MAKING VALUE FOR AMERICA
Embracing the Future of Manufacturing, Technology, and Work

Technological developments, reengineered operations, and economic forces are changing the way products and services are conceived, designed, made, distributed, and supported. Manufacturing or “making things” can no longer be considered separate from the value chain, the system of research and development, product design, software development and integration, and lifecycle service activities performed to deliver a valuable product or service to market. Businesses are focusing on this entire system to ensure that they are “making value” for their customers and are less likely to be disrupted by competitors or new technologies.

Furthermore, the convergence of these factors is causing major transformations that require the United States—and the companies that operate here—to carefully examine their abilities to innovate and capture the benefits. Businesses are experiencing increased competition from emerging economies around the world; while US-based businesses remain world leaders in many measures of innovation along the value chain, competitors from other countries are catching up quickly. The nature of work has also changed, causing jobs that consist of repetitive tasks to be disrupted by automation or offshoring to lower cost providers. At the same time, developments in software and data collection are enabling businesses to better understand customers’ needs, optimize design and production processes, and discover new market opportunities, which can generate increased demand and new enterprises that will create jobs.

It is important for businesses and communities across the United States to understand and respond to the changes affecting value chains for manufacturing and high-tech services not only because these activities account for a significant portion of the country’s economic growth and middle-class jobs but also because the economy as a whole mirrors these changes. The same technologies that are transforming manufacturing and high-tech services are poised to transform enterprises in energy, health care, and education. And, by some estimates, 50 percent of jobs are ripe for disruption.

“Far too much of our nation is waiting for new ways of working to arrive. We hear lots of rhetoric about how the nature of work will change, as if it relates to some unknown distant future. The fact is that it is happening now, and we need a broader recognition of this fact and policies and education that reflect it.”

—Charles M. Vest
The Complete Value Chain

Business and policy leaders need a holistic understanding of the value chain in order to take effective action in response to the changing manufacturing and high-tech sectors. To systematically identify and successfully address customers’ needs and capture higher returns, businesses must draw on in-house capabilities and external partners to carry out a set of interlinking activities spanning economic sectors. For example, in order to sell cars, automotive companies engage in research, product development, supply-chain logistics, production, and sales, as well as pre- and postsale customer services such as maintenance, financing, and information and entertainment capabilities.

While companies have always been involved in a range of activities that cross economic sectors, it is increasingly difficult to recognize clear dividing lines between manufacturing, the production of software, and the provision of services in a company’s product offerings. The service content provided by manufacturers has grown in importance, accounting for a larger proportion of total revenues in many industries. At the same time, companies primarily known for software and services have branched into providing manufactured products.

New Opportunities from Digital Technologies and Distributed Tools

There is tremendous potential to improve productivity and create new demand and new businesses along the value chain through the infusion of software, data, and distributed tools. Developments in data collection and analytics, digital manufacturing, and crowd-sourcing have opened up a wealth of possibilities for companies and entrepreneurs to better understand customer needs and desires, optimize design and production processes, discover new market opportunities, and acquire new investment funds. Distributed tools such as cloud computing are lowering the barriers for potential entrepreneurs to start new businesses. And many businesses in diverse industries are creating new offerings by integrating systems of software, data, and manufactured products. In the pharmaceutical industry, for example, there is great opportunity to provide apps and services to help increase the extent to which patients correctly take their medications. In the automotive industry, the expansion of software and information content incorporated in vehicles both enhances product performance and provides additional services to customers.

Competition in the Global Economy

Globalization and the development of emerging economies are increasing competition. While the United States remains a world leader along multiple indicators of research and production of high-tech manufactured goods and services, other countries are advancing rapidly. US-based companies face growing competition from emerging corporations around the world. Many US-based businesses have moved their operations abroad to take advantage of growing demand from emerging markets, easy access to capital, more efficient operations, established supply chains, particular workforce expertise and tax advantages. Others are beginning to move some manufacturing operations back onshore, as cost advantages sometimes erode and the loss of connection with other parts of the value chain, such as research and development and new product development, becomes more problematic.

Although the development of economies around the world has intensified competition, it also presents an enormous opportunity to expand demand for US goods and services, which may be increasingly important to drive economic growth. Indeed, for the past 30 years, the birth rate of new establishments in the United States across the value chain—in production, retail, and services—has been declining. Considering the significant role of new businesses in job creation and productivity growth, this is not a good sign. It underscores the importance for the United States to produce world-leading businesses to sustain its economy.

The Nature of Work

Over the past several decades, globalization and technological advances have changed not only the total demand for production workers but also the nature of production jobs. Manufacturing jobs that consist of handling and attaching parts by hand or other repetitive tasks are largely disappearing. Factory work in the United States is shifting to favor specialty skills in areas such as robotics-controlled maintenance, advanced composites, and radio-frequency identification of parts. At Boeing’s plant in Everett, Washington, for example, workers control high-tech machines that use indoor GPS and laser-positioning systems to assemble the 787’s advanced composite parts.

Advanced technologies and streamlined operations improve product quality and speed to market, thereby enhancing the competitiveness of US manufacturing operations in the global economy and providing higher-paying jobs. But because these advances make each worker more productive they also mean that fewer employees are needed to produce each car, airplane, or bottle of medications. Similar trends are occurring in other areas of the value chain and the broader economy, such as transportation, retail, education, and health care, and are likely to continue as advances in robotics and software enable machines to perform more complex tasks. The best bet to aid workers that have been left behind by these transformations is to advance their skills...
and create an effective ecosystem that continuously attracts and creates skilled jobs in all sectors of the economy.

