



Industrial Transformation: Key to Sustaining the Productivity Boom

A White Paper

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National Coalition for Advanced Manufacturing

NACFAM is an industry-led, non-profit 501(c)(3) education, research, and services organization committed to enhancing the productivity and competitiveness of U.S.-based manufacturing. NACFAM's goal is the accelerated development and deployment of advanced technologies and related workforce skills and knowledge within all tiers of the U.S. industrial base.

NACFAM provides leadership in developing public policies and programs in areas directly related to the manufacturing process; increased R&D investment in manufacturing science and technology; workforce skills assessment and certification; and technical assistance to smaller suppliers.

Founded in 1989, NACFAM has built a unique, public-private community of over 1,500 corporations, 20 national trade associations, and 350 non-profit organizations that offer productivity enhancing services to manufacturers: Federal labs and university research centers in the field of R&D; community and technical colleges in the field of workforce education and training; and manufacturing extension services in the field of supply chain optimization.

Industrial Transformation: Key to Sustaining the Productivity Boom

Executive Summary

Manufacturing is the primary source of productivity growth and remains critical to the nation's future prosperity and security. Yet, U.S.-based manufacturers are facing a crisis today as significant as the competitiveness crisis of the 1980's—a crisis marked by a steep decline in business investment, a sluggish economy at home and abroad, and sharpened competition from low wage countries, especially China.

To deal with this new set of challenges, this paper takes the view that the U.S. can compete successfully with low-wage countries if industry and government rally around two basic goals: (1) increase labor productivity by greatly accelerating the use of advanced technologies and (2) leverage national resources through a major expansion of public-private partnerships.

As the central elements of that strategy, NACFAM's Advanced Manufacturing Leadership Council recommends the following measures:

- *Move global competitiveness higher on the national agenda and establish a high-level advocate for manufacturing within the Administration*
- *Develop and deploy next generation process technologies: "A New Tool Kit"*
- *Better enable American workers to keep pace with technological change*
- *Decrease supply chain vulnerability and support the nation's smaller suppliers*

This paper contains specific policy suggestions for achieving each of these goals.

Taking such steps will accelerate the rate of manufacturing innovation, stimulate investment in the most advanced manufacturing equipment, continually improve workforce skills and create a voice in the federal government to ensure the continuation of manufacturing-friendly public policies. The overarching effect of implementing these recommendations would be the reduction of unit labor costs made possible by high rates of productivity growth, thereby enabling U.S.-based manufacturers to be competitive in any industry sector where they choose to do business.

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Introduction

In the 1980's, Japan and the Asian Tigers threatened US industrial leadership with a global economic competitiveness crisis. US industry rose to that challenge as evidenced by its performance as the world's most competitive economy throughout much of the 1990's and into the 21st century.¹

The beginning of the 21st century is confronting US industry with a new crisis brought on by a prolonged economic slowdown, steep decline in business investment, a weakened stock market, global economic downturn, and sharpened competition from low-wage countries, especially China. That competition is creating a surging trade deficit—now costing the US well above *\$1 billion per day* (see Fig. 1 below)—that simply can no longer be ignored. A softening dollar is now providing temporary relief for exporters, but only a robust, highly competitive manufacturing sector, combined with effective trade policies, can substantially reverse this trend over the long term.

Figure 1. Ballooning Trade Deficit

The goods deficit stood at \$427 billion in 2001 increased to \$484 billion in 2002 and is on track to hit \$550 billion in 2003. Moreover, the level of goods imports is projected to exceed \$1.2 trillion in 2003.

Source: Bureau of Economic Analysis

The manufacturing sector in the US has been particularly hard hit by these macroeconomic forces, experiencing 32 consecutive months of job loss totaling roughly 2.3 million jobs, fully 90% of the total jobs lost in the period. In fact, the recent recession might have been appropriately termed a manufacturing one since the economic dislocation fell disproportionately on its shoulders. While recent economic indicators are mildly positive, the current post-recession manufacturing recovery is the weakest on record. The manufacturing sector remains fragile.

This paper explains why the manufacturing crisis is so fateful for the US economy. It also notes how transformational industrial capabilities can create a pathway to sustaining the productivity boom that has persisted even during the current economic slump and leading the nation to a brighter economic future.

