The National Network for Manufacturing Innovation

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Summary

Congress maintains a strong interest in the health of U.S. manufacturing due to its central role in the U.S. economy and national defense. In 2012, in his FY2013 budget, President Obama proposed the creation of a National Network for Manufacturing Innovation (NNMI) to help accelerate innovation by investing in industrially relevant manufacturing technologies with broad applications, and to support manufacturing technology commercialization by bridging the gap between the laboratory and the market. The proposal included a request for $1 billion in mandatory funding for the National Institute of Standards and Technology (NIST) for the establishment of up to 15 NNMI Institutes for Manufacturing Innovation (IMIs). No legislation to enact the President's proposal was introduced in the 112th Congress.

In 2013, the President renewed his call for an NNMI in his FY2014 budget request, again seeking $1 billion in mandatory funding. In August 2013, bills entitled the Revitalize American Manufacturing and Innovation Act were introduced in the House (H.R. 2996) and the Senate (S. 1468) to establish a Network for Manufacturing Innovation. H.R. 2996 passed the House in September 2014. S. 1468 was reported by the Senate Committee on Commerce, Science, and Transportation in August 2014. No further legislative action was taken.

In 2014, the President's FY2015 budget again sought authority and funding to establish the NNMI, including $2.4 billion in discretionary funding to establish up to 45 IMIs. In December 2014, Congress passed, and the President signed into law, the Revitalize American Manufacturing and Innovation Act of 2014 (RAMI Act), as Title VII of Division B of the Consolidated and Further Continuing Appropriations Act, 2015 (P.L. 113-235). The RAMI Act directs the Secretary of Commerce to establish a Network for Manufacturing Innovation program at NIST. The RAMI Act includes provisions authorizing NIST, the Department of Energy (DOE), and other agencies to support the establishment of IMIs and establishing and providing for the operation of a Network for Manufacturing Innovation. NIST is authorized to use up to $5.0 million per year of appropriated funds for FY2015-FY2024 to carry out its responsibilities under the act. The Department of Energy is authorized, but not required, to transfer to NIST up to $250.0 million of appropriated funds over the same FY2015-FY2024 period. The Secretary of Commerce is also authorized to accept funds, services, equipment, personnel, and facilities to carry out the program. The act also establishes a National Office of the Network for Manufacturing Innovation Program at NIST to oversee and carry out the program.

Prior to enactment of the RAMI Act, President Obama used existing authorities and regular appropriations of the Department of Defense (DOD) and DOE to establish several NNMI-like institutes. Under the RAMI Act, these and other institutes may be designated as part of the Network for Manufacturing Innovation. As of the date of this report, 14 IMIs have been established, eight by DOD, five by DOE, and one by the Department of Commerce.

Enactment of the Consolidated Appropriations Act, 2016 (P.L. 114-113) provided a new impetus for congressional oversight as appropriations were made explicitly for the first time for the NNMI. P.L. 114-113 provides NIST with $25 million for the purpose of establishing IMIs and coordinating their activities. Among the issues of interest are the selection of focus areas for the new centers and the integration of these centers with existing ones. Another area of possible congressional attention is to the network of IMIs. While the RAMI Act specifies which new and existing institutes are eligible to be a part of the network and designates the National Program Office as "a convener of the Network," it does not further specify the purpose, federal role, and activities of the network.

The Trump Administration has not yet indicated its disposition toward the NNMI program.

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Introduction

Congress maintains a strong interest in the health of U.S. manufacturing due to its central role in the economy and national defense. Manufacturing accounts for about 12% of the nation's gross domestic product (GDP). Manufacturing enterprises directly employ approximately 12 million U.S. workers and indirectly support millions of additional jobs in other industries. Manufacturers also fund about two-thirds of the nation's industrial research and development (R&D), providing a foundation for technological innovation and continued U.S. technological leadership. Total average compensation (wages and benefits) for manufacturing workers ($81,347) exceeds total average compensation for all workers ($71,161).[1] With respect to national defense, the United States depends heavily on its manufacturing base to produce military weapons, aircraft, ground vehicles, ships, and other equipment.

Analysts hold divergent views of the health of U.S. manufacturing. Some see the sector as vibrant and healthy. Those holding this view tend to point to, among other things, the sector's strong growth in output and productivity, as well as the United States' world-leading share of global manufacturing output.[2] From its low point in March 2010, U.S. manufacturing employment has grown by 885,000 (7.7%) to a recent high of 12.338 million in January 2016 (though it subsequently experienced a drop of 73,000 jobs through October 2016).[3]

Other analysts, however, believe that the U.S. manufacturing sector is at risk. Those holding this view express concerns about a "hollowing-out" of U.S. manufacturing resulting from the decision of many U.S. manufacturers to move production activities offshore; policy and program efforts of other nations to attract and grow manufacturing companies; and a decades-long trend in declining U.S. manufacturing employment.

The 2007-2009 recession and the relatively slow subsequent pace of recovery contributed to increased concerns about the health of U.S. manufacturing. Some stakeholders and policymakers advocate for changes to improve the business environment, including reducing tax and regulatory burdens on manufacturers and reforming the nation's tort laws.

Other stakeholders and policymakers support more direct and focused efforts funded by the federal government, such as those that aim to help a particular technology or industry. In particular, President Obama has undertaken and proposed the creation and funding of a variety of initiatives (e.g., the Advanced Manufacturing Partnership, the National Robotics Initiative, and the Materials Genome Initiative) to help address concerns about U.S. manufacturing. One of the President's key proposals to help U.S. manufacturers is the establishment of a National Network for Manufacturing Innovation (NNMI).

