



Innovation and Product Development in the 21st Century

Hollings Manufacturing Extension Partnership Advisory Board February 2010

Gary Yakimov and Lindsey Woolsey with Contributions from MEP Staff



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Table of Contents

- Introduction**7
- Exploring the Complex Reality of Manufacturing Today**9
 - Is U.S. Manufacturing Disappearing? 10
 - Is Manufacturing Still Important to the U.S. Economy? 10
 - Are There High Quality Manufacturing Jobs Left in the U.S.? 13
 - Can Innovation Alone Rebuild the U.S. Economy?..... 14
 - Can Firms Simply Follow the Market to Stay Competitive? 16
- Characteristics of Successful Manufacturers** 18
 - Innovate Constantly to Adapt to Economic and Technological Changes 19
 - Embrace Green and Green Lean21
 - Recognize and Navigate Opportunity in the Global Value Chain 23
 - Develop and Retain Current and Future Talent27
- Opportunities for Action**31
 - Innovate Constantly to Adapt to Economic and Technological Changes31
 - Embrace Green and Green Lean32
 - Recognize and Navigate Opportunity in the Global Value Chain33
 - Develop and Retain Current and Future Talent34
- Appendix**36
 - A: U.S. Products Lost or At-Risk to Globalization36
 - B: Understanding the Global Marketplace37
 - C: Sustaining the Supply Chain: Suggested Model for Decision Making ..38
- Acknowledgements**38
- Endnotes**40

Letter from the Chair



Edward W. (Ned) Hill, Chair

Manufacturing policy in the U.S. is at a critically important juncture. No fewer than a dozen reports and studies with various conclusions and recommendations have been issued regarding manufacturing since the Presidential Election of 2008. Most of these reports were drafted by special interests with pre-determined agendas that paint manufacturing as either a leaner, stronger sector than ever before or an industry in dire condition. At the Hollings Manufacturing Extension Partnership Advisory Board (“MEP Board”) we believe the truth lies somewhere in between. The reality about manufacturing is that it is complicated and not easily captured by a single data point or a single picture of either impending demise or dramatic revival.

Our report and the subsequent Opportunities for Action call for a federal policy that promotes technical assistance over compliance and recognizes that America’s manufacturers need the public, private, and education sectors operating in unison and taking responsibility for a competitive future based on reasonable economic fundamentals. No one entity can address what ails manufacturing, nor can one successful firm be held up as indicative of appropriate solutions.

This paper lays out the complex realities of the manufacturing industry, identifies responses of successful firms to the dynamic technological and economic changes in front of them, and suggests opportunities for action that can be taken to help leading manufacturers retain their global competitiveness while helping all manufacturers navigate the difficult terrain before them. On behalf of the MEP Advisory Board I want to stress the need to move forward with a manufacturing policy. While some will argue that we should not have a formal industrial policy, we believe we already have one. What has evolved as our policy is a disjointed set of interventions related to taxation, trade, health care, tort reform, energy, regulation of the financial sector, and the by-product of a near-heroic effort to restructure the domestic automobile assembly industry. The law of unintended consequences is our de facto policy. The U.S. has a choice: do nothing and continue as is, or establish a set of policies that help leading American manufacturing firms make the transition to product innovation, development, and deployment in new sales and new markets.

We are encouraged by the events of late 2009 and the efforts of the Vice-President’s Middle Class Task Force to recommend formal manufacturing policy options. We look forward to a renewed conversation about the future importance and direction of manufacturing as the economy continues its recovery. We also encourage that federal and state governments recognize that this is a time of transition for many programs of relevance to the nation’s manufacturing base. They will need to respond to new policy mandates related to climate change and environmental quality. They will need to help employers respond to structural changes in the value of the dollar versus other currencies. And they will have to work hand-in-hand with employers to sustain a globally competitive workforce.

Just as the MEP program systematized and popularized lean manufacturing over the past 20 years, there is an important role for intermediary organizations in developing tools and systems of practice that will sustain American manufacturing competitiveness in the future. Many of these organizations and their contributions are cited in this report; some are not. However, all are part of the important industrial commons that is the public’s contribution to a prosperous future. We can do more to learn about these programs, anticipate demands that will be made upon them, and make them more responsive to the increasingly competitive marketplace.

The MEP Board, MEP national program office and the nationwide system of MEP affiliates look forward to the continued conversation about the future of U.S. manufacturing.

Sincerely,

A handwritten signature in blue ink that reads "Edward W. Hill". The signature is fluid and cursive, written in a professional style.

Edward W. (Ned) Hill, Chair
Hollings MEP Advisory Board and
Dean, Maxine Goodman Levin College of Urban Affairs, Cleveland State University

Executive Summary

Introduction and Purpose

U.S. manufacturing is at a critical crossroads. Policymakers have a choice to establish a framework to guide the future of manufacturing in the U.S. and to accelerate adjustments to markets or leave its future up to serendipity, chance, complacency, and indifference. U.S. policymakers can help manufacturing firms change, innovate, move into new markets, and adapt to a constantly changing global economic environment or operate under the

false assumptions that the industry is not worth the effort. As the third largest economic sector in the U.S. economy, one that pays premium wages, and creates more total direct and indirect jobs than any other sector, manufacturing is worth a focused, pro-active federal policy agenda. Without one, the risks to U.S. living standards, national security, and economic security are too great.

Manufacturing is an important part of the nation's competitive backbone and represents a large, complex and diverse cluster of industries made up of individual firms that undertake a broad spectrum of activities. These activities extend far beyond production. They include research, design, logistics and distribution, technological services, back-office support, and customer care, among others. Over the past several decades, each of these activities has been outsourced to some degree, depending on the precise cost and quality needs of an individual firm.

As a result, manufacturing has become a decentralized, complex web of suppliers and distributors that extends across the globe. Indeed, in this era of globalization, it is often hard to identify the nationality of a firm. Traditional large U.S. manufacturers have many overseas operations, while foreign companies like Toyota and Novartis have U.S. facilities that employ thousands of U.S. workers. It is this picture that makes defining U.S. manufacturing more complex than it once was, but perhaps more important too. Acknowledging its complexity, the MEP Advisory Board believes, will lead to a set of modern and relevant public policies that will increase competitiveness for all manufacturers, and therefore be good for U.S. workers, communities, and consumers.



Exploring the Complex Realities of Manufacturing Today

Recent reports and studies paint a diverse portrait of the health and vitality of the current and future manufacturing industry in the U.S., as well as its importance in the U.S. economy. Is it thriving or merely surviving? Manufacturers themselves disagree about the health of their industry, some painting a rosy picture of a leaner, stronger sector than ever before; others warning that the industry is in dire condition. The reality lies somewhere in between; manufacturing is complicated and cannot be captured in a single data point nor is it captured in a single picture of impending demise or dramatic revival. However, there are a set of complex realities that apply to the industry broadly. Understanding these complex realities is critical to understanding how and why federal policy action can help shape a more vital industry, and therefore more prosperous communities. Consider the following points:

- Manufacturing remains a significant part of the U.S. economy, generating \$1.64 trillion worth of goods in 2008. If U.S. manufacturing were a country in itself it would represent the 8th largest economy in the world. But...
...Manufacturing is no longer the dominant sector of the U.S. economy but it remains a critically important component. As of 2008, it represented 12% of GDP, down from nearly 30% in the early 1950's.
- The U.S. share of global manufacturing value added is holding steady and among all U.S. exports, manufactured products are the most dominant, accounting for 57% of total value. But...
...The U.S. trade deficit for high-tech products in 2007 was \$54 billion, nearly doubling the \$29 billion deficit of 2000.
- Manufacturing pays nine percent higher in wages and benefits than the overall economy, and nearly one in five jobs in science and engineering are in the manufacturing sector (2nd highest). But...
...Employment in manufacturing as a share of total U.S. employment has fallen from about one in three jobs in 1950 to one in ten jobs today.
- In 2006 the U.S. performed an estimated \$62 billion of basic research, \$75 billion of applied research, and \$204 billion of development. But...
...Both the business sector's share of research and development as well as the federal share are in decline. More than half of all basic research in the U.S. is now performed at universities and colleges.

Characteristics of Successful Manufacturers and Opportunities for Action

The Hollings Manufacturing Extension Partnership Advisory Board ("MEP Board") believes that rebuilding a strong, sustainable innovation and product development and deployment capacity in the U.S. will require building on what works for firms. Through a literature review of dozens of reports and studies and interviews with Board members, the following four interconnected responses to change emerged. The Advisory Board is encouraged that for each of the four major opportunity areas, there is an MEP or MEP Center partner related program already in place that can help foster these changes in new firms, or to help leading firms reach even higher levels.

Innovate constantly to adapt to economic and technological changes

1. Streamline innovation and growth services targeted to manufacturers. Only 20 percent of manufacturers can be considered truly advanced and engaged in that they: (a) do not panic in the face of bad economic news and look for long-term opportunities; (b) will not be caught flat-footed by the impending worker imbalance and shortages; (c) do not fear the growing influence of China, India, and other low-cost producers; and (d) do not allow their products to be commoditized by purchasing agents at their OEM customers.¹ According to a survey of over 1,000 manufacturers, having a well-defined process for innovation was identified as the primary driver of excellence in a disciplined approach to manufacturing. This includes designing structured, standardized processes for generating ideas, developing them, and bringing them to market.² Customer-focused innovation and mass customization were other innovation trends among leading manufacturers.
2. R&D investments should be targeted to where measures and outcomes indicate.

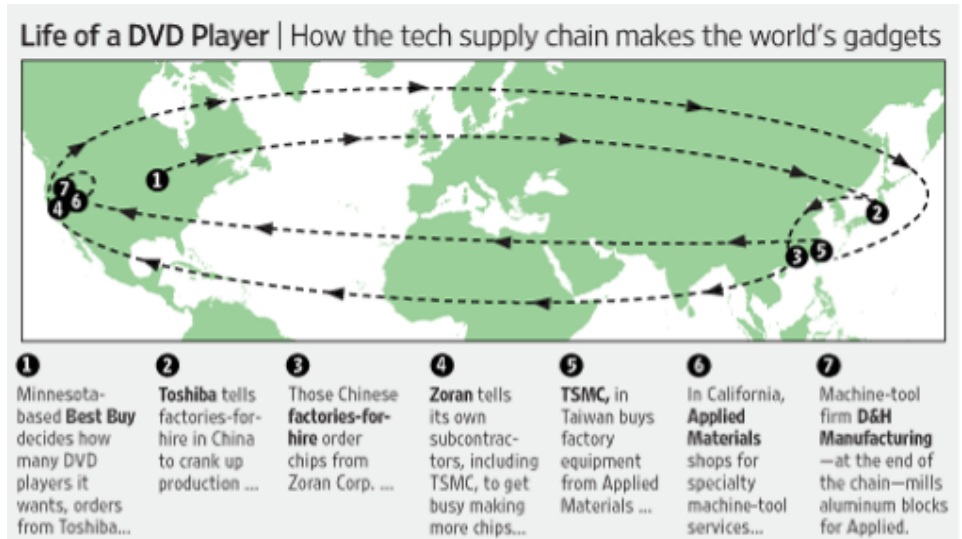
Embrace green and green lean

3. Invest in clean energy innovation and expand the clean energy supply chain while clarifying linkages between green lean and continuous improvement and product development. Manufacturers have been embracing the concept of lean for many years. There are many variants to lean but MEP defines lean manufacturing as the establishment of a systematic approach to eliminating waste and creating flow throughout the whole company. Companies that are both green and lean are seeking to reduce their environmental impact while simultaneously increasing their efficiency, productivity, and profitability. An example of this is reduced water consumption that helps to reduce work-in-process costs, increase productivity and quality, and increase profits. More and more manufacturers are requesting that their suppliers adhere to standards of environmental quality and processes. These include firms such as Hewlett-Packard, Nokia, Ericsson, and Bristol-Myers-Squibb. MEP partners with the Environmental Protection Agency to provide the Green Suppliers Network that helps reduce the environmental impact of small and mid-sized manufacturers while simultaneously increasing those companies' efficiency, productivity, and profitability, and thus their competitiveness within and across the supply chain.
4. Increase awareness, understanding of, and implementation of green and new energy economy industrial standards.
5. Create market opportunities for global challenges.

Recognize and navigate opportunities in the global value chain

6. Increase efforts to help manufacturers navigate export markets and streamline technology export processes. Manufacturers are thinking about globalization, offshoring, and the supply chain in different ways. Success in the global marketplace for manufacturers looks different depending on the sub-sector and the size of the firm. For example, some firms are finding that as expertise develops overseas they have even more reason to send design, development, and production across the world. Other manufacturers are moving production and design back to the U.S. as the transportation and logistics costs of supply chain management become prohibitive and energy costs continue to increase. Still others are expecting that future production may be accomplished in many smaller facilities in the U.S. and abroad to meet environmental concerns and react to special market demands.
7. Increase efforts to help manufacturers diversify their markets.
8. Improve the data available to present the value of manufacturing.

In this emerging structure, supply chains are evolving and becoming less linear. First-tier suppliers and customers are now involved in design, manufacturing, and delivery, and original equipment manufacturers are forming partnerships with firms deeper into the supply chain because they are attracted to unique technical knowledge, process, and production expertise.³ One way to maintain competitiveness in this environment is through collaboration and cluster-based partnerships between like firms, government, and educational institutions. Some manufacturers are morphing their product and service offerings. Regardless, navigating the complexities of the global supply chain will continue to be important to manufacturers. The National Innovation Marketplace (www.usinnovation.org) is an MEP initiative connecting manufacturers to one another and to innovators looking to take their product to market.



