ostp/pcast).

<sup>47</sup> Ibid., 35.

<sup>48</sup> American Society for Engineering Education, "CEED General Information," 1, [http://ceed.asee.org/index.php?section=Main&page=General\\_Info](http://ceed.asee.org/index.php?section=Main&page=General_Info), April 4, 2013.

<sup>49</sup> World Association for Cooperative Education, "Vision," (2013): 1, <http://www.waceinc.org/mission.html>, April 5, 2013.

<sup>50</sup> World Association for Cooperative Education, "WACE Global Institutions, United States," (2013): 1, [http://www.waceinc.org/global\\_institutions.html](http://www.waceinc.org/global_institutions.html), April 5, 2013.

<sup>51</sup> U.S News & World Report LP, "Internships/Co-ops," (Spring 2012): 1, <http://colleges.usnews.rankingsandreviews.com/best-colleges/rankings/internship-programs>, April 3, 2013.

<sup>52</sup> M.B. Reilly, "Prestigious State Grant Will Expand Co-op and Internship Opportunities for Students," (December 13, 2012): 1, <http://www.uc.edu/news/NR.aspx?id=17051>, April 5, 2013.

<sup>53</sup> <http://www.bls.gov/new.release/unemployment.htm>

<sup>54</sup> <http://www.bls.gov/news.release/vet.a.htm>



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<sup>55</sup> <http://www.getskillstowork.org>

<sup>56</sup> <http://www.whitehouse.gov/the-press-office/2011/11/21/fact-sheet-returning-heroes-and-wounded-warrior-tax-credits>

<sup>57</sup> The Manufacturing Institute, *Facts About Manufacturing*, (Washington, D.C.: National Association of Manufacturers, November 2012), 42.

<sup>58</sup> Alan J. Auerbach, “A Modern Corporate Tax,” *The Center for American Progress and The Hamilton Project*, (Washington, D.C.: Center for American Progress, December 2010), linked from <http://www.americanprogress.org/wp-content/uploads/issues/2010/12/pdf/auerbachpaper.pdf> (accessed April 16, 2013), 2.

<sup>59</sup> Manufacturers Alliance for Productivity and Innovation, *2011 Report on the Structural Costs of Manufacturing*, (Washington, D.C.: The Manufacturing Institute, October 2011), 3.

<sup>60</sup> Stephen Gold, “The (High) Cost of Manufacturing in America,” *Industry Week* Vol 260, Issue 11, in ProQuest (accessed March 25, 2013), 12.

<sup>61</sup> Joel Popkin and Kathryn Kobe, “Manufacturing Resurgence – A Must for U.S. Prosperity,” *National Association of Manufacturers*, (Washington, D.C.: NAM Council of Manufacturing Associations, January 2010), linked from <http://www.nam.org/~media/13A10411852D446F84977230D8DD5B8D.ashx> (accessed April 16, 2013), 33.

<sup>62</sup> Claude Solnik, “Deal Extends Research and Development Tax Credit Through 2013,” *Long Island (NY) Business*, January 3, 2013, in LexisNexis Academic (accessed March 17, 2013).

<sup>63</sup> Luke A. Stewart et al., “We’re #27!: The United States Lags Far Behind in R&D Tax Incentive Generosity,” (Washington, D.C.: *The Information Technology, and Innovation Foundation*, July 2012), linked from <http://www2.itif.org/2012-were-27-b-index-tax.pdf> (accessed April 16, 2013), 1.

<sup>64</sup> William T. Evans, Brian F. O’Neil, and William J. Stevenson, “Revitalizing U.S. Manufacturing: The Role of Tax Policy,” 52.

<sup>65</sup> Paul Oosterhuis, “Tax Incentives to Conduct Offshore Manufacturing Under Current Law,” *Tax Policy and U.S. Manufacturing in a Global Economy*, briefing slides with scripted commentary, (Washington, D.C.: Brookings Institute, March 15, 2013), linked from <http://www.brookings.edu/~media/events/2013/3/15%20manufacturing%20tax%20policy/15manufacturingtaxpolicyoosterhuis.pdf> (accessed April 16, 2013)

<sup>66</sup> National Association of Manufactures, “Manufacturers: Blueprint to Double Exports in Five Years,” July 26, 2010, 3, [http://www.nam.org/~media/721F46B89BF1436DA9C3832874FE7BCE/Blueprint\\_to\\_Double\\_Exports\\_in\\_Five\\_Years.pdf](http://www.nam.org/~media/721F46B89BF1436DA9C3832874FE7BCE/Blueprint_to_Double_Exports_in_Five_Years.pdf).

