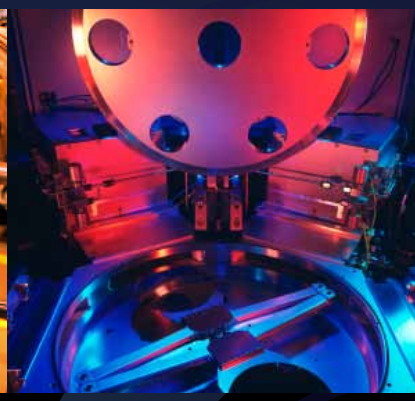
National Governors Association

A National Governors Association Policy Academy Report



"MAKING" OUR FUTURE

What States Are Doing to Encourage Growth in Manufacturing through Innovation, Entrepreneurship, and Investment

THE NATIONAL GOVERNORS ASSOCIATION (NGA), founded in 1908, is the collective voice of the nation's governors and one of Washington, D.C.'s, most respected public policy organizations. Its members are the governors of the 55 states, territories and commonwealths. NGA provides governors and their senior staff members with services that range from representing states on Capitol Hill and before the Administration on key federal issues to developing and implementing innovative solutions to public policy challenges through the NGA Center for Best Practices. NGA also provides management and technical assistance to both new and incumbent governors.

The NGA Center for Best Practices is the only research and development firm that directly serves the nation's governors and their key policy staff. Through the NGA Center, governors and their policy advisors can:

- Learn about what works, what doesn't and share lessons learned
- Participate in meetings of leading policymakers, program officials and scholars
- Obtain specialized assistance

For more information about NGA and the Center for Best Practices, please visit www.nga.org.

Acknowledgments

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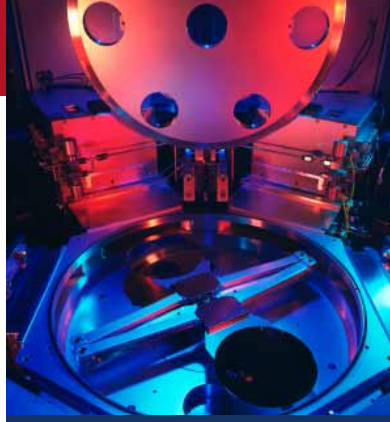


Executive Summary

The policy agenda for U.S. manufacturing is changing. Five years ago the debate was mostly about how to rescue and retain existing footholds in manufacturing, but lately the debate is increasingly about how to set the stage to lead the world in new technologies and innovations that are changing the face of manufacturing. That shift in direction was underscored this year when eight states prepared new strategies not through the lens of "let's save manufacturing" but through the lens of "let's lead in what lies ahead," including robotics, nanotechnology, and advanced materials.

Given all that is happening in manufacturing today, including advances in technology, a greater focus on tailor-made goods aimed at specific individuals and industry users, and the growing importance of sustainable forms of production, opportunities for the United States to lead are becoming increasingly clear. That leadership, however, will be built on a different breed of policy than the usual formula of enticing global public companies to build plants in this country. It will be built on a combination of worker education, business innovation, and public and private sector entrepreneurship that allows the United States to take the lead in shaping the way that manufacturing addresses "global wicked problems," such as needs for energy, water, food, health, security, and public infrastructure. That new formula is taking shape.

This report is about what states are doing to support this new shift in direction. It focuses especially on recent actions by the states of **California, Colorado, Connecticut, Illinois, Kansas, Massachusetts, New York,** and **Pennsylvania.** Their new focus on advanced manufacturing has grown out of a recently concluded National Governors Association Center for Best Practices Policy Academy designed to generate a new scale of effort, a sharp focus on the future, and opportunities for states to work together and learn from one another.

These eight states are not the only ones taking a new look at manufacturing, but the work they are doing is especially relevant because:

- Together the states represent 30 percent of total U.S. manufacturing Gross Domestic Product (GDP), one-third of U.S manufacturing jobs, and more than 25 percent of U.S. exports of manufactured goods;
- They signal a common agenda for states. Although each of the eight states arrived at its agenda independently, their agendas are remarkably similar in the priorities they set and the policies they are implementing; and
- As an eight-state cohort working on similar priorities, they can scale up efforts and generate effects that are greater than what can be done by a single state working alone.

As a result of the NGA Policy Academy, the states:

- **Established new programs,** such as Connecticut's innovation voucher program, which is providing $800,000 to help connect small and medium-sized businesses to partners and to universities to encourage them to take up regular R&D and innovation activities;
- **Redesigned organizations or created new ones,** such as the Colorado Advanced Manufacturing Alliance and the Pennsylvania Governor's Manufacturing Advisory Council, to ensure a consistent industry voice about the issues and policy priorities and to seed a strong connection among manufacturers, suppliers, financiers, academic research centers and to universities, and key government agencies;
- **Passed legislation,** such as California's measure to renew and extend the community college initiative that funds manufacturing and other regional industry workforce partnerships, or Connecticut's establishment of a bipartisan legislative advanced manufacturing caucus to identify top issues for legislative action in 2013; and,
- **Secured funding allocations for their manufacturing priorities**, such as the $1 million for the Massachusetts Advanced Manufacturing Futures Fund, for initiatives across five high-priority areas.

"Best Practice" Lessons Offered for Other States

In preparing this report on the results from the NGA Policy Academy on advanced manufacturing, NGA recognized that other states would benefit from knowing of the optimistic vision and associated policy steps taken by the eight states to encourage growth in manufacturing through innovation, entrepreneurship, and investment. In particular, other states would benefit from knowing that these states:

- Did not see their work as "saving manufacturing." Rather, they saw their work as creating the best location for the development of new technologies that radically improve production processes or that can be transformed into innovative new products;
- Recognized a big "missed opportunity" with small and medium-sized companies (SMEs) and thus emphasized doing a better job of supporting startups and SMEs;
- Determined that because of important developments already occurring, the most immediate benefits can be obtained by assembling, improving, coordinating, connecting or replicating, and scaling up those resources to manufacturers;
- Found crucial voids remaining to be filled, sometimes because the right services for manufacturers did not exist and sometimes because the services needed lacked the scale and steady commitment for success;
- Recognized that an intermediary valued by all parties (particularly industry) is crucial not only for developing an effective policy framework but also for sustaining broad support for advanced manufacturing as a high state priority;
- Focused on the interplay between state policy and regional action;
- Recognized the value of finding investments in the immediate term and mobilizing support for the future;
- Understood that they must "just get started" and secure some early achievements and momentum that make a difference to manufacturers; and
- Recognized that traditional metrics may need to be updated for advanced manufacturing (e.g., adding metrics to capture manufacturing as a critical driver of innovation, productivity, and competitiveness, in addition to being a source of job growth).

Introduction

The policy agenda for U.S. manufacturing is changing. Five years ago the debate was mostly about how to rescue and retain existing footholds in manufacturing, but lately the debate is increasingly about how to set the stage to lead the world in new technologies and innovations that are changing the face of manufacturing. That shift in direction was underscored when eight states prepared new strategies based not on the desire to "save manufacturing" but with the idea, "Let's lead in what lies ahead," including robotics, nanotechnology, and advanced materials.

While playing defense against the changes that are happening still holds enormous appeal, there is a growing sense that U.S. companies and workers can also play offense by adroitly following the changes happening in global manufacturing and using them to invigorate the domestic manufacturing base. Given all that is happening in manufacturing today—including advances in technology, a greater focus on tailor-made goods aimed at specific individuals and industry users, and the growing importance of sustainable forms of production—opportunities for the United States to lead are becoming increasingly clear.[1] That leadership, however, will be built on a different kind of policy than the usual formula of enticing global public companies to build plants in the United States. It will be built on a combination of worker education, business innovation, and public and private sector entrepreneurship that allows this country to lead in shaping a manufacturing sector that addresses "global wicked problems," such as the needs for energy, water, food, health, security, and public infrastructure.[2] That new formula is already taking shape.

It is not easy to pinpoint just what signals the beginning and the end of a policy agenda, but one indicator may be movement in a similar direction by both public and private sectors. By that standard, a shift is under way today in U.S. manufacturing. In the past two years alone, multiple public sector efforts to enable and create an environment for competitive and innovative companies to flourish and lead in what lies ahead have developed. For example, the Advanced Manufacturing Partnership (AMP) is a national effort bringing together industry, universities, the federal government, and other stakeholders to create university-industry partnerships that identify emerging technologies with the potential to create high-quality domestic manufacturing jobs and enhance U.S. global competitiveness. A group of states is working together to encourage growth opportunities in manufacturing through innovation, entrepreneurship, and investment. And in the private sector, the March 2012 *Harvard Business Review*—titled Reinventing America—and other journals have reported that manufacturers

[1] Peter Marsh, *The New Industrial Revolution: Consumers, Globalization and the End of Mass Production* (New Haven and London: Yale University Press, 2012).

[2] Global wicked problems refer to public policy challenges to which there is no immediate or simple solution. The term was introduced by Horst Rittel and Melvin Webber in "Dilemmas in a General Theory of Planning," pp. 155–169, Policy Sciences, Vol. 4, Elsevier Scientific Publishing Company, Inc., Amsterdam, 1973.

BOX 1. The NGA Policy Academy Process

The NGA Policy Academy provided the states a venue in which to develop their strategies to encourage growth in manufacturing through innovation, entrepreneurship, and investment.

The NGA Center's Policy Academy gathers governor-designated state teams for an intensive, year-long strategic planning process that creates a unique forum for advancing state policy. A policy academy is a process, not an event. What distinguishes it from "one-shot" meetings is that an academy requires a long-term investment of time, energy, and resources in a facilitated process that is designed to produce tangible outcomes such as executive orders, changes in administrative practices, and new legislation.

During the policy academy, NGA Center staff and other experts provide workshops, dedicated technical assistance, and information and reports to help a state achieve its own policy objectives. Furthermore, because the NGA Center works with a group of states simultaneously, it creates an opportunity to have a national impact in a way that individual state efforts do not.

The state teams are selected for participation by a group of independent expert reviewers through a competitive application process. Each state team has four to seven members, designated by the governor. The teams include members from the governor's office and from workforce and economic development agencies, university presidents, state legislators, state business leaders, and others.

such as General Electric and investors such as The Carlyle Group are beginning to recalculate their rush to globalize and reverse course to renew American manufacturing operations.

This report describes what states are doing to support this new shift in direction. States are looking to bring new focus to advanced manufacturing, set the stage to ensure that their companies and workers are ready for the challenges ahead, and thus generate new business and good jobs. It focuses especially on recent actions by eight states: **California, Colorado, Connecticut, Illinois, Kansas, Massachusetts, New York,** and **Pennsylvania.** Their new focus on advanced manufacturing has grown out of a recently concluded National Governors Association Center for Best Practices Policy Academy designed to generate a new scale of effort, a sharp focus on the future, and opportunities for states to work together and learn from one another. The NGA Policy Academy process is described in Box 1. NGA collaborated with, and received funding support from, the U.S. Department of Commerce's National Standards of Institutes and Technology (NIST) Manufacturing Extension Partnership (MEP) Program and the U.S. Department of Commerce's Economic Development Administration to expose states to leading edge thinking and best practices and to help shape strategies to support a new policy direction.

As a result of the NGA Policy Academy, the eight states:

- **Established new programs,** such as Connecticut's innovation voucher program, which is providing $800,000 to help connect small and medium-size businesses to partners and to universities to encourage them to take up regular R&D and innovation activities;
- **Redesigned organizations or created new ones,** such as the Colorado Advanced Manufacturing Alliance and the Pennsylvania Governor's Manufacturing Advisory Council, to ensure a consistent industry voice about the issues and policy priorities and to seed a strong connection among manufacturers, suppliers, financiers, academic research centers and universities, and key government agencies;
- **Passed legislation,** such as California's measure to renew and extend the community college initiative that funds manufacturing and other regional industry workforce partnerships, or Connecticut's establishment of a bipartisan legislative advanced manufacturing caucus to identify top issues for legislative action in 2013; and

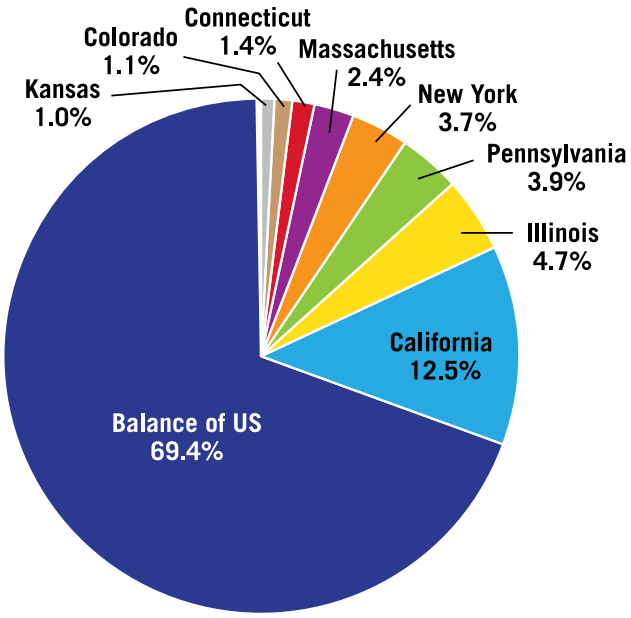
- **Secured funding allocations for their manufacturing priorities,** such as the $1 million for the Massachusetts Advanced Manufacturing Futures Fund, for initiatives across five high-priority areas.

The eight states that participated in the NGA Policy Academy are not the only ones taking a new look at manufacturing. **Maryland,** for example, recently launched a manufacturing commission to find new ways to support manufacturing in the state. In August 2012, the governors of **Illinois, Michigan, Missouri,** and **Tennessee** formed a bipartisan National Governors Auto Caucus to help foster growth of the U.S. industry and its suppliers. And the Southern Governors Association is focusing on manufacturing in 2012–2013. The work that the eight states that participated in the NGA Policy Academy are doing is of particular relevance because of the following:

- Together the states represent 30 percent of total U.S. manufacturing GDP, one-third of U.S manufacturing jobs, and more than 25 percent of U.S. exports of manufactured goods (see data spread on page 6 and 7);
- They signal a common agenda for states. Although each of the eight states arrived at its agenda independently, their agendas are remarkably similar in the priorities they set and the policies they are implementing; and
- As an eight-state cohort working on similar priorities, they can scale up efforts and generate effects that are greater than what can be done by a single state working alone.

