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Manufacturing USA: Advanced Manufacturing Institutes and Network

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SUMMARY

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Manufacturing USA: Advanced Manufacturing Institutes and Network

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. Manufacturing USA is a network of institutes focused on facilitating the development and commercialization of emerging manufacturing technologies. The existing network consists of 16 institutes sponsored by the Departments of Commerce (DOC), Defense (DOD), and Energy (DOE) and co-funded with private sector partners.

The program traces its roots to President Obama's FY2013 budget proposal to create 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 sought $1 billion in mandatory funding for the National Institute of Standards and Technology (NIST) within the DOC to establish up to 15 NNMI institutes. Congress did not act on the proposal in the 112th Congress.

President Obama renewed his call for an NNMI in his FY2014 budget request, seeking $1 billion in mandatory funding, and in FY2015 with a request for $2.4 billion in discretionary funding to establish up to 45 institutes. Congress did not provide the requested funding. In the absence of explicit authority and dedicated appropriations, the Obama Administration, relying on existing agency authorities and appropriations of DOD and DOE, began to establish NNMI institutes.

In December 2014, Congress enacted 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 (). The act directed the Secretary of Commerce to establish a Network for Manufacturing Innovation program at NIST. The RAMI Act authorized NIST, DOE, and other agencies to establish institutes, and established a National Office of the Network for Manufacturing Innovation to oversee the program and coordinate the network.

Section 1741 of the National Defense Authorization Act for Fiscal Year 2020 (P.L. 116-92) amended the RAMI Act. Among its provisions, the act codified the 2016 rebranding of the program by DOC as the Manufacturing USA program, expanded the scope of potential technology focus areas for institutes, established required and permissible activities for each institute, and authorized the designation of "substantially similar" institutes as Manufacturing USA institutes for purposes of participation in the network. P.L. 116-92 also authorized the Secretaries of Commerce and Energy and other agency heads (except DOD) to make financial awards of five to seven years in duration to establish Manufacturing USA institutes, and to renew the awards subject to merit review. Further, P.L. 116-92 eliminated a RAMI Act provision requiring consideration be given to whether a proposed institute could function without long-term federal funding, and authorized appropriations for Manufacturing USA institutes and network support for NIST through 2030 and for DOE Manufacturing USA institutes through FY2024.

While P.L. 116-92 addressed a variety of issues associated with the Manufacturing USA program, institutes, and network, Congress might opt to consider a number of other issues moving forward. Among these are the appropriate number of institutes; potential limitations on institute renewals; selection of technology foci for future institutes; the level and type of appropriations to be made to support the institutes and network; the purpose(s) of the Manufacturing USA network; recognition of institutes as Manufacturing USA institutes; participation of other institutes in the network; applicability of financial and performance reporting requirements; establishment of short- and long-term performance goals; the role of the federal government in the Manufacturing USA program after 2030; and the long-term financial stability of the institutes in the absence of federal baseline funding.

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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 11% of the nation's gross domestic product (GDP).[1] In 2019, manufacturing enterprises directly employed approximately 12.5 million full-time employees in the United States and indirectly supported millions of additional jobs in other industries.[2] Manufacturers also funded more than 62% of the nation's industrial research and development (R&D), providing a foundation for technological innovation and continued U.S. technological leadership.[3] Wages and salaries per full-time equivalent employee in manufacturing were $72,735 in 2019, compared to $66,778 for employees in all industries.[4] 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 manufacturing 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. Some also point to what may be an end to the long-term decline in U.S. manufacturing employment. From its low point of 11.5 million in March 2010, U.S. manufacturing employment grew to 12.9 million in November 2019 and remained at about that level until Coronavirus Disease 2019 (COVID-19) pandemic-related closures hit the sector in March 2020. (By April 2020, manufacturing employment had dropped to 11.5 million, but it has recovered somewhat, standing at 12.3 million in December 2020.)[5]

Other analysts, however, believe that the U.S. manufacturing sector is at risk of losing market share and employment to foreign competitors. 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 while retaining selected functions (e.g., design, engineering), as well as policy and program efforts of other nations to attract and grow manufacturing companies. U.S. manufacturing employment today remains substantially below its 1970-2000 levels of approximately 16 million to 19 million.[6] National security and economic concerns about

[1] CRS analysis of Bureau of Economic Analysis (BEA), Department of Commerce, Gross Domestic Product, Table 14, https://www.bea.gov/sites/default/files/2020-12/gdp3q20_3rd_0.xlsx.