[1] CRS analysis of data from Table 6.2D (Compensation of Employees by Industry) and Table 6.5D (Full-Time Equivalent Employees by Industry), National Income and Product Accounts, Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.gov/iTable/iTable.cfm?ReqID=9&step=1#reqid=9&step=1&isuri=1. In addition, manufacturing workers earn higher average annual wages ($48,610 in 2014) than the overall annual wages for U.S. workers ($47,230) (Occupational Employment Statistics, May 2012, Bureau of Labor Statistics, U.S. Department of Labor, http://www.bls.gov/oes/current/naics2_31-33.htm#00-0000).

[2] For more information, see CRS Report R41898, *Job Creation in the Manufacturing Revival*, by (name redacted)

[3] After peaking in 1979, U.S. manufacturing employment fell to 11.5 million, a 69-year low, in March 2010. December 2015 is the most recent month for which data is available. (Source: Bureau of Labor Statistics, U.S. Department of Labor, Current Employment Statistics survey database, data for manufacturing employment, all employees, seasonally-adjusted, http://data.bls.gov/cgi-bin/dsrv?ce.)

The NNMI is the main focus of this report. The report begins with a discussion of the NNMI proposal and subsequent legislative action. It reviews related institutes established during the legislative debate. It then addresses several broad policy and implementation issues that continue to face Congress, including the availability of funding, the proper role of the federal government, and oversight of NNMI implementation.

NNMI Proposal and Legislative Action

In February 2012, in his FY2013 budget, President Obama proposed the establishment of the NNMI, requesting $1 billion in mandatory funding to support the establishment of up to 15 institutes.[4] He formally introduced the concept in a speech at a manufacturing facility in Virginia on March 9, 2012.

During 2012, the Advanced Manufacturing National Program Office (AMNPO)[5] sought nationwide input from industry, academia, state and local governments, economic development authorities, industry associations and consortia, private citizens, and other interested parties to help guide the design of the NNMI. The AMNPO held four regional workshops and published a Request for Information (RFI) in the *Federal Register* inviting public comment on the proposed NNMI program. The AMNPO used the input gathered from the workshops and the RFI in the preparation of a January 2013 National Science and Technology Council report, *National Network for Manufacturing Innovation: A Preliminary Design*.[6]

No legislation to enact the President's proposal was introduced in the 112th Congress. In 2013, the President renewed his call for an NNMI in his FY2014 budget request, again seeking $1 billion in mandatory funding. In August 2013, bills titled the Revitalize American Manufacturing and Innovation Act were introduced in the House (H.R. 2996) and the Senate (S. 1468) to establish a Network for Manufacturing Innovation. H.R. 2996 passed the House in September 2014. S. 1468 was reported by the Senate Committee on Commerce, Science, and Transportation in August 2014. No further legislative action was taken.

The President's FY2015 budget proposal once again sought authority and funding to establish the NNMI. The request was not part of the President's FY2015 base budget request, but rather a part of his adjunct $56 billion Opportunity, Growth, and Security Initiative (OGSI) proposal. The OGSI included $2.4 billion in discretionary funding to establish up to 45 NNMI institutes. No legislative action was taken on this OGSI proposal.

In December 2014, nearly three years after President Obama first proposed the establishment of the NNMI, Congress passed the Revitalize American Manufacturing and Innovation Act of 2014 (RAMI Act), as Title VII of Division B of the Consolidated and Further Continuing Appropriations Act, 2015 (P.L. 113-235). President Obama signed the bill into law on December

[4] The terms Centers for Manufacturing Innovation, Manufacturing Innovation Institutes, Institutes for Manufacturing Innovation, and Clean Energy Manufacturing Innovation Institutes have been used in different contexts to refer to institutes participating in the NNMI. For consistency, this report uses the term Institute for Manufacturing Innovation (IMI) to refer to any such institute.

[5] The AMNPO is a multi-agency activity focused on the coordination of federal manufacturing resources and programs to foster U.S. innovation and industrial competitiveness. It is hosted by the National Institute of Standards and Technology. Participating agencies include the Department of Commerce, Department of Defense, Department of Education, Department of Energy, Department of Homeland Security, Department of Labor, National Aeronautics and Space Administration, National Science Foundation, and Small Business Administration.

[6] Executive Office of the President, National Science and Technology Council, *National Network for Manufacturing Innovation: A Preliminary Design*, January 2013, http://www.manufacturing.gov/docs/nnmi_prelim_design.pdf.

16, 2014. The RAMI Act directs the Secretary of Commerce to establish a Network for Manufacturing Innovation (NMI)[7] program within the Commerce Department's National Institute of Standards and Technology (NIST). The provisions of the RAMI Act are discussed throughout this report and detailed in **Appendix**, "NNMI Provisions of the RAMI Act."

In Setpember 2016, the Department of Commerce (DOC) rebranded the program "Manufacturing USA."[8]

Institutes for Manufacturing Innovation (IMIs)

Pre-RAMI Act IMIs

Prior to passage of the RAMI Act, the Obama Administration relied on regular appropriations and the existing statutory authorities of the Department of Defense (DOD) and Department of Energy (DOE) to establish seven NNMI-like institutes. Five of these institutes were competed and awarded by DOD:[9]

- National Additive Manufacturing Innovation Institute (America Makes), Youngstown, OH[10]
- Digital Manufacturing and Design Innovation Institute (Digital Manufacturing and Design Innovation Institute, DMDII), Chicago, IL[11]
- Lightweight and Modern Metals Manufacturing Innovation Institute (Lightweight Innovations For Tomorrow, LIFT), Detroit, MI[12]
- Integrated Photonics Institute for Manufacturing Innovation (American Institute for Manufacturing Integrated Photonics, AIM Photonics), Rochester, NY[13]
- Flexible Hybrid Electronics Manufacturing Innovation Institute (NextFlex), San Jose, CA[14]

Two IMIs were competed and awarded by DOE:

- Next Generation Power Electronics Manufacturing Innovation Institute (PowerAmerica), Raleigh, NC[15]
- Advanced Composites Manufacturing Innovation Institute (Institute for Advanced Composites Manufacturing Innovation, IACMI), Knoxville, TN[16]

[7] For clarity, the program is generally referred to in this report as the National Network for Manufacturing Innovation or NNMI, though the RAMI Act uses the term Network for Manufacturing Innovation (NMI).