Eight states account for 30% of total U.S. manufacturing GDP.

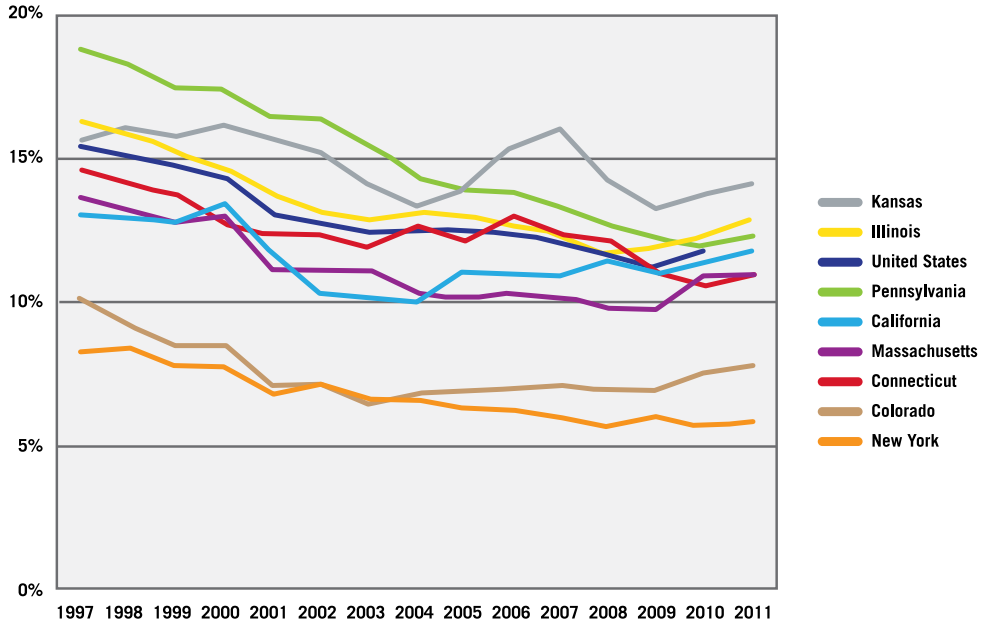
Manufacturing as a % of Total US Manufacturing GDP (2011)



Source: US Bureau of Economic Analysis

Further, manufacturing makes a significant contribution to state GDP, and in several states that contribution has grown over the past two years.

Manufacturing as a % of Total State Gross Domestic Product

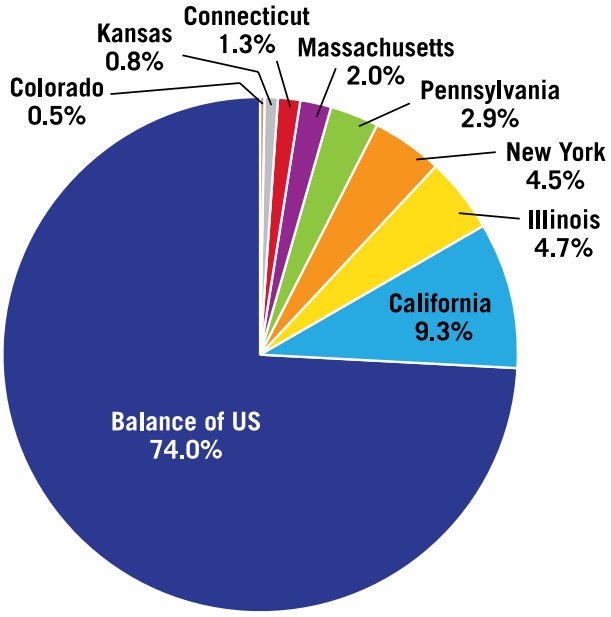


Source: US Bureau of Economic Analysis

THE 8 POLICY ACADEMY STATES ALSO ACCOUNT FOR…

More than 25 percent of manufactured goods exported.

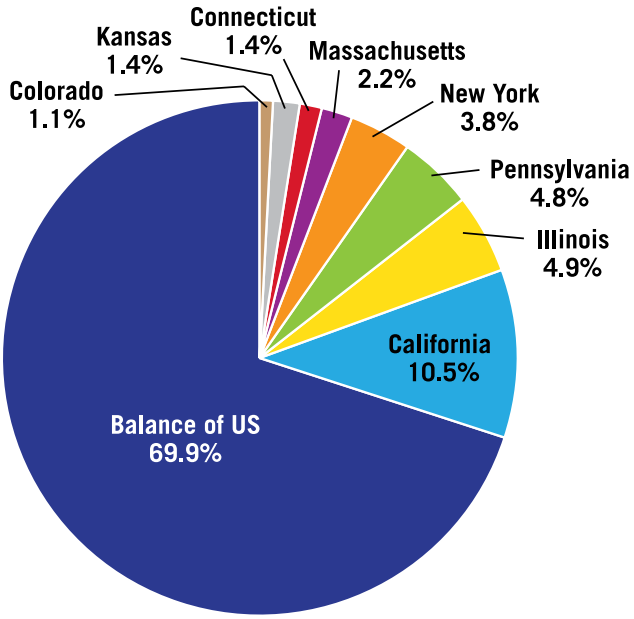
State Contribution to the Exporting of US Manufactured Goods (2011)



Source: US Census Bureau, Foreign Trade Division

3 out of 10 U.S. manufacturing jobs.

Manufacturing as a % of Total US Manufacturing Employment (2012)



Source: Economic Modeling Specialists, Inc. 2012 Q2 Covered Employment Data

Manufacturing Jobs Pay Average of Nearly 25 Percent More than the Average Job Across Policy Academy States

STATE	MFG JOBS	MFG AS A % OF TOTAL EMP	AVG ANNUAL WAGES IN MFG (2012)	MFG WAGES RELATIVE TO OVERALL STATE AVG WAGES
Massachusetts	256,744	7.9%	$78,703	132.4%
Connecticut	165,703	10.1%	$76,868	126.2%
California	1,244,995	8.2%	$76,649	138.9%
Colorado	131,891	5.7%	$62,000	126.9%
Illinois	587,131	10.3%	$61,600	121.3%
New York	457,149	5.3%	$61,231	99.3%
Pennsylvania	571,435	10.1%	$55,723	118.4%
Kansas	164,217	12.0%	$52,328	129.6%
USA	**11,886,075**	**8.9%**	**$59,787**	**124.2%**

Source: Economic Modeling Specialists, Inc. 2012 Q2 Covered Employment Data

TAKING A NEW LOOK AT MANUFACTURING

Why shift policy gears? Although the specific economic environment and historical context vary across the eight states participating in the NGA Policy Academy, the states are similar in the ways that they frame the reasons for a renewed drive to be competitive and the strategies for getting there. Their reasons include the following:

First, evidence is growing that:

- Manufacturing is too important to lose;
- Manufacturing has changed and is changing;
- Too many small and medium-size manufacturers are not growing through innovation and global exports—but could; and
- The "deindustrialization" of the United States is not inevitable. In fact, new technologies and advanced manufacturing processes create a new opportunity in the United States.

Second, belief is widespread that:

- Leadership in this "new" manufacturing is still up for grabs—but it requires understanding and developing innovation ecosystems; and
- States control a variety of policies associated with well-developed ecosystems of innovation.

Each of those points is briefly reviewed here because they form the foundation of the eight states' choices of initiatives and strategies that are discussed in the report and also because other states may benefit from the logic.

Manufacturing Is Too Important to Lose.

Although in 2010 China overtook the United States as the world's largest manufacturing nation, measured by value of output, manufacturing is the third-largest sector in the U.S. economy. It pays premium wages and includes activities that extend far beyond production, for example, into research, design, technological services, and logistics. On average, every manufacturing job supports 2.5 jobs in other sectors. At the upper end, every high-tech manufacturing job supports 16 others.[3]

BOX 2. Manufacturing Matters to the U.S. Economy

- **Manufacturing as an industry accounted for 18.6 million jobs** in 2009—11.8 million direct jobs, and 6.8 million indirect jobs in industries such as transportation and warehousing and professional, business, and financial services.
- **Manufacturing in the United States offers premium jobs.** Manufacturers pay 9 percent more in wages and benefits than the entire economy. On average, U.S. manufacturing jobs are more likely to provide health, pension, and other benefits than ones in other sectors.
- **Manufacturing has a greater secondary economic impact (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.
- **The United States attracts the most foreign direct investment of any nation** in the world, as investors continue to be drawn by its large and open market, the quality of its infrastructure, high income levels, and access to cutting-edge technology and research.

Source: L. Woolsey and G. Yakimov, "Innovation and Product Development in the 21st Century," Hollings Manufacturing Extension Partnership Board, February 2010.

Manufacturing also is integral to American innovation, accounting for two-thirds of private sector research and development—which is a key driver of innovation—and employing 63 percent of domestic scientists and engineers.[4] The high level of innovation that characterizes so much of U.S. manufacturing depends in large part on production and R&D being located in close proximity.[5]

Manufacturing accounts for about 65 percent of all U.S. trade, including both exports and imports.[6] It makes an outsize contribution to GDP growth: in the 16 years from 1997 to 2012, real manufacturing output grew by an average of 3 percent per year, compared to the average of 2.3 percent for the overall economy (see Box 2 for more evidence that manufacturing matters to the U.S. economy).[7]

Adding to that, manufacturing is part of the supply chains for health care, business services, national defense, energy, construction, and environmental sustainability; that is, manufacturing products and technologies are required to create better health care systems, more energy-efficient buildings, and alternative energy sources (photovoltaics, advanced energy storage devices); to ensure U.S. security; and to create better transportation systems. Box 3 shows the cross-cutting importance of manufacturing.

Manufacturing Has Changed and Is Changing.

A lot is happening, everywhere. Today's factories are high-tech and highly efficient. The dirty, boring factory jobs of 50 years ago are now done by robots. The jobs of today require skill, know-how, and ability in everything from R&D to data analytics to product design. (See Box 4 for an example of how manufacturing employment has changed.)

[3] Ross DeVol et al., "Manufacturing 2.0: A More Prosperous California" (Santa Monica: Milken Institute, June 2009), www.milkeninstitute.org/pdf/CAManufacturing_ES.pdf.

[4] Charles W. Wessner and Alan Wm. Wolff, eds., *Rising to the Challenge: U.S. Innovation Policy for Global Economy* (Washington DC: Committee on Comparative National Innovation Policies: Best Practice for the 21st Century; Board on Science, Technology, and Economic Policy; Policy and Global affairs; National Research Council; National Academies Press, 2012), 79-102; and Stephen J. Ezell and Robert D. Atkinson, Fifty Ways to Leave Your Competitiveness Woes Behind: A National Traded Sector Competitiveness Strategy (Washington DC: Information Technology and Innovation Foundation, September 2012).

[5] Susan Helper, Timothy Kruger, and Howard Wial, "Why Does Manufacturing Matter? Which Manufacturing Matters? A Policy Framework" (Washington DC: Brookings Institution, Metropolitan Policy Program, February 2012).

[6] Ibid.

[7] Mark J. Perry, "U.S. Manufacturing Leads Current Economic Growth as It Has for 15 Years," *SeekingAlpha*, May 20, 2012.

[8] National Academy of Engineering, *Making Value: Integrating Manufacturing, Design, and Innovation toThrive in the Changing Global Economy* (Washington DC: National Academies Press, 2012).

This is partly because of the increase in resources being directed toward the design, development, and marketing parts of the product development cycle. As the National Academy of Engineers has noted, "Rapidly advancing technologies in areas such as biomanufacturing, robotics, smart sensors, cloud-based computing, and nanotechnology have transformed not only the factory floor but also the way products are invented and designed."[8]

The new areas of nanotechnology and synthetic biology illustrate the trend. Scientists, engineers, and manufacturers are finding a wide variety of ways to deliberately make materials at the nanoscale level to take advantage of enhanced properties such as higher strength, lighter weight, increased control of light spectrum, and greater chemical reactivity than their larger scale counterparts. Synthetic biology offers the hope of creating biological factories for a virtually unlimited number of products.