[2] Table 6.5D (Full-Time Equivalent Employees by Industry), National Income and Product Accounts, Bureau of Economic Analysis, Department of Commerce, https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=2&isuri=1&1921=survey#reqid=19&step=2&isuri=1&1921=survey.

[3] CRS analysis of data from National Science Foundation, *Business Research and Development: 2018*, Detailed Statistical Tables, NSF 21-312, Table 26, https://ncses.nsf.gov/pubs/nsf21312/assets/data-tables/tables/nsf21312-tab026.xlsx.

[4] Table 6.6D (Wages and Salaries per Full-Time Equivalent Employee by Industry), National Income and Product Accounts, BEA, U.S. Department of Commerce, https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=2&isuri=1&1921=survey#reqid=19&step=2&isuri=1&1921=survey. According to BEA, "Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part-time schedules converted to a full-time basis. The number of full-time equivalent employees in each industry is the product of the total number of employees and the ratio of average weekly hours per employee for all employees to average weekly hours per employee on full-time schedules. An industry's full-time equivalent employment will be less than the number of its employees on full- and part-time schedules, unless it has no part-time employees." (BEA, "What Are Full-Time Equivalent Employees?," https://www.bea.gov/help/faq/368.)

[5] U.S. Bureau of Labor Statistics, Current Employment Statistics survey, customized table (all employees, manufacturing, seasonally adjusted), https://data.bls.gov/cgi-bin/dsrv?ce.

[6] Some manufacturing sector job losses during this period are attributable to the outsourcing of a variety of business functions (e.g. accounting, legal, information technology, customer service, shipping, logistics).

China and shortages of domestically produced supplies needed to address the COVID-19 national emergency have increased attention on U.S. reliance on overseas manufacturing, potential vulnerabilities in global supply chains, and U.S. technological leadership and industrial competitiveness. In 2010, China displaced the United States as the largest manufacturing country,[7] and manufacturing output, measured in each country's local currency adjusted for inflation, has been growing more slowly in the United States than in China, South Korea, Germany, and Mexico.[8]

Heightened concerns about the health of U.S. manufacturing have led some stakeholders and policymakers to advocate for changes to improve the business environment for domestic manufacturers. Such changes include reducing tax and regulatory burdens, reforming tort laws, changing tax rules for companies that engage in offshoring, and enacting domestic content requirements and "Buy America"-type provisions that prioritize the purchase of American-made goods when available.[9]

Other stakeholders and policymakers have aimed to accelerate the advance of U.S. manufacturing technology to make U.S. manufacturers more competitive internationally. In particular, President Obama proposed the creation and funding of a National Network for Manufacturing Innovation (NNMI), since rebranded as Manufacturing USA (statutorily, the Manufacturing USA program, which consists of the Manufacturing USA institutes and Manufacturing USA network).

The Manufacturing USA institutes and network are the foci of this report. The report begins with a discussion of President Obama's original NNMI proposal and subsequent legislative action. It then provides a review of the statutory provisions regarding the establishment and operation of the Manufacturing USA program. The report then identifies the institutes established prior to and after the passage of the Revitalize American Manufacturing and Innovation Act of 2014 (RAMI Act, P.L. 113-235).[10] The report concludes with a discussion of several policy and implementation issues that continue to face Congress, including the availability of funding, the proper role of the federal government, and operation and oversight of the Manufacturing USA institutes and network.

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.[11] He formally introduced the concept in a speech at a manufacturing facility in Virginia on March 9, 2012.

[7] As measured by output on a value-added basis in current U.S. dollars. (World Economic Forum, "These Are the Top 10 Manufacturing Countries in the World," https://www.weforum.org/agenda/2020/02/countries-manufacturing-trade-exports-economics/.)