The paper then suggests a public policy strategy that can help accelerate this transformation, with enormous benefits for both economic and national security. This strategy can aid industry's effort to respond to the current crisis just as effectively as it did to the competitiveness crisis of the 1980's.

¹ World Economic Forum: Global Competitiveness Rankings
National Coalition for Advanced Manufacturing
Washington, D.C.

The Vital Importance of Manufacturing

Restoring the manufacturing sector to health is key to the future prosperity of our nation. Despite the job loss, manufacturing still employs 16.5 million people and, due to the multiplier effect, supports at least 3 additional jobs for each manufacturing one elsewhere in the economy.² Moreover, manufacturing:

- Contributes roughly 17% of our nation's GDP, and adds 29% to our national output
- Provides 71% of our exports
- Funds 67% of total national R&D, a figure that rises to 75% when industrial research performed under government contracts is included³
- Is a major customer for information and communications technologies, signaling that manufacturing and information service industries are actually fusing.

Most importantly, manufacturing is the prime source of productivity growth, setting the pace in the 1990's and achieving high levels of productivity even during the present downturn. Productivity growth is the economic magic that allows the economy to increase its economic "speed limit," growing with low rates of inflation and rising real wages.

Manufacturing also plays a prominent, yet often overlooked, role in our national security. Given the intimate link between the war-fighter and logistics, the Pentagon's commitment to transforming military strategy and weapons systems requires a parallel commitment to transforming the defense industrial base. In the field of homeland security, our ability to provide transportation hubs, first-responders and ordinary citizens with new terrorism-fighting products and technologies on a nationwide scale is critical.

The Vision: Industrial Transformation

Manufacturing has the potential to take a great leap forward in being able to provide the products we want or need, when we want them and at an affordable price. There are various technologies currently in various stages of development that can dramatically alter the way products are designed and made. These include, for example:

- *Reconfigurable Software Tools and Systems* – Single tools or machines that can perform multiple functions including functions not anticipated in the original design and without requiring new tool production.
- *Solid Free Form Fabrication* – The rapid creation of solid objects through the deposition of raw material in a controlled, systematic fashion.
- *Advanced Sensors* – devices that respond to external stimuli and feed that data into larger monitoring, diagnostic and actuation systems.
- *Micro-fabrication* – The creation of materials and parts through the manipulation of matter at the molecular level.

²For recent data on this multiplier effect, see the Millken Institute's report, "Manufacturing Matters: California's Performance and Prospects." (2002).

³ National Science Foundation data, 2001

- *Modeling, Simulation and Visualization* – Using high-speed computers, the ability to build virtual representations of parts, processes and systems, simulate their interaction with one another and their environment and observe that process in a way that is useful.
- *Smart Systems* – Computer-integrated, electro-mechanical systems and processes that have the capacity to *learn*.
- *Designer Materials* – For example, an airfoil that responds to airflow by changing shape or a synthetic material that mimics that which occurs in nature.⁴

As an early step towards transformation, technologies and processes are already in the pipeline to manufacture a “product of one.” Also known as “mass customization,” this would mean the production of highly individualized products on a mass scale. If combined with low cost and high quality, the benefits of the widespread adoption of this capability would be pronounced.

For many industries, mass customization would mean a shift in traditional thinking from one of supply “push” (build it and they will come) to one of demand “pull” (build it because the customer ordered it). Customers would be able to order products according to their own specifications and have them delivered or be able to pick them up in a relatively short period of time. In layman’s terms, such a migration would amount to a “Dell” model applied across the economy. It would thus be a win-win development: companies can reduce inventory and work in process and customers get the products they want, as and when they want them.

If manufacturers across the nation accelerate the development and use of advanced production technologies to transform the means of production, this would profoundly enhance the productivity and global competitiveness of U.S.-based manufacturing. Realizing this vision across the economy would result in substantial economic and societal benefits. However, the widespread adoption of productivity-enhancing technologies within all tiers and sectors of industry will not occur in a vacuum.