BOX 3. Manufacturing Covers a Wide Array of Disciplines, Systems, Applications, and Environments

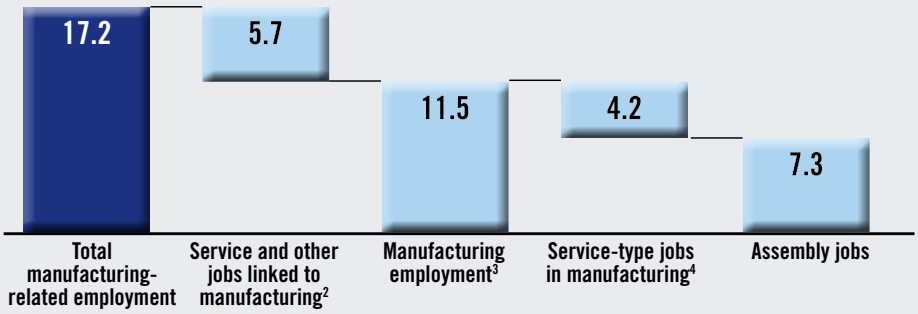
	MODELING & SIMULATION	ROBOTICS	MATERIALS SCIENCES (nano materials, plastics, textiles, plasma tools)	ENERGY & ENVIRONMENTAL TECHNOLOGY	BIOTECHNOLOGY	ENGINEERING SYSTEMS TECHNOLOGY
DEFENSE/ AEROSPACE	• Test and evaluation support • Concept definition and analysis-of-alternatives • Rapid prototyping • Manufacturing process modeling for process improvement & control • Human effects monitoring • Mission planning & exercise modeling	• Precision manufacturing • Testing	• High-performance composites • Propulsion systems	• Directed energy (lasers, microwaves)		• Systems integration • Computation • Process design • Product engineering
MEDICAL DEVICES	• Drug development • In-vivo health monitoring • Clinical trials design & analysis • Advanced therapeutics • R&D instrumentation	• Precision manufacturing • Testing • Health monitoring	• Nano materials • Nano manufacturing • High-performance composites	• Environmental science	• Translational genomics/medicine • Biomanufacturing	• Process design • Product engineering
ANALYTICAL INSTRUMENTS (signal processing, navigational, optic, measurement tools)	• Test and evaluation support • Concept definition and analysis-of-alternatives • Rapid prototyping • Manufacturing process modeling	• Precision manufacturing • Testing	• Nanosensors • Nano materials • Nano manufacturing	• Climate monitoring systems • Environmental sensors • Smart grid components • Smart transportation / infrastructure	• Health monitoring systems • Environmental monitoring systems	• Systems integration • Process design • Product engineering • Process engineering
ELECTRONICS & SEMI-CONDUCTORS	• Rapid prototyping • Manufacturing process modeling • Test & evaluation support	• Precision manufacturing • Testing	• Nano materials • Nano manufacturing • High-performance composites	• Renewable energy components		• Manufacturing technology • Process design • Product engineering

Source: Collaborative Economics, Inc.

BOX 4. Manufacturing Jobs Are Changing

In the United States, production jobs make up less than half of the total manufacturing-related employment

US MANUFACTURING EMPLOYMENT, 2010[1] (MILLION)



1 Employment is total FTEs plus self-employed.

2 4.7 million jobs in services and 1 million jobs in primary resource industries that are directly and indirectly linked to manufacturing. Employment multipliers were applied to import-adjusted final demand for manufacturing. Employment mulitpliers were calculated applying employment to output ratios to the output multiplier table. Output multipliers were advanced using an inmport-adjusted input-output table.

3 Manufacturing employment as reported by the US Bureau of Economic Analysis.

4 Non-production jobs in manufacturing sectors, such as product R&D, marketing and sales, customer care and service, back-office functions, and facilities management.

Source: McKinsey Global Institute, *Manufacturing the Future: The Next Era of Global Growth and Innovation,* November 2012.

Meanwhile, a shift toward smaller runs and custom-designed products is favoring agile and adaptable workplaces, business models, and employees—and creating entirely new opportunities for entrepreneurs to start, grow, and renew businesses. With developments such as three-dimensional printers, computational modeling and simulation, and Internet connectivity, more ideas than ever before are making their way from the research stage, to development, to market. At the same time, technological improvements in communication, logistics, and IT make it possible to integrate players in multiple countries into global supply chains—and the management of the mix is becoming a highly prized skill.

These features are important not only because they illustrate how manufacturing has changed and is changing, but also because they emphasize that entrepreneurs, economic developers, educators, students, and parents will need new approaches and capabilities to boost competitiveness and gain the maximum benefits from the changes.

Too Many Manufacturers Are Not Growing through Innovation and Global Exports—but Could.

Leading firms do more than survive. They thrive by continuing to innovate their way through economic and technological shocks and disruptions, and even use them to their advantage (see Box 5). But only 20 percent of manufacturers can be considered truly advanced and engaged in continuous innovation, according to one 2009 survey.[9;10] The remaining 80 percent say that they are struggling to adapt to change, to connect to the global marketplace, or do more than stay afloat. Recent survey data show that only 25 percent rank their business's progress toward becoming a world-class, global business as good or better. Although an array of agencies, programs, and policies exists to support and facilitate innovation, commercialization, and the launch and growth of new ventures, a substantial number of manufacturers, particularly small and medium-size enterprises (SMEs), are not connected to such services and resources. Only 5 percent to 8 percent of manufacturing SMEs nationally are receiving services from the federal

BOX 5. New Products, Processes Key to Company Growth

Michael Porter, of the Harvard Business School, told the nation's governors in 2011, "If a company in your state is doing the same thing that it did 10 years ago—using the same production processes, producing the same products—it's going to be very hard to succeed" (National Governors Association Winter Meeting, Washington, D.C., February 2011).

government's Manufacturing Extension Partnership (MEP) program,[11] for example, and most SMEs do not benefit from frequent and extensive contacts with universities, as many large manufacturers do.[12] In fact, large corporations increasingly emphasize access to key resources such as universities for talent and R&D partnerships as they look for new places to set up shop in the United States.[13]

BOX 6. Nothing Is Inevitable about the Industrial Decline of the United States

Anecdotal Evidence in California… A reporter for the San Jose Mercury News put it vividly when he reported on September 2, 2012, that the Silicon Valley and Bay Area are in the midst of a modern manufacturing revival, thanks in part to China. "Rising wages and other increasing costs there help make the case for manufacturing here. Add to that the other advantages of manufacturing domestically—more control, quicker turnaround, higher quality, more secure intellectual property—and it makes abundant sense for some companies to sell products designed in California and made in California." He goes on to say, "If someone told me the same thing six months ago, I would have said they were nuts. But I've spent that time visiting factories and talking to dozens of academics, executives, economists, production workers, policymakers and educators. I've talked to a CEO bringing jobs back to San Jose from China, a team that is building desktop computers in Santa Clara and an East Bay CEO who is starting production in Asia to serve customers there, but who is also hiring at his Livermore factory."

Source: Mike Cassidy, "Silicon Valley, Bay Area Poised for Manufacturing Revival," September 2, 2012, *Mercury News, http://www.mercurynews.com/business/ci_21435517/cassidy-silicon-valley-bay-area-poised-manufacturing-revival.*

Empirical Evidence in Massachusetts… Report cards on Massachusetts manufacturing in 2008 and 2012 indicate "staying power" for advanced manufacturing. Although many manufacturers have either left the state or ceased production altogether because they could not compete in national and international markets, what is left in the state—among its more than 7,500 manufacturing firms—are enterprises that for the most part have remained competitive by investing in advanced technologies that boosted productivity at prodigious rates and by training their labor force to take advantage of the new technologies. That is true not only of "new" manufacturing companies in state-of-the-art, high-technology industries, but also of "old" manufacturing firms in traditional industries such as food processing, fabricated metal operations, and plastic extrusions. Using a "technological intensity" indicator, based on a methodology provided by the Organization for Economic Cooperation and Development (OECD), Northeastern University researchers tracked the technological intensity of the entire manufacturing sector in the state from 1970 to 2010. The level of technology (low-technology, medium-low-technology, medium-high-technology, and high-technology) specific to an industrial sector is measured by the ratio of research and development (R&D) expenditure to value-added in an industry and the technology embodied in purchases of intermediate and capital goods. In 1970, nearly 40 percent of the Massachusetts manufacturing workforce was in low-tech industries, with less than 20 percent in the high-tech sector. But in 2010, the low-tech sector had shrunk to less than 25 percent and the high-tech sector had expanded to 31 percent of the total workforce. Employment in the two medium-tech sectors grew by one to two percentage points during the same 40 year span. That important finding suggests that the strength of Massachusetts manufacturing is not only in the most R&D-intensive sectors, but also in a broad range of companies that remain competitive by redesigning product lines and the ways in which they manufacture them. In short, the evidence is clear that low-tech manufacturing is a thing of the past in U.S. manufacturing. High-tech manufacturing is the current driver and appears to be growing.

Source: Barry Bluestone, et al., *Staying Power II A Report Card on Manufacturing in Massachusetts* 2012 (Northeastern University Kitty and Michael Dukakis Center for Urban and Regional Policy, 2012.)

[9] Lindsey Woolsey and Gary Yakimov, "Innovation and Product Development in the 21st Century," (Hollings Manufacturing Extension Partnership Board, February 2010.)

[10] A study of U.S./U.K. manufacturing sectors found that approximately 33 percent and 37 percent of the manufacturing sectors, respectively, can be characterized as having low technological intensity. Another 23 percent of the manufacturing sector can be characterized as having medium-high technological intensity. Reported in the Information Technology and Innovation Foundation (ITIF) report, Stephen J. Ezell and Robert D. Atkinson, *International Benchmarking of Countries' Policies and Programs Supporting SME Manufacturers,* September 2011, 41.

[11] The MEP Program of the U.S. Department of Commerce, which helps small businesses apply new techniques and technologies, has a modest $125 million annual budget that is spread among 66 centers across the country; it is supported on a matching basis by the states, as well as through fees.

[12] Interviews with both small manufacturers and universities indicate that SMEs do not engage as often as big companies. In *The Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing* (July 2013), the President's Council of Advisors on Science and Technology suggests that more than 300,000 small and midsized firms are largely outside the U.S. innovation system.

[13] Members of the 2005 Rising Above the Gathering Storm Committee, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, *Rising Above the Gathering Storm, Revised, Rapidly Approaching Category* (Washington DC: National Academies Press, 2010).

The "Deindustrialization" of America Is Not Inevitable. In Fact, New Technologies and Advanced Manufacturing Processes Create a New Opportunity for America.

During the last few years positive indications have appeared that technologically sophisticated, high-value manufacturing—advanced manufacturing, as it is sometimes called—can thrive in the United States. First, the Bureau of Labor Statistics projects a continuing decline in the number of manufacturing jobs in the United States through 2020 but an increase in value added by the sector—that means gains concentrated in particularly high-wage, more productive segments of manufacturing (e.g., search/detection/navigational instruments, guided missiles and space vehicles, and electromedical apparatus).[14] Second, changes in manufacturing are occurring that may favor American ingenuity, entrepreneurship, and "tight connections among innovation, design, and manufacturing, and also our ability to integrate products and services."[15] Third, manufacturing companies are returning to, or reinvesting in, North America, particularly manufacturers that rate high in product innovation, intensive customer service, supply chain connectedness and cost.[16] Recent case studies show that companies that previously sent work offshore are bringing it back to the United States because of "rising oil prices, longer shipping times, rising wages in coastal Chinese cities, intellectual property leakage, the desire to create innovation hubs, and a fuller appreciation, based on years of experience, of the downsides of offshoring [17] (See Box 6 for state examples.) American firms are now more likely to appreciate 'hidden costs' of production abroad, such as administrative costs, legal costs, risks and complexities."

BOX 7. The Keys to Capturing Competitive Advantage in Advanced Manufacturing

In its *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing,* the American Manufacturing Partnership recommended two things. The partnership identified 11 cross-cutting technology areas for attention because "they are pivotal in enabling U.S. manufacturing competitiveness, both in terms of differentiation and tradability of goods." It also suggested that "universities, national labs, intermediate technology institutes, independent research institutions, and community colleges will need to work together with industry to support research, development, and deployment of these manufacturing technologies, and to develop the talent pipeline for industry":

- Advanced sensing, measurement, and process control
- Advanced materials design, synthesis, and processing
- Visualization, informatics, and digital manufacturing technologies
- Sustainable manufacturing
- Nanomanufacturing
- Biomanufacturing and bioinformatics
- Additive manufacturing
- Advanced manufacturing and testing equipment
- Industrial robotics
- Advanced forming and joining technologies

Source: AMP Steering Committee, President's Council of Advisors on Science and Technology, *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing* (Washington DC: AMP Steering Committee, President's Council of Advisors on Science and Technology, July 2012).

Leadership in This "New" Manufacturing Is Largely Up for Grabs—but It Requires Understanding and Developing Innovation Ecosystems Like Those that Created Companies such as Apple, Amazon, and Google.

Although not everyone agrees that a new industrial revolution has begun, it is widely agreed that nearly all the features of manufacturing—technology platforms, consumer choice, value chains, markets, and new manufacturing nations and clusters—are changing and becoming increasingly intertwined.[18] (Some of the new opportunities are described in Box 7.) Grabbing leadership in this dynamic and complex context requires businesses and policymakers to decide to compete in innovating new technologies, new production processes, and new business models and in initiating new ventures. They must also lay the basis for well-developed ecosystems of innovation, such as

[14] Bureau of Labor Statistics, "Employment Outlook: 2010-2020, Overview of Projections to 2020," *Monthly Labor Review,* January 2012.
[15] National Academy of Engineering, *Making Value: Integrating Manufacturing, Design, and Innovation to Thrive in the Changing Global Economy.* (Washington DC: National Academies Press, 2012).
[16] Paul Bjacek and Larry Oglesby, "North America Flexes Its Industrial Muscle," in *Accenture Outlook,* June 2012. http://www.accenture.com/us-en/outlook/Pages/outlook-journal-2012-north-america-flexes.
[17] Helper, Kruger, and Wial, "Why Does Manufacturing Matter?"
[18] Marsh, *The New Industrial Revolution.*

establishing collaborations between universities and business and between public and private pools of risk capital. They must generate a strong, reliable, and well-trained workforce that will support the entire life cycle of technology development—from R&D, invention, innovation, and commercialization, to scale-up for efficient production and export development—and the emergence of new, and newly enhanced, advanced manufacturing clusters and global value chains.

Belief Is Widespread that States Control a Variety of Policies Associated with Well-Developed Ecosystems of Innovation.

Increasingly states are helping to create innovation ecosystems, or innovation hubs, of the type that have made Austin, Texas, and San Diego, California, leaders in specific industry clusters (in Austin, semiconductors and software; in San Diego, biotechnology). Although not every state has a Silicon Valley or a Stanford University, they know that public and private leaders can work together to develop an array of statewide proficiencies—smart people, unique research institutions, strong collaborations, and other links and resources—both to help entrepreneurs establish high-growth businesses and to create strategic advantages for existing small and medium-sized companies that must compete in the global economy. States such as **Arizona, Oregon, Ohio, New York,** and **Utah** are already benefiting from their stepped-up efforts during the last decade to support and facilitate innovation ecosystems for biosciences, nanotechnology, and alternative energy (see Box 8 on results in Oregon). More and more governors and other state leaders are gaining confidence that their states can apply the lessons learned from earlier efforts in biosciences and nanotechnology industry clusters to catalyze and support next-generation advanced manufacturing.