[8] For more information on global manufacturing trends, see CRS Report R42135, *U.S. Manufacturing in International Perspective*, by Marc Levinson.

[9] For more information on Buy America and domestic content restrictions, see CRS Report R44850, *Buying American: Protecting U.S. Manufacturing Through the Berry and Kissell Amendments*, by Michaela D. Platzer.

[10] The RAMI Act was incorporated as Title VII of Division B of the Consolidated and Further Continuing Appropriations Act, 2015.

[11] 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 Manufacturing USA. For consistency, this report uses the term institute to refer to any such institute.

During 2012, the Advanced Manufacturing National Program Office (AMNPO)[12] 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*, that sought to provide a framework for institute competition and operations.[13]

No legislation to enact the President's proposal was introduced in the 112th Congress. The President renewed his call for an NNMI in his FY2014 budget request, again seeking $1 billion in mandatory funding. During the 113th Congress, the Revitalize American Manufacturing and Innovation Act—introduced as H.R. 2996 and S. 1468 in August 2013—would have established a Network for Manufacturing Innovation. The House passed H.R. 2996 in September 2014. The Senate Committee on Commerce, Science, and Transportation reported S. 1468 in August 2014. No further legislative action was taken on either.

President Obama's FY2015 budget proposal 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 proposed $2.4 billion in discretionary funding to establish up to 45 NNMI institutes. Congress did not take legislative action on the OGSI proposal.

In December 2014, nearly three years after President Obama first proposed the establishment of the NNMI, Congress passed the RAMI Act. President Obama signed the bill into law on December 16, 2014. The RAMI Act directed the Secretary of Commerce to establish a Network for Manufacturing Innovation (NMI)[14] program within the Commerce Department's National Institute of Standards and Technology (NIST). The act included provisions authorizing NIST, the Department of Energy (DOE), and other agencies to support the establishment of manufacturing institutes, and providing for the establishment and operation of a network of these institutes. In September 2016, the Department of Commerce (DOC) rebranded the NMI as "Manufacturing USA."[15]

In December 2019, Section 1741 of the National Defense Authorization Act for Fiscal Year 2020 (P.L. 116-92) amended the RAMI Act, including revising the statutory name of the program to the "Manufacturing United States of America Program" or "Manufacturing USA Program" in

[12] 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 currently serves as the National Office of the Manufacturing USA Network (also referred to as the National Program Office), and 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.

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

[14] 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).

[15] 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.

alignment with the NMI's 2016 rebranding.[16] The provisions of the RAMI Act, as amended, are discussed throughout this report.[17]

The Manufacturing USA program

Program Establishment

The RAMI Act, as amended (15 U.S.C. §278s), authorizes the Secretary of Commerce, operating through the NIST Director, to establish a Manufacturing USA program. The program consists of Manufacturing USA institutes and a Manufacturing USA network. In addition, the statute directs the Secretary of Commerce to establish a National Office of the Manufacturing USA Network (referred to herein as the National Program Office or NPO) to oversee and carry out the program.

Manufacturing USA Institutes

Institute Definition

The act defines a Manufacturing USA institute as one:

- established to address challenges in advanced manufacturing and to assist manufacturers in retaining or expanding industrial production and jobs in the United States;
- with a predominant focus on a manufacturing process, novel material, enabling technology, supply chain integration methodology, or another relevant aspect of advanced manufacturing;
- with the potential to improve the competitiveness of U.S. manufacturing, to accelerate non-federal investment in advanced manufacturing production capacity in the United States, or to enable the commercial application of new technologies or industry-wide manufacturing processes;[18] and
- which includes active participation among representatives from multiple industrial entities, research universities, community colleges, and other entities as 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.[19]

Institute Roles

Manufacturing USA institutes are intended to:

- improve the competitiveness of United States manufacturing and to increase the production of goods manufactured predominantly within the United States;

[16] 15 U.S.C. §278s(c)(2).

[17] See 15 U.S.C. §278s (Manufacturing USA) for the provisions of the RAMI Act, as amended.