Source: "Clarity is Missing Link in Supply Chain," Phred Dovorak, Wall Street Journal, 5/18/2009

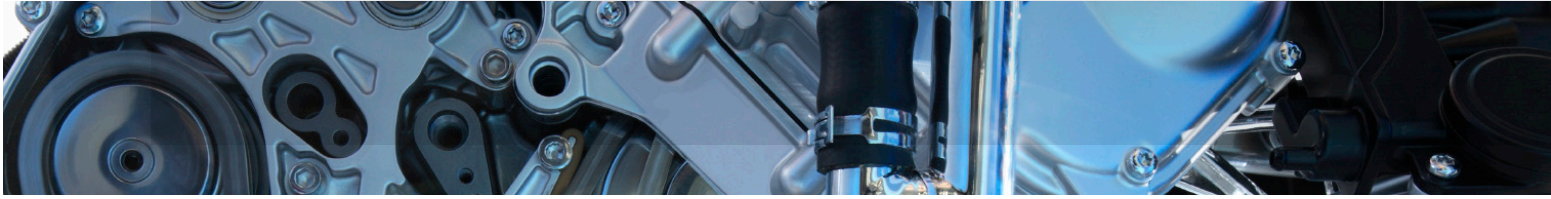
9. Rebrand manufacturing as "product innovation, development, and deployment."
10. Promote and expand career pathways.
11. Endorse and promote national certification and skill standards related to manufacturing.
12. Partner with federal, state, and local workforce system to proactively avert layoffs.

Develop and retain current and future talent

Despite the economic downturn and a perceived lack of jobs, data from a May 2009 survey of manufacturers indicate that skills shortages still exist, especially for the most profitable companies and for skilled production workers, scientists, and engineers.⁴ Evidence exists to suggest the lack of skilled workers extends to all levels of a manufacturing enterprise. The National Association of Manufacturers ("NAM") has identified many workforce challenges including dissatisfaction among manufacturers with the quality of K-12 education and the lack of adequate and accurate career counseling as well as the negative perceptions and attitudes of young workers with careers and job satisfaction in manufacturing.⁵ Perhaps rebranding manufacturing as the process of moving from product innovation into product development and deployment (including new sales and new markets) is a way to engage young workers who are interested in idea generation and research and development.

A critical partner in training the current and future workforce is the community college system. More than half of the community colleges (55% or approximately 1,200 institutions) offer specialized training in manufacturing skills. There are about 871,000 students enrolled in these courses.⁶

Beyond the skill gap issues is a deeper issue around developing a talent-driven firm. According to the recent report by the Aspen Institute, most businesses are still based on well-established command and control structures and have a hard time accepting systems, like those built on web-based social networking tools, that encourage bottom-up horizontal collaboration, even internally.⁷ As a result, the most exciting innovations in building talent-driven firms may well occur in smaller entrepreneurial firms and at the edge of large enterprises rather than their core.



Introduction

U.S. manufacturing is at a critical crossroads. Policymakers have a choice to establish a framework to guide the future of manufacturing in the U.S. and to accelerate adjustments to markets or leave its future up to serendipity, chance, complacency, and indifference. U.S. policymakers can help manufacturing firms change, innovate, move into new markets, and adapt to a constantly changing global economic environment, or operate under the false assumptions that the industry cannot compete and thus investment in new tools and ways of operating are not worth the effort. As the third largest economic sector in the U.S. economy, one that pays premium wages and creates more total direct and indirect jobs than any other sector, manufacturing is worth a focused, pro-active federal policy agenda. Without one, the risks to U.S. living standards, national security, and economic security are too great.

Manufacturing is an important part of the nation's competitive backbone and represents a large, complex, and diverse cluster of industries made up of individual firms that undertake a broad spectrum of activities.

These activities extend far beyond production. They include research, design, logistics and distribution, technological services, back-office support, and customer care, among others. Over the past several decades, each of these activities has been outsourced to some degree, depending on the precise cost and quality needs of an individual firm. As a result, manufacturing has become a decentralized, complex web of suppliers and distributors that extends across the globe. Indeed, in this era of globalization, it is often hard to identify the nationality of a firm. Traditional large U.S. manufacturers have many overseas



operations, while foreign companies like Toyota and Novartis have U.S. facilities that employ thousands of U.S. workers. It is this picture that makes defining U.S. manufacturing more complex than it once was, but perhaps more important too. Acknowledging its complexity will lead to a set of modern and relevant public policies that will increase competitiveness for all manufacturers, and thereby benefit U.S. workers, communities, and consumers.

To understand the future competitive position of U.S. manufacturing, the backdrop of the past decade must be understood. Economic policy of the past decade was based on an expensive dollar, unsustainable trade imbalances in the goods sector, and delayed reaction to new global competitive realities. Going forward, global markets will demand manufactured goods from America as trade balances correct, but only as long as the nation's manufacturing infrastructure is intact so that it can respond to market signals that will inevitably come with recovery from the current recession.

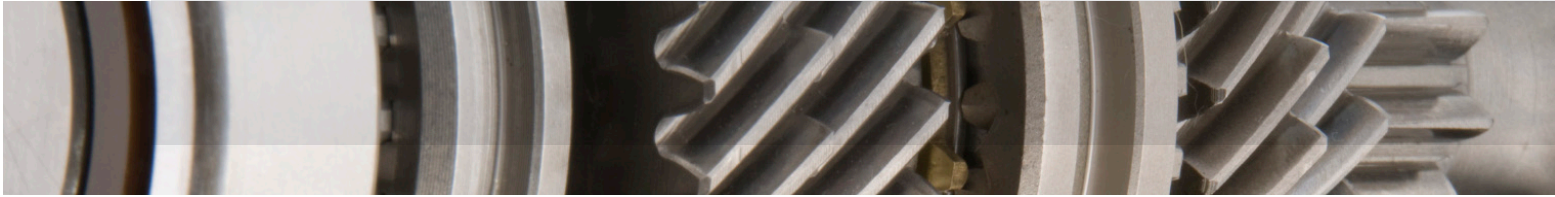
So how does U.S. manufacturing remain competitive? An important factor will be to more clearly define a central constraint on the growth of the manufacturing sector – the ability to translate innovation into commercial products. Federal policy can help renew manufacturing in America by improving the process of transition from research and development to domestic product design, manufacturing, and product deployment. Unfortunately, many of today's manufacturers suffer from a lack of access to new technologies, new processes, new markets, and a skilled workforce to make this transition. Many firms have knowledge about what needs to be done but need help in taking appropriate action. Other firms must be educated toward new opportunities. Current public policies can do more to assist U.S. firms at the scale needed to compete.

Over the past several decades, a disjointed set of interventions related to taxation, trade, health care, tort reform, energy, and others has evolved in the U.S. in place of a focused manufacturing policy. In many ways, we have allowed the law of unintended consequence to shape our economic competitiveness. This de-facto industrial policy has not kept pace with the changing nature of globalized manufacturing, and in some cases hinders manufacturers from staying competitive. But it is not too late to take action. The U.S. has a choice: do nothing and continue as is or establish a set of policies that help firms make the transition to product innovation, product development, and product deployment.

This paper seeks to set the context for a new discussion about U.S. manufacturing, one that supplements the concept of "manufacturing" based solely on production with that of "product innovation, development, and deployment." The term "manufacturing" is fraught with traditional biases and young workers and students see no future in it. By changing the foundational context, we see an opportunity to reinvigorate the conversation so that policy makers and the public get excited about innovation and product development and the resulting production in a way that transforms the national dialogue about our industrial competitiveness.

We must consider the elements of a successful manufacturing sector, starting with innovation and moving through the process and transitions necessary for product design, manufacture, and product deployment. Thinking of manufacturing in these terms is critical to understanding where federal policy can make a difference.

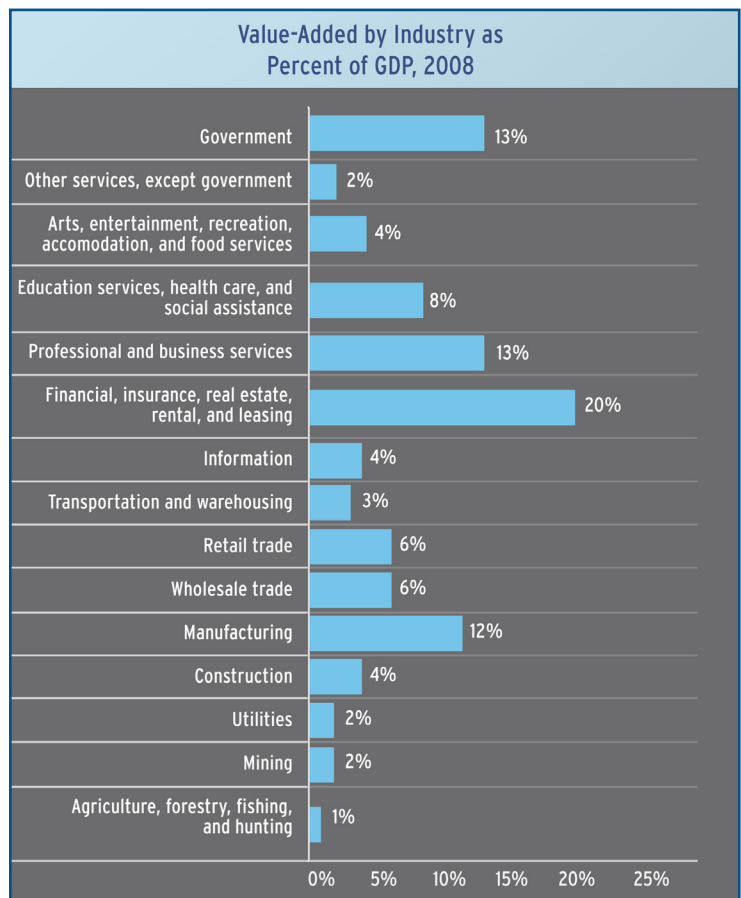
This paper explores common perceptions (and misperceptions) about manufacturing, moving through the characteristics of successful manufacturers, and presents opportunities for action at the federal policy level. We believe that this approach provides valuable insight into the set of pro-active U.S. federal policies that will enable U.S. manufacturing and manufacturers to resume their growth, as indicated by a growth in the percentage of GDP and a concurrent improvement in the U.S. balance of trade in goods.



Exploring the Complex Reality of Manufacturing Today

Recent reports and studies paint a diverse portrait of the health and vitality of the current and future manufacturing industry in the U.S., as well as its importance in the U.S. economy. Is it thriving or merely surviving? Manufacturers themselves disagree about the health of their industry; some paint a rosy picture of a leaner, stronger sector than ever before, while others warn that the industry is in dire condition. The reality lies somewhere in between. To help discern the true picture of U.S. manufacturing, the Hollings Manufacturing Extension Partnership Advisory Board (“MEP Board”) issues this report to increase the knowledge about the true state of manufacturing, the public policy opportunities for its sustained economic growth, and implications for the MEP Program.

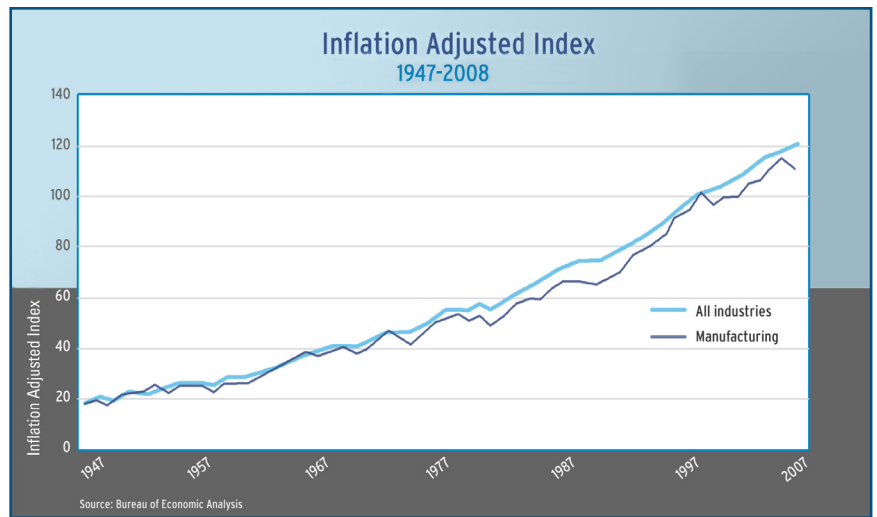
An effective federal policy agenda must start with an informed perspective about the reality of the industry. The reality about manufacturing is that it is complicated – it is not captured in a single data point nor is it captured in a single caricature of impending demise or dramatic revival. But there is a set of realities that apply to the industry broadly. Understanding these realities is critical to understanding how and why federal policy action can help shape a more robust industry, and therefore more prosperous communities.



Is U.S Manufacturing Disappearing?

For years we have recognized and acknowledged the transition from a production-based economy to a service-based economy. Yet, even before the bumpy ride experienced by the financial and real estate sectors over the past two years, data demonstrated that manufacturing remains a significant part of the U.S. economy. However, key indicators remain mixed on the true condition of the industry.