[8] U.S. Department of Commerce, press release, "U.S. Secretary of Commerce Penny Pritzker Announces Manufacturing USA: New Brand for National Network for Manufacturing Innovation," September 12, 2016, https://www.commerce.gov/news/press-releases/2016/09/us-secretary-commerce-penny-pritzker-announces-manufacturing-usa-new.

[9] The name of each institute as specified for the competition by the sponsoring agency is listed first in each bulleted item, followed parenthetically by the name assigned the institute by the grantee, followed by the IMI's location.

[10] For additional information, see https://americamakes.us.

[11] For additional information, see http://dmdii.uilabs.org.

[12] For additional information, see http://lift.technology.

[13] For additional information, see http://www.aimphotonics.com.

[14] For additional information, see http://www.nextflex.us.

[15] For additional information, see https://www.poweramericainstitute.org.

The RAMI Act allows certain existing manufacturing institutes to be classified as an IMI for participation in the network. In particular, the act incorporates

> the National Additive Manufacturing Innovation Institute and other manufacturing centers formally recognized as [IMIs] pursuant to Federal law or executive actions, or under pending interagency review for such recognition as of the date of enactment of the Revitalize American Manufacturing and Innovation Act of 2014.[17]

However, the RAMI Act prohibits such institutes from receiving any financial assistance authorized by the act.

Post-RAMI Act IMIs

Since passage of the RAMI Act, seven additional IMIs have been awarded. Three of these have been awarded by DOD:

- Revolutionary Fibers and Textiles Manufacturing Innovation Institute (Advanced Functional Fabrics of America, AFFOA), Cambridge, MA;[18]
- Advanced Tissue Biofabrication Manufacturing Innovation Institute (Advanced Regenerative Manufacturing Institute, ARMI), Manchester, NH;[19] and
- Advanced Robotics Manufacturing Institute (Advanced Robotics Manufacturing (ARM) Institute), Pittsburgh, PA.[20]

Three IMIs were competed and awarded by DOE:

- Manufacturing Innovation Institute for Smart Manufacturing: Advanced Sensors, Controls, Platforms, and Modeling for Manufacturing (SMART Manufacturing Innovation Institute), Los Angeles, CA;[21]
- Modular Chemical Process Intensification Institute (Rapid Advancement in Process Intensification Deployment (RAPID) Institute), New York, NY;[22] and
- Reducing Embodied Energy and Emissions of Manufactured Materials (Reducing Embodied-energy and Decreasing Emissions (REMADE) Institute), Rochester, NY.[23]

One IMI was competed and awarded by DOC:

- National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), Newark, DE.[24]

In December 2015, Congress appropriated specific funding, for the first time, for the establishment and coordination of IMIs under the provisions of the RAMI Act. The Consolidated

(...continued)

[16] For additional information, see http://iacmi.org.

[17] P.L. 113-235.

[18] For additional information, http://www.rle.mit.edu/fabric/.

[19] No website associated with this IMI had been established as of the date of this report.

[20] For additional information, see http://www.arminstitute.org.

[21] For additional information, see https://www.smartmanufacturingcoalition.org.

[22] For additional information, see http://processintensification.org.

[23] For additional information, see http://www.rit.edu/remade.

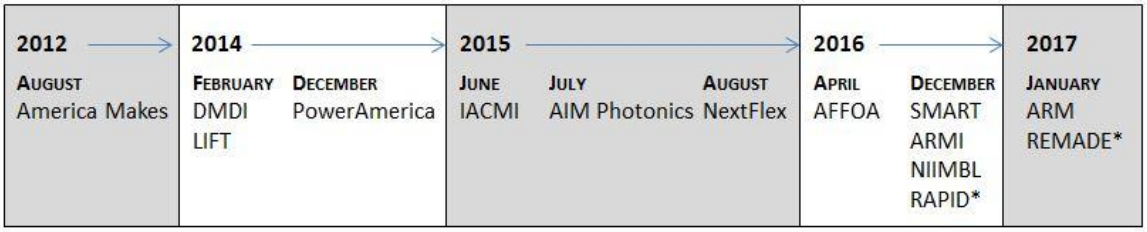
[24] For additional information, see http://www.niimbl.org.

Appropriations Act, 2016 (P.L. 114-113) provided NIST with $25.0 million for FY2016 for the NNMI, to include funding for establishment of IMIs and up to $5.0 million for coordination activities.[25] The explanatory statement accompanying the act directed NIST to follow the direction of the Revitalize American Manufacturing and Innovation Act of 2014 in requiring open competition to select the technological focus areas of industry-driven manufacturing institutes.[26]

NIST held an open competition in 2016. NIST stated that it intended to establish two institutes, providing up to a total of $70 million per institute over five to seven years, with federal funding matched by private and other nonfederal sources.[27] As identified above, NIST has selected only one IMI.

Anticipating the possibility that agencies might establish IMI-type organizations outside the parameters of the RAMI Act, the act provides for the potential subsequent incorporation into the NNMI network.

Figure 1. Chronology of IMI Awards



Source: Advanced Manufacturing National Program Office; various White House, DOD, DOE, and DOC announcements.

Notes: Asterisk indicates a center's month of announcement rather than month of award.

[25] The act also directs NIST to merge its Advanced Manufacturing Technology Consortia (AMTech) program into the NNMI.