[18] The statute identifies several examples of key advanced manufacturing technologies, including nanotechnology, advanced ceramics, photonics and optics, composites, bio-based and advanced materials, flexible hybrid technologies, tool development for microelectronics, food manufacturing, superconductors, advanced battery technologies, robotics, advanced sensors, quantum information science, supply chain water optimization, aeronautics and advanced materials, and graphene and graphene commercialization.

[19] 15 U.S.C. §278s(d)(1).

- stimulate United States leadership in advanced manufacturing research, innovation, and technology;
- facilitate the transition of innovative technologies into scalable, cost-effective, and high-performing manufacturing capabilities;
- facilitate access by manufacturing enterprises to capital-intensive infrastructure, including high-performance electronics and computing, and the supply chains that enable these technologies;
- accelerate the development of an advanced manufacturing workforce;
- facilitate peer exchange of and the documentation of best practices in addressing advanced manufacturing challenges;
- leverage nonfederal sources of support to promote a stable and sustainable business model without the need for long-term federal funding;
- create and preserve jobs; and
- contribute to the development of regional innovation initiatives across the United States.[20]

Institute Activities

The RAMI Act, as amended, authorizes both required and permissible activities of Manufacturing USA institutes.

Required Activities

Manufacturing USA institutes are required to:

- conduct research, development, and demonstration projects, including proof-of-concept development and prototyping, to reduce the cost, time, or risk of commercializing new technologies and improvements in existing technologies, processes, products, and materials-related R&D to solve precompetitive industrial problems with economic or national security implications;
- develop and implement education, training, and workforce recruitment courses, materials, and programs addressing workforce needs through training and education programs at all appropriate education levels, including programs on applied engineering;
- develop innovative methodologies and practices for supply chain integration and introduction of new technologies into supply chains;
- conduct outreach and engagement with small and medium-sized manufacturing enterprises, including women, minority, and veteran owned manufacturing enterprises, in addition to large manufacturing enterprises; and
- develop roadmaps or leverage existing roadmaps for technology areas being pursued by that Manufacturing USA institute, taking into account R&D undertaken at other Manufacturing USA institutes and federal agencies.

[20] 15 U.S.C. §278s(b)(2).

Permissible Activities

Manufacturing USA institutes may conduct other activities consistent with the program's statutory purposes specified in 15 U.S.C. §278s(b)(2).

Institutes Awarded

As of the date of this report, there are 16 Manufacturing USA institutes, including 4 that were awarded or under competition prior to enactment of the RAMI Act in December 2014, and 12 that have been awarded since then.[21]

Pre-RAMI Act Institutes

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 four Manufacturing USA-like institutes. Three of these institutes were awarded by DOD:[22]

- America Makes (National Additive Manufacturing Innovation Institute), Youngstown, OH;[23]
- MxD, Manufacturing x Digital, previously the Digital Manufacturing and Design Innovation Institute, DMDII (Digital Manufacturing and Design Innovation Institute), Chicago, IL;[24] and
- LIFT, Lightweight Innovations For Tomorrow (Lightweight and Modern Metals Manufacturing Innovation Institute), Detroit, MI.[25]

One institute was awarded by DOE:

- PowerAmerica (Next Generation Power Electronics Manufacturing Innovation Institute), Raleigh, NC.[26]

The RAMI Act, as amended, recognized these institutes as Manufacturing USA institutes for participation in the network:

> the National Additive Manufacturing Innovation Institute and other manufacturing institutes formally recognized as Manufacturing USA institutes pursuant to Federal law or executive actions, or under pending interagency review for such recognition as of December 16, 2014, shall be considered Manufacturing USA institutes for purposes of this section.[27]

[21] Institute summaries are available for download on the Manufacturing USA website at https://www.manufacturingusa.com/institutes.

[22] 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 institute's location.

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

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

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

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

[27] 15 U.S.C. §278s(d)(3)(A).