Manufacturing generated \$1.64 trillion worth of goods in 2008 – despite a recession that dramatically impacted the domestic automobile industry - and inflation-adjusted value added has increased by 22 percent over the past ten years. If U.S. manufacturing were a country in itself, it would represent the 8th largest economy in the world.⁸



Even so, manufacturing is no longer the dominant sector of the U.S. economy. However, it remains a critically important component. As of 2008, manufacturing represented 12 percent of GDP, which is a significant decline from nearly 30 percent in the early 1950's. This is a reality of economic development - as wealth increases and real wages rise, families consume more services. Despite its declining share of the value of GDP, the real value or manufactured output has kept pace with the economy for fifty years. Total output in U.S. manufacturing reached its all time high in 2008, producing over \$1.6 trillion in added value.⁹

Is Manufacturing Still Important to the U.S. Economy?

Trade data paints a troubling picture. The U.S. is simply no longer an exporting nation. As of October 2009, the U.S. trade deficit for all goods and services was \$32.9 billion and while some sectors are doing better than others, it is a gloomy snapshot overall.¹⁰ For example, in 2000 the U.S. exported \$29 billion more high-tech products than we imported and by 2007 this had turned into a \$54 billion trade deficit.¹¹

While the U.S. high-tech manufacturing sector is still relatively strong, it ceased being the world leader in high-technology production in 2003 when overtaken by China. During the 1990s, U.S. high-technology industries (communications equipment, computers and office machinery, pharmaceuticals, scientific instruments, and aerospace) accounted for about 20 percent of the world's high-technology exports, approximately twice the level of all other U.S. manufacturing industries. Starting in the late 1990s, the U.S. world export share declined continuously across all five high-technology manufacturing industries, dropping to an average of 12 percent of the world's exports in 2005. Losses in communications

A survey of 1,000 Americans in 2009 indicated that 82% of respondents thought manufacturing important to U.S. economic prosperity, and identified it as the domestic industry most important to the U.S. in helping maintain a strong national economy.

—Public View of Manufacturing, Deloitte and the Manufacturing Institute, June 2009

equipment, office machinery, and computers, which collectively account for nearly 60 percent of U.S. high-technology exports, primarily drove the overall decline.¹²

Despite export losses, the U.S. still has the single largest share of high-technology value-added produced in the world (35 percent in 2005). This is an economic sector where the rate of growth in world gross revenue in high technology manufacturing has been double that of non-high technology manufacturing sectors over the past 20 years. The U.S. is ranked first in value-added world share in three of five high-technology industries (scientific instruments, aerospace, and pharmaceuticals) and is ranked second in the other two (communications equipment, office machinery and computers).¹³

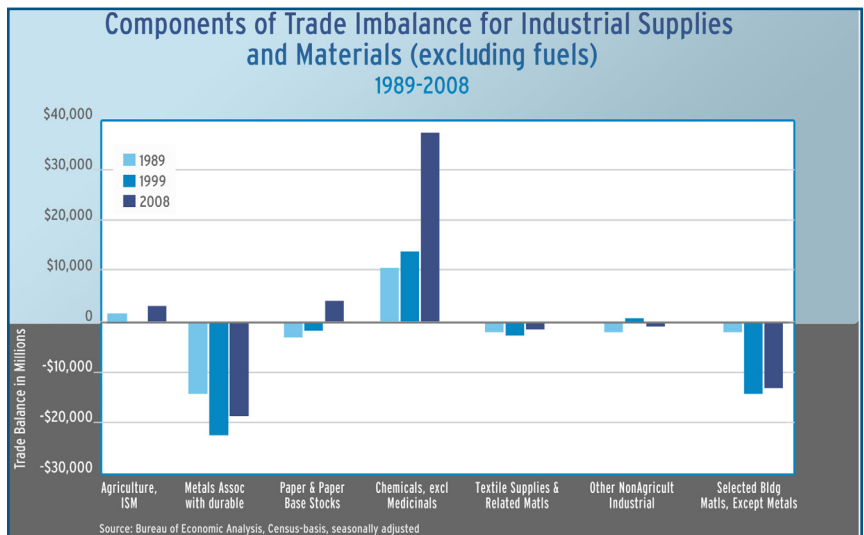
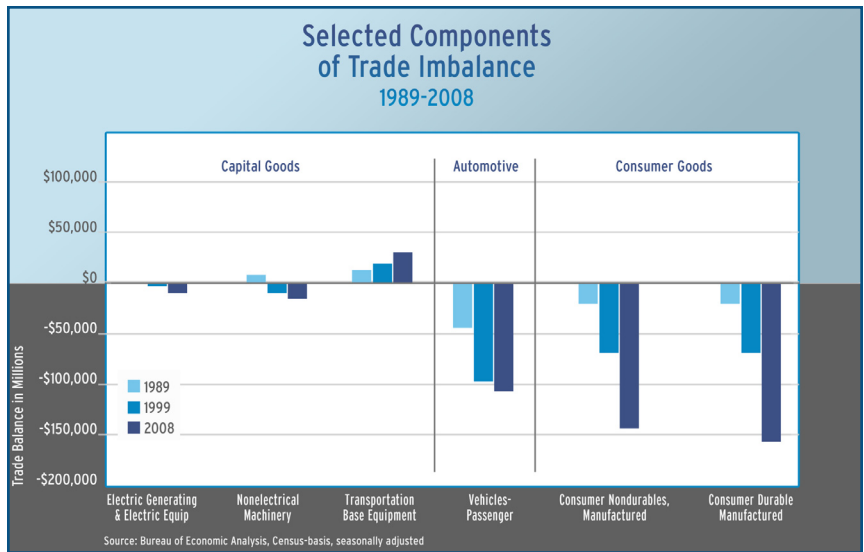
There are a handful of industries that account for a large share of exports. These include:

computers and electronics, transportation equipment (including aerospace), chemicals, non-electrical machinery, primary metals, petroleum and coal, apparel and accessories, electrical equipment, fabricated metals, food and kindred, plastics and rubber, and leather.

As of 2008, the only two significant industries in which the U.S. has a trade advantage are chemicals and non-passenger-vehicle transportation equipment (including aerospace).

Despite all of this, the sky is not falling. There are several trade indicators that reflect a positive light on the state of U.S. manufacturing. According to the recently released Facts about Modern Manufacturing: 8th Edition by the NAM:¹⁴

- The U.S. share of global manufacturing value added is holding steady at a little less than 25 percent...but China's share is now 15 percent and gaining rapidly.



- Among all U.S. exports, manufactured products are the most dominant, accounting for 57 percent of total value. Services are at 30 percent, agriculture at 6 percent, and all others at 7 percent.
- Traded industries have a very positive impact on overall wages. Employees in the top-third of the most trade intensive industries (where combined exports and imports amount to at least 70 percent of their domestic industrial output) earn an annual total compensation package of about \$86,000, 47 percent more than in the least-third trade engaged sectors of manufacturing (\$58,614). Those in the middle-third trade engaged sectors earn \$67,963.
- The U.S. attracts the most foreign direct investment of any nation in the world as investors continue to be attracted by its large and open market, the quality of its infrastructure, high income levels and access to cutting-edge technology and research. U.S. manufacturing affiliates of foreign firms now employ about 2 million manufacturing workers and sell about \$1.1 trillion in goods each year (as of 2006). Foreign firms now employ about 1 in 12 U.S. manufacturing workers.

Manufacturing Establishment by Size		
Number of Employees	No. of Mfg Establishments	% of Total
ALL	331,335	100.0%
1-4	119,182	36.0%
5-9	57,779	17.4%
10-19	51,422	15.5%
20-49	50,094	15.1%
50-99	24,359	7.4%
100-249	18,943	5.7%
250-499	6,172	1.9%
500-999	2,384	0.7%
1000 or more	1,020	0.3%

There is a business case for investing in manufacturing and in manufacturers. Despite the current trade imbalance, U.S. manufacturers still exported \$86.8 billion dollars in goods during August 2009. The U.S. remains very competitive in many industries and there are opportunities for owners and investors as well as policy makers to continue building on the strengths of manufacturing to help revitalize the U.S. economy. There is an economic development case to be made as well. U.S. manufacturing is often perceived as the domain of some of the global economy's largest firms such as Boeing, Exxon, General Electric, IBM, Microsoft, Philip Morris, and numerous others. In fact, small and medium-sized businesses are the backbone of the industry.

According to 2007 data from the U.S. Census Bureau, approximately 177,000 manufacturing establishments have nine employees or less, and approximately 119,000 establishments have four employees or less. In total, these account for 53 percent and 36 percent of all manufacturing establishments respectively. Another 31 percent (101,000) of manufacturing establishments have between 10 and 49 employees. Despite perceptions that the global economy belongs to only the biggest players, these establishments penetrate the global marketplace in many ways. The share of small and medium-sized manufacturers reporting that exports account for more than one-quarter of their sales more than tripled from 3.8 percent during 2001 to 12.8 percent during 2008.¹⁵ Tomorrow's large companies are likely be built from today's smaller companies.

Are There High Quality Manufacturing Jobs Left in the U.S.?

Employment in manufacturing as a share of total U.S. employment has fallen from about one in three U.S. jobs in 1950 to about one in ten jobs today. The September 2009 manufacturing employment figure of 11.7 million jobs represents a decline of nearly 2 million jobs since the recession began in December 2007, a drop of 8 million jobs since peaking in 1979 (19.4 million jobs) and is at its lowest level since 1940 (9.8 million jobs).¹⁶

Some of the decline can be explained by the way the data is calculated. For example, many functions previously done within manufacturing companies and previously counted as manufacturing jobs – packaging, transportation, professional services, publishing, warehousing – are now counted outside of the manufacturing sector as services. Yet much of it can be accounted for by structural changes in manufacturing, including technological advances, increased productivity and production efficiencies, and globalization.



Despite these job losses manufacturing as an industry accounted for 18.6 million jobs in 2009 (11.8 direct jobs, and 6.8 indirect jobs in industries like transportation and warehousing, and professional, business, and financial services).¹⁷ Manufacturing still has a greater secondary economic impact (i.e., multiplier effect) than any other sector of the economy, with an estimated additional \$1.40 in output from other sectors being generated for every \$1.00 in final sales of manufactured products.¹⁸ Only information services; agriculture, forestry, fishing, and hunting; and construction come close at slightly over \$1.00 each. Retail trade (\$0.58) and wholesale trade (\$0.55) sectors have the lowest impact per dollar of economic activity.

Manufacturing in the U.S. also offers premium jobs. Manufacturers pay 9 percent higher in wages and benefits than the entire economy. On average, U.S. manufacturing jobs are more likely to provide health, pension, and other benefits compared to other sectors. Employers' ability to pay premium wages to workers is due in large part to their ability to do more with less - productivity is high, and production and distribution processes have been streamlined. Declining employment rates clearly show that this streamlining has included workers.

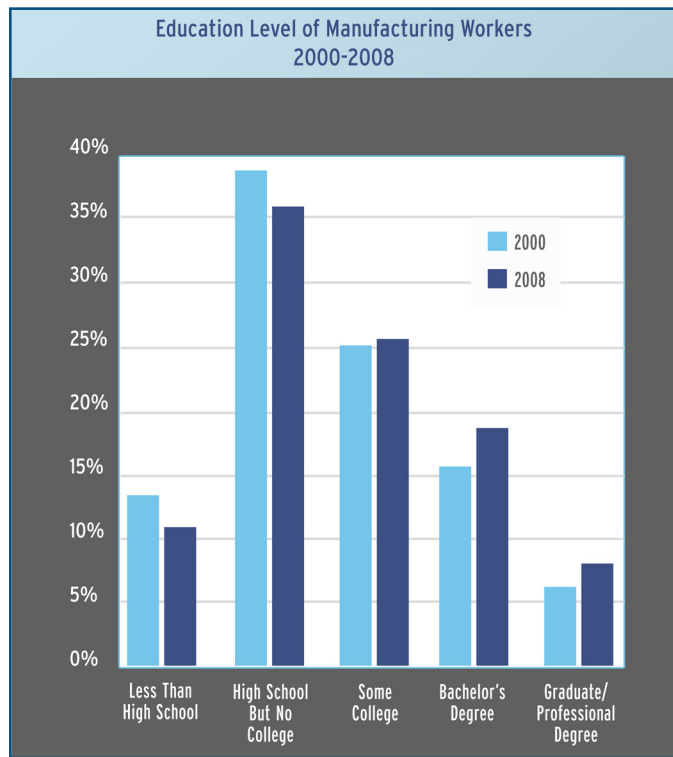
Unit labor costs of U.S. manufacturers have declined by 40 percent relative to the average unit labor cost of fourteen other countries that are major competitors in global markets.¹⁹

It is no surprise that the skills and education needed by workers in manufacturing have also dramatically shifted. In 1973, over half of manufacturing production workers had not finished high school. By 2001, only 21 percent lacked a high school degree. Over the same period, the share of production workers with some post-secondary education rose from 8 percent to over 30 percent.²⁰ When non-production workers (i.e. sales, R&D) are included, the high level of skills and education needed is more evident, with only 12 percent of all manufacturing workers holding less than a high school diploma and over 50 percent having some post-secondary education in 2008.²¹ Furthermore, 17 percent of all jobs in science and engineering occupations are found in the manufacturing sector, behind only the professional, scientific, and technical services industry.²²

These latter industries include many jobs that are important to and often functionally integrated within manufacturing, including: engineering, drafting, research and development, industrial design, computer systems, and environmental and energy services. In other words, large parts of the U.S. technology economy may really be the manufacturing economy.