BOX 8. Best Practice Model—Oregon's Innovation Ecosystem for Nanotechnology

Through NGA's policy academy process, states had an opportunity to learn from organizations that connect small businesses to an ecosystem of supports, including access to research, commercialization assistance, and shared facilities. Oregon's Nanoscience and Microtechnologies Institute (ONAMI) is fostering research and development capacity in the new field of micro- and nanotechnologies among Oregon's four research universities, the Pacific Northwest National Laboratory, and the state's "Silicon Forest" high-technology industry cluster.

To facilitate commercialization, ONAMI offers proof-of-concept grants to university researchers and companies to advance technology into the marketplace. Funding comes with business development services, as ONAMI operates with the understanding that new companies have two major gaps to overcome: the gap between a research result and a manufacturable product, and the gap between a technology-based solution and demand for that solution from an established market.

ONAMI has 250 researcher members from its four partnering research institutions. Members are eligible for competitive participation in ONAMI-sourced large projects, and they can apply for matching funds for research, workforce development, and equipment purchases. ONAMI provides a 5 percent match if only one ONAMI-affiliated institution participates. Matching increases to 7 percent if two or more institutions participate. Shared equipment proposals are matched up to 16.5 percent of the value of the equipment. In addition to funding, ONAMI staff have built collaborative teams of university and industry researchers for research and commercialization.

ONAMI operates facilities that provide access to specialized equipment and promotes them to businesses statewide via the State Business Development Office. The ONAMI high-tech extension service connects a group of shared/open user facilities to industry—now over 150 companies of all sizes—on a fee-for-service basis.

Its effort to "bootstrap an ecosystem" is already paying off for Oregon, generating new firms, new jobs, and new economic strengths. As of May 2011, ONAMI had invested $4.6 million in its commercialization gap fund to assist 23 start-up companies that have raised a total of $93.3 million in external funding. New research awards and contracts to ONAMI researchers grew from less than $10 million in 2002 to more than $50 million in 2010. ONAMI can also link increases in company revenue to increased industrial use of the shared-user facilities, including access to focused ion beam and microanalytical and XPS capabilities.

Source: Oregon Nansocience and Microtechnologies Institute, "Metrics and results," http://www.onami.us/index.php/economic-impact/metrics_and_results (accessed May 29, 2012).

TECHNOLOGY AND TIME BRING A NEW PERSPECTIVE

All eight NGA policy academy states emerged from independent analyses of strengths, weaknesses, opportunities, and threats with the view that (a) manufacturing matters to economic growth, and (b) their public policy choices will strengthen that economic role. Two perspectives appeared to carry the day:

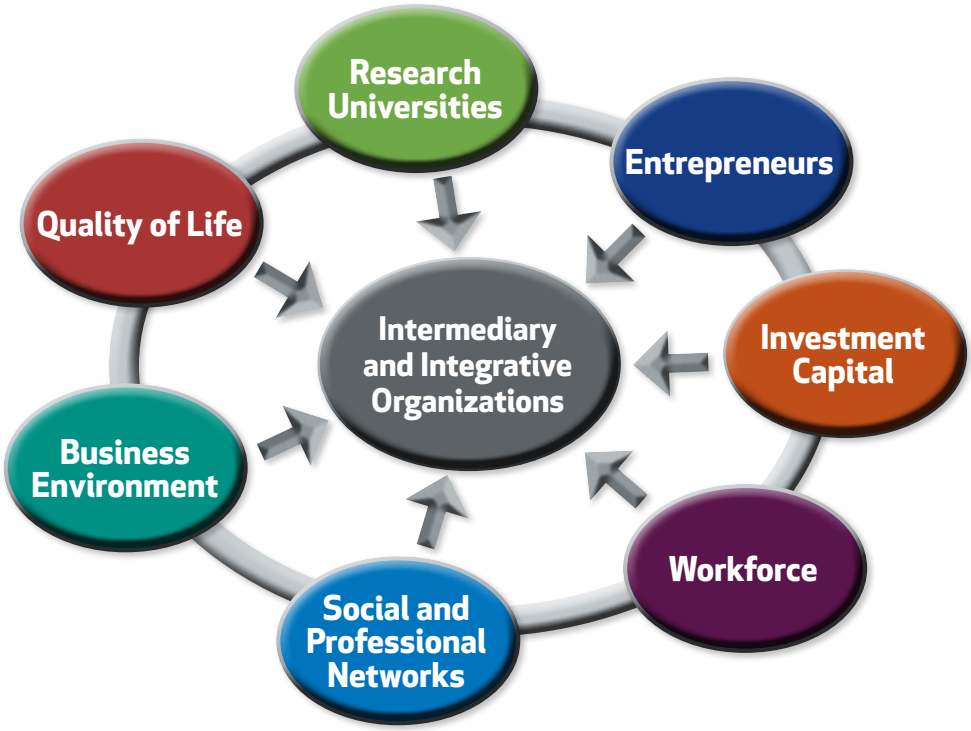
- **Technology.** New technologies (e.g., robotics, 3D printing, additive manufacturing) and business models will continue to shake up manufacturing, and that opens new opportunities to lead in global manufacturing.

- **Time.** Times have changed since the United States first experienced massive offshoring, and important trends are beginning to favor U.S. locations. Those include rapidly rising wages in emerging economies, increasing transportation and logistical costs, and shortening product life cycles.[19]

Moreover, after a decade or so of practicing cluster-based, science and technology–oriented economic development strategies, states are now more assured that they know how to strengthen the nation's competitive advantage in advanced manufacturing by embracing innovation hubs and ecosystems.

[19] Michael E. Porter and Jan W. Rivkin, "The Looming Challenge to U.S. Competitiveness," *Harvard Business Review,* March 2012, 55–62.

FIGURE 1. Key Elements of Innovation Ecosystems



Source: Mary Walshok et al, *Closing America's Job Gap: How to Grow Companies and Land Good Jobs in the Age of Innovation* (University of California Regents, Business Books, 2011).

Both Republican and Democratic governors have supported the development of clusters in their states. Key features of this strategy, as characterized by the NGA Center for Best Practices (the NGA Center), are state actions in four areas:

- Investing to build strong research capabilities, provide shared facilities, and produce and attract globally competitive talent in strategic areas;
- Encouraging interaction by requiring collaboration among universities, firms, and others and cultivating strong networks, industry-driven intermediaries, well-designed research facilities, and compact geographical location (because proximity enables greater interaction);
- Putting people from diverse industries, knowledge fields, and cultures together by cultivating strong networks and well-designed research facilities to increase collective capabilities and creativity; and
- Encouraging the application and commercialization of research by experimenting with university-industry partnerships, pioneering open intellectual property policies and faculty tenure changes, and keeping industry continuously engaged.

The essence of the strategy is tight alignment of industry, university, and government resources so that all components of the system are moving toward the same goal: to be the best location for high-value, specialized, and innovative activities.

A number of diagrams of "innovation ecosystems" have been created to help guide coordinated public policy and investment choices. One of them, shown in Figure 1, depicts eight elements that San Diego identifies as the sources of the innovation performance and global competitiveness of its high-technology and life science clusters.

BOX 9. Several Caveats About U.S. Manufacturing

Good signs come with caveats, and the eight NGA Policy Academy states are not Pollyannas. They recognize that all is not well with American manufacturing:

- The number of jobs in manufacturing dropped 41 percent between 1979, when manufacturing employment peaked, and the end of 2009, when it reached its recent low point.[20]
- Facilities involving large numbers of jobs and high-end work moved out of the United States over the past decade at a faster rate than that at which some companies are currently bringing facilities back. Harvard Business School conducted a survey of 1,700 alumni who were personally involved in firm location decisions and found that more than half of the decisions concerned the possibility of moving existing activities out of the United States, whereas only about 10 percent considered moving activities from another country into the United States.[21]
- A manufacturing revival will not solve the country's problem of unemployment, partly because modern plants use robots and fewer workers and run day and night, 365 days a year, and partly because the jobs that new factories do create will be high-skill jobs, requiring workers trained in "STEM" subjects—science, technology, engineering, and math.
- The United States is lagging in innovation in the manufacturing sector relative to high-wage nations such as Germany and Japan, and it has been losing significant elements of the research and development activity linked to manufacturing to other nations. It has also been losing its ability to compete in the manufacturing of many products that were invented here—from laptop computers, to flat panel displays, to lithium ion batteries.[22]
- "Whether it is Apple iPhones or Rolls-Royce Trent aero engines, the real profit is not made in the basic assembly of goods. The margins are in servicing, brands, design and after-sales."[23]
- Nations around the world, most notably China, Germany, Korea, and India, are improving the climate for new industrial plants and encouraging business investment locally. For example, China has more than 300 research centers, second only to the United States, and the number is increasing. A multiyear initiative is under way to make India a global nanotechnology hub, including the establishment of 14 new world-class universities.[24]

[19] Michael E. Porter and Jan W. Rivkin, "The Looming Challenge to U.S. Competitiveness," *Harvard Business Review,* March 2012, 55–62.

[20] Susan Helper and Howard Wial, "Accelerating Advanced Manufacturing with New Research Centers" (Washington DC: Metropolitan Policy Program at Brookings, Brookings Institution, February 2011).

[21] Michael E. Porter and Jan W. Rivkin, "Prosperity at Risk: Findings of Harvard Business School's Survey on U.S. Competitiveness" (Boston: Harvard Business School, January 2012).

[22] AMP Steering Committee Report, President's Council of Advisors on Science and Technology, *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing* (Washington DC: President's Council of Advisors on Science and Technology, July 2012).

[23] Luke Johnson, "Making It in the New Industrial Revolution," *Financial Times,* August 28, 2012; and Dan Breznitz and Peter Cowhey, "America's Two Systems of Innovation: Recommendations for Policy Changes to Support Innovation, Production and Job Creation" (San Diego: CONNECT Innovation Institute, February 2012).

[24] Members of the 2005 Rising Above the Gathering Storm Committee et al.

WHAT STATES ARE DOING TO FORGE NEW MANUFACTURING STRENGTHS

Although the eight states arrived at their agendas independently of one another, their agendas are remarkably similar in key issues and priorities. This part of the report discusses policies, programs, and approaches that the states have been pursuing that appear to be both innovative and promising for helping American manufacturers begin operations, grow, and compete globally.

Four objectives rose to the top across all states as the focus for their strategies:

- Pursue an integrated approach to developing an advanced manufacturing strategy, connecting large and small manufacturers, as well as state, federal, and regional partners;
- Develop and implement industry-driven priorities and partnerships;
- Boost the innovation and commercialization capacities of manufacturers, particularly small and midsized firms, by connecting them to partners, consortia, and a whole system of supports; and
- Provide talent both to fill the immediate specialized needs of employers and to deliver lifelong, industry-relevant training for workers at all levels.

Pursue an Integrated Approach to Developing a Manufacturing Strategy, Connecting Large and Small Manufacturers, as well as State, Federal, and Regional Partners.

The states participating in the NGA Policy Academy independently developed similar lists of the most critical areas of focus for manufacturers. The areas included access to capital, industry-relevant workforce and education, streamlined business services and environment, innovation, and improved marketing and branding. States also similarly realized that duplication in effort, parallel but disconnected policies and programs, and misaligned approaches across federal, state, and local programs are a problem for manufacturers trying to navigate public support programs. Comprehensive manufacturing strategies were essential to connect the many needed pieces.

Broadly, there were three approaches to strategy development:

- Using statewide councils comprising large, midsized, and small manufacturers (**Pennsylvania** and **Massachusetts**);
- Emphasizing a regional, bottom-up process, involving a series of meetings of local public and private stakeholders (**Colorado, New York,** and **California**);
- Assembling, improving, and coordinating activities that are already in progress (**Kansas** and **Connecticut**).

The Statewide Council Approach

PENNSYLVANIA In fall 2011, Governor Tom Corbett formed the Governor's Manufacturing Advisory Council (GMAC) as a public-private partnership. He appointed the secretary of the Department of Commerce and Economic Development and the president and CEO of Kennametal, Inc., as co-chairs, along with 24 manufacturing leaders and experts from across the commonwealth as its members. The members included a cross-section of manufacturing interests from the areas of heavy manufacturing, minerals, pharmaceuticals, plastics, steel, and textiles. The GMAC was given six months to develop recommendations for sustaining and growing Pennsylvania manufacturing.

The governor assigned the Team Pennsylvania Foundation (a unique, nonpartisan, charitable nonprofit, created in 1997 to allow government and the private sector to collaborate for the betterment of the Commonwealth of Pennsylvania) to manage the GMAC without using tax dollars. With support from the NGA Policy Academy and the Pennsylvania staff leadership team, the council organized its work around six monthly, full-day meetings, each focusing on a specific topic, including an overview of the manufacturing environment in Pennsylvania; talent and workforce development; opening new domestic and international markets; making government work for manufacturers; innovation; and access to capital. The final meeting summarized findings, challenges, opportunities, and next steps. The governor released the council's recommendations at a press event on August 21, 2012. The Pennsylvania policy academy leadership team received the task of developing a plan to implement the recommendations. In September 2012, the Pennsylvania policy academy leadership team met with other stakeholders to begin developing the implementation plan. They organized into four teams based on the categories of recommendations in the GMAC paper:

- Talent and workforce;
- Opening new markets (international, domestic, and emerging energy);
- Innovation; and
- Access to capital.

MASSACHUSETTS Beginning in 2010, Massachusetts began consultations with manufacturers about their needs, including a wide array of state agencies, federal programs, and local institutions and organizations to identify potential solutions and complementary roles. Massachusetts' approach emphasizes regional collaboration among manufacturers, educators, and other civic leaders but recognizes

that those collaborations will be most effective when connected to statewide collaboratives composed of policymakers, academic and civic leaders, and manufacturers from throughout the state.