The Structural Challenges

The challenge is to ensure that the technologies and processes to enable this transformation are more rapidly developed and deployed. Only when the use of these advanced technologies reach critical mass will they have the desired macroeconomic benefits.

To adopt transformational technologies and related processes, however, US-based manufacturers need to deal with several structural challenges:

Declining rates of capital investment – In response to the economic slowdown and global uncertainties, most companies have been sluggish in investing in the new technologies required to drive transformational change.

Insufficient R&D investment in manufacturing process technologies – Although technology-based productivity growth is enabling the non-inflationary economic growth, funding for basic and applied R&D for productivity-enhancing technologies is scarce within both government and industry.⁵ In addition, the relative long lead times for basic and applied

⁴ For further details, see “Potentially Disruptive Advanced Manufacturing Technologies,” NACFAM, 2003

⁵ See, “Federal Support for Manufacturing Science & Technology,” May 2001, NACFAM

research need to be compressed, if government-funded research in the field of manufacturing process technologies R&D is to play a significant role in industrial transformation.

A deepening skills gap - Although rapid technological change is requiring new kinds of skills, the skills gap is growing. Nearly 60% of the new jobs in the early 21st Century will require skills that are held by just 20% of the present workforce. Responses to this skills crisis at both federal and state levels remain inadequate.⁶ The skills gap is a critical issue, because greater labor productivity will be essential if the US is going to compete successfully with low-wage countries, such as China. (See Figure 2)

Figure 2: The China Challenge

Today, the greatest competitiveness threat to US-based manufacturing comes from low-wage countries, particularly China. China benefits from a surplus of well-educated cheap labor (According to UN estimates China's average wages are 1/3 of Mexico's, 1/5 of Malaysia's and Taiwan's, 1/10 of Singapore's, and 1/20 of U.S. wages). It is not surprising then that Chinese manufacturing has come to dominate labor-intensive industries such as toys, shoes, clothes etc.

What is surprising is that the wealth generated from these activities has created little to reverse the goods trade deficit. There are two significant contributing factors, among others. First, China's economy, and other developing economies in Asia, is deliberately structured to favor exports, the vast majority of which are bound for the United States. Competitive regional devaluations, or simply fixed currency regimes pegged at artificially low rates in the case in China, keep the exports flowing.

The second factor is that the labor surplus is of such a magnitude that, although China has seen astounding growth in recent years for an economy its size, real wages have been *falling*. The Chinese economy is simply not creating enough jobs for the masses who want them.

This is significant because economic theory suggests that wage differentials should reflect differences in productivity levels and that any misalignments among countries correct themselves over time. This was true of Japan, the Asian Tigers and even Europe after World War II. The concern is that in the case of China, the adjustment process will be painfully long.

Sources: BCA Research, *The Economist*, MarketWatch, Morgan Stanley

If US-based manufacturers aggressively use advanced technologies and higher skills to substantially reduce labor costs, they will be able to compete successfully with low-wage countries.⁷ This process will substitute higher-skill/higher-wage jobs for lower-skills/lower-wage jobs. It will also lead to an overall increase in jobs for several reasons:

- More productive and competitive companies will gain markets, enabling them to expand their businesses and create new jobs

⁶For details on the growing skills gap, see "The Case for Enhancing American Workforce Skills," April 2003, NACFAM, Washington DC

⁷ According to *The Economist*, the labor cost factor has already declined from 30% of total costs in 1960 to roughly 12-15% today.

- Expanded use of advanced technologies will create more jobs in service sectors (systems integrators, computer technicians, engineers, designers, software developers, etc.) directly related to advanced manufacturing.

Supply chain vulnerabilities and weaknesses – Secure lines of supply are needed for both industrial efficiency and national security reasons. Terrorism has increased the vulnerability of supply lines from abroad. U.S.-based suppliers are competing on the front lines with the realities of global procurement.

Lack of a High-level Focal Point for Manufacturing Productivity – Although the areas cited above—incentives for capital investment, manufacturing sciences R&D, workforce skills development, reliable suppliers—are central to manufacturing productivity and competitiveness, these are areas of systemic under-investment at the federal level. This is partly due to the reality that there is no focal point within the Executive Branch for examining these various issues in an integrated, strategic manner.