Very little of the “old manufacturing” sector - as typified by long production runs of standardized parts and products - exists today. New manufacturing is represented by firms dependent on constant innovation and adoption of new technologies that require higher skilled workers. According to a recent survey of leading manufacturers, new product innovation and a high-skilled, flexible workforce were identified as the two most important factors to business success.²² Product innovation and a flexible workforce represent the necessary elements to transition from innovation to product development and deployment.

According to the same survey, 51 percent of the workforce demand in manufacturing is currently for skilled production workers, 46 percent for scientists and engineers, and only 7 percent for unskilled production workers. This need for skilled production workers is often linked with an increased emphasis on science, technology, engineering, and math related skills. Yet the U.S. lags in math and science scores among young people compared to other advanced economies such as Germany, Japan, and the United Kingdom, as well as developing economies such as those in Hungary and Poland.²⁴ This means that it may become more challenging for manufacturers to find new workers with the appropriate levels of skills and education, at the same time they are challenged to advance their current workers in a way that encourages innovation in process, product, and markets. Innovation and a skilled workforce are intrinsically linked.



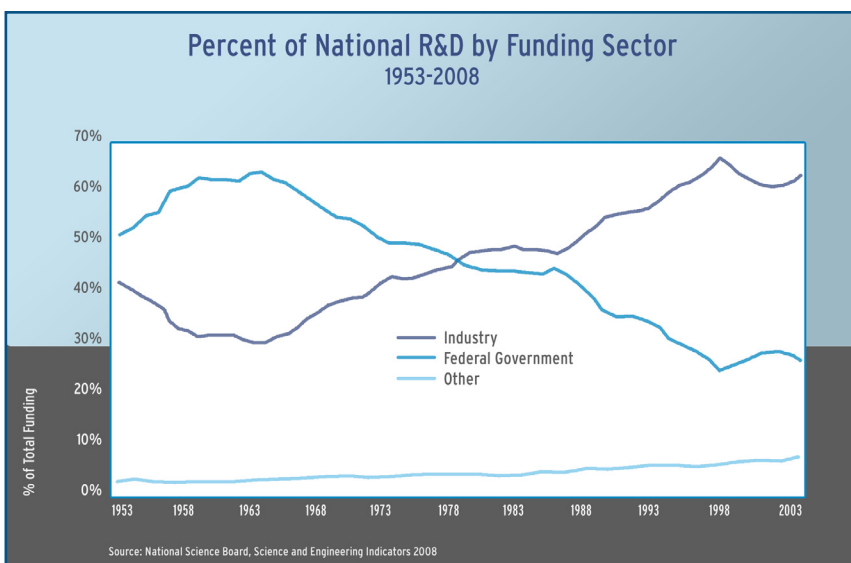
Source: Bureau of Labor Statistics, Current Population Survey

Can Innovation Alone Rebuild the U.S. Economy?

Many recent papers and reports about manufacturing have emphasized the need to increase federal investment in basic and applied research. Data seems to indicate such an increase is warranted. Consider these trends in research and development:²⁵

- U.S. research and development expenditures (in inflation-adjusted terms) have increased by only 2.5 percent in average annual change over the past four years.
- In 2006 the U.S. performed an estimated \$62 billion of basic research, \$75 billion of applied research, and \$204 billion of development.

- Universities and colleges historically have been the largest performers of basic research in the U.S. and now account for more than half (56 percent) of the nation's basic research being performed.
- The business sector accounts for the largest share of R&D spending in the U.S. and provides most of the nation's R&D funding, but the business sector's share of R&D is decreasing (from a peak of 75 percent in 2000 to 71 percent in 2006).



- The federal share of R&D spending first fell below 50 percent in 1979 and dropped to a low of 25 percent in 2000.
- 60 percent of the federal R&D budget in FY 2008 is for defense. There is an important innovation role that is played by military R&D, particularly as it relates to the technology transfer of defense technology into commercial products.

The declining share of federal spending is one data point in a complex R&D and innovation story. A recent article in the Harvard Business Review noted that “over recent years and past decades the innovation infrastructure that once drove American ingenuity has slowly dissipated. As low-wage competitor countries become more highly skilled, with more sophisticated facilities for not only production, but research and development, some manufacturers in the U.S. worry that our main export is innovation itself, not innovative products.”²⁶

Clearly there are roles to play for the federal government, business and industry, and higher education in funding and performing research and development and in rebuilding and readying the collective “industrial commons”.²⁷ This industrial commons is the collective research and development, engineering, and manufacturing capabilities that sustain innovation. The commons serves as the foundation for innovation and competitiveness that includes R&D know-how, advanced process development and engineering skills, and manufacturing competencies related to specific technologies. Such resources can be embedded in a large number of companies and universities as well as the skills, and equipment related to the development of products through human capital.

Increased federal investment in R&D alone is not sufficient. Nor is the increase of R&D in private companies and universities, or increased emphasis on science and engineering curriculum in secondary and post-secondary education. It is a combination of all of these things and more, including but not limited to innovation, multi-firm collaboration, and infrastructure that will maintain the U.S. standing as the world's innovation leader.

Can Firms Simply Follow the Market to Stay Competitive?

Markets matter. There is a clear and empirical link between the value of the dollar and the export of goods. As the value of the dollar increases relative to other currencies, the price of our goods to customers in other nations increases, and thus they buy less and exports decrease. As the value of the dollar decreases relative to other currencies, the price of our goods for consumers in other nations decreases, they purchase more, our exports increase, and U.S. goods and services make up a greater share of the global marketplace.

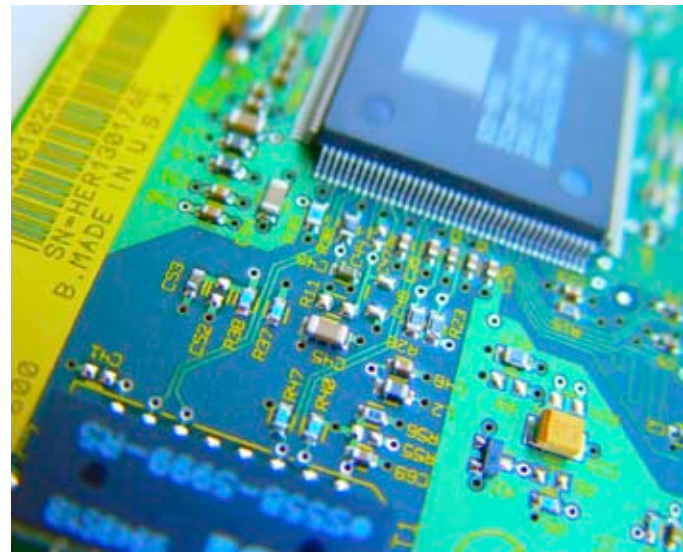
Given the current state of our global economy, the value of the dollar is expected to decrease. This is good news for manufacturers as the declining dollar will likely result in an increase in exports. Additionally, to take advantage of this increased demand for U.S. goods, more goods that might otherwise have been imported will likely be produced domestically (a classic case of import substitution).

Firms are responsible for driving the market, not just responding to it, and as the value of the dollar declines, firms must recognize the opportunity to be strategic and take advantage of the double benefit they will face – expanded opportunities in export markets and expanded opportunities created by import substitution.

However, opportunities exist to fill market gaps. For example, with the contraction, restructuring, and impaired capital of the finance sector of the economy, there is a gap in access to capital for manufacturers.

Many small manufacturers, even those with orders that are relatively healthy, have been unable to finance growth or execute business and product diversification plans in the current environment due to the prevailing underwriting practices, devalued assets, and what seems to be a perceived transitional risk associated with transforming away from legacy products and practices and investing in new products. Many lenders have enhanced this risk aversion in the current economic climate. However, there are actions that the federal government can do to respond to these unusual conditions in the finance markets that are threatening the manufacturing sector. Current financial policy efforts operate on the assumption that by decreasing the cost of capital to banks, banks will thus increase lending activity to small businesses. Decreasing the cost of financing may create increased spreads for lenders and make them healthier, but will not necessarily induce them to make any new loans when the bank cannot sustain loan losses due to its impaired capital or increased regulatory scrutiny.

The efforts unfortunately do not address the need to offset from the lenders perspective financial deficiencies of borrowers brought about by asset devaluation and what the banks see as transitional risk to cash flows as companies attempt to diversify to other products. Access to capital can only be significantly improved through targeted initiatives that mitigate risk taking or loan losses by lenders or by some kind of loan enhancement programs which directly reduce specific risks on a loan by loan basis.



Market opportunities created by currency fluctuations are a partial solution to the revitalization of the manufacturing sector; access to capital quite another. Through the course of this paper we promote federal policy interventions when it can be helpful, but recognize the need for business to lead the way. The solutions likely lie in the public and private sector working together in a creative and collaborative effort.

Summary – Complex Realities

Manufacturers disagree on the health of their industry - some paint a rosy picture of a leaner, stronger sector than ever before, while others warn that the industry is in dire condition. The reality lies somewhere in between. An effective federal policy agenda must start with an informed perspective about the reality of the industry. The reality about manufacturing is that it is complicated – it is not captured in a single data point nor is it captured in a single picture of impending demise or dramatic revival. But there is a set of realities that apply to the industry broadly. Understanding these realities is critical to understanding how and why federal policy action can help shape a more vital industry, and therefore more prosperous communities.

Consider the following illustrative points:

- Manufacturing remains a significant part of the U.S. economy, generating \$1.64 trillion worth of goods in 2008. If U.S. manufacturing were a country in itself, it would represent the 8th largest economy in the world. But...
...Manufacturing is no longer the dominant sector of the U.S. economy but it remains a critically important component. As of 2008, it represented 12 percent of GDP, down from nearly 30 percent in the early 1950's.
- The U.S. share of global manufacturing value added is holding steady and among all U.S. exports, manufactured products dominate, accounting for 57 percent of total value. But...
...The U.S. trade deficit for high-tech products in 2007 was \$54 billion, nearly doubling the \$29 billion deficit of 2000.
- Manufacturing pays 9 percent higher in wages and benefits than the overall economy, and nearly one in five jobs in science and engineering are in the manufacturing sector (2nd highest). But...
...Employment in manufacturing as a share of total U.S. employment has fallen from about one in three jobs in 1950 to one in ten jobs today.
- In 2006 the U.S. performed an estimated \$62 billion of basic research, \$75 billion of applied research, and \$204 billion of development. But...
...Both the business sector's share of research and development as well as the federal share are in decline. More than half of all basic research in the U.S. is now performed at universities and colleges.



Characteristics of Successful Manufacturers

Introduction and Purpose

Jeffrey Immelt of General Electric offers one take on how to re-build a thriving manufacturing sector, providing a set of guideposts for public policy makers to consider. Other publications list numerous factors such as cost and resource management, product development, flexibility, service offerings, reliability, decisive leadership, environmental sustainability, and the ability to look beyond the competitive threat from other nations such as China.

Rebuilding a strong, sustainable product development and deployment capacity in the U.S. will require building on what works for firms. Through a literature review of dozens of reports and studies, and interviews with MEP Advisory Board members (a majority of whom are manufacturers), the following four interconnected responses to inevitable change emerged. For each of these, a set of opportunities for action through public policy also came into clear focus when viewed within the context of contemporary manufacturing.

The ability of firms to fully embrace each of these four strategies is mixed. In fact, a recent study analyzed how well America's manufacturers are prepared to meet the challenges of the new marketplace.²⁸ The results illustrate that in the face of a deep recession many manufacturers struggle just to survive, let alone innovate and grow. Large firms may better understand the need for change and have more tools to adapt, while small and medium-sized firms often need help to identify and navigate the pathway to success. Even so, small and medium-sized firms tend to be very agile and once they see their path to success they can be flexible in getting there.

While there are many factors that contribute to a manufacturing firm's success, we believe these four are most critical. A thumbnail sketch of why the characteristic is important and the challenges that often prevent manufacturing firms from being world-class is provided for each.

We should create an American Industrial Renewal by moving on five fronts: invest in new technology; win where it counts in clean energy and affordable health care; become a country that is good at manufacturing and exports; embrace public-private partnerships; and promote leaders who are also good citizens.

—Jeffrey Immelt, CEO of General Electric, excerpted from July 2009 speech to Detroit Economic Club²⁹

Stages of Competitive Manufacturers

from The State of Manufacturing 2009, Enterprise Minnesota

Truly Advanced – 5% of employers are aware of the marketplace and are actively engaged in a continual process of improvement that will enable them to compete anywhere, with anyone, within any economic environment.

Engaged – 15% of employers know what they have to do. They have begun the process, sometimes in fits and starts, but are committed to becoming truly advanced.

The top 20 percent consists of “truly advanced” and “engaged” manufacturers who:

- (a) do not panic in the face of bad economic news and look for long-term opportunities;
- (b) will not be caught flat-footed by the impending worker imbalance and shortages;
- (c) do not fear the growing influence of China, India, and other low-cost producers; and
- (d) do not allow their products to be commoditized by purchasing agents at their OEM customers.