In November 2011, Governor Deval Patrick established the Advanced Manufacturing Collaborative to align and focus public and private resources statewide in support of manufacturing initiatives, to enhance the effectiveness of regional networks, and to promote the visibility of manufacturing in and outside the state. The collaborative developed five working groups focused on particular areas identified through the consultative process: promoting manufacturing; workforce and education; technical assistance and innovation; access to capital; and the cost of doing business. Each working group continues to be led by industry co-chairs and includes representatives of education and state and federal government, as well as other stakeholders.

In July 2012 the state legislature formally established the Advanced Manufacturing Collaborative in statute, to sustain the integrated approach, and also established an Advanced Manufacturing Futures Fund, with authority to finance initiatives in the five areas. In addition, the legislature increased the funding of key partners in the strategy, including Massachusetts' Manufacturing Extension Partnership (MEP) and existing workforce training activities.

The Regional Bottom-Up Approach

COLORADO Colorado's approach to building a comprehensive manufacturing strategy started with regional meetings of local public and private stakeholders as part of Governor John Hickenlooper's intensive program of listening sessions, conducted around the state early in his administration. Those sessions led to the *Colorado Blueprint,* a framework for strengthening Colorado's industries, including advanced manufacturing, around six core objectives:

1. Build a business-friendly environment;
2. Retain, grow, and recruit companies;
3 Increase access to capital;
4. Create and market a stronger Colorado brand;
5. Educate and train the workforce of the future; and
6. Cultivate innovation and technology.

Since the regional listening sessions, the governor's office and the Colorado Office of Economic Development and International Trade (OEDIT) have convened CEOs and other top executives from 14 key industries into individual industry steering committees. Those steering committees create business plans for their industry networks, centered on the six core objectives. Tactical teams on workforce development, education, economic development, and other support programs then are responsible for implementing the actions in the business plans. Advanced manufacturing was the first industry to create a business plan, in early 2012.

The original Advanced Manufacturing Steering Committee represented 26 industry leaders from across the state's regions, its diverse manufacturing, and its small and large companies (including Vestas Towers and Intrex Aerospace, for example). The steering committee concluded that Colorado lacked a unified structure or association aligning issues and goals across the industry to meet the needs of small and medium-sized enterprises (SMEs) and original equipment manufacturers (OEMs). In response, OEDIT joined with industry members to create the Colorado Advanced Manufacturing Alliance (CAMA), a 501(c)(6) organization guided by a board made up of the original steering committee and a full-time president and funded by private investments. The alliance is organized across three areas:

- Member strategic services, which focuses on implementing the advanced manufacturing business plan, includes increasing and streamlining access to state programs related to business development, access to capital, branding and marketing, and workforce development;

- Direct services to manufacturers, which will incorporate a partnership with manufacturing service providers, such as a restructured Manufacturing Extension Partnership Center focused on continuous improvement services, innovation engineering assistance, and a workforce training network; and
- Technology and innovation acceleration, which includes a new Center for Entrepreneurship (inclusive of various existing Colorado incubator and entrepreneurship programs) and a new Colorado Advanced Manufacturing Innovation Institute, whose form is currently being analyzed but which may be modeled on Virginia's Commonwealth Center for Advanced Manufacturing (see Box 10).

NEW YORK When Governor Andrew Cuomo took office in 2011, he created a new plan for economic development, one that changed New York's economic development strategy from one in which leadership and decision making were concentrated at the state level to a model that empowers regions to develop and invest in their own strategies for job creation and business growth.

Regional economic development councils were created in each of the state's 10 regions. Local business, university, labor, and community leaders were charged to develop their own strategic plans based on their region's assets, strengths, and aspirations. It is important that each regional council is co-chaired by a business leader and a university leader. That choice expressed the governor's fundamental belief that economic growth in today's global environment requires a strategic link between the state's business and university strengths.

Through an intensive, deliberative process, each region discussed, debated, and designed its own strategic plan. The state received 10 different plans tailored to the strengths, needs, and opportunities of each region.

Although the plans were unique, common elements were found in almost all. Most relevant to the NGA Policy Academy work was the emphasis that each region placed on entrepreneurship and innovation for growth. The regional councils expressed the need to create cultures of innovation and entrepreneurship on their campuses, in their communities, and within their corporations. Another common characteristic was an emphasis on manufacturing, particularly advanced manufacturing, as a catalyst for the growth of the regions. The plans of Western New York, the Finger Lakes Region, Central New York, the North Country, the mid-Hudson Valley, and Long Island all placed a high priority on the growth of manufacturing.

The governor's office charged state agencies to align their programs and resources to respond to the needs and opportunities identified by the regional councils. The state provided an initial round of $785 million in funding, through a consolidated application process that combined resources available from individual state agencies. The state made more than $700 million available in a second round of funding to maintain the regional councils as the driving force for economic development. Eleven state agencies participated in the 2012 consolidated funding application, including Empire State Development, the New York Department of Labor, the Council on the Arts, the New York Power Authority, Homes and Community Renewal, and the New York State Energy Research and Development Authority, among others.[25]

The state received more than 2,800 finalized applications in the latest round of consolidated funding. The regional councils completed their ranking of projects, giving special attention to those that aligned with the regional strategic plans and awarding the highest scores to projects that are "regional priorities." Many of those projects are based on new partnerships in which business and industry are attempting to unleash the innovation potential of new technologies or addressing specific industry needs, such as shortages of workers in skilled trades.

[25] New York Works for Business, Regional Economic Development Councils, http://regionalcouncils.ny.gov/.

During fall 2012, Governor Cuomo and a strategic implementation assessment team met with each council in their region to assess how well each region is progressing toward its objectives.

Both competitive and collaborative processes are at work. Regions compete for funding, and that competition has required that partners identify and leverage their greatest strengths. It also is forging collaborations, as individuals and institutions learn more about their regional assets and how they can be collectively deployed to address common objectives. Round two has witnessed the development of some collaborative projects between regions, many of which address technological and innovation needs of companies throughout the state.

CALIFORNIA California's manufacturing policy academy team linked to and leveraged a new, strategic statewide economic policy process. The California Economic Summit process was initiated by two civic organizations—California Forward and the California Stewardship Network—to identify and mobilize around economic priorities for the state. The summit process involved more than 1,400 Californians, who attended one of the 14 regional forums or a statewide meeting and launched seven major "signature initiatives" in areas such as workforce development, innovation, infrastructure, access to capital, and regulatory reform. During the process, participants voiced support for stronger efforts to promote manufacturing, resulting in a specific recommendation to seed "regional manufacturing pilot projects" across California. In turn, based on discussions between policy academy and state community college leaders, manufacturing was made eligible as a focus for regional industry partnership seed funding. Funding was awarded to more than 10 manufacturing partnerships statewide. In addition, legislation was passed to renew and extend the California community college initiative responsible for funding manufacturing and other regional industry workforce partnerships.

The Assembling and Coordinating Approach

Sensing that manufacturers had little or no appetite for another manufacturing strategy and priority-setting exercise and wanted "action" instead, **Kansas** and **Connecticut** took the "assemble and coordinate" approach for their initiative.

KANSAS A series of regional meetings with manufacturers, local officials, and higher education and other service providers revealed a number of common challenges:

- Numerous initiatives, programs, and organizations focused independently on different dimensions of manufacturing;
- A lack of consistent and comprehensive communication to manufacturers about the array of assistance available;
- No systematic mechanism for feedback to policymakers on manufacturing needs and limited manufacturing presence in commercialization and technology transfer discussions at state universities; and
- No actionable evaluative process to measure the impact of various programs and investments designed to help manufacturers.

Rather than focus on a statewide effort, the state embarked on several regional initiatives to integrate a multitude of plans and bring a coherent focus to advanced manufacturing using the strengths and assets of each region. For example, Wichita is exploring ways to extend technologies, facilities, equipment, workforce programs, and partnerships within aviation to other advanced manufacturing industry segments. Those transferable assets can support new opportunities for existing companies, stimulate new, high-growth start-ups, and attract new businesses to the area. Leaders are also looking outside the metro area to identify new collaborations that will build on Wichita's existing and emerging industrial and research strengths.

Kansas City is partnering with a number of groups to use its newly designated National Cancer Institute Center and technology upgrades related to the Google Gigabit Fiber pilot as focal points for attracting new wealth to the region. In addition, the city has created a new program, funded by the board of public utilities and industry with technical expertise in sustainable manufacturing (provided by the Mid-America Manufacturing Technology Center, the local MEP center and a Department of Commerce affiliate) to improve the competitiveness of its manufacturers by reducing energy costs in aging facilities.

At the state level, to reinforce the integrated approach, the Mid-America Manufacturing Technology Center, a Department of Commerce affiliate, is implementing a partnership plan and an information/collaboration portal as a centralized reference point for manufacturers.

CONNECTICUT Connecticut started the NGA Policy Academy process already having a good understanding of the top issues for Connecticut manufacturers, partly because it had already conducted studies. Rather than reconvene manufacturers to discuss challenges that had already been identified, the policy academy team took the issues that they knew were priorities and created an action plan, with input from representatives of manufacturing companies, the state legislature, and universities, and workforce and economic development leaders in the state.

The priority areas identified by the policy academy team include (1) creating a sustainable, business-friendly environment for manufacturers; (2) improving connectivity among manufacturers, institutions, and companies in relevant fields, leading to new ideas and partnerships for commercial opportunities; (3) helping manufacturers enhance their technology and processes; and, (4) attracting, educating, and maintaining strong talent to support current and future manufacturing.

For each area, the team worked to identify actions that could be implemented quickly and could lead to long-term change. For example, the team knew that the high cost of energy in Connecticut was a challenge for manufacturers, so the Department of Economic and Community Development joined with the Clean Energy Finance and Investment Authority to develop and launch a Clean Energy Business Solutions program. The program is designed to address energy cost challenges for existing Connecticut businesses or potential new arrivals. That program will provide financing to targeted companies of strategic importance for economic development in Connecticut, with the goal of improving their competitiveness by delivering cleaner, cheaper, and more reliable energy to their operations.

At the same time, State Senator Gary LeBeau, who was a member of the policy academy team, launched a bipartisan "advanced manufacturing caucus" in the legislature to identify the most important issues for legislative action in 2013. The caucus now includes 30 legislators, spanning the state and representing various legislative committees.

Develop and Implement Industry-Driven Priorities and Partnerships.

It is widely agreed that employer engagement is critical in making any state manufacturing strategy a success. However, many programs engage employers through a one-time (or sometimes annual) solicitation of information about their needs, then design and provide services for them as customers. Often that approach has yielded disappointing results. And efforts to foster engagement in additional ways, such as industry association meetings and workshops, tend to yield recommendations for general business environment priorities (taxes and regulations) but not much in terms of concrete industry research priorities or types of real-time services useful for manufacturers seeking to produce globally competitive products. Some states are moving to a more systematic and lasting employer engagement strategy of working with manufacturers as partners in both setting priorities and implementing them. In that way, employers share ownership of the strategy and continue to contribute their guidance and unique resources to drive results.

During their NGA Policy Academy work, both **Massachusetts** and **Colorado** formed new public-private partnerships to ensure that industry leaders are staying engaged and working with other public and private entities to help implement specific initiatives. Both states saw a need to engage stakeholders in additional ways besides industry associations. Both states spent considerable time looking at the purpose and structure of the Commonwealth Center for Advanced Manufacturing (CCAM), which NGA suggested as one model for more structured coordination among industry, university, and government (see Box 10 for a description of CCAM).

MASSACHUSETTS Massachusetts consulted with hundreds of employers of all sizes across every region of the state to determine priorities and then established the Massachusetts Advanced Manufacturing Collaborative, led by industry, to focus on five major priority areas. Most members of the collaborative are manufacturers, plus leaders from academia, the legislature, and

BOX 10. Best Practice Model—Commonwealth Center for Advanced Manufacturing

Through the policy academy process, states had an opportunity to learn about a new kind of organization that uses industry funding and input to advance industry priorities, particularly in workforce development and industry-relevant research. Virginia's Commonwealth Center for Advanced Manufacturing (CCAM) is a collaboration among the state, the University of Virginia, Virginia Tech, Virginia State University, and manufacturing companies worldwide. The state was primarily responsible for developing a large and diverse partnership to bring a Rolls Royce production facility to Virginia. The partnership now provides tailored research and development (R&D) and workforce training to eight large manufacturing companies, and expanded participation by supplier companies is being planned.

By pooling resources and keeping research focused on company needs, CCAM increases the value of the R&D dollar. Members share facilities, personnel, and pre-competitive research. The partnership bridges the gap between fundamental research typically performed at universities and product development routinely performed by companies. Research is conducted in areas (for example, surface engineering) that add value to manufacturers in diverse sectors. Manufacturers are able to direct the research toward production and focus it on commercial uses.

CCAM's eight industry members, including Newport News Shipbuilding, Rolls Royce, and Siemens, make sizable contributions to the partnership. Tier 1 industry members contribute $400,000 annually for at least five years, have one full-time staff person on-site at the CCAM facility, and engage two other companies (often smaller suppliers) as Tier 2 members. Tier 1 membership fees cover two kinds of research—generic and directed. All members have a nonexclusive, royalty-free license to intellectual property developed from generic research. Directed research is owned by the member company that funded it. The cost of entry for Tier 2 members is lower. They have access to generic but not directed research. Industry partners have committed to contribute more than $25 million to CCAM over five years.

CCAM's collaborative pre-competitive model is also focused on preparing a skilled workforce for manufacturing jobs. Students participate in CCAM's research and development through internships and graduate student internships, which foster the transfer of skills between seasoned industry veterans and students. CCAM is also partnering with Virginia's community college system to develop training that meets the specific workforce needs of its industry members.

The state has made a number of commitments to CCAM's continued development, including matching research funds and funding laboratory renovations, faculty hires, graduate research assistantships, undergraduate student interns, and workforce development programs. The state's contributions to CCAM will total at least $40 million over five years.