[26] Explanatory Statement, Consolidated Appropriations Act, 2016, Division B (Commerce, Justice, Science and Related Agencies Appropriations Act), *Congressional Record*, Vol. 161, No. 184-Book II (December 17, 2015), p. H9733. IMI selection criteria specified in the RAMI Act are provided in the Appendix. (See "IMI Selection Considerations.")

[27] National Institute of Standards and Technology, Department of Commerce, *Notice of Intent: National Network for Manufacturing Innovation (NNMI) Institute Awards*, December 21, 2015, http://www.nist.gov/amo/nnmi/upload/NIST-NNMI-NOI-2015-12-21.pdf.

Options for Congressional Action

While the RAMI Act established the NNMI program, set forth its purposes, and authorized its structure, funding, and operation, a number of options remain for Congress to consider as the program is implemented.

Availability and Prioritization of Appropriations

The RAMI Act authorizes the Secretary of Commerce to use up to $5 million in funds appropriated to the NIST Industrial Technology Services (ITS) account to carry out the NNMI program. The availability of funds for the NNMI, however, depends on the level of annual appropriations. In addition, appropriations made to the ITS account may be subject to congressional prioritization and restrictions included in report language accompanying the appropriations bill. In FY2015, Congress appropriated $138.1 million for the ITS account, directing NIST to spend $130.0 million on the Hollings Manufacturing Extension Partnership and $8.1 million on NIST's Advanced Manufacturing Technology Consortia program. It did not provide explicit funding for the NNMI in FY2015. As discussed above, the FY2016 NIST appropriation exceeds the RAMI Act authorization, providing $25 million for the NNMI for establishing new IMIs and for coordination activities. As of the date of this report, NIST was operating on a continuing resolution (Further Continuing and Security Assistance Appropriations Act, 2017, P.L. 114-254) that provides funding for FY2017 at 99.8% of FY2016 funding through April 28, 2017.

A second source of NNMI funding provided for by the RAMI Act is authority given to the Department of Energy to transfer to NIST up to $250 million for the period FY2015-FY2024. However, the availability of funds provided by the DOE to NIST depends, in part, on the level of annual appropriations made to the DOE's Energy Efficiency and Renewable Energy account specifically for advanced manufacturing R&D. This source of funding for the NNMI may also be subject to prioritization and potential restrictions included in report language accompanying the appropriations bill. In addition, the availability of these funds to NIST will depend on DOE's willingness to transfer funds to NIST for the NNMI program. In FY2015 and FY2016, DOE did not transfer any funding to NIST for this purpose.

A third possibility for funding the program is the authority given to the Secretary of Commerce to accept funds, services, equipment, personnel, and facilities from other sources to carry out the program.

The RAMI Act does not specify how the funds provided by NIST, DOE, or other agencies are to be allocated between program management activities and funding for the IMIs. In the absence of such specifications, it appears that funds may be used for either or both of these purposes.

If Congress desires to provide funding for the NNMI for FY2017 and beyond, it may opt to appropriate funds to NIST directly, or to DOE or another federal agency with direction to transfer the funds to NIST for this purpose. President Obama's FY2017 budget request for NIST includes $47 million in discretionary funding for the NNMI, an increase of $22.0 million (88.0%) from the FY2016 level. Of the requested funds, $42.0 million is sought for establishing and supporting three additional IMIs on topics proposed by industry, and $5.0 million is sought for coordination of the NNMI network. In addition, President Obama is requesting $1.9 billion in mandatory funding for NIST to complete the development of the NNMI network with a total of 45 institutes by FY2025.

The Role of the Federal Government in the Network

In addition to authorizing the establishment of IMIs, the RAMI Act authorizes the establishment of a network of these IMIs. In this regard, the act specifies which institutes are eligible to be a part of the network and designates the National Program Office as "a convener of the Network."[28] However, the act does not further specify the purpose, federal role, or activities of the network of IMIs. Congress may consider amending the act to clarify these points or to authorize NIST and participating agencies to do so.

The Role of the Federal Government After FY2024

The RAMI Act authorizes the NNMI through FY2024 and requires the Comptroller General of the United States to make a final assessment by December 31, 2024. No specifications are made in the act for a federal role after the end of FY2024. As the program progresses, Congress may consider whether to continue the NNMI beyond FY2024 or to allow it to expire.

Future of the Advanced Manufacturing Technology Consortia (AMTech) Program

Prior to FY2016, NIST operated an Advanced Manufacturing Technology Consortia (AMTech) program to establish industry-led consortia to identify and prioritize research projects supporting long-term industrial research. This program was complementary to the goals of the NNMI but distinct from it. In December 2015, the Explanatory Statement accompanying the Consolidated Appropriations Act, 2016 (P.L. 114-113)

> merges the activities of the Advanced Manufacturing Technology Consortia (AMTech) into NNMI.[29]

The President's FY2017 request includes no separate funding for AMTech. It is unclear whether FY2016 funds provided to NIST for the NNMI may be used by the agency to support new AMTech grants as part of the NNMI activity. Congress may consider providing additional direction to NIST with respect to the continuance of AMTech activities.

H.Rept. 114-605, accompanying the House version of the Commerce, Justice, Science, and Related Agencies Report Appropriations Bill, 2017 (H.R. 5393), did not provide any guidance regarding AMTech.

S.Rept. 114-239, accompanying the Senate version of the Commerce, Justice, Science, and Related Agencies Report Appropriations Bill, 2017 (S. 2837), provided more detailed instructions regarding the NNMI, but did not provide any additional guidance regarding AMTech:

> National Network for Manufacturing Innovation.—The Committee provides $25,000,000 for NIST's activities in the National Network for Manufacturing Innovation [NNMI], to include funding for center establishment and up to $5,000,000 for coordination activities. NIST shall follow the direction of the Revitalize American Manufacturing and Innovation Act of 2014 (Public Law 113–235), which requires open competition to select the technological focus areas of these industry-driven institutes.

[28] Section 703(f)(2)(F).