Earliest Stages – 50% of employers are in the “earliest stages” of growth. The upper end of this group really knows that they must do certain things to be more engaged, but in general, they struggle to adapt to the vagaries of the marketplace and the economy, but they end up reacting to changes in their markets on someone else’s terms rather than anticipating them on their own. As you move down this hierarchy, we find companies that let the urgent dead-lines of the day-to-day operations get in the way of strategic improvements and longer-term planning.

Disengaged – 30% of employers are surviving, but they aren’t adding the kind of sales growth and profitability that enables them to invest in their businesses to take them into the next generation. They live off of yesterday. In a good economy they are standing still. And sadly, in this challenging economy, many of them are going to disappear.

Innovate Constantly to Adapt to Economic and Technological Changes

Leading firms continue to innovate their way through economic and technological shocks and disruptions, and even use them to their advantage. Shocks are generally thought of as external impacts to the firm, such as the current economic conditions, the rising cost of health care, or rising energy costs. Disruptions tend to be internal to the firm, such as the deployment of new technologies or processes.

In the context of the current financial crisis, for example, some businesses are finding ways to deal with this external shock by managing just-in-time inventory and sub-contracting the making of tools to be used in the manufacturing process in order to stay lean and absorb the financial crunch. Shocks are not always negative, and depending on the industry they can have wide-scale positive impact. The current administration’s push for energy efficiency makes this a good time, for example, to invest in and deploy energy efficient products and processes. While some manufacturers will see energy efficiency as a disruption to the way they do business, others will manage this change so that the business comes out in an improved competitive position. Nanotechnology and

I equate growth with survival. If my company is not growing, it will not survive. If I’m not innovating, I’m not driving growth.

—Mark Rice, President, Maritime Applied Physics and MEP Advisory Board Member

3-D simulation are two powerful technologies shaping manufacturing today, but for some firms these represent a significant disruption to current products and processes. For strong firms, these disruptions will be turned into opportunities. For others, the pace of change will be too rapid and will be considered a threat.

Additionally, in a recent survey of over 1,000 manufacturing firms conducted by the NAM, having a well-defined process for innovation was identified as the primary driver of excellence in a disciplined approach to manufacturing.³⁰ This includes designing structured, standardized processes for generating ideas, developing them, and bringing them to market. Leading manufacturers believe that process discipline is integral to their success. But this process must be able to weather and adapt to change. Entire U.S. industries have been unable to adapt to recent shocks and disruptions caused by the global marketplace and others are under serious threat. Semiconductors, electronic displays, and advanced materials are just a few of several industries with products already lost or under threat of being lost. Appendix A provides a list of industries and products that fall into this category.

There are also strong indicators that more and more U.S. firms are voluntarily sharing their research, development, design, and patent information with foreign countries and companies as part of business agreements. Recent data from the National Science Board indicates that in 2005, U.S. companies had conducted over \$6 billion in trade with unaffiliated companies in receipts and payments.³¹ This consists of U.S. trade in industrial processes, including patents and trade secrets, used in the production of goods. While this figure provides an indication of the strength in U.S. research and development capabilities, our willingness to outsource our nation's leadership in research and development by producing offshore, raises questions about industrial trade and its long-term impacts on our ability to be innovation leaders.

Throughout industrial history there have been examples of production being sent to nations with lower production costs. This is good for the economy of other countries and for American consumers due to the lower cost of the product. However, the U.S. based company is in danger of losing control over its technology; tacit knowledge and process innovations will not accrue to the original innovating company, and eventually the innovating company will lose the product. Artful foreign competitors will eventually establish their own brands that will be positioned as the industry leader in products based on successor technologies. This happened in the color television industry and is occurring again in many segments of the consumer and electronics industry (see Appendix A).

Finally, the need for firms to consider the green marketplace is expanding. As evidenced in the subsequent section, the nation is at a tipping point in its conversation about environmentally friendly products and production processes. The "green wave" is an example of the need for firms to be ready to adapt to and innovate through change. The next section looks at green as a process improvement. But it is important to also realize the potential for innovating new products that are environmentally friendly and help to minimize the impact on the environment. New products that help reduce or alleviate our nation's carbon footprint will be in great demand in the years to come and present a new market opportunity for the most innovative of manufacturers.

Responses to Change by Successful Manufacturers

1. Innovate constantly to adapt to economic and technological changes;
2. Embrace green and green lean;
3. Recognize and navigate opportunities in the global value chain; and
4. Develop and retain current and future talent.

Embrace Green and Green Lean

When it comes to issues of green and “sustainability” many manufacturers are aware of the perceived importance but have yet to make a connection with their balance sheets. Despite the need to find alternative sources of energy as well as react to a more environmentally conscious consumer market, many manufacturers have been slow to respond:

- The industrial sector (including mining, agriculture, fishing, and manufacturing) accounts for 31 percent of total U.S. energy consumption, the largest share of any sector including transportation (28 percent), residential (22 percent), and commercial (19 percent).³³
- Manufacturing accounts for two-thirds of the industrial sector’s energy consumption. Natural gas and traditional electricity accounts for most of the manufacturing sector’s energy sources.³⁴
- While 47 percent of manufacturers reported average progress or better towards world-class green and sustainability measurement benchmarks in a recent survey, only 13 percent described their green measurement systems reviews as including regular monitoring or transparency.³⁵
- Only one-third of the manufacturers surveyed report having more than three-quarters of their sales volume from products that are recyclable and/or reusable.³⁶

Yet, even with this apparently slow response on the part of industry, green signals continue to be generated by our political, economic, and social discourse, particularly given the American Recovery and Reinvestment Act’s (ARRA) emphasis on renewable energy as an economic and workforce driver. This emphasis on green has proven to be complementary to

Green Headlines³⁵

(from State of Green Business, 2009 Greenbiz.com)

- General Electric said it plans to cut freshwater use 20 percent in absolute terms through reuse efficiencies in its commercial and manufacturing processes.
- Anheuser-Busch announced that its companywide water use increased 2.4 percent over five years while its beverage production climbed about 2 percent. By adopting a number of efficiency efforts, the brewer managed to reduce the amount of water used to make beer and keep its water use flat.
- 72 percent of facility managers surveyed by Johnson Controls said they pay more attention to energy efficiency, up to 10 percent from the year before.
- When asked what their number one initiative was for 2009 nearly 40 percent of companies surveyed answered “reducing energy use through efficiency.” In second place: “making sure that green stays on the agenda.”
- Product stewardship is increasing. Dell said it planned to eliminate 20 million pounds of packaging worldwide within the next four years, a move expected to save about \$8 million.
- Hewlett-Packard introduced a notebook PC in a recycled laptop bag with 97 percent less packaging than typical laptops.
- Carbon reduction is becoming a business imperative. Companies such as Alcoa and Merck are just two examples of those that have variously promised to slash emissions, increase reporting, or adapt a set of climate principles.

traditional lean concepts deployed by many competitive manufacturers, and provides opportunities to marry the two in both concept and implementation to provide important production cost savings.

Manufacturers have been embracing the concept of lean for many years. There are many variants of the definition but MEP defines lean manufacturing as the establishment of a systematic approach to eliminating waste (such as overproduction) and creating flow throughout the whole company. Lean also helps develop and implement a long-term plan to streamline operations for success. The benefits of lean include reduced cycle time, reduced inventory, reduced work-in-process costs, increased capacity, improved lead time, increased productivity, improved quality, and increased profits.

Marrying lean with green process concepts opens up additional opportunities to help improve the balance sheet. Companies that embrace lean and green production processes are seeking to reduce their environmental impact while simultaneously increasing their efficiency, productivity, and profitability. Typically this is being done through reduction of total energy use, waste sent to landfills, greenhouse gas emissions, and water consumption, among other negative environmental impacts. This approach aligns with lean concepts to reduce work-in-process costs, increase productivity and quality, and increase profits.

While some manufacturers remain skeptical of the words “sustainability” and “green,” there is a clear indication that efforts to become more energy efficient and better environmental stewards have reached a tipping point amongst manufacturers. While many manufacturers understand what needs to be done, many do not and require assistance in the identification and navigation of the path forward. Often times, introducing lean green production processes is not done alone but in partnership with local, state, and federal government resources, and utilities. E3 (Economy, Energy, and the Environment) is a model that combines the resources of five federal agencies, working with local government and utilities, to enhance sustainability and competitiveness in local and regional economies and to spur job growth and innovation. Federal and local resources are being combined to conduct in-depth front-end assessments and gap analyses of company manufacturing processes, the results of which are used to develop comprehensive improvement plans on behalf of and in collaboration with the participating communities. The federal agencies involved in this effort are:

- MEP (Department of Commerce)
- Pollution Prevention Program (Environmental Protection Agency)
- Industrial Technologies Program (Department of Energy)

Green Suppliers Network

The Green Suppliers Network (“GSN”) is an innovative collaboration between the Environmental Protection Agency, MEP, state and local government, and industry that focuses on the dual challenge of reducing the negative environmental impact of small and mid-sized manufacturing suppliers while simultaneously increasing those companies’ efficiency, productivity, and profitability. GSN reviewers employ lean and clean technologies, which concentrate on the root causes of waste of one process line in a facility and provide a framework for achieving specific, measurable, environmental business objectives. Among other things companies learn to establish systems to use energy more efficiently and improve the use and selection of more environmentally friendly raw materials (www.greensuppliers.gov).

When American Electric Power (“AEP”) joined the Green Suppliers Network in 2007, they had a goal to enlist five non-fuel suppliers to participate in the first year. By the end of the year ten suppliers were on board. Doing business with AEP now means that suppliers are subject to greater scrutiny of their environmental performance. When AEP issues Requests for Proposals, suppliers are asked about their environmental practices to determine if they align with AEP’s vision for sustainability (www.AEP.com/cr).

- Employment and Training Administration (Department of Labor)
- Small Business Development Centers (Small Business Administration)

These agencies work with local partners, utilities, and manufacturers to sustain the manufacturing infrastructure of a region, make manufacturing plants more energy efficient and cost effective, reduce the environmental impact of participants, and improve the economy by creating and retaining jobs.



E3 is an example of how the behavior of one firm can positively impact its community. One firm's behavior can also impact the behavior of other firms. Most manufacturers agree that greening the supply chain is the next evolution in achieving improved energy efficiency. From materials to components to design, finished product, and end use, many original equipment manufacturers are requesting that their suppliers adhere to standards of environmental quality and processes. These include Hewlett-Packard, Nokia, Ericsson, and Bristol-Myers Squibb. These developments have seen the supply chain adapt from one of compliance to OEM environmental mandates to one of using green lean to create value or lower costs. Suppliers once viewed environmental quality as something thrust upon them, but are beginning to understand that by becoming lean and green they are more economically competitive and thus more likely to survive in a competitive supply chain where all suppliers are now adhering to environmental quality control. In the new value chain model of green, socially responsible suppliers will be the most successful. A significant challenge over the next several years will be helping more and more companies make the transition to green lean and fostering growth within the growing green economy.

Recognize and Navigate Opportunity in the Global Value Chain

Manufacturers think about globalization, offshoring, and the supply chain in different ways. Success in the global marketplace for manufacturers looks different depending on the sub-sector and the size of the firm. Appendix B highlights the top import and export trading partners for the U.S. by high technology sector.

For example, some firms are finding that as expertise develops overseas they have even more reason to send design, development, and production across the world. Other manufacturers are moving production and design back to the U.S. as transportation and logistics costs of supply chain management become prohibitive and energy costs continue to increase. Of these, some cite quality concerns for changing their supply chain. For example, Houston-based Farouk Systems is moving all of its production of hand-held appliances from China to Houston in part to be closer to its customers as well as to better control quality and inventory and to fight counterfeiting. Owner Farouk Shami says the Houston-made hair irons will cost about \$2.50 more than those produced in China but he plans to absorb the cost without raising the price.³⁷ Even the U.S. military is reconsidering where they get their supplies. In 2003 the U.S. Department of Defense and the National Security Agency created the "trusted sources" program to make sure they are buying parts that will not fail because they have been (intentionally or unintentionally) infected with inferior or counterfeit parts.³⁸

Despite these activities there is not yet a clear link for many sectors between supply chain management and the global value chain. Recent survey data shows that:³⁹

- Sixty-eight percent of manufacturers rank supply-chain management and collaboration as key to their organization's success over the next five years.
- Sixty-six percent identify their organization's progress towards world-class supply-chain management and collaboration as average or better.
- Sixty-three percent describe their end-to-end supply chain's ability to respond to unexpected customer demand for existing products as "efficient" or "real-time."
- Sixty-four percent rate the importance of global engagement to their organization's success over the next five years as average importance or higher. Forty-six percent rate it as above average importance or higher.
- Twenty-five percent rank their organization's progress towards becoming a world-class global player as good or better.
- Only eight percent have increased their percentage of dollar volume of sales outside the U.S. by fifty-one percent or higher; only twelve percent operate or partner in 6 or more countries outside the U.S.; and only seventeen percent have sales and/or distribution facilities in 6 or more countries outside the U.S.