The three founding universities also contribute resources to CCAM. Each university member commits one staff person to be on-site at CCAM facilities full-time. The universities are committing $10 million to CCAM over five years through faculty hires and start-up packages, matching research funds, new manufacturing courses, and research equipment funding.

government agencies. The five priorities were assigned to working groups with co-chairs from industry. Specific actions in each area were identified and refined and became the scope for the the new $1 million Advanced Manufacturing Futures Fund (Futures Fund) created by the legislature. The futures fund will help seed industry-led regional manufacturing partnerships that pursue a customized workforce, technical assistance and innovation, and other strategies. The state-level Advanced Manufacturing Collaborative, now formalized in statute, will promote and oversee action in all five priority areas. It will be led by two industry co-chairs and include strong employer participation.

COLORADO The Colorado Advanced Manufacturing Alliance (CAMA) identified two big obstacles impeding the ability of programs and policies to meet the needs of industry: the lack of a consistent industry voice about issues and needs and the absence of a strong network to facilitate business-to-business activity and partnering. Regional manufacturing sector partnerships exist in the southern and western parts of the state, but they are disconnected from one another and are not present in other regions. Like other states, Colorado has had industry networks or clusters rolled out before, but this time the governor and OEDIT staff deliberately sought out permanent homes for each of the governor's 14 key industry networks, so that industry executives can convene regularly and so that one organization, in partnership with other stakeholders, is responsible for keeping the industry voice front and center while aligning, improving, or creating policies and programs. In the case of advanced manufacturing, a credible convener did not exist, and so CAMA was created. In addition to its 26-member board, CAMA is propelled by industry-led committees. It established a membership goal of more than 100 manufacturers in its first six months.

Boost Innovation and Commercialization Capacity of Manufacturers, Particularly for Small and Midsized Firms, by Connecting Them to Partners, Consortia, and a Whole System of Supports.

The common challenges of manufacturers across the United States are well documented, and despite increases in overall productivity by U.S. manufacturers, largely because they have adopted lean processes, individual manufacturers still report barriers to growth that prevent them from creating new jobs. Barriers that affect small and midsized companies (SMEs) directly can include a lack of access to:

- Modernized equipment, high-powered computing or modeling, and simulation and analysis software to create new products and implement new technologies, processes, and techniques;
- Rapid cycle product development techniques and the specialized capabilities to produce a rapid prototype for proof of concept;
- Local laboratories for testing, inspection, process development, interoperability, environmental, and other similar resources critical for translating research into innovations and innovations into successful new products;
- State universities and federally funded R&D activities and new product or process innovations; and
- Networks, relationships, and spaces (physical and virtual) that connect government, universities, and industry—and permit real-time information exchanges, knowledge flows, and collaborations—to achieve a higher level of innovation, entrepreneurship, and commercialization.

As part of their NGA Policy Academy work, the states undertook a number of actions to address challenges facing small and midsized manufacturers, including the following:

- Creating an innovation voucher program, modeled after successful programs in Europe, to help connect SMEs to partners and universities that can help their R&D and new product development efforts;
- Building formal and informal institutions and networks (including portals to build virtual networks) that promote detailed information and technology transfer and joint problem solving among manufacturers, federal labs, academic research center, and universities;
- Providing shared scientific infrastructure, such as high-powered computing or modeling, simulation and analysis software, and the like, which can be expensive for smaller firms to own;
- Addressing gaps in access to capital for innovation, commercialization, and business expansion; and
- Providing export assistance to expand into new markets.

BOX 11. Best Practice Model—Encouraging SMEs to Take Up Regular R&D and Innovation Activities

As part of the policy academy process, states learned from a number of countries or international regions that have created innovation voucher programs to strengthen ties between small and medium-sized companies and sources of innovation, such as universities or research organizations. Those programs provide companies with relatively small vouchers (typically $5,000 in value), which a company can use to purchase innovation expertise and services; the vouchers are designed to have a fast and light application and administration process. The NGA Center for Best Practices assisted with a virtual, conference-call-based "study tour" of programs in the Netherlands, Germany, Austria, Switzerland, and Canada. Those calls informed the design of Connecticut's innovation vouchers program. Many of the key lessons learned are summarized below.

Goals of the program. Common goals of innovation voucher programs include bridging the gap between companies and universities, expanding innovative capacity within a company by helping to solve a particular problem, or spurring innovation in companies that have not traditionally tried to develop new products or processes. Many of the programs aim to engage small and medium-sized companies that have limited interaction with universities or government programs to encourage them to cooperate with research organizations.

Voucher size. Programs tend to offer vouchers in the range of $5,000 to $15,000. Smaller vouchers are often easier to administer, tend to not require a company match, and are often used to promote either new innovative activity in a company or a new relationship with a partner such as a university or other service provider. Larger vouchers tend to require some form of match from the company, often include a longer and more rigorous vetting process, and are targeted to solve a problem for which a company needs very specific expertise.

Eligible services to companies. Countries that have implemented an innovation vouchers program have defined eligible services differently. For the smaller voucher programs, some countries decided that all services were eligible and approved all applications. In contrast, Austria focused its services mostly on idea studies and proof of concept, R&D studies, prototyping, and innovation management. Germany followed suit, with the main focus on R&D and innovation. Innovation voucher programs that limit eligible services tend not to allow vouchers to be used for projects such as training, financing, IT consulting, and investment because they are difficult to define or are only loosely connected to innovation.

Approved service providers. In some cases, innovation voucher programs limit eligible service providers to public universities and research institutions, but others allow private service providers to participate. When providers are limited to public sector institutions, the reason is often that the country is focused on improving connections between companies and research institutions.

Application process. The length and rigor of the innovation vouchers application process often depend on how companies structure the voucher size, eligible services, and approved providers. For example, if eligible services are focused on technical projects that address a specific company problem, then a technical review by an expert may be required before the voucher can be approved. This level of review adds time to the application process and requires access to technical experts in a range of technology areas.

Creating an Innovation Voucher Program

CONNECTICUT Connecticut is launching an innovation voucher program, based on a best practices review of programs in other countries, to better connect small and medium-size companies to sources of innovation and the technical assistance they need to develop and commercialize new products (see Boxes 11 and 12 for international examples and lessons learned). The state has allocated $800,000 to launch its innovation vouchers pilot program, which will be administered as part of Governor Dannel Malloy's Innovation Ecosystem Initiative, which has designated four innovation hubs in the state.

The goal of the program is to help some of the state's most promising early stage companies develop their ideas and get products to market faster. To spur collaboration between early stage companies and service providers in the innovation ecosystem, the

BOX 12. Best Practice Model—Innovation Voucher Program Results

As part of the policy academy process, states learned from a number of countries or international regions that have created innovation voucher programs to strengthen ties between small and medium-sized companies and sources of innovation, such as universities or research organizations. Evaluations of the programs have uncovered a number of important lessons learned:

Very small, innovative companies are most likely to use innovation vouchers. Innovation vouchers are attractive to very small firms because they are easily accessible and are not difficult to administer. They thus can be effective in reaching companies that have not sought out state resources in the past, but which could benefit from innovation assistance. The vouchers tend to be used by the more innovative companies. In the Netherlands, an evaluation found that less-innovative SMEs often apply for the vouchers but fail to redeem them. In Alberta, the companies that applied for vouchers were regionally diverse, but the program was particularly successful with rural areas.

Vouchers most often fund projects that would not otherwise be undertaken. Evaluations of the European programs have found strong "additionality." "Additionality" is a measure of whether a firm would have undertaken a project without a voucher. An evaluation of the Dutch program found that 81.5 percent of the firms receiving small vouchers would not have undertaken their project without it. In Austria, 80 percent would not have carried out the project without the voucher. Of those that would have carried out the project, 35 percent would have carried it out differently. The evaluation concluded that "the innovation voucher makes SMEs conduct a larger, better project more quickly." Some SMEs noted that the voucher reduced time-to-market by as much as 50 percent. In the Swiss case, 90 percent of the firms that received innovation vouchers said that they would not have undertaken their project without the innovation voucher.

Vouchers promote continued interaction between companies and universities. In the evaluation of the Swiss and Austrian programs, a significant number of companies reported new and intensified contacts with research organizations, follow-up activities, and less reluctance to cooperate with a research organization. In the Netherlands, an evaluation found that companies did not go back for a repeat project but expressed interest in staying in contact with the research organization. It also found that the program prompted research organizations to adopt a more active approach to SMEs.

Services exist that universities and other research organizations will offer for $5,000. Those services most often include technical development, proof-of-concept, design services, product development, technology exploration, intellectual property management, and market studies. Projects funded by innovation vouchers in the Netherlands included developing a prototype of a women's shoe with an adjustable heel, testing systems to catch mussel larvae, finding a market niche in Internet music databases that led to the creation of a new music platform, and increasing patent protection for a product whose export base is growing. In many cases, though the individual voucher was small, universities saw an opportunity in the potential volume of vouchers. Universities also began to inventory the services they could offer to SMEs.

Sources: Barbara Good and Brigitte Tiefenthaler, "Innovation Voucher - Small Is Beautiful," *Platform FTeval,* December 2011. European Commission, *Availability and Focus of Innovation Voucher Schemes in European Regions,* November 2009. Interview with Alex Umnikov, Advanced Technology Industries Division, Alberta Enterprise and Advanced Education, July 2012.

program gives companies a voucher to purchase innovation or commercialization services from a specific provider. Service providers are public and private entities (for example a university or an engineering firm) that have a specific expertise that can help a company develop or commercialize a new product or service.

Companies that are selected to participate in the pilot program will be provided with a $5,000 voucher that they can use to purchase specific services from an approved provider. The company is not required to provide a financial match. Services could include anything from small-scale prototyping or preparatory work for research and development, to an innovation audit, an engineering design, or the preparation of legal documents to protect new intellectual property. To be eligible for a voucher, companies must propose a clear deliverable in one of four categories: research and development, business model development or market feasibility, operations, or legal assistance. A recipient company must also be a start up (that is, not yet profitable and often employing fewer than 10 people) or a stage 2 company (that is, profitable and often employing between 11 and 100) and be identified as high-performing by the Connecticut Innovation Ecosystem staff.

Implementing a program with a quick turnaround time was of particular importance to the state. A 2010 study of high-growth companies found that many did not have a positive view of state programs and were not likely to interact with the state. Designing a program with small grants and quick turnaround was therefore a priority. A joint application process is expected to speed the time between application and project approval, which is expected to be no more than four weeks. Companies can apply for two innovation vouchers within one year, but they must apply jointly with a service provider partner. Paired with the innovation hubs initiative, the vouchers provide a way for the hubs to connect with a large number of high-potential companies and service providers. The vouchers program thus becomes a front door to the other resources and services to which the innovation hubs can link companies, such as training and education, peer networks, mentoring, and strategic and technical support.

Building Formal and Informal Institutions and Networks that Promote Technology Transfer and Joint Problem Solving

NEW YORK New York has focused a good deal of attention on better connecting SMEs to the technology resources that already exist at the state level, including university technology centers and MEP centers. Encouragement and direction provided by the NGA Policy Academy led to an unprecedented meeting of all the state's Centers for Advanced Technology (15), Centers of Excellence (6), and Regional Technology Development Centers (10). It was followed by the launch of an interactive portal with a systemwide customer relations and referral protocol to encourage better collaboration among resource providers. The academy assisted Empire State Development in its work with the state's Centers of Excellence in developing center-specific commercialization plans designed to expand strategic industry outreach efforts to serve more companies in more regions of the state.

In its most recent effort to align its technology resources with the needs of SMEs, the MEP network of Regional Technology Development Centers (RTDCs) is conducting 10 region-based "Solution Fairs." The Solution Fairs are designed to take the state's technology resources to industry customers. A half-day forum in each region of the state allows companies to discuss their individual technology need or challenge with university technology centers.

That effort is consistent with the NGA Policy Academy's efforts to identify new models for more effective delivery of services to SMEs. It is also consistent with Governor Cuomo's directive to align existing resources with regional needs and regional priorities.

ILLINOIS The Illinois Open Innovation Network is currently being developed to forge better connections between SMEs and sources of innovation. The Open Innovation Network is a partnership between the Governor's Innovation Council, the Illinois Department

of Commerce and Economic Opportunity, the Illinois Science and Technology Coalition, and Illinois' major research institutions. It will connect industry to research institutions, and research institutions to one another. The network will aggregate researcher expertise, publications, available technologies, unique facilities, and collaborative history. Its goals are (1) to enhance university-industry collaboration; (2) to facilitate the capture of federal funding; and (3) to maintain Illinois' prominence in research, development, and innovation.

CALIFORNIA California has found that its small and medium-sized manufacturers (SMEs) need to be world class to compete, but most lack access to technical assistance, resources, and innovation services that are required to be competitive in global markets. Although high-quality research and development is taking place at the state's universities and technology industries, that R&D is often disconnected from the real-world challenges facing SMEs. Although California will remain a high-cost location relative to Asia, manufacturers can compete on innovation, flexibility, and quality, meeting rapidly changing consumer demands by remaining closer to design. In fact, some flexible, high-value manufacturing has been returning to the state. However, better links between California technologies in such areas as modeling and simulation, robotics, and information technologies and the manufacturing community are needed.

California is focusing on the establishment of a California Network for Manufacturing Innovation to build a bridge between technology developers and manufacturers. The collaborative presently includes the state's two MEP centers, Lawrence Livermore National Laboratory, the University of Southern California, iHubs, Research Triangle Institute (RTI) and El Camino Community College (also representing the 11 Centers for Applied Competitive Technologies in California). California's iHub network was established in 2010 to leverage the state's innovation assets (e.g., research parks, technology incubators, universities, and federal laboratories) and codify relationships among them. This network has provided a platform for start-up companies, economic development organizations, business groups, and venture capitalists to improve the state's national and global competiveness.