[29] Explanatory Statement accompanying the Consolidated Appropriations Act, 2016 (P.L. 114-113), http://docs.house.gov/meetings/RU/RU00/20151216/104298/HMTG-114-RU00-20151216-SD003.pdf.

Congressional Oversight

Congress may conduct oversight hearings on the implementation of the NNMI program to ensure that it is operating as Congress intends, with respect to funding, interagency cooperation, the establishment of new IMIs, the incorporation of existing institutes as part of the network, the integration of the NNMI with existing federal manufacturing activities (such as the NIST Manufacturing Extension Partnership program), and other related issues.

Issue: Is There a National Need for the NNMI Program?

While the RAMI Act included a number of findings that highlight the role manufacturing plays in the U.S. economy, it did not identify specific shortcomings of the U.S. manufacturing sector that the NNMI program is to address. Just as analysts hold divergent views of the health of U.S. manufacturing, some may be supportive of the NNMI effort while others may question whether there is a compelling national need for it.

Some analysts believe that the U.S. manufacturing sector is at risk. Expressed concerns of those holding this view include the following:

- a "hollowing-out" of U.S. manufacturing resulting from the decision of many U.S. manufacturers to move production activities and other corporate functions (e.g., research and development, accounting, information technology, tax planning, legal research) offshore;[30]
- focused efforts by other nations to grow the size, diversity, and technological prowess of their manufacturing capabilities and to attract manufacturing operations of U.S.-headquartered multinational companies using a variety of policy tools (e.g., tax holidays, worker training incentives, market access, and access to rare earth minerals); and
- a decades-long declining trend in U.S. manufacturing employment, punctuated by a steeper drop from 2001 to 2010. In March 2010, U.S. manufacturing employment fell to its lowest level (11.5 million) since March 1941, down more than 41% from its peak of 19.6 million in June 1979.[31]

On the other hand, some analysts argue that long-term employment losses in manufacturing are inevitable and that federal policy should focus elsewhere. In a July 2014 *Wall Street Journal* article, former Treasury Secretary Lawrence Summers argued that "the economic challenge of the future will not be producing enough. It will be providing enough good jobs." Summers described the loss of manufacturing jobs over the long term as "inexorable and nearly universal," a result of technology and market forces mirroring the earlier loss of agricultural jobs, only this "change will come faster and affect a much larger share of the economy." Summers did not offer a prescriptive alternative, but rather stated the need for government policies and approaches that "meet the needs of the information age."[32]

[30] For more information, see CRS Report R41712, *"Hollowing Out" in U.S. Manufacturing: Analysis and Issues for Congress*, by (name redacted).

[31] See, for example, CRS Report R41898, *Job Creation in the Manufacturing Revival*, by (name redacted).

[32] Lawrence Summers, "Lawrence H. Summers on the Economic Challenge of the Future: Jobs," *Wall Street Journal*, (continued...)

In support of the President's proposal for a National Network for Manufacturing Innovation, the Information Technology and Innovation Foundation, a Washington, DC-based think tank, articulated a variety of reasons why there is a need for an NNMI-like federal program in a report titled *Why America Needs a National Network for Manufacturing Innovation*. Among the ITIF's assertions:

- An NNMI-like program would address two issues important to U.S. manufacturing competitiveness: technology and talent.
- Spillovers from successful innovations resulting from a firm's investments can yield substantial benefits captured by competitors, producing a market failure that results in underinvestment in manufacturing R&D and innovation.
- Other types of market failures—for example, the need for large-scale capital investments and training outlays that may require many years to pay off—may "limit the scale-up of innovative manufacturing processes, the installation of new capital equipment, and the full integration of manufacturing systems across supply chains."

Supporters of the program may note that foreign governments engage in a variety of policy and programmatic activities designed to attract U.S. and other manufacturing firms to their countries; subsidize and protect domestic producers; or "repress labor, condone intellectual property theft, and manipulate their currency values in order to expand their manufacturing footprint." Meanwhile, the federal government provides little support for manufacturing-focused U.S. based research activities: Such funding is scattered among multiple agencies and "has rarely been a priority for any of them." This position contends that U.S. academia, in general, does not incentivize engineering advances and practical problem-solving. Instead, the emphasis on "engineering as a science" in U.S. academic engineering programs focuses on "originality and breakthroughs."[33]

Others may view the U.S. manufacturing sector as vibrant and healthy without a need for the NNMI. Those holding this view tend to point to, among other things, the sector's strong growth in output and productivity, as well as the United States' substantial share (17.4%) of global manufacturing value-added (second only to China, 22.4%).[34] As noted in the introduction, between March 2010 and December 2015, manufacturing employment added approximately 878,000 jobs, growing to 12.3 million.[35] Many analysts attribute the previous long-term trend in U.S. manufacturing employment losses to broader global technology and business trends, such as technology-driven productivity improvements, increases in capital-labor substitution, movement of labor-intensive production activities to lower-wage regions of the world, foreign competition in manufactured goods in both U.S. and foreign markets, and disaggregation of work processes resulting in the contracting of service work previously performed by employees of manufacturing firms as well as the offshoring of manufacturing activities. From this perspective, the NNMI may be either unnecessary or swimming against the tide of history.

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July 7, 2014.

[33] Quotations from David M. Hart, Stephen J. Ezell, and Robert D. Atkinson, *Why America Needs a National Network for Manufacturing Innovation*, Information Technology and Innovation Foundation, December 2012, http://www.itif.org/publications/why-america-needs-national-network-manufacturing-innovation.

[34] MAPI, https://www.mapi.net/china-has-dominant-share-world-manufacturing.

[35] Bureau of Labor Statistics, U.S. Department of Labor, Current Employment Statistics survey database, data for manufacturing employment, all employees, seasonally adjusted, http://data.bls.gov/cgi-bin/surveymost.