According to Dr. Irene Petrick of the Enterprise Informatics and Integration Center at Penn State University, globalization in the context of an individual firm can range from multiple operations in globally distributed locations (global production) to selling to customers in multiple locations (global sales and distribution) to linkages and collaborations with other firms or organizations in multiple geographic locations (global supply chains). Dr. Petrick believes that for many small and medium-sized enterprises (SMEs) the first option is not feasible and the latter two often confound small suppliers that frequently lack a strategic long-term commitment to globalization. She recommends a niche market approach to globalization where the SME commits to learning from mistakes and incorporating that learning into a long-term commitment that can benefit subsequent endeavors.⁴⁰

Still other manufacturers expect that future production may be accomplished in many smaller facilities in the U.S. and abroad to meet environmental concerns and react to local market demands. In this model, manufacturers may produce the same product in smaller lots in many smaller production facilities that are located closer to the specific markets they serve

The Shift from Supply Chain to Value Stream

Excerpt from Supply Chain Globalization, by Dr. Irene Petrick, Manufacturing a Better Future for America, 2009.

OEMs that lead traditional supply chains are now being challenged by networks of firms competing in a coordinated and collaborative fashion. Companies coordinating their activities in a "value stream" tend to be less linearly organized. Interactions between several firms are orchestrated to achieve a common goal. Thus, communication, collaboration and coordination are not tightly tied to the tiered structure of a supply chain. This is important for SMEs to understand as they seek to remain relevant. It suggests new opportunities for interaction with other companies in the network based on adding value rather than strictly on their position in a tiered arrangement.

Under this emerging structure, the buyer must understand that first-tier suppliers and customers are now involved in design, manufacturing, and delivery. Logistics networks are needed to complete the integrated supply chain management cycle. These linkages were most often between Tier 1 (suppliers) and OEM firms, but there is increasing evidence that a growing number of OEMs are forming partnerships with firms deeper in the lower tiers. The OEMs are attracted to companies that possess unique technical knowledge, process and production expertise.

National Innovation Marketplace

www.usainnovation.org

The MEP is connecting manufacturers to technology and business opportunities resulting in new markets and new products that are necessary for success in the global marketplace. In partnership with other organizations, the MEP program is developing the National Innovation Marketplace (NIM) to facilitate connections between technology requestors and potential suppliers. NIM encourages technology translation and adaptation, and estimates the potential for business growth. As a clearinghouse the NIM, the MEP, and their network of partners are facilitating the building of technology based supplier networks.

Process Equipment Company (PECo) of Dayton, Ohio participated in the National Innovation Marketplace to help overcome its drastically declining auto sector and layoffs (one-third of employees in the last year). Now having been connected to a patented 3D nanopositioner, PECO expects to see an annual revenue increase of over 7%, hire 15 new employees to handle expansion, and as one manager said, "It could really put us on the map."

(such as China, South America, or the southern U.S.) in order to both meet environmental and transportation concerns as well as to produce products that meet local market demands and differing standards for labeling, safety, and other factors.

Regardless, understanding the complexities of a global value chain can prove difficult, and no single formula is right for all firms or sectors, or even for the same sector over time. During economic disruptions (such as the current recession) firms often are out of synch as they try to understand where different parts of a large supply chain may be cutting back or gearing up. Consider the "Life of a DVD Player" supply chain graphic as an example of a complex, global value chain.

Regardless of whether a manufacturer is becoming more localized or more globalized, global supply chains remain a key characteristic of today's manufacturing landscape. This is true for large multi-national firms that have been negotiating the global marketplace for years and for small firms with limited global activity.

Making it all work smoothly requires strong relationships, strong coordination, and a certain amount of risk-taking and trust. The lead partner in the value chain may not be based on size and revenue but rather on intellectual property, process innovations, or product innovation. Or there may not be a lead partner at all, but rather a partnership of interconnected companies which understands that working better together will increase the economic competitiveness of all the partners involved.

One way in which manufacturers increase their competitiveness in the global value chain is to collaborate with others. This may include other (competitor) businesses, higher education, and government. Collaboration to increase regional competitiveness of firms is often referred to as a cluster strategy: networks of firms related by common suppliers, shared markets, labor pools or infrastructure that leverage interactions (including

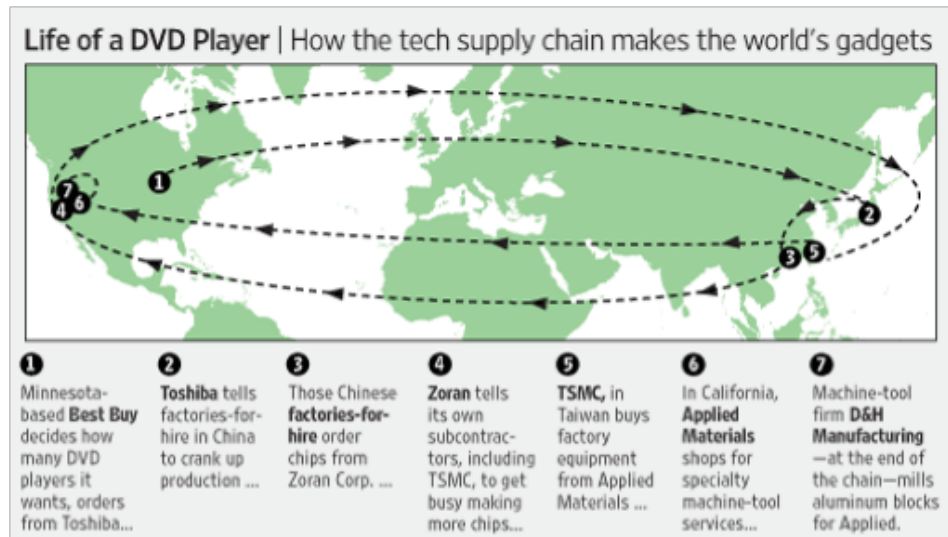
competition) to their mutual advantage. Manufacturing clusters often cited are the semi-conductor cluster in the Austin, TX area or medical devices in Jacksonville, FL or Minneapolis, MN. For manufacturing, the connection backward to raw material producers and intermediate product suppliers is not a straight line, but involves orchestrating a complex web of financial management, transportation and logistics, research and development, adequately skilled labor, appropriate technology, and domestic and international regulations.

Connecting firms into competitive cluster strategies is an important role played by government, industry associations, economic development agencies, and others within a state or region. A recent report from the Center for American Progress identified the most important characteristics to a successful regional cluster initiative as: (1) a pro-innovation environment including the presence of research institutions and committed government, and research and business leadership;

(2) management and workforce talent; (3) risk capital and debt financing; and (4) a regional innovation network of similar companies competing—especially in pre-competitive research—and cooperating with each other.⁴¹

An additional challenge for manufacturers trying to compete in the global economy is the increasingly blurry line between manufacturing and services. Based on evidence drawn from over 10,000 firms in 25 different countries, it appears that the majority of manufacturers around the world are adopting a range of strategies that make their products more marketable. These strategies include, but are not limited to:⁴²

1. Suppliers take on more responsibility for retail, distribution, finance, and logistics;
2. Manufacturers attach services to the product for the benefit of the customer, (e.g. installation, consultation, and maintenance);
3. Services are incorporated directly into the product by means of high-tech methods, such as “coupled product and service” (e.g. a Health Usage Monitoring System);
4. Use-oriented product-service systems where the customer is not the owner of the tangible product; instead the product, process, or service is shared, pooled, or leased (such as a leased cable modem or a vehicle painting system that is installed in an OEM’s assembly plant but owned and operated by the supplier); and
5. Result-oriented product service systems whereby the product is replaced by a service (such as support staff or replacing answering machines with voice mail service).



Source: “Clarity is Missing Link in Supply Chain,” Phred Dovorak, Wa| Street Journal, 5/18/2009

ExporTech

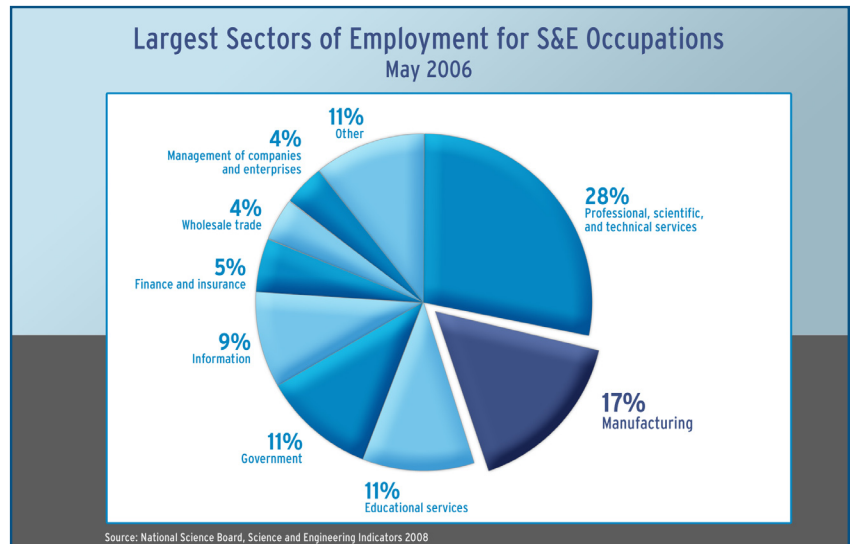
ExporTech is focused on helping manufacturers enter or expand into global. Developed as a pilot by the Maryland District Export Council, Baltimore U.S. Export Assistance Center, and the Manufacturing Extension Partnership, ExporTech is now deployed nationally as a collaborative partnership between MEP, U.S. Export Assistance Centers, and state international trade offices, among others. Participating companies meet for three one-day sessions over a three-month period, and develop export plans that are vetted by local experts. As exporting continues to present significant opportunities for manufacturers and is receiving significant support at the federal and local levels, the MEP Board supports national program goals to expand ExporTech program into more states in FY2010.

Wilco Machine & Fab is a manufacturer (located in Marlow, Oklahoma) of fabricated and machined equipment, products, and tools for the energy industry. In 2009 exports accounted for less than 8% of their total revenue. Following their participation in ExporTech, halfway through 2009 Wilco’s exports had jumped to 51% of its revenue and were expected to reach 60% of total revenue by the end of 2009.

This hybrid of products and services within manufacturing clearly indicates a new level of sophistication and complexity and requires that manufacturers understand the value-add demanded by consumers related to service offerings. It also requires the know-how to manage costs and timescales related to developing and executing non-standardized contracts or establishing long-term relationships with suppliers.

Develop and Retain Current and Future Talent

Despite the economic downturn and a perceived lack of jobs, data from a May 2009 survey of manufacturers indicates that skills shortages still exist, especially for the most profitable companies and for skilled production workers, scientists, and engineers. The survey also identified that having a highly skilled, flexible workforce remains critical to business success and that new product innovation is now seen as the most important driver of business success, which also requires a highly skilled, flexible workforce.⁴³



Anecdotal evidence suggests the lack of skilled workers extends beyond engineers and scientists to all levels of a manufacturing enterprise. The job of machinists and welders is now more dependent on a strong base of knowledge and skills than ever before. There is a shortage of appropriately skilled workers at nearly all levels of manufacturing, and major challenges to be overcome. In addition to concern over the declining percentage of students in U.S. universities studying science and engineering, the most recent skills gap report released by the NAM identified additional workforce challenges including: the exodus of Baby Boomers from the workforce with substantial accumulated skills; changing job requirements, necessitating some level of technical skill in almost all jobs and making truly unskilled jobs a thing of the past; significant dissatisfaction among manufacturers with the quality of K-12 education and the dearth of adequate and accurate career counseling; and the changing attitudes about careers and job satisfaction among Generation Y.⁴⁴

Since the U.S. trade imbalance began growing at the beginning of the 21st Century, so too have cries that the U.S. education and training system must focus on science, technology, engineering, and math (STEM) based curricula to increase our long-term global competitiveness. Science and engineering occupations in particular are critical to the manufacturing sector. Manufacturing is the second largest employer of individuals in science and engineering occupations, behind the professional, scientific, and technical services industry. It is worth noting that the research, development, and design industry is tightly tied to manufacturing. This industry exemplifies the transition from innovation to product deployment for new sales and new markets and is a critical part of manufacturing's supply chain.

The skills gap report by the NAM identified the changing attitudes about careers and jobs satisfaction among Generation Y as a major workforce challenge. This is concerning because long-term attitudes about working in manufacturing are important to

the industry's economic competitiveness. While manufacturing was identified as key to economic vitality in the Public View of Manufacturing survey, the perception exists – particularly among young people – that all of manufacturing represents the old economy. Younger people (age 18-24) are less likely to think that manufacturing is important to our economy, less likely to believe that additional investments in manufacturing are needed, less likely to think of manufacturing as high-tech, and least likely to agree that manufacturing jobs are clean and safe. Additionally, while manufacturing ranked first in terms of economic importance, it ranked only fifth as a career choice. Despite data that indicates older populations have a more favorable view of manufacturing, parents do not appear to think much differently from their children. Less than one in three Americans (30 percent) would encourage their child to pursue a career in manufacturing.⁴⁵

Yet, what if young workers thought of manufacturing for what it truly is - products that will be solutions to major challenges in our world (such as renewable energy and pharmaceutical manufacturing), products that young people relate to (such as automobiles and energy drinks), products that require high-tech skills and offer premium jobs? What if young workers thought about their careers in terms of occupations, skills, and learning opportunities rather than as being in an industry silo? Firms and policy makers alike should consider how working in advanced technology occupations appeals to younger generations. This may trigger a generational transition with significant economic impact.