COLORADO Colorado is working with the National Aeronautics and Space Administration (NASA) to create a first-of-its-kind, statewide partnership between CAMA and NASA. The partnership will explore opportunities for collaboration around topics such as incubation and technology transfer, STEM education, commercialization and acceleration, open innovation, and economic development. There will be several subagreements, the first of which will be the existing NASA agreement with the Colorado Association for Manufacturing and Technology (CAMT) that defines the partnership around technology transfer, getting NASA's technologies commercialized, especially among SMEs.

KANSAS Kansas has developed an "Innovation Community" pilot in the city of Pittsburg with economic development officials, university leaders and company executives implementing a set of prioritized initiatives, tools and processes designed to help the manufacturing industry thrive in a newly connected innovation ecosystem. The city has taken the leadership role for the entire project while the Mid-America Manufacturing Technology Center, with help from partner Network Kansas, is guiding the implementation of the strategies at the university and company level. Pittsburg is adding additional support by addressing policy, incentives, infrastructure and marketing. Initial focus areas include the roll out of a newly-developed innovation engineering minor at the university and individualized innovation-based growth plans at the participating companies.

Addressing Gaps in Access to Capital for Innovation, Commercialization, and Business Expansion

MASSACHUSETTS Massachusetts is implementing a series of workshops on access to capital. Sponsored by several banks in the state, the workshops will help companies to better understand the financial system and their

BOX 13. Federal Resources and Centers Are an Important Part of State Networks

States have found that federal resources and centers have played an important role in building formal and informal networks to promote technology and joint problem solving. Two examples are the resources provided by the Manufacturing Extension Partnership (MEP) Program at the National Institute of Standards and Technology and the U.S Economic Development Administration:

Manufacturing Extension Partnership

NIST MEP is a public-private partnership with a nationwide network of over 1,400 technical experts located in every state in the form of state, university-based, or non-profit organizations. MEP centers work with U.S. manufacturers to help them create and retain jobs, increase profits, and save time and money. Services include: innovation strategies, product design and protyping, supply chain opportunities, reshoring, process improvements, green manufacturing and exporting. MEP partners at the state and federal level on programs that position manufacturers to develop new customers, expand into new markets and create new products. More than 460,000 of these types of projects have been completed since the program's inception 25 years ago. Customers are usually manufacturers with fewer than 500 employees in virtually every type of industry – from food processors to solid state circuitry assemblers to medical device manufacturers.

MEP CLIENT IMPACTS

Results reported by MEP clients receiving services in FY 2011. Of the 9,952 cleints selected to be surveyed, 7,658 completed the survey. Recurring or cumulative benefits may be larger.

Total Increased/ Retained Sales	$8.2 BILLION
Total Increased/ Retained Jobs	60,497
Cost Savings	$1.3 BILLION
New Client Investments	$1.9 BILLION

MEP delivers a high return on investment. For every one dollar of federal investment, the MEP generates around $30 in new sales growth. This translates into $3.6 billion in new sales annually among MEP clients. And for every $2,067 of federal investment, MEP creates or retains one manufacturing job.

U.S. Economic Development Administration

As the only federal agency with economic development as its exclusive mission, the U.S. Commerce Department's Economic Development Administration (EDA) promotes the economic ecosystems in which jobs are created. EDA strives to advance global competitiveness, foster the creation of high-paying jobs, and leverage public and private resources strategically.

EDA builds a foundation for sustainable job growth upon two key economic drivers: innovation and regional collaboration.

Innovation is the key to global competitiveness, new and better jobs, a resilient economy, and the attainment of national economic goals, including the advancement of the manufacturing sector. The new global economy is built on centers of excellence and competition. Those regions that work together to leverage resources and use strengths to overcome weaknesses will fare better against global competition than those that do not.

EDA works directly with local economic development officials to support their bottom up, regionally-owned economic development initiatives. Linking EDA's investments to a community's strategic economic development plan enables the federal government to better leverage public and private sector investments in order to achieve economic development goals.

EDA offers a complementary, balanced portfolio of tools designed to help rural and urban communities evolve through the economic development process to become robust regional engines for business creation and job growth.

options within it, as well as help them to recognize investment opportunities offered by SMEs that are moving into advanced manufacturing products and processes. The Advanced Manufacturing Collaborative's capital access work group is joining with the Boston Federal Reserve Bank to identify and work through any specific regulatory hurdles that may keep banks in the state from lending to manufacturers. The work group is creating a matchmaking guide to resources, which will include a matrix that matches manufacturers' needs with relevant public and private capital sources.

COLORADO Based on needs expressed by manufacturing executives, Colorado is creating a capital resource portal to connect industry with capital resources. The state is also looking into creating a fund of private investment capital to be channeled toward high-growth companies in industry sectors including advanced manufacturing.

Providing Export Assistance to Expand into New Markets

CALIFORNIA California discovered growing interest in exporting among SMEs but found that most such businesses did not know how to take the initial steps. The state also found that current approaches to educating small and midsized manufacturers and matching them to export opportunities are ineffective, largely because of poor alignment among the public and private sector organizations focused on export development. Although many individual services are available, including workshops, seminars, and trade missions for manufacturers, no overall methodology, curriculum, or coordinated effort exists to establish a systematic approach for SMEs to follow. Recognizing that problem, the state is implementing a series of "Trade Connect" workshops to build a consistent message among participating export assistance partners about benefits and available services and how they work together. The state is also piloting the use of ExporTech training for Trade Connect partners, a shared method for working with SMEs in manufacturing. Additional funding from the State Trade and Export Promotion

BOX 14. Best Practice Model—Washington's Workforce Intermediaries

Through the policy academy process, states learned from workforce intermediaries that involve industry in developing curriculum and in both funding and providing training. Two of those intermediaries are based in **Washington** state: the Center of Excellence for Aerospace and Advanced Materials Manufacturing and the Aerospace Joint Apprenticeship Committee.

Washington established 10 industry-specific centers of excellence, each located at a community or technical college, to serve as central points of contact and resource hubs for industry trends, curriculum development, and fast, flexible, customized training. The centers were originally established to serve regional industry needs but have evolved to oversee the services and training provided in their sector across all 34 two-year colleges in the state.

The Center of Excellence for Aerospace and Advanced Materials Manufacturing, through Workforce Investment Act (WIA) funding, was able to cross-map community college course codes in aerospace and manufacturing with Boeing's entry level job codes. The cross-mapping catalog is a first step in creating a cohesive training program within Washington's community college system that aligns with the knowledge, skills, and abilities that industry is looking for.

In addition, the center convenes the Aerospace Curriculum Alignment Team (ACAT), a growing consortium of colleges, training centers, and industry representatives that clarifies industry needs and matches them with college and training center capabilities and programs.

Washington's Aerospace Joint Apprenticeship Committee (AJAC) was established to help meet the demand for skilled workers in the aerospace industry by creating new apprenticeship programs. The committee is composed of industry employers, employees, and the International Association of Machinists and Aerospace Workers. AJAC develops and implements apprenticeship programs for multiple aerospace and manufacturing occupations. Ninety-three percent of the education takes place as paid on-the-job training that is managed by an AJAC apprenticeship coordinator. The apprentice is supervised by a journey-level employee from their workplace. Apprentices must also attend related college classroom instruction to learn the theory behind what they are learning on the job.

(STEP) grant has helped export promotion activities through partnerships among the Governor's Office of Business and Economic Development (GO-Biz), California Community Colleges' Centers for International Trade Development (CITD), California Chamber of Commerce, and other agencies throughout the state.

Provide Talent Both to Fill the Specialized Needs of Employers Quickly and to Deliver Lifelong Training for Workers at All Levels.

The importance of a skilled workforce to the success and growth of all manufacturing companies cannot be overstated. Yet across the country, the education and training programs that could prepare job seekers for successful careers in manufacturing are underused or, where they exist, are often misaligned with the actual needs of industry. Successful models that engage industrial firms, assess their needs, and create programs and credentials that provide real currency for job seekers are gaining more attention. For example, Box 14 presents some examples from Washington, and Box 15 contains a snapshot of the growing support for sector partnerships across the country.

For SMEs, finding and keeping a skilled workforce can be particularly challenging because of the following:

- Rapidly changing and increasing skill requirements to operate manufacturing equipment make it difficult for education and training providers—as well as employers themselves—to stay current;
- It is often difficult to attract and retain middle-skill workers with significant engineering and technical skills, as well as problem-solving acumen;
- Customized on-the-job training of incumbent workers often entails risk and high cost; it can take equipment out of production or cause damage to valuable equipment; and
- The public has a generally negative perception of manufacturing careers, and awareness is lacking about career opportunities in manufacturing, resulting in young people being discouraged from considering manufacturing as a career.

Although the states participating in the policy academy took a number of approaches to producing and attracting globally competitive talent for manufacturers, all the approaches emphasized public-private partnerships and industry-driven solutions. A number of states also found that many such activities already exist and that immediate benefit was to be gained by improving, replicating, and scaling up those existing resources.

COLORADO Gaps in the skills and experience of workers are top priorities for both the OEMs and the SMEs in Colorado. More than 25 percent of human resource executives in the state rate the skills and experience of workers as their company's number-one concern for the next three to five years. The persistent problems of Colorado manufacturers include the lack of a strong trade school network and limited access to opportunities for workplace experience through internships, job shadowing, pre-apprenticeships, and apprenticeships. State labor statistics indicate that the average Colorado manufacturing employee is within 10 years of retirement. Members of CAMA have made it clear that there is no time to waste in engaging current workers in developing and mentoring the next generation of the state's manufacturing employees. Colorado manufacturers also believe that they do not consistently engage the K–12 and higher education communities in constructive conversation about the opportunities in manufacturing or about crafting curricula to align with the needs of Colorado's manufacturing companies and with national manufacturing credentialing standards. Colorado is not at square one, however. Its recent work in implementing regional sector partnerships is proving effective in engaging industry and coordinating

education and training providers to meet the real needs of industry. Two regional manufacturing sector partnerships currently exist. The Colorado Office of Economic Development and International Trade (OEDIT) is now working with the Colorado Workforce Development Council (the state workforce investment board) to find ways to align, expand, and replicate them.

MASSACHUSETTS Massachusetts' manufacturing education and workforce strategy is focused on three priorities: first, expanding use of the existing workforce training fund for on-the-job-training for new hires and incumbent worker training in manufacturing; second, providing technical assistance to new regional manufacturing sector partnerships that are getting started; and third, providing support to accelerate the work of existing sector partnerships through resources such as the state's workforce competitiveness trust fund.

Massachusetts has strong regional networks that are organized to meet the needs of manufacturers and provide pathways to jobs for new workers. For example, in Worcester County, the workforce and training system, led by Quinsigamond Community College, WPI, MassMEP, and Fitchburg State, has organized a seamless approach to training and educating workers. MassMEP has led in training returning veterans for manufacturing jobs. For this and other reasons, MassMEP received a nearly 50 percent increase in

BOX 15. Best Practice Model—Industry Sector Partnerships

Through the policy academy process, states could build on national experiences, as well as their own (in the cases of Massachusetts, Colorado, and California), with sector strategies. An estimated 1,000 regional sector partnerships are operating across the country, and more than 25 states are exploring or implementing sector strategies to address industry needs through education and training. The strategies are known by different names in different states: Industry Partnerships in Pennsylvania, Skill Alliances in Illinois, and Clusters of Opportunity in California. Massachusetts has been using a sector strategy approach for almost three decades, funding hundreds of local partnerships through its workforce competitiveness trust fund. Pennsylvania's investment has seeded over 90 industry partnerships since 2005, more than 40 of which are still active. Washington State launched its first skill panels in 2000 and since then has funded more than 100 public-private partnerships among business, labor, and education.

Regardless of what they are called, at the regional labor market level, these are partnerships of employers within one industry that bring together government, education, training, economic development, labor, and community organizations to focus on the workforce needs of their industry. At the state level, they are policies and investments that support the development of local sector partnerships. At both levels, a growing body of evidence demonstrates their effectiveness for employers and workers.

In a survey of employers participating in sector partnerships in Massachusetts, 41 percent reported a reduction in turnover; 19 percent reported a reduction in rework on the job; 23 percent reported a reduction in customer complaints; and 100 percent reported that participation in a sector partnership was valuable. In 2009 in Pennsylvania, 84 percent of surveyed employers participating in industry partnerships reported significant increases in productivity.

Workers also benefit from training and education programs that develop out of sector partnerships. A 2009 random assignment evaluation of three sector partnerships found that participants earned significantly more (18 percent more, or $4,500 over a 24-month period) than the control group. The reasons were that they were more likely to work, worked more consistently, and worked in jobs with higher wages. They also had higher-quality jobs, as measured by benefits such as health insurance, paid vacation, and paid sick leave. In short, sector partnerships are being adopted by more workforce development organizations, education institutions, and other stakeholders because they work: they provide a process and mechanism to engage industry and assess its workforce needs and to create customized solutions across multiple training and education programs in a way that provides job seekers real currency in today's labor market. For more context and details, see the NGA publication *Sector Strategies Coming of Age—Implications for State Workforce Policy Makers.*

funding, and it remains a key partner in the work of the Advanced Manufacturing Collaborative across the state.

In Hampden County, the region's precision manufacturers, working with the Hampden County Regional Employment Board, established a sector partnership involving all of the region's educational and training partners, including the seven vocational schools, Springfield Technical and Holyoke Community Colleges, and UMass Amherst. The industry-led Precision Manufacturing Regional Alliance Project (PMRAP), as the partnership is known, identified a need for over 1,600 new manufacturing workers in the following 40 months, and the Hampden County Regional Employment Board received $750,000 to train the region's workers for those jobs, including the region's returning veterans, the unemployed, minorities, and youth.

The Massachusetts Workforce Competitiveness Trust Fund has been an important source of resources and expertise to build regional sector partnerships in many industries, including advanced manufacturing. The state legislature authorized the recapitalization of the fund with $5 million. The Commonwealth Corporation, which administers the fund, is a part of the Advanced Manufacturing Collaborative and is designing additional technical assistance to support new regional sector partnerships along the lines of the successful central and western Massachusetts models.