**IMPLICATIONS FOR ENTERPRISES AND COMMUNITIES IN THE UNITED STATES**

To meet the challenges of a more competitive environment, and to take advantage of emerging opportunities, companies will need to adopt new approaches, which will include reengineering their operations and management systems in ways that improve productivity and speed to market.

While every business aims to optimize its operations for productivity, very few have implemented the advanced practices necessary to achieve leading productive operations. Employee training programs and collaborations across value chains and industries are needed to transfer the deep experience that can empower every worker to critique and improve operations. To ensure a sustainable stream of new products and services, companies will also need to leverage technology and talent to better understand customer needs and identify market opportunities. More individuals will need training in the skills and practices that will help them identify opportunities and execute the business models and resources needed to commercialize solutions. The ability to take advantage of burgeoning opportunities associated with the integration of systems of products, software, and data will require advanced computing and connectivity capabilities as well as a strong talent pipeline for software development, data analytics, and systems integration. Integrating systems across value chains presents significant opportunity for businesses focused on front-end activities as well as traditional manufacturers.

Policymakers, educators, and community leaders have important roles to play to ensure that the United States has an ecosystem that facilitates the adoption of best practices and attracts and creates businesses along the value chain and the broader economy. Just as American companies and communities reinvented themselves throughout the 19th and 20th centuries as the emergence of new technologies were coupled with the adoption of new business processes and investments in education and infrastructure, the current changes require forward-thinking leadership and action.

To prosper in the 21st century, US companies and communities must take action to upgrade America’s ability to “make value.” The committee has identified the following recommendations as a blueprint for these actions.

**ACTIONS LEADING TO A PROSPEROUS PATH FORWARD**

Individual businesses can create value by coordinating value chains and optimizing operations.

- Businesses should establish training programs to prepare workers for modernized operations and invest in advancing the education of their low- and middle-skilled workforce.
- All businesses in value chains for manufacturing and life-cycle services should examine their business models and search for missed opportunities to leverage distributed tools and coordinate value chain systems to provide new products and services and improve productivity.
- Manufacturers should implement the principles and practices, such as Lean Production, necessary to enable employees to improve productivity and achieve continuous improvement.
- Researchers should further investigate and codify best practices for recognizing unmet needs and commercializing solutions, and effective methods of teaching them.

Collaborative actions are needed to improve the education and skills of the US workforce, particularly in manufacturing and high-tech value chains.

- Businesses, local school districts, labor, community colleges, and universities should form partnerships to help students graduate from high school, earn an associate’s degree, and take part in continuing education in the workplace. State governments and Congress should provide tax incentives or other methods (e.g., formal mentoring, certification programs) to encourage investment and industry involvement in these education partnerships.
- To reduce financial barriers to the postsecondary education needed for jobs across the value chain, the cost-effectiveness of degrees at US universities and community colleges should be measured, publicized, and improved.
- Businesses, industry associations, and higher education institutions should work together to establish national skills certifications that are widely recognized by employers and count toward degree programs, and improve access for students and workers to gain these certifications.

Collaborative actions are needed to encourage the development of new businesses across manufacturing and high-tech value chains to stimulate innovation and job creation.

- The establishment of local innovation networks across the United States will foster the formation of new businesses and connect entrepreneurs to individuals, investors, tools, and institutions, both locally and around the world, that can help grow their businesses.
Certain fundamental areas need improvement on a federal basis to facilitate innovation throughout the value chain.

- US programs that contribute to innovation, such as the Small Business Administration, Manufacturing Extension Partnership, and the National Network of Manufacturing Innovation, should be directed and optimized as appropriate to facilitate the adoption of best practices and help young businesses to grow.

- US infrastructure must be upgraded. Businesses across manufacturing and high-tech value chains must have access to reliable energy and natural resources, transportation, and communication systems. Increasingly, many businesses also need access to high-performance computing grids and information storage. A world-leading infrastructure will attract businesses and facilitate the creation of new ones in the United States.

- US fiscal policy must incentivize long-term capital investments. The current tax structure encourages a preference for quicker returns over long-term investments to create new products and businesses.

- Data suggest that the rate of new business creation in the United States is declining. To understand the causes of this decline and enable the formulation of policies to reverse it, the National Science Foundation and other research funders should put a priority on supporting studies in this area.

- Federal programs and statistics should be modernized to account for the diminishing distinction and complex relationships between manufacturing, information, and services.

In today’s highly globalized economy, companies need the best teams in the world to stay competitive. This requires not only developing and attracting top talent but also leveraging diversity to achieve better team performance.

- Businesses and universities should implement programs to attract and retain diverse talent, including along gender, race, and socioeconomic lines. Diverse teams have been shown to be more innovative and often produce better outcomes.

- Middle schools, high schools, universities, and local communities should expand opportunities for students to participate in team-based design experiences and learn to use emerging tools that enable new business creation. Students exposed to these types of experiences are better prepared to innovate in today’s economy.

- Congress must reform immigration policy to welcome and retain high-skilled individuals with advanced science, technology, engineering, and mathematics (STEM) degrees, especially those educated in the United States. Many of these individuals become entrepreneurs and the United States should ensure that their businesses are in this country.

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