Getting workers of all ages the knowledge and skills they need to be successful in today's manufacturing is critical. For manufacturers, the country's community colleges remain a strong public option for these activities. More than half of community colleges (55 percent or approximately 1,200 institutions) offered specialized training in manufacturing skills, with about 871,000 students enrolled in these courses.⁴⁷ A Center for Regional Economic Development Survey of 1,013 community colleges in June 2005 found that the majority of funding for these programs came from contracts or grants with private companies working in conjunction with a state.⁴⁸ These types of public-private partnerships are the key to helping manufacturers obtain the workers to stay competitive, and to training job seekers with the skills to obtain a good job.

Basic and advanced skill development itself is not sufficient for creating the internal infrastructure necessary to foster the product innovation that companies identify as their most important economic driver. To help spur innovation many companies are embracing the concept of employee leadership and empowerment. Workers drive the innovation of new processes and products from within the firm, either as individuals or as part of a group, sometimes from a role that is different than their official duties within their organization. How do firms create a culture that allows their talent to grow and prosper? This involves some combination of talent, process, and rewarding innovation. Two key methods that have been used by business to foster employee leadership and empowerment include:⁴⁹

- Employees are granted some form of ownership rights in the internal enterprises they help create.
- Employee teams are treated as a profit center rather than a cost center and are responsible for their own bottom line. One way companies handle this is for the team to have its own budget and its own internal bank account.

Small and medium-sized firms are often owned by local business people and are funded through local financial institutions. The needs of these manufacturing organizations, and their potential to revitalize America through the introduction of new products, should be a top federal priority. . . . Many case studies indicate that firms with greater training and workforce development are more competitive and are achieving higher productivity gain. It is difficult for most of these companies to find the resources necessary to support these activities.

—Jim Jacobs, President of Macomb Community College in Michigan and MEP Advisory Board Member⁴⁶

Companies are experimenting with employee leadership and empowerment in green product development and green lean process innovation. There are strong indications that universities are also following this trend. Beyond becoming green and lean themselves, universities have begun educating and training the next generation of leaders who understand the environmental aspects of business. For example, a new program offered by the University of Pennsylvania's Wharton School and School of Arts and Sciences is enabling graduate students to earn a dual Master of Business Administration/Master of Environmental Studies degree. Four Ohio campuses launched an advanced energy master's degree program. The first

Layoff Aversion

The Workforce Investment Act (WIA) authorizes services and funds for dislocated workers as well as rapid response activities to facilitate a smooth transition to new jobs and careers when workers lose their jobs. Over the last decade WIA dislocated worker funds have been utilized for layoff aversion – to prevent the layoff or minimize its scope and effect on both workers and communities. In recent years layoff aversion programs have been developed in Oklahoma, Missouri, Michigan, New York, Pennsylvania, and Indiana, and other states, such as California, have nascent efforts.

The Missouri MEP Center – Missouri Enterprise – has been responsible for conducting assessments for the state's layoff aversion program at no cost to the employers. For these at-risk businesses, Missouri Enterprise analyzes and prioritizes challenges and opportunities for the company's survival, and helps to develop strategies to avert plant closings and business failures. By addressing risk factors before they become critical, Missouri Enterprise helps businesses increase their available options, the likelihood of successfully averting layoffs, and helps to stabilize a company so that it can consider growth opportunities with new products and markets, new technologies, and even new jobs. During 2007-2009, 202 jobs were created and an additional 371 jobs were retained across 69 companies through Missouri's Layoff Aversion program.

doctoral degree in sustainability was launched at the Rochester Institute of Technology, with the goal of advancing research and education in alternative energy development, sustainable design, green product development, industrial ecology, and pollution prevention.⁵⁰

As firms consider their culture of employee leadership and empowerment, the sharing of information and internal talent development and talent management becomes critical. A 2009 roundtable of leaders from academia (Harvard and University of Michigan), business (Corning, Cisco Systems, Goldman Sachs and IBM), and others (Aspen Institute, Conference Board, Deloitte and Fortune Magazine) identified what it means to be a talent driven firm. The accompanying text box identifies ways in which the roundtable described the relationship between information, knowledge, innovation, and talent.⁵¹

Finally, the need to create and retain jobs is an important element of economic and workforce strategy. During these difficult economic times, one strategy to stop the hemorrhaging of jobs is for business services to focus on stabilizing a company so that future growth opportunities can present themselves. This strategy of stabilizing a company so that it can retain current employees and prepare for future job growth within the company is commonly referred to as layoff aversion strategies. Many states across the nation are beginning to align their formal workforce development layoff aversion strategies with business services such as those offered by the MEP.

Small and medium-sized firms are often owned by local business people and are funded through local financial institutions. The needs of these manufacturing organizations, and their potential to revitalize America through the introduction of new products,

should be a top federal priority. Many case studies indicate that firms with greater training and workforce development are more competitive and are achieving higher productivity gain. It is difficult for most of these companies to find the resources necessary to support these activities.

The Talent Driven Firm

In 2009 the Aspen Institute convened a roundtable of private and public sector leaders who observed that:

Manufacturing firms identify talent as one of the top issues impacting their competitiveness. While knowledge and skills development is often done through education and training programs, today's firms acknowledge an innate need for individual workers to gain knowledge and skills within and across firms, through social and professional networks and through experimentation and innovation. This will drive the next generation of research and development employees. Tacit knowledge is the most valuable type of knowledge, which often embodies subtle but critical insights about process or nuances of relationships, and is best communicated through stories and personal connections – modalities that are typically discounted in most enterprises.

- The primary source of value for companies is shifting from accumulating and exploiting static “stocks of knowledge” to managing continuous “flows of knowledge.” The information age now means that knowledge is gained continuously, 24/7.
- How exactly does talent get better faster? Not simply by formal training, but by trying new things, by allowing workers to experiment with what they do in their jobs and how they do it, and by tackling real problems with other talented people with different backgrounds and skills – people who are just as likely to work for other companies, in their locales, as they are to be working in the same company. Talented employees develop best by participating in talent networks, the largely invisible matrix structures, made up of knowledge flows that run within firms and, with increasing frequency, between and across them.
- Most businesses are still based on well-established command and control structures and have a hard time accepting systems, like those built on web-based social networking tools, that encourage bottom-up horizontal collaboration, even internally. As a result, the most exciting innovations in building talent-driven firms may well occur in smaller entrepreneurial firms and at the edge of large enterprises, rather than at their core.

Summary – Characteristics of Successful Manufacturers

Four interconnected responses to change have emerged among successful manufacturers. These include:

- Innovating constantly to adapt to economic and technological changes;
- Embracing green and green lean;
- Recognizing and navigating opportunity in the global value chain; and
- Developing and retaining current and future talent.

The Manufacturing Extension Partnership, in combination with federal, state, and local partners are working with firms that are advanced in these responses to help them use these strategies as sustaining sources of competitive advantage. The MEP and its partner organizations are also working with firms that are seeking a navigator, guide, and strategic partner in shaping their responses to post-recession economic realities. For example, the Green Supplier Network and E3 are helping firms to link energy usage and environmental mitigation with economic success. The National Innovation Marketplace is helping to spur innovation and connect manufacturers within the supply chain. And layoff aversion strategies are helping firms and communities retain jobs and remain competitive in these challenging economic times.



Opportunities for Action

The MEP Advisory Board seeks policy action that will help trigger and support the transition to product innovation, development and deployment into new sales and new markets. We believe that the manufacturing industry has the potential to be part of the backbone of the nation's economic recovery and the economic future of the nation. By recognizing and more clearly defining the characteristics of successful manufacturers, policy makers can cohesively support, promote, and re-energize the growth of U.S. manufacturers and in the process re-brand what American manufacturing is and what it does. We believe that all policies must abide by three principles: (1) help, not hinder, including greater emphasis on technical assistance over compliance; (2) add value; and (3) replicate lean manufacturing by streamlining government efficiency and effectiveness. We recognize that firms themselves are ultimately responsible for their individual success across the four critical categories of response outlined in this report. It is not enough to "survive" in the short-term; companies must be pro-active about long-term sustainability. Toward this end, we offer a menu of opportunities for action across each of the four characteristics of competitive manufacturers.

Innovate Constantly to Adapt to Economic and Technological Changes

1. **Streamline innovation and growth services targeted to manufacturers.** There are a multitude of programs and practices focused on increasing the competitiveness of U.S. manufacturers, and businesses in general, but too often they operate in silos that deter collaboration and stimulate competition among programs for federal resources. The National Innovation Marketplace is a promising effort to electronically connect manufacturers and product developers. These connections can also be strengthened through the place-based strategies - also called "cluster" or "sector" strategies - that are being promoted by the current Administration. In order to increase these nascent federal efforts to support innovation we recommend that a formal review of existing incentives and barriers to innovation, performed by a body such as the Manufacturing Council or another policy group or task force, is necessary. A review of the balance between existing patent and licensing laws should be included in this effort. Why is it that a musical artist can write a song and get copyright protection forever, but inventors get patents for only 17 years? While the two scenarios have their undeniable differences, this time interval may be a deterrent to manufacturers making more significant research and development investments. The MEP can work collaboratively with the U.S. Patent and Trade Office to develop an efficient and effective process to adjust the balance between patent lengths and licensing issues and how products are eventually expanded into competitive markets to open the product to new or additional innovations that a competitive marketplace can better provide.

2. **Target R&D investments to where measures and outcomes indicate success.** While many and varied reports and studies have called for a renewed investment in basic and applied research, it is important to see the national laboratories (such as Department of Energy, Department of Defense, and National Institute of Health) held accountable for including technology transfer measures as part of their mission. We believe the lab should be closely connected to MEP and that MEP can help take innovations into the marketplace through its network of regional centers. We would encourage a system that links the availability of base funding for national labs to successful technology transfer indicators, and that the MEP is in a position to assist these laboratories in making their technology transfer processes more efficient and effective. Furthermore, MEP should oversee a manufacturing technology arm of the Small Business Innovation Research (SBIR) program to better coordinate services to small and medium-sized manufacturers.

Embrace Green and Green Lean

3. **Invest in clean energy innovation and expand the clean energy supply chain.** We support the increased research and development of products related to clean energy technologies including wind, solar, biofuels, fuel cells, energy storage and transmission technologies, and advanced carbon capture and storage, as they present great opportunities in both innovation and green lean. As investments in this area increase, we expect to see more and more companies migrating from declining sectors within the manufacturing industry into clean energy manufacturing. To help with this transition we support the expansion of E3 (Economy-Energy-Environment) and the Green Supplier Network, two collaborative, resource-sharing models between U.S. agencies, local utilities, local government, and small and medium-sized manufacturers.
4. **Increase awareness, understanding, and implementation of green and new energy economy industrial standards.** While many standards are emerging, such as the International Organization for Standardization's ISO14000 Environmental Management Standard, there are likely to be many more standards to come. There is a need to both inform U.S. manufacturers about looming standards, certifications, and performance measures in a systematic manner and provide training on ways to meet or exceed the standards. Due to the location of the MEP within the National Institute for Standards and Technology (NIST) we believe the program is uniquely positioned to bridge the gap around standards awareness and implementation with manufacturers.
5. **Create market opportunities from major global challenges.** We were glad to see this as a major recommendation in the recently released report by the National Economic Council and the Office of Science and Technology Policy's report on "A Strategy for American Innovation: Driving towards Sustainable Growth and Quality Jobs." If we are going to focus on innovative new product development, we should also emphasize the social and economic benefits of addressing challenges faced across the world, including health care access, costs, and breakthrough treatments; food and hunger issues; and drinkable water. MEP can play a role in linking the research done through NIST and other federal laboratories to the state and local MEP centers through technology transfer, technical assistance, and other aspects of its current product and service offerings.



Recognize and Navigate Opportunity in the Global Value Chain

6. **Increase efforts to help manufacturers navigate export markets and streamline the technology export process.** One very promising practice is ExporTech, a collaborative effort between MEP, the U.S. Export Assistance Centers, District Export Councils, Small Business Development Centers, and state-based international trade programs. This program is a “how to” service to help companies expand into global markets by developing a proactive international growth plan customized for their business and moving the company into actual, profitable export sales. The program offers detailed guidance – all in one place – on the variety of elements critical to understand for executing an exporting program, from banking and financing to freight forwarding, licensing, and strategy. Secretary of Commerce Gary Locke recently announced an initiative to streamline the Department of Commerce’s licensing of dual use technology exports to many countries. Additional effort is needed to revamp the process by which dual use and military technologies are identified, licensed, and controlled. These processes should be streamlined into an expedited “one-stop” process that eliminates the current split licensing process that is managed by the Department of State and the Department of Commerce (with Department of Defense involvement in both processes). The current licensing process is a major impediment to U.S. exporting.
7. **Increase efforts to help manufacturers diversify their markets.** Growth services include the development of new products and services, but just as important they include the creation of new market opportunities. For many manufacturers, this means diversification from existing markets into emerging industries. The Michigan Manufacturing Technology Center (MMTC), the MEP center for the State of Michigan, has developed a program specifically focused on assisting companies in aligning their core competencies and strengths with new customers in both current markets and in new markets, improving sales effectiveness and return on investment, and increasing marketing support for new sales efforts.
8. **Improve the data available to present the value of manufacturing.** It is hard to truly understand the competitiveness of U.S. manufacturing based on traditional indicators. New data is critically needed to track the implications of the globalization of manufacturing and services in high technology industries for the U.S. economy as a whole, and for the health of our manufacturing sector. This need should be addressed expeditiously by relevant Federal agencies and include new measurements beyond job creation and production. It is critical that America has a real discussion about what we believe constitutes a healthy manufacturing sector. We encourage MEP to work with data leaders from key federal agencies and national organizations to identify a series of manufacturing dashboard indicators beyond the traditional measures of employment and productivity and produce more just-in-time data to inform national manufacturing policy and practice.