Issue: What Is the Appropriate Role of the Federal Government in Manufacturing?

Independent of their perspective on the health of the U.S. manufacturing sector, some analysts and policymakers may believe that there should not be an NNMI program because it is not an appropriate role for the federal government. The appropriate role of the federal government in fostering technological innovation or supporting a particular company, industry, or industrial sector (e.g., manufacturing) has been the focus of a long-running national policy debate. Views range from those who believe that the federal government should take a hands-off or minimalist approach to those who support targeted federal investments in promising technologies, companies, and industries. While there has been broad agreement on federal support for fundamental research, the consensus in favor of federal support frays as technology matures toward commercialization.

Advocates for a strong federal role in advancing technologies and industries often assert that such interventions are justified by the economic, national security, and societal benefits that generally accompany technological advancement and U.S. technological and industrial leadership. For such reasons, the manufacturing sector has received the attention of the federal government since the nation's founding.[36]

Critics of a strong federal role provide a variety of arguments. For example, some contend that the federal government should not favor or subsidize particular companies, industries, or technologies, asserting that such interventions skew technology development and competition by replacing decisions of companies, capital providers, and researchers with the judgment of government bureaucrats or politicians (sometimes referred to as the government "picking winners and losers"). Those who hold this view generally assert that this may result in inefficient allocation of capital, development and deployment of inferior technologies, and political favoritism (sometimes referred to as "crony capitalism"). Others assert that such interventions often represent a transfer of wealth from taxpayers to already-prosperous companies and their shareholders (sometimes referred to as "corporate welfare").

Some critics may assert that the role envisioned for the NNMI should be performed by the private sector; that the NNMI would be ineffective or counterproductive; that the funds that would go to the NNMI should be used to support manufacturing in other ways; that the funds should be used for different federal functions altogether; or that the funds should be directed toward deficit reduction.

Others may prefer an approach that is more technology- or industry-neutral, such as reducing costs and other burdens on manufacturers by reducing taxes, regulations, and frivolous lawsuits.

Even some advocates of a strong federal role in supporting U.S. manufacturing may prefer alternative approaches, including increasing federal funding for manufacturing R&D, providing

[36] For example, the Constitution vests Congress with the power to "fix the Standard of Weights and Measures" and to establish a patent system, functions central to manufacturing and trade in manufactured goods. In 1791, Treasury Secretary Alexander Hamilton presented his "Report on the Subject of Manufactures" to Congress with policy recommendations to foster the development of manufacturing in the United States. The Morrill Land-Grant Acts enacted in the 1860s granted states federal lands to use for the establishment of colleges "to teach such branches of learning as are related to agriculture and the mechanic arts" to provide, in part, knowledgeable engineers and technicians for the manufacturing sector. A century later, Congress created programs such as the Manufacturing Extension Partnership and the Small Business Innovation Research program to help improve U.S. innovation and manufacturing in response to increased foreign innovation and competition.

grants and loan guarantees for domestic manufacturing, or subsidizing production of products for which there are positive benefits for the nation that cannot be captured by the manufacturer.

Both supporters and opponents may believe that the NNMI is, in part or in whole, duplicative of other federal programs, such as the Manufacturing Extension Partnership; or, as a new and separate program, represents an increasing fragmentation of federal efforts to help manufacturers. Some may question whether additional federal funding will produce more innovation and whether and how the U.S. manufacturing base will effectively absorb such innovations.

When considered in the context of the overall U.S. economy, manufacturing output, or federal spending, the scale of the NNMI may seem relatively small. Nevertheless, both proponents and opponents of the NNMI may see the current program as opening the door to future increases in funding for the NNMI as well as establishing a precedent for the creation of additional programs of a similar nature for manufacturing or other sectors of the U.S. economy.

Appendix. NNMI Provisions of the RAMI Act

The RAMI Act amends the National Institute of Standards and Technology Act (codified at 15 U.S.C. 271 et seq.) to establish the NNMI program,[37] setting forth its purposes and authorizing its structure, funding, and operation. The act also establishes a National Program Office to support the NNMI program.

Purposes

The RAMI Act specifies eight purposes of the NNMI program:

- to improve the competitiveness of U.S. manufacturing and to increase the production of goods manufactured predominantly within the United States;
- to stimulate U.S. leadership in advanced manufacturing research, innovation, and technology;
- to facilitate the transition of innovative technologies into scalable, cost-effective, and high-performing manufacturing capabilities;
- to facilitate access by manufacturing enterprises to capital-intensive infrastructure, including high-performance electronics and computing, and the supply chains that enable these technologies;
- to accelerate the development of an advanced manufacturing workforce;
- to facilitate peer exchange and the documentation of best practices in addressing advanced manufacturing challenges;
- to leverage nonfederal sources of support to promote a stable and sustainable business model without the need for long-term federal funding; and
- to create and preserve jobs.

Structure

The act directs the Secretary of Commerce to establish a Network for Manufacturing Innovation program at NIST.[38] The Secretary, acting through NIST, is directed to support the establishment of IMIs and to establish and support a network of IMIs.

Institutes for Manufacturing Innovation

The act defines an IMI[39]—including institutes established prior to the act, as well as ones established under the provisions of the act—as one that meets each of the following criteria:

- has been established to address challenges in advanced manufacturing and to assist manufacturers in retaining or expanding industrial production and jobs in the United States;

[37] The RAMI Act uses the term Network for Manufacturing Innovation (NMI) rather than the National Network for Manufacturing Innovation (NNMI). For consistency and clarity, this report uses the term NNMI.

[38] 15 U.S.C. 278s(a)(1).

[39] The RAMI Act uses the term "center for manufacturing innovation," but this report uses the term Institute for Manufacturing Innovation or IMI for consistency.