Post-RAMI Act Institutes

Since passage of the RAMI Act, DOD, DOE, and DOC have competed and awarded 12 additional institutes. As for the pre-RAMI Act institutes, DOD and DOE awarded their additional institutes under departmental authorities other than those provided by the RAMI Act. DOD has awarded six institutes since passage of the RAMI Act:

- AIM Photonics, American Institute for Manufacturing Integrated Photonics (Integrated Photonics Institute for Manufacturing Innovation), Rochester, NY;[28]
- NextFlex (Flexible Hybrid Electronics Manufacturing Innovation Institute), San Jose, CA;[29]
- AFFOA, Advanced Functional Fabrics of America (Revolutionary Fibers and Textiles Manufacturing Innovation Institute), Cambridge, MA;[30]
- BioFabUSA Institute (Advanced Tissue Biofabrication Manufacturing Innovation Institute), Manchester, NH;[31]
- ARM, Advanced Robotics for Manufacturing (Advanced Robotics Manufacturing Institute), Pittsburgh, PA;[32] and
- BioMADE, Bioindustrial Manufacturing and Design Ecosystem (Bioindustrial Manufacturing Innovation Institute), St. Paul, MN.[33]

DOE has awarded five:

- IACMI, Institute for Advanced Composites Manufacturing Innovation (Advanced Composites Manufacturing Innovation Institute), Knoxville, TN;[34]
- CESMII, Clean Energy Smart Manufacturing Innovation Institute (Manufacturing Innovation Institute for Smart Manufacturing: Advanced Sensors, Controls, Platforms, and Modeling for Manufacturing), Los Angeles, CA;[35]
- RAPID, Rapid Advancement in Process Intensification Deployment Institute (Modular Chemical Process Intensification Institute), New York, NY;[36]
- REMADE, Reducing Embodied-energy and Decreasing Emissions Institute (Reducing Embodied Energy and Emissions of Manufactured Materials), Rochester, NY;[37] and
- CyManII, Cybersecurity Manufacturing Innovation Institute (Cybersecurity Manufacturing Innovation Institute), San Antonio, TX.[38]

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

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

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

[31] For additional information, see https://www.armiusa.org/.

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

[33] For additional information, see https://ebrc.org/bioindustrial-manufacturing-and-design-ecosystem/.

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

[35] For additional information, see https://www.cesmii.org/.

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

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

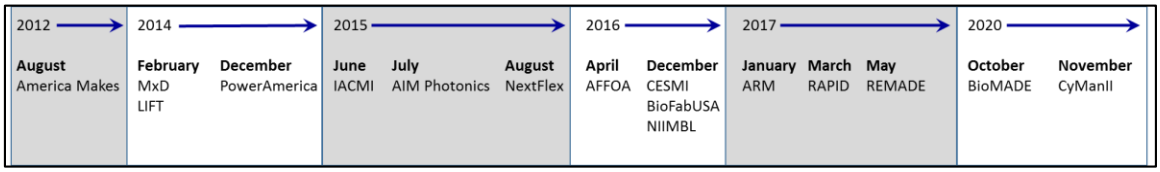
[38] For additional information, see https://cymanii.org.

One institute, awarded by DOC, has been established under the authorities provided by the RAMI Act:

- NIIMBL, National Institute for Innovation in Manufacturing Biopharmaceuticals, Newark, DE.[39]

Figure 1 shows the month and year each Manufacturing USA institute was awarded.

Figure 1. Chronology of Manufacturing USA Institute Awards



Source: Compiled by CRS from various Advanced Manufacturing National Program Office, White House, DOD, DOE, and DOC announcements.

Pathways to Becoming a Manufacturing USA Institute

Under the RAMI Act, as amended, there are three pathways by which an institute can be designated a Manufacturing USA institute and thus part of the Manufacturing USA network.

Pathway 1

Institutes established under non-RAMI Act authorities as of December 16, 2014, that had been recognized as Manufacturing USA institutes pursuant to federal law or executive actions, or that were under pending interagency review for such recognition, are considered Manufacturing USA institutes.[40] Except for NIIMBL, all of the current institutes were designated as Manufacturing USA institutes through this pathway.

Pathway 2

The Secretary of Commerce is authorized to recognize "substantially similar" institutes as Manufacturing USA institutes, upon the request of the entity, for purposes of participation in the Manufacturing USA network.[41] Such an institute is not required to meet every element of the act's description of an institute[42] and must not have received financial assistance under 15 U.S.C. §278s(e). This pathway, referred to informally as the "alliance pathway," has not been used as of the date of this report.