What is a healthy manufacturing sector? Opinions vary.

- Is it jobs and productivity?
- Is it year to year firm survival?
- Is it wealth generation in a community?
- Is it stable, premium wage employment?
- Is it a firm’s ability to increase its ROI?
- Is it sustained levels of research and development investment?
- Is it sustained levels of new product, process, and market innovations?
- Is it a sustained percentage of revenue from products 5 years old or younger?
- Is it a neutral balance of trade across the industry’s sub-sectors?
- Is it the development of manufacturing professionals?

Develop and Retain Current and Future Talent

9. **Promote career pathways and a rebranding of manufacturing in the economic sector where innovation leads to product, development and deployment into new sales and new markets.** This effort will take a tremendous amount of outreach, awareness, and education. However, it is extremely worthwhile and important to our overall goals for many reasons, including attracting young workers to manufacturing. Manufacturing has a largely negative connotation with the media and the general public and the value of producing goods has never been held in lower esteem. We need to rebrand manufacturing for what it is, a high-technology activity that transitions innovation to product deployment. We need to highlight to manufacturers, parents, students, workers, and the media that this is done through employee leadership and in “talent driven firms”, and that a career in manufacturing is a career in product innovation, development, and deployment. In order to do this, MEP must work with key national, state, and local partners to help ensure workplace-based education can be translated into academic credit; to better connect job training and adult education to careers in manufacturing; and to use co-op programs and internships as a federal funding source for higher education. As importantly, we must integrate vocational and adult education with academic training so that we recognize career and technical education as a gateway into innovation, product development and deployment and reinvigorate trade skills as a choice not an alternative in high school.
10. **Emphasize manufacturing within the higher education curriculum.** We strongly support an increase in the manufacturing emphasis in formal engineering education, an increased emphasis on manufacturing and supply chains in both business and science degree programs, and the expansion of international business competitions (in high school and post-secondary) to include a focus on manufacturing products. For example, manufacturing courses should require mathematics and English as prerequisites. More students need exposure to mechatronics, the trend towards the synergistic combination of precision mechanical engineering, electronic control, and systems thinking in the design of products and manufacturing processes. MEP should work with national, state, and local education leaders to stress the need for more mechatronics training in secondary and post-secondary education and training courses. The Eureka Ranch, a strategic partner of MEP, is working on building an innovation curriculum to be utilized in this effort.
11. **Endorse and promote national certification and skill standards that relate to manufacturing.** The U.S. Department of Labor’s 2006 Framework of Competencies for the Advanced Manufacturing Sector⁵² was developed with manufacturers to identify a consistent set of knowledge, skills, and abilities needed to thrive in the 21st century world of manufacturing. This effort is being revisited and revised by the Department of Labor and includes staff from MEP in the process. In addition to this effort, the Manufacturing Institute partnered with the National Manufacturing Skills Standard Council, the National Institute for Metalworking Skills, the American Welding Society, the Society of Manufacturing Engineers, and ACT Inc. to develop the NAM-Endorsed Skills Certification System⁵³ that was released in 2009. These efforts should be applauded and built upon as a basis for effective communication between education and industry.
12. **Partner with the federal, state, and local workforce system to proactively avert layoffs.** We are in unprecedented economic times and layoffs are all too commonplace. Preventing or minimizing the scope and effect on both workers and communities is an important aspect of economic and workforce development. Companies and workers can be determined to be “at risk” of closing or necessitating layoffs for a variety of factors, addressing these risk factors before they become critical increases the number of available options and improves the likelihood of successfully averting layoffs. Layoff aversion assistance is clearly authorized in the Workforce Investment Act and in its final regulations, allowing dislocated worker funds to be used for economic trends monitoring and creation of early warning networks, pre-feasibility studies, employee stock ownership plans, incumbent worker training, and linkages to loan programs and other business assistance programs. The MEP Centers in Missouri, Oklahoma, Pennsylvania, and others are leading the way in working with the state and local workforce system (through early warning systems and other processes) to avert mass layoffs. This process needs to be fully supported - layoff aversion is a critical job creation strategy in today’s economic climate.

Summary – Opportunities for Action

The MEP Advisory Board offers twelve specific recommendations across four broad categories that are designed to emphasize technical assistance over compliance, add value, and share the burden across the private, public, and education sectors. Our recommendations fall into the following four areas:

- Innovate constantly to adapt to economic and technological changes;
- Embrace green and green lean;
- Recognize and navigate opportunity in the global value chain; and
- Develop and retain current and future talent.

The Manufacturing Extension Partnership, in combination with its federal, state, and local partners is ahead of the curve in working with firms that are advanced in these responses to challenges of accelerated global competition. This partnership is ready to continue to work with firms to make continuous innovation, green product development, and green lean continuous process improvement a sustaining source of global competitive advantage. The MEP and its partner organizations are also ready, willing, and able to work with small and mid-sized firms that are seeking a navigator, guide, and strategic partner in shaping their responses to these ongoing global challenges.

For example, the Green Suppliers Network and E3 are helping firms in a way that links energy and environmental impacts with economic success. The National Innovation Marketplace is helping to spur innovation and connect manufacturers within the supply chain. And layoff aversion strategies are helping firms and communities retain jobs and remain competitive in these challenging economic times. These programs must be supported, expanded, and taken to scale to serve more firms, communities, and workers.

Appendix

Appendix A:

U.S. Products Lost or At-Risk to Globalization

Excerpted from Harvard Business Review, July-August 2009, "Restoring American Competitiveness," by Gary P. Pisano and Willy C. Shih

Many high-tech products can no longer be manufactured in the United States because critical knowledge, skills, and suppliers of advanced materials, tools, production equipment, and components have been lost through outsourcing. Many other products are on the verge of the same fate.

Industry	Already Lost	At-Risk
Semiconductors	"Fabless Chips"	DRAMs Flash Memory Chips
Lighting	Compact fluorescent lighting	LEDs for solid-state lighting, signs, indicators, and backlights
Electronic Displays	LCDs for monitors, televisions, and handheld devices like mobile phones Electrophoretic displays for Amazon's Kindle e-reader and electronic signs	Next-generation electronic paper displays for portable devices like e-readers, retail signs, and advertising displays
Energy Storage and Green Energy Production	Lithium-ion, lithium polymer, and NiMH batteries for cell phones, portable consumer electronics, laptops, and power tools Advanced rechargeable batteries (NiMH, Li-ion) for hybrid vehicles Crystalline and polycrystalline silicon solar cells, inverters, and power semiconductors for solar panels	Thin-film solar cells (the newest solar-power technology)
Computing and Communications	Desktop, notebook, and netbook PC's Low-end servers Hard disk drives Consumer-networking gear such as routers, access points, and home set-top boxes	Blade servers, midrange servers Mobile handsets Optical-communication components Core network equipment
Advanced Materials	Advanced composites used in sporting goods and other consumer gear, Advanced Ceramics, and Integrated circuit packaging	Carbon composite components for aerospace and wind energy applications

Appendix B:

Understanding the Global Marketplace

Three largest export markets for U.S. technology products: 2006⁵⁴

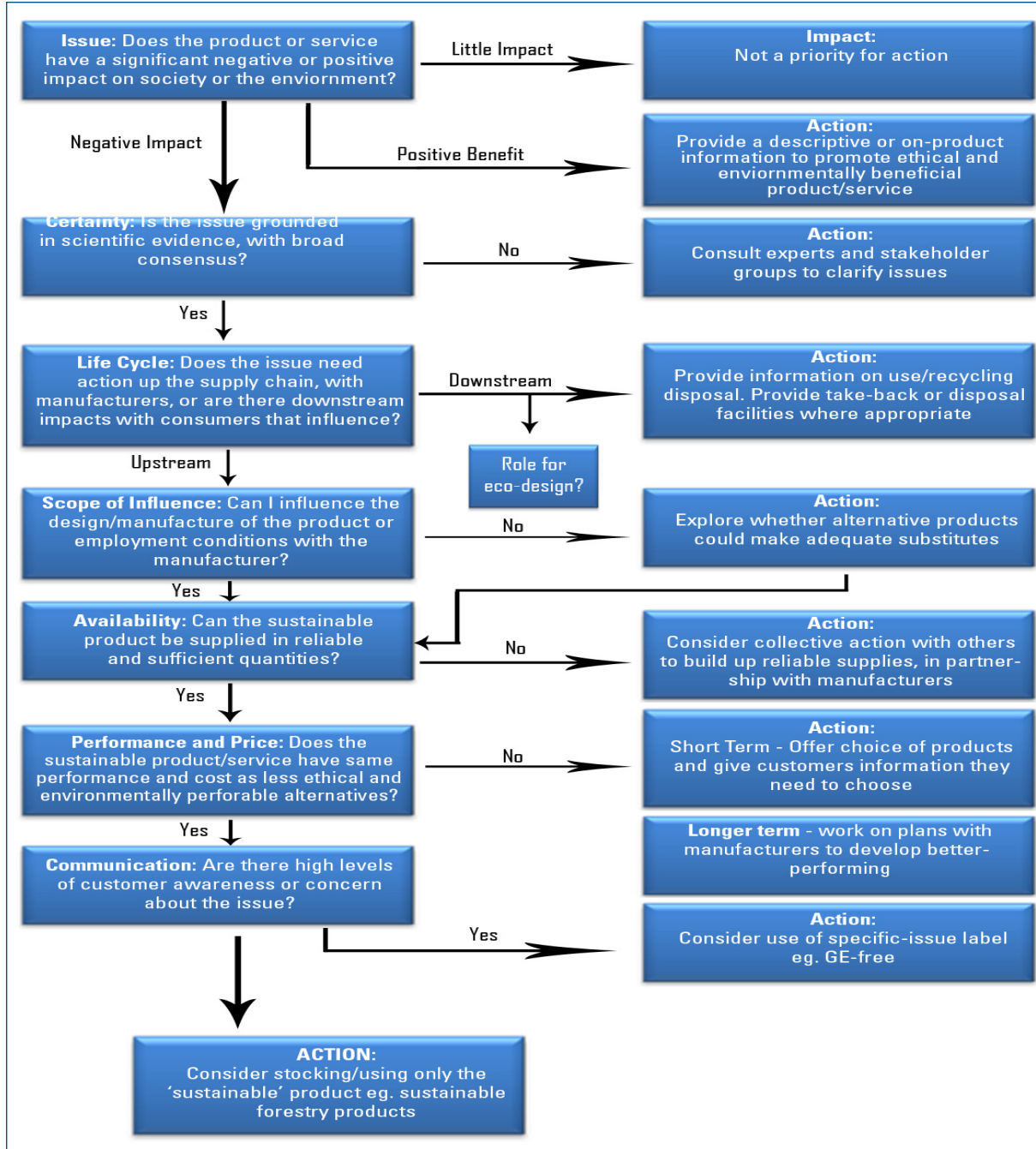
Export	Largest Market		Second Largest Market		Third Largest Market	
	Country	Percent	Country	Percent	Country	Percent
All technologies	China	9.6	Canada	9.3	Japan	7.7
Computer software	Canada	41.6	Mexico	8.6	China	6.5
Advanced materials	Mexico	14.1	China	11.5	Japan	11.1
Aerospace	Japan	8.7	France	8.5	China	8.1
Biotechnology	Netherlands	28.8	Belgium	13.1	UK	12.6
Electronics	China	16.9	Malaysia	11.1	Mexico	10.6
Flexible manufacturing	South Korea	15.4	Taiwan	13.7	Japan	13.0
Information/ communications	Canada	16.2	Mexico	13.7	China	8.0
Life sciences	Japan	12.6	Germany	10.9	Canada	8.6
Nuclear technology	Japan	36.9	UK	15.0	Taiwan	9.8
Optoelectronics	Japan	15.4	Germany	10.6	Taiwan	9.7
Weapons	UK	16.4	Japan	14.4	South Korea	10.0

Three largest foreign suppliers of technology products to United States: 2006⁵⁵

Import	Largest Supplier		Second Largest Supplier		Third Largest Supplier	
	Country	Percent	Country	Percent	Country	Percent
All technologies	China	25.3	Mexico	10.6	Japan	8.9
Advanced materials	Japan	44.2	Mexico	11.3	Germany	10.1
Aerospace	France	24.7	Canada	22.9	UK	13.0
Biotechnology	Germany	25.6	Ireland/UK	11.1	Belgium	9.3
Computer software	Mexico	23.7	China	17.0	Canada	16.6
Electronics	Taiwan	16.2	South Korea	11.1	Malaysia	10.8
Flexible manufacturing	Japan	43.4	Netherlands	10.2	Germany	9.5
Information/communications	China	40.5	Malaysia	13.4	Mexico	10.1
Life sciences	Ireland	35.3	Germany	10.6	Mexico	6.6
Nuclear technology	UK	29.9	Russia	27.8	Netherlands	14.9
Optoelectronics	Mexico	51.9	China	22.8	Japan	6.8
Weapons	Canada	15.8	UK	15.0	China	13.4

Appendix C:

Sustaining the Supply Chain: Suggested Model for Decision Making



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