- has a predominant focus on a manufacturing process; novel material; enabling technology; supply chain integration methodology; or another relevant aspect of advanced manufacturing, such as nanotechnology applications, advanced ceramics, photonics and optics, composites, bio-based and advanced materials, flexible hybrid technologies, and tool development for microelectronics;
- has the potential, as determined by the Secretary of Commerce, to improve the competitiveness of U.S. manufacturing; to accelerate nonfederal investment in advanced manufacturing production capacity in the United States; or to enable the commercial application of new technologies or industry-wide manufacturing processes;
- includes active participation among representatives from multiple industrial entities, research universities, community colleges, and such other entities as the Secretary of Commerce considers appropriate, which may include industry-led consortia; career and technical education schools; federal laboratories; state, local, and tribal governments; businesses; educational institutions; and nonprofit organizations.

IMI Activities

The act authorizes activities of an IMI to include the following:

- research, development, and demonstration projects (including proof-of-concept development and prototyping) to reduce the cost, time, and risk of commercializing new technologies and improvements in existing technologies, processes, products, and research and development (R&D) of materials to solve precompetitive industrial problems with economic or national security implications;
- development and implementation of education, training, and workforce recruitment courses, materials, and programs;
- development of innovative methodologies and practices for supply chain integration and introduction of new technologies into supply chains;
- outreach and engagement with small and medium-sized manufacturing enterprises, including women- and minority-owned manufacturing enterprises, in addition to large manufacturing enterprises; and
- such other activities as the Secretary of Commerce, in consultation with federal departments and agencies whose missions contribute to or are affected by advanced manufacturing, considers consistent with the purposes specified in the act.

Identification of Existing Institutes for Inclusion in the Network

The act allows a number of existing manufacturing institutes to be classified as an IMI for participation in the network. As noted above, President Obama initiated the establishment of several such institutes prior to enactment of the RAMI Act under the existing general statutory authority of the Department of Defense and Department of Energy. In particular, the act incorporates

> the National Additive Manufacturing Innovation Institute and other manufacturing centers formally recognized as [IMIs] pursuant to Federal law or executive actions, or

> under pending interagency review for such recognition as of the date of enactment of the Revitalize American Manufacturing and Innovation Act of 2014.[40]

However, the RAMI Act prohibits such institutes from receiving any financial assistance authorized by the act.

Financial Assistance to Establish and Support IMIs

The RAMI Act authorizes the Secretary of Commerce to award financial assistance to a person or group of persons to assist in planning, establishing, or supporting an IMI. The act requires an open process for the solicitation of applications that allows for the consideration of all applications relevant to advanced manufacturing, regardless of technology area, and competitive merit-based review of the applications that incorporates peer review by a "diverse group of individuals with relevant experience from both the public and private sectors."[41] Political appointees are prohibited from participating on any peer review panel, and the Secretary of Commerce is required to implement a conflict of interest policy that ensures public transparency and accountability, as well as full disclosure of any real or potential conflicts of interest of individuals participating in the IMI selection process.

The Secretary of Commerce is required to make a description of the bases for any award of financial assistance to an IMI publicly available at the time of the award, including the merits of the winning proposal relative to other applicants. The Secretary must also develop and implement performance measures to assess the effectiveness of the funded activities.

In making IMI selections, the act requires the Secretary, working through the National Program Office, to collaborate with federal departments and agencies whose missions contribute to or are affected by advanced manufacturing.

IMI Selection Considerations

The RAMI Act requires the Secretary to apply certain considerations in the selection of IMIs. The considerations specified in the act include the following:

- the potential of an IMI to advance domestic manufacturing and the likelihood of economic impact, including creation or preservation of jobs, in the predominant focus areas of the IMI;
- the commitment of continued financial support, advice, participation, and other contributions from nonfederal sources to provide leverage and resources to promote a stable and sustainable business model without the need for long-term federal funding;
- whether the financial support provided to the IMI from nonfederal sources significantly exceeds the requested federal financial assistance;
- how the IMI will increase the nonfederal investment in advanced manufacturing research in the United States;
- how the IMI will engage with small and medium-sized manufacturing enterprises to improve the capacity of such enterprises to commercialize new processes and technologies;

[40] P.L. 113-235.

[41] Section 703(d)(4)(A).

- how the IMI will carry out educational and workforce activities that meet industrial needs related to its predominant focus areas;
- how the IMI will advance economic competitiveness and generate substantial benefits to the United States that extend beyond the direct return to participants in the program;
- whether the predominant focus of the IMI is a manufacturing process, novel material, enabling technology, supply chain integration methodology, or other relevant aspect of advanced manufacturing that has not already been commercialized, marketed, distributed, or sold by another entity;
- how the IMI will strengthen and leverage the assets of a region; and
- how the IMI will encourage education and training of veterans and individuals with disabilities.

The act allows for other factors to be considered.

IMI Funding

The RAMI Act includes several provisions related to IMI funding:

- Financial assistance may not be awarded to an IMI more than seven years after the date the Secretary of Commerce first awards financial assistance to that IMI.
- Total federal assistance awarded to an IMI, including funding made under the provisions of the RAMI Act, may not exceed 50% of the total funding of the IMI in that year. The Secretary of Commerce may make exceptions in circumstances in which an IMI is making large capital facilities or equipment purchases. The Secretary is directed to give preference to IMIs seeking less than the maximum federal share of funds allowed.
- IMIs are to receive decreasing levels of funding in each subsequent year of funding. The Secretary may make exceptions to this requirement when an IMI is otherwise meeting its stated goals and metrics, unforeseen circumstances have altered the IMI's anticipated funding, and the IMI can identify future nonfederal sources of funding that would warrant a temporary exemption.