Pathway 3

A Manufacturing USA institute may be established under the authorities granted by the RAMI Act, as amended.[43] This is the pathway used to establish the NIST-sponsored NIIMBL institute.

Sixteen DOD-, DOE-, and DOC-sponsored institutes are thus characterized as Manufacturing USA institutes and participate in the Manufacturing USA network. One institute—the DOC-

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

[40] 15 U.S.C. §278s(d)(3)(A).

[41] 15 U.S.C. §278s(d)(3)(B).

[42] 15 U.S.C. §278s(d)(1).

[43] 15 U.S.C. §278s.

sponsored institute—is subject to the purposes, activities, and reporting requirements of the RAMI Act, as amended.

Funding, Selection Considerations, and Performance Metrics and Standards

The requirements of the RAMI Act, as amended, discussed in the section apply to the NIST-sponsored Manufacturing USA institute; however, it is not clear whether the provisions apply to the other 15 Manufacturing USA institutes.[44]

The statute authorizes the heads of federal agencies (except DOD) to award financial assistance for planning, establishing, or supporting a Manufacturing USA institute.[45] Initial awards are to be made for a period of no less than five years and no more than seven years.[46] Federal agencies may renew institute awards, subject to a rigorous merit review; additional funding for the renewal period is authorized for a period not to exceed the duration of the initial period of the award.[47] The act also provides direction for the review regarding performance measurement, transparency, and accountability.[48]

Initial awards for the 16 current institutes ranged from approximately $56 million to $110 million over a period of five to seven years.[49] Total initial federal funding for these institutes was approximately $1.2 billion, with an additional $2.4 billion provided in matching funds by the non-federal institute partners (see **Table 1**), for a total of $3.6 billion.[50]

In making an award under the RAMI Act, as amended, an agency head is required to use a competitive, merit review process. This review is to be conducted by a diverse group of individuals with relevant expertise from both the private and public sectors. In making an award, an agency head is to ensure that the technology focus of an institute does not substantially duplicate the technology focus of any other Manufacturing USA institute.[51]

[44] The Department of Defense and Department of Energy assert that none of their institutes were established under 15 U.S.C. §278s(e), and thus are not subject to many of the requirements of the RAMI Act, as amended. For conciseness, this report does not repeat this caveat in each place it may be applicable.

[45] 15 U.S.C. §278s(e)(1).

[46] 15 U.S.C. §278s(e)(2)(A).

[47] 15 U.S.C. §278s(e)(2)(B).

[48] 15 U.S.C. §278s(e)(5).

[49] *National Network for Manufacturing Innovation: A Preliminary Design*, the January 2013 document that sought to provide a framework for the Manufacturing USA program (then the National Network for Manufacturing Innovation), specified a federal investment range of $70 million to $120 million over a five to seven year period. The federal award for America Makes, the pilot institute established by DOD in 2012 prior to the publication of this framework, was $56 million. Since then, every institute award has been for $70 million or more for five years (though agencies can authorize no-cost extensions).

[50] CRS analysis of U.S. Government Accountability Office, *Advanced Manufacturing: Innovation Institutes Have Demonstrated Initial Accomplishments, but Challenges Remain in Measuring Performance and Ensuring Sustainability*, GAO-19-409, May 2019, pp. 12-13, https://www.gao.gov/products/GAO-19-409; DOD, "Manufacturing Technology Program," https://www.dodmantech.com/Institutes/; DOE, Energy Efficiency and Renewable Energy Office, "Advanced Manufacturing," https://www.energy.gov/eere/amo/research-development-consortia; NIST, "U.S. Secretary of Commerce Penny Pritzker Announces Biopharmaceutical Manufacturing Institute Joining Manufacturing USA Network," https://www.nist.gov/news-events/news/2016/12/us-secretary-commerce-penny-pritzker-announces-biopharmaceutical.

[51] 15 U.S.C. §278s(e)(4).