A high-level advocate for manufacturing is needed within the Administration. Greater attention to manufacturing from senior levels of government will also help stimulate an increase in public-private collaboration, an effective means for mobilizing the nation’s resources and creating a more supportive infrastructure for industrial transformation.

The Response: A National Strategy

To consider public policy directions that might address these structural challenges, NACFAM held an “Advanced Manufacturing Policy Planning Session,” hosted by GM at its new Tech Center in Warren MI, on March 26, 2003. Nearly 100 executives attended, representing 44 companies and 26 other organizations in both the private and public sectors who are working on the front lines to increase manufacturing productivity.

Statements at this meeting from companies dealing successfully with the competitiveness challenge from low-wage countries supported the view that the U.S. could compete effectively, if industry and government build a strategy based around two basic goals:

1. Increase labor productivity by greatly accelerating the use of advanced technologies.
2. Leverage national resources through a major expansion of public-private partnerships.

In this connection, the group developed forceful policy recommendations, including those cited below.

Move global competitiveness higher on the national agenda:

- A sustained, stronger focus on manufacturing productivity across the highest levels of the Administration, including the Secretary of Commerce, the President’s Advisor on Science and Technology, and the President’s Council of Advisors on Science and Technology Policy.
- More effective use of the manufacturing-related programs at the National Institute of Standards and Technology given its unique responsibility for assisting industry.

- Use “Save \$1 Billion a Day” as a galvanizing goal for reducing the trade deficit as a measure of America’s ability to compete.
- Accelerate depreciation of investments in new hardware & software for all manufacturers.

Develop and deploy next generation process technologies: “A New Tool Kit”:

- Substantially increase federal investment in productivity-enhancing manufacturing science & technology research.
- Utilize “industry-led, government-enabled” consortia models akin to Sematech.
- Move research more rapidly towards practical application through the concept of “R&I” (Research and Implementation) rather than “R&D.”

Enable America’s workers to keep pace with technological change:

- Provide a tax incentive for technical re-training over a worker’s career.
- Integrate academic and technical/applied learning into the Perkins Act authorization.
- Integrate industry-led skill standards into education and training programs under Workforce Investment Act reauthorization.
- Accelerate development of skills standards-based certification systems.

Decrease supply chain vulnerability and support the nation’s smaller suppliers:

- Avoid trade disruptions and maintain secure logistics & supply networks.
- “Hedge” critical military and homeland security products through a strong domestic supplier base.
- Build much higher levels of cooperation and collaboration between Manufacturing Extension Partnership (MEP) services and the supply chain optimization programs of large manufacturers at the sub-tiers.
- Fund the Enterprise Integration Bill for greater standards interoperability and improve IT capabilities of suppliers.

Taking such steps would accelerate the rate of manufacturing innovation, stimulate investment in the most advanced manufacturing equipment, continually improve workforce skills and create a voice in the federal government to ensure the continuation of manufacturing-friendly public policies. The overarching effect of implementing these recommendations would be the reduction of unit labor costs made possible by high rates of productivity growth. Taking the above steps would help industry respond to current competitiveness challenges as effectively as they did to the earlier challenges of the 1980’s. In response to the challenges facing manufacturing today this strategy would promise multiple benefits for both industry and the nation.

The Benefits

Striving for and building a future for advanced manufacturing in the United States requires a firm commitment, but would reap many rewards including:

- Sustained levels of productivity growth and wealth creation
- Increased revenues to reduce the federal deficit while meeting a growing range of both domestic and national security requirements
- Higher real wages, leading to improved standards of living for all Americans
- More highly skilled, well paying jobs, both in manufacturing and in the expanding service industries that directly support manufacturing
- Enhanced quality of life through increased consumer choice, higher product quality, and technical solutions to human problems (cleaner environment, improved safety, physical security).
- A corresponding increase in global living standards as technical advancements travel across borders, strengthening domestic markets and providing the political and economic stability that can, and often does, follow.
- A reduction in the alarmingly high trade deficit in goods. As U.S.-based manufacturers increase the flow of products that are fully competitive on the basis of cost, quality, delivery and customization, the incentive for consumers to buy imported goods will decline.



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