Authorization of Appropriations

The RAMI Act authorizes NIST to use $5 million per year for FY2015-FY2024 from funds appropriated to its Industrial Technology Services account to carry out the Network for Manufacturing Innovation program. The act also authorizes the Department of Energy to transfer to NIST up to $250 million over the FY2015-FY2024 period from funds appropriated for advanced manufacturing R&D in its Energy Efficiency and Renewable Energy account.

The Secretary of Commerce, in addition to amounts appropriated to carry out the program, may accept funds, services, equipment, personnel, and facilities from any covered entity to carry out the program, subject to certain conditions and constraints.[42]

[42] For purposes of this provision, a covered entity is any federal department, federal agency, instrumentality of the United States, state, local government, tribal government, territory or possession of the United States, or of any political subdivision thereof, or international organization or any public or private entity or individual.

National Program Office

The RAMI Act directs the Secretary of Commerce to establish, within NIST, a National Program Office of the Network for Manufacturing Innovation to oversee and carry out the program.

The act specifies the following functions of the National Program Office:

- to oversee planning, management, and coordination of the program;
- to enter into memoranda of understanding with federal departments and agencies whose missions contribute to or are affected by advanced manufacturing, to carry out the authorized purposes of the program;
- to develop a strategic plan to guide the program no later than one year from the date of enactment of the act, and to update the strategic plan at least once every three years thereafter;
- to establish such procedures, processes, and criteria necessary and appropriate to maximize cooperation and coordination of the activities of the program with programs and activities of other federal departments and agencies whose missions contribute to or are affected by advanced manufacturing. The act, in particular, calls for the Secretary to ensure that the NIST Hollings Manufacturing Extension Partnership (MEP) is incorporated into program planning to ensure the results of the program reach small and medium-sized entities;
- to establish a clearinghouse of public information related to the activities of the program; and
- to act as a convener of the network.

In support of the development and updating of the strategic plan, the Secretary of Commerce is directed by the act to solicit recommendations and advice from a wide range of stakeholders, including industry, small and medium-sized manufacturing enterprises, research universities, community colleges, and other relevant organizations and institutions on an ongoing basis. The Secretary is directed to transmit the strategic plan to the Senate Committee on Commerce, Science, and Transportation and the House Committee on Science, Space, and Technology.

The act authorizes any federal government employee to be detailed to the National Program Office without reimbursement and without interruption or loss of civil service status or privilege to the employee.

Mandated Reports and Audits

The RAMI Act requires several reports and audits to be conducted with respect to the program.

Annual Reports by IMIs to the Secretary of Commerce

The RAMI Act directs the Secretary of Commerce to require each recipient of federal assistance under the act to submit an annual report to the Secretary that describes the finances and performance of the IMI for which assistance was awarded. Each report is required to include an accounting of expenditures of amounts awarded under the program to the IMI; a description of the performance of the IMI with respect to its goals, plans, financial support, and accomplishments; and an explanation of how the IMI has advanced the purposes of the program as specified by the act.

Annual Reports by the Secretary of Commerce to Congress

The RAMI Act requires the Secretary of Commerce to report annually to Congress through December 31, 2024, on the performance of the program during the most recent one-year period. Each report is to include a summary and assessment of the annual reports provided by each IMI; an accounting of funds expended by the Secretary under the program, including any temporary exemptions granted; an assessment of the participation in, and contributions to, the network by any IMIs for manufacturing innovation not receiving financial assistance under the program; and an assessment of the program with respect to meeting the purposes described in the act.

Biennial Assessment by the U.S. Government Accountability Office

The RAMI Act requires the Comptroller General of the United States (the head of the Government Accountability Office) to conduct an assessment of the program at least once every two years during the operation of the program, covering the two most recent years of the program on the overall success of the program, and a final assessment to be made not later than December 31, 2024.

Each assessment is to include, for the period covered by the report, a review of the management, coordination, and industry utility of the program; an assessment of the extent to which the program has furthered the purposes identified in the act; such recommendations for legislative and administrative action as the Comptroller General considers appropriate to improve the program; and an assessment as to whether any prior recommendations for improvement made by the Comptroller General have been implemented or adopted.

Additional Program-Related Authorities

Other provisions of the RAMI Act authorize

- the Secretary of Commerce to appoint such personnel and enter into such contracts, financial assistance agreements, and other agreements as the Secretary considers necessary or appropriate to carry out the program, including support for R&D activities involving an IMI;
- the Secretary of Commerce to transfer to other federal agencies such sums as the Secretary considers necessary or appropriate to carry out the program—however, such funds may not be used to reimburse or otherwise pay for the costs of financial assistance incurred or commitments of financial assistance made prior to the date of enactment of the RAMI Act;
- agencies to accept funds transferred to them by the Secretary of Commerce, in accordance with the provisions of the RAMI Act, to award and administer, under the same conditions and constraints applicable to the Secretary, all aspects of financial assistance awards under the RAMI Act; and
- the Secretary of Commerce to use, with the consent of a covered entity[43] and with or without reimbursement, land, services, equipment, personnel, and facilities of such covered entity.

The RAMI Act also specifies that the provisions of 35 U.S.C. 18, Patent Rights in Inventions Made with Federal Assistance, shall apply to any funding agreement[44] awarded to new or existing

[43] See footnote 42.

institutes. This chapter of the U.S. Code is widely known as the Bayh-Dole Act and formally titled the University and Small Business Patent Procedures Act of 1980.[45]

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(...continued)

[44] As defined in 18 U.S.C. 35, Section 201, the term "funding agreement" means "any contract, grant, or cooperative agreement entered into between any Federal agency, other than the Tennessee Valley Authority, and any contractor for the performance of experimental, developmental, or research work funded in whole or in part by the Federal Government. Such term includes any assignment, substitution of parties, or subcontract of any type entered into for the performance of experimental, developmental, or research work under a funding agreement as herein defined."

[45] For more information about the Bayh-Dole Act, see CRS Report RL32076, *The Bayh-Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology*, by (name redacted) .