Table 1. Initial Funding Awards for Manufacturing USA Institutes

Federal, anticipated cost share, and total funding, in millions of dollars

Sponsor/Institute	Federal Funding	Anticipated Cost Share	Total Anticipated Institute Funding
Department of Defense			
America Makes	56	85	141
MxD: Digital Manufacturing Institute (formerly Digital Manufacturing and Design Innovation (DMDI))	70	106	176
Lightweight Innovations for Tomorrow (LIFT)	70	78	148
American Institute for Manufacturing Integrated Photonics (AIM)	110	503	613
NextFlex, the Flexible Hybrid Electronics Manufacturing Innovation Institute	75	108	183
Advanced Function Fabrics of America (AFFOA)	75	242	317
Advanced Robotics for Manufacturing (ARM)	80	173	253
BioFabUSA	80	241	321
Bioindustrial Manufacturing and Design Ecosystem (BioMADE)	88	180	268
Department of Energy			
PowerAmerica	70	77	146
Institute for Advanced Composites Manufacturing Innovation (IACMI)	70	95	165
SMART Manufacturing Innovation Institute (CESMI)	70	171	241
Rapid Advancement in Process Intensification Deployment (RAPID) Institute	70	109	179
Reducing EMbodied-energy And Decreasing Emissions (REMADE)	70	70	140
Cybersecurity Manufacturing Innovation Institute (CyManII)	70	41	111
National Institute of Standards and Technology			
National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL)	70	129	199
Total, All Manufacturing USA Institutes	**1,194**	**2,408**	**3.601**

Source: Compiled by CRS from Government Accountability Office, *Advanced Manufacturing: Innovation Institutes Have Demonstrated Initial Accomplishments, but Challenges Remain in Measuring Performance and Ensuring Sustainability*, GAO-19-409, May 2019, pp. 12-13, https://www.gao.gov/products/GAO-19-409; DOD, "Manufacturing Technology Program," https://www.dodmantech.com/Institutes/; DOE, Energy Efficiency and Renewable Energy Office, "Advanced Manufacturing," https://www.energy.gov/eere/amo/research-development-consortia; NIST, "U.S. Secretary of Commerce Penny Pritzker Announces Biopharmaceutical Manufacturing Institute Joining Manufacturing USA Network," https://www.nist.gov/news-events/news/2016/12/us-secretary-commerce-penny-pritzker-announces-biopharmaceutical; AMNPO.

Institute proposals are to be evaluated for selection and for renewal based on the following considerations:

- the potential of the institute to advance domestic manufacturing and the likelihood of economic impact, including the creation or preservation of jobs, in the predominant focus areas of the institute;

- 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;
- whether the financial support provided to the institute from nonfederal sources exceeds the requested federal financial assistance;[52]
- how the Manufacturing USA institute will increase the nonfederal investment in advanced manufacturing research in the United States;
- how the institute will engage with small and medium-sized manufacturing enterprises to improve the capacity of such enterprises to commercialize new processes and technologies and to improve the domestic supply chain;
- how the institute will carry out educational and workforce activities that meet industrial needs related to the predominant focus areas of the institute;
- how the institute will advance economic competitiveness and generate substantial benefits to the nation that extend beyond the direct return to participants in the Manufacturing USA program;
- whether the predominant focus of the institute 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 institute will strengthen and leverage the industrial, research, entrepreneurship, and other assets of a region; and
- how the institute will encourage the education and training of veterans and individuals with disabilities.[53]

Nonfederal funding must comprise 50% or more of the total amount of funding made available for the operation and support of the institute. An agency head may waive this requirement in the case of satellite centers, large capital facilities, equipment purchases, workforce development, or general operations.[54]

For each institute award, the sponsoring agency head is to develop metrics to assess the effectiveness of funded activities in making progress toward the purposes of the Manufacturing USA program, including its effectiveness in advancing technology readiness levels or manufacturing readiness levels; establish performance standards for these metrics; and conduct an assessment of the institute every five years following the initial award until federal financial assistance is discontinued to confirm whether the institute is meeting the established performance standards.[55] No member of the review may be a political appointee.[56]

[52] DOE did not require nonfederal support to equal or exceed federal funding for CyManII; using authorities other than those provided under the RAMI Act, as amended, DOE required a 20% cost share instead of a 50% cost share (DOE, https://eere-exchange.energy.gov/FileContent.aspx?FileID=88d2bc97-2ef0-4b7a-9c0e-9e7a06e9043e). For more information on cost sharing requirements, see 2 C.F.R. §200.306 and 2 C.F.R. §910.130.