As the focus of the state's efforts turns to supporting and scaling regional sector partnerships, the Advanced Manufacturing Collaborative is launching a statewide forum for sharing best practices and for continuous improvement that includes the state's community colleges, workforce investment boards, and vocational schools. The collaborative is also aligned with the major, U.S. Department of Labor–funded $20 million initiative by the state's community college system to establish seamless career pathways for workers in growing industries.

At the same time, Massachusetts has launched a multifaceted outreach campaign to fill the workforce pipeline, aiming to increase interest in career opportunities in manufacturing among students, parents, counselors, and others. MassDevelopment and the Advanced Manufacturing Collaborative are launching a new campaign to promote manufacturing careers throughout the commonwealth. The campaign, "AMP it up," is designed to reach young people and provide career information to parents, career counselors, and teachers—the people who most influence young people's choices.

CALIFORNIA California has realized that as its small and medium-sized manufacturers have emerged from the recession and are executing growth strategies, they have workforce skills requirements that are not being met through existing training programs. Clear pathways from K–12 through community colleges or through the workforce training system do not exist for students and workers to gain needed skills. Because of the economic diversity of California, every region needs its own approach, based on its unique set of industries and skill needs. With the formation of the California policy academy team, conversations took place at the state level with the vice chancellor of workforce and economic development of California's community colleges. The team discussed with her the significance of advanced manufacturing for the state's economy. That resulted in the inclusion of advanced manufacturing as an industry sector in the Chancellor's Office's *Doing What Matters for Jobs & the Economy* report and made the manufacturing sector eligible for state grant funding. Eight grants supporting manufacturing throughout the state were awarded earlier this year.

California has begun moving on several fronts to meet the immediate needs of manufacturers and establish a foundation for longer-term support for developing the state's manufacturing workforce. In May 2012, the California Economic Summit process (caeconomy.org) issued a call to action to "prioritize

existing workforce-training and career-education resources to focus on major regional industry sectors." Manufacturing was specifically identified as a major sector for several regions. Subsequently, the California community college chancellor's office directed funding to 10 manufacturing-focused partnerships through its industry-driven regional collaboratives, responsive training fund, and job development incentive fund. Two legislative bills were enacted to sustain community college efforts in this area and to align career technical education with regional industry needs. In addition, funding for the state's "Regional Industry Clusters of Opportunity" program has been increased, with a specific focus on creating sector partnerships in clean transportation manufacturing and fuels.

ILLINOIS Illinois recently launched the Manufacturing STEM Learning Exchange, a statewide public-private network that will coordinate resources and investments that support the manufacturing talent pipeline. The Manufacturing STEM Learning Exchange will be led by the Illinois Manufacturers Association Education Foundation and has initially targeted work-based learning as a priority area. The learning exchange will aggregate industry partners to provide mentorships, internships, apprenticeships, and other practical training and learning opportunities. That partnership network will also monitor P-20 (pre-school through grade 20) and workforce talent pipeline performance and advise the state on coinvestment strategies and supports.

BEST PRACTICE LESSONS OFFERED FOR OTHER STATES

In preparing this report on the results from the NGA Policy Academy on advanced manufacturing, NGA recognized that other states would benefit from knowing of the optimistic vision and associated policy steps taken by the eight states to encourage growth in manufacturing through innovation, entrepreneurship, and investment. In particular, other states would benefit from knowing that these states:

Did not see their work as "saving manufacturing." Rather, they saw their work as creating the best location for the development of new technologies that radically improve production processes or that can be transformed into innovative new products.

Their ongoing work is to strengthen the innovation system within their states by providing manufacturers streamlined access to specialized workforces, research and development partnerships, commercialization services, innovation networks, and unique business infrastructure to support quick, sustained, and spectacular competitive advantage in developing commercial devices, manufacturing them in the state, and getting them into global markets.

Recognized a big missed opportunity with small and medium-sized companies (SMEs) and thus emphasized doing a better job of supporting startups and SMEs.

Recognizing that 62 percent of net new jobs from 1992 to 2010 were created by SMEs and that recently the success rate of small businesses has dropped, states did not believe that they could be a part of the new manufacturing leadership without helping SMEs build their capacity to innovate and commercialize new products. Accordingly, they plan to encourage SMEs to take up regular R&D and innovation activities, enlarging their R&D base and their opportunities for growth through innovation and global exports. From this overarching objective came a wide range of efforts, including programs to increase universities' ability and willingness to cooperate with SMEs and overcome companies' reluctance to approach and work with research organizations; programs to get people into apprenticeships, internships, and education programs designed to lead to full-time jobs with small and medium-sized manufacturers; and programs to mentor SMEs in working more successfully as suppliers to large companies.

Determined that because of important developments already occurring, the most immediate benefits can be obtained by assembling, improving, coordinating, connecting or replicating, and scaling up those resources to manufacturers.

That means proactively ensuring that manufacturers know what is available, that manufacturers are directly involved in program design and consulted on program effectiveness, and that manufacturers are encouraged (even provided incentives) to approach and work with government or university organizations. But it also means that universities, community colleges, financial institutions, and other key parts of the innovation system have to embrace the new opportunities related to advanced manufacturing, as well as the concept that manufacturers, just as bioscience or clean energy firms, will benefit from specialized (sector-focused) programs and services promoting innovation, entrepreneurship, investment, and education as crucial for business growth and competitiveness. In short, states realize they must build on what works. Examples include the ways in which Colorado, California, and Massachusetts have found ways to replicate their business sector partnerships and expand them to advanced manufacturing. New York has adopted a similar approach by funding regional partnerships focused on new technologies and related workforce training.

Found crucial voids remaining to be filled, sometimes because the right services for manufacturers did not exist and sometimes because the services needed lacked the scale and commitment for success.

Reinforcement of this message came as the policy academy states studied what some other states and other nations such as Germany are doing to support their industries. Some states are engaged in big collaborations, such as the Automotive Manufacturing Technical Collaborative (AMTEC), which involves 30 community colleges and 34 auto-related plants in 12 states in a new kind of public-private partnership for training and retraining workers. In Germany, organizations such as the Fraunhofer Institutes partner with companies to turn advanced technologies into production processes and commercial products. These initiatives are coupled with active export promotion support from the highest level of government. Both of these efforts—AMTEC and Fraunhofer Institutes—underscore what is missing in terms of focus, scale, and steady commitment in many states.

Recognized that an intermediary valued by all parties (particularly industry) is crucial not only for developing an effective policy framework, but also for sustaining broad support for advanced manufacturing as a high state priority.

It must be some entity's responsibility both to sort out the complex interplay between different actors and mechanisms crucial to research and product development activities and to connect the activities of dozens or perhaps hundreds of firms and organizations. Both the Colorado Advanced Manufacturing Alliance and the Massachusetts Advanced Manufacturing Collaborative and Advanced Manufacturing Futures Fund illustrate the deliberate and strategic play that states are making to create new public-private partnerships that the community values and that can push all players to align their investments and improve their support for advanced manufacturing firms within their borders, so as to capture the economic activity and high-quality jobs that they can bring.

Focused on the interplay between state policy and regional action.

States recognized that a combination of state enabling actions and regional collaboration, with strong industry engagement, would be necessary to implement an effective advanced manufacturing strategy. STEM exchanges in Illinois, regional manufacturing partnerships in Massachusetts and California, customized regional initiatives in Kansas and New York all are examples of how state policy encourages, seeds, and rewards effective action at the regional or local level.

Recognized the value of finding investments in the immediate term and mobilizing support for the future.

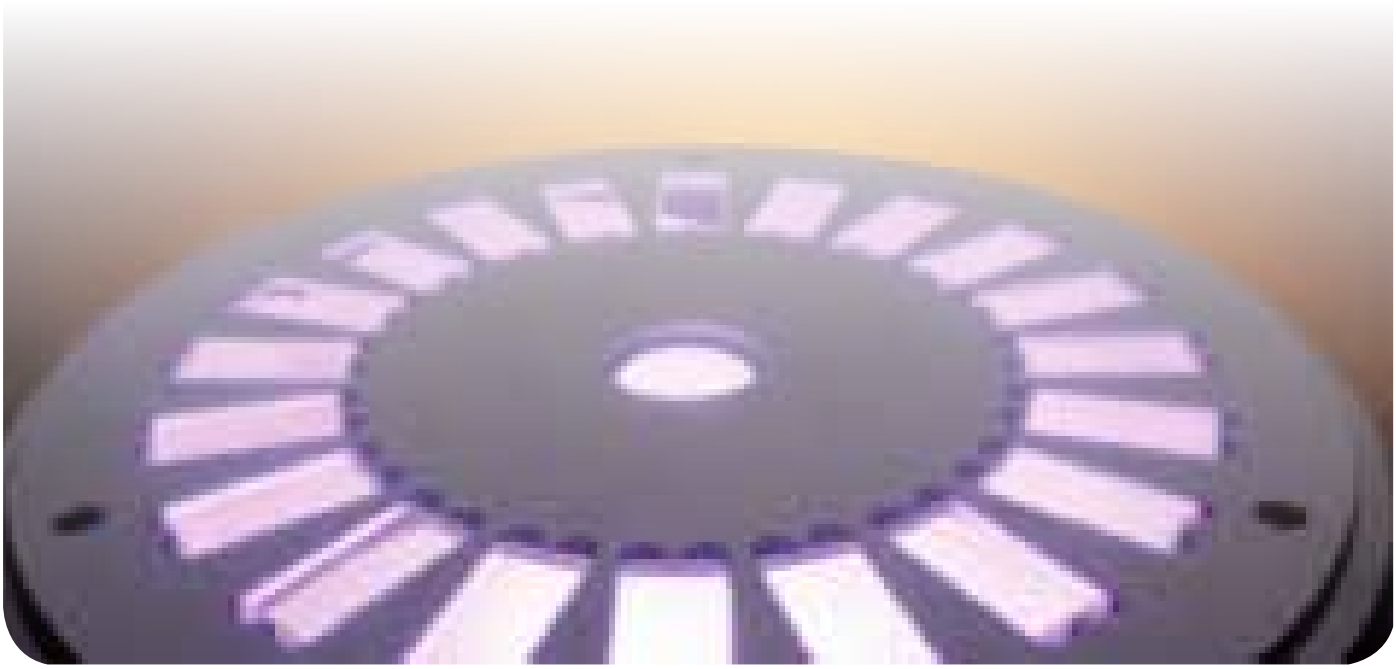
Most of the policy academy states acknowledged that funding exists, but it is often a matter of finding it for the right purposes, both in the immediate term and for future needs. New York provides a great example of bringing multiple state agencies together to fund an initiative that speaks to their different missions. Joint agency funding carries a lot of weight, especially for operating programs that otherwise would not work together. Connecticut's foresight in engaging members of the state legislature during its planning process led to a bipartisan legislative manufacturing caucus, now positioned to act for the benefit of advanced manufacturing during upcoming legislative sessions.

Understood that they must "just get started" and secure some early achievements and momentum that make a difference to manufacturers.

No strategic plan is successfully launched without early wins. Achieving them requires figuring out what actions can be implemented in a short time, with few or no new resources, that will garner increased support going forward. For Colorado, that meant launching CAMA—quickly and with private sector funding. For Connecticut, it meant the innovation voucher program; for New York, the Solutions Fairs; and for Illinois, the Open Innovation Network. Rolling out programs like these does not imply abandoning the fuller strategic plan; these are the programs that demonstrate real action to existing and new stakeholders while the fuller plan is implemented.

Recognized that traditional metrics may need to be updated for advanced manufacturing.

Colorado is revising performance metrics based on best practices and discussions through the NGA Policy Academy. Because innovation and productivity growth has become a critical component of the state's advanced manufacturing platform, OEDIT has expanded its current metrics to include not only net new jobs but also capital investment and gross state product, on the theory that innovation investment may lead to increased productivity and profitability but not necessarily new jobs. The performance metrics used by MEP centers, which employ third-party survey organizations to document jobs created and retained, sales increased or retained, cost savings achieved, and investments leveraged, provide a model that has been widely recognized in the federal government.



NGA CENTER DIVISIONS

The NGA Center is organized into five divisions with some collaborative projects across all divisions.

- **Economic, Human Services & Workforce** provides information, research, policy analysis, technical assistance, and resource development on key issues relevant to governors and their staff across a range of current and emerging issues, including economic development and innovation, workforce development, employment services, research and development policies, and human services for children, youth, low-income families, and people with disabilities.

- **Education** provides information, research, policy analysis, technical assistance and resource development for governors and their staff in the areas of early childhood, K-12 and postsecondary education. Issue areas include birth to 3rd grade access, readiness and quality; the Common Core State Standards, STEM and related assessments; teacher and leader effectiveness; turning around low-performing schools; high school redesign; competency-based learning; charter schools; and postsecondary (higher education & workforce training) access, success and affordability.

- **Environment, Energy & Transportation** provides governors and their staff with analysis and information about best practices, tailored technical assistance, and insights into emerging policy trends across the energy, environment, and transportation sectors. The division helps states promote the efficient use of energy across all sectors; improve the use of traditional and alternative fuels for electricity and transportation; better protect and cleanup the environment; effectively manage their natural resources; and develop a transportation system that safely and efficiently moves people and goods.

- **Health** provides information, customized technical assistance, policy analysis, best practices and periodic national meetings facilitating peer exchange for governors and their staff. The Health Division covers issues in the areas of health care service delivery and reform, including payment reform, health workforce planning, quality improvement and public health and behavioral health integration with the medical delivery system.

- **Homeland Security & Public Safety** provides governors and their staff with analysis and information about best practices, tailored technical assistance, and insights into emerging policy trends across homeland security and public safety. The division provides detailed analysis and technical assistance to governors on all matters related to homeland security, emergency management, public safety, and criminal justice.

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