<sup>67</sup> Loren Thompson, “Ex-Im Bank is Vital to U.S. Trade,” *Lexington Institute*, March 2012, 6, <http://www.lexingtoninstitute.org>.

<sup>68</sup> Stephen P. Jacobs, “U.S.-EU High Level Working Group on Jobs and Growth (USTR–2012–0001), NAM Federal Register Comments on U.S.-EU Trade,” February 3, 2012, 1, [http://www.nam.org/~media/2E9BB1822D704073B11C7E7D226053B9/FR\\_Submission\\_on\\_US\\_EU\\_trade.pdf](http://www.nam.org/~media/2E9BB1822D704073B11C7E7D226053B9/FR_Submission_on_US_EU_trade.pdf).

<sup>69</sup> National Association of Manufacturers, “A Stronger Model BIT and a Reenergized BIT Program is Vital to Strengthen the U.S. Economy and Support U.S. Jobs and Economic Growth,” January 8, 2010, 1-2, <http://www.nam.org/Issues/Trade/Manufacturing-And-Trade-Bilateral-Trade.aspx?p=2>.



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<sup>70</sup> Office of the Press Secretary, “President Obama Lays the Foundation for a New Export Control System to Strengthen National Security and the Competitiveness of Key U.S. Manufacturing and Technology Sectors,” *The White House*, August 30, 2010, 1.

<sup>71</sup> Coalition for Security and Competitiveness, “Recommendations for a 21<sup>st</sup> Century Technology Control Regime, 10-11, <http://www.securityandcompetitiveness.org>, March 31, 2012.

<sup>72</sup> Benefits of Distributed Generation, *Distributed Generation Education Modules*, <http://www.dg.history.vt.edu/ch1/benefits.html>, March 17, 2013

<sup>73</sup> What is Cogeneration, *Intelligen Power Systems LLC* <http://www.intelligenpower.com/whatiscogen.htm>, March 5, 2013

<sup>74</sup> Dan Rafter, “The Time Is Right for CHP”, in *Distributed Energy the Journal of Energy Efficiency & Reliability* March-April 2013, <http://www.distributedenergy.com/DE/articles/20637.aspx>,

<sup>75</sup> Basics of Combined Heat & Power, *United States Clean Heat and Power Association*, <http://www.uschpa.org/i4a/pages/index.cfm?pageid=3283>, March 17, 2013

<sup>76</sup> Maryland Energy Administration, “*Solar Renewable Energy Credits*”, Maryland Energy Administration, <http://energy.maryland.gov/Business/cleanenergygrants/documents/SRECInformationv2.1.pdf>, March 23, 2013

<sup>77</sup> Office of Electricity Delivery & Energy Reliability, “Smart Grid”, Energy.Gov, <http://energy.gov/oe/technology-development/smart-grid>, March 23, 2013

<sup>78</sup> “*Electric Generation Using Natural Gas*”, Natural Gas [http://www.naturalgas.org/overview/uses\\_eletrical.asp](http://www.naturalgas.org/overview/uses_eletrical.asp)

<sup>79</sup> Gardner Carrick, “Figure 40 - The U.S. Does Not Keep Pace with Falling Corporate Tax Rates,” *Facts About Manufacturing*, briefing slides, (Washington, D.C.: Manufacturing Institute for Productivity and Innovation (MAPI), February 2013), linked from <http://www.themanufacturinginstitute.org/Research/Facts-About-Manufacturing/Facts-2012.aspx>, (accessed April 16, 2013), Figure 40.

<sup>80</sup> Gardner Carrick, “Figure 38 - The U.S. Has a Structural Cost Disadvantage,” *Facts About Manufacturing*, briefing slides, Figure 38.