[53] 15 U.S.C. §278s(e)(4)(C).

[54] 15 U.S.C. §278s(e)(7).

[55] 15 U.S.C. §278s(e)(5).

[56] 15 U.S.C. §278s(e)(4)(B)(i).

The sponsoring agency head must notify an institute that fails to meet its performance standards of any deficiencies and provide the institute with one year to correct the deficiencies.[57] Manufacturing USA institutes that fail to correct identified deficiencies are not eligible for renewal and the agency head is to notify the institute of its ineligibility.[58]

Manufacturing USA Network

In addition to the institutes, the statute establishes a Manufacturing USA network under the program.[59] The network comprises of all Manufacturing USA institutes, as well as other similar institutes that may be designated such by the Secretary of Commerce at the request of an institute. Those designated by the Secretary cannot have received funding for their establishment and support under the provisions of 15 U.S.C. §278s(e).[60]

Network Charter

In December 2016, the Manufacturing USA Interagency Working Group published the Network Charter of the Manufacturing USA program and revised it in October 2019. The Network Charter states that the functions of the network are to facilitate intra-network collaboration, fulfilling the need for an internal information clearinghouse; foster communication between the network and external stakeholders, serving as an external information clearinghouse for the program; and sustain, strengthen, and expand the network. The charter also articulates four operating principles regarding network governance:

- The network supports its member institutes in meeting the goals of the program and creates a collective impact greater than the sum of constituent parts. Individual institute governance is the purview of the lead funding agency and respective institute members. Legislatively mandated reporting on individual institute performance is the responsibility of the respective lead funding agencies.
- Network governance is a shared responsibility amongst the network membership. Mechanisms and structures are necessary to collect inputs and needs of key stakeholders, including those in the private sector.
- Decisions concerning inter-institute issues in the network should be made at the lowest responsibility level. In resolving issues, there should be a general preference towards empowering action at the institute level.
- The AMNPO is responsible for supporting network functions. The AMNPO, working with the lead funding agencies and other participating federal agencies, is also responsible for reporting to Congress on the Manufacturing USA program and related institutes.[61]

[57] 15 U.S.C. §278s(e)(2)(B)(iii).

[58] 15 U.S.C. §278s(e)(2)(B)(iv).

[59] 15 U.S.C. §278s(c).

[60] 15 U.S.C. §278s(d)(3)(B).

[61] NIST, *Network Manufacturing USA Program*, NIST Advanced Manufacturing Series 600-4r1, October 2019, p. 3, https://nvlpubs.nist.gov/nistpubs/ams/NIST.AMS.600-4r1.pdf.

Institute Directors Council

In addition, to facilitate cooperation and collaboration among the institutes, the directors of the Manufacturing USA institutes launched the Institute Directors Council, composed of the directors of each institute. According to its charter, the council is responsible for:

- promoting collaboration and cooperation among the institutes in support of the goals of Manufacturing USA;
- facilitating communications and engagement among the institutes and between the institutes and the federal government;
- encouraging institute activities that leverage the diversity and strengths of the Manufacturing USA network to collaborate on cross-cutting activities;
- facilitating the institutes' collaboration with the Manufacturing Extension Partnership (MEP) program and other established regional assets;
- supporting collaborative efforts on workforce development that provide enhanced experiential learning opportunities across the network;
- recommending to the network common policies and guidelines for institutes;
- developing best practices and approaches for project calls involving two or more institutes and supporting as appropriate (with input from the respective project funding agency) joint project calls by institutes with existing resources;
- appointing committees to advise the council on matters within its mission and to carry out responsibilities of the council; and
- adopting such other policies and rules and performing such other activities as are reasonably incidental to the administration and governance of the council.[62]

Manufacturing USA National Program Office

The statute also establishes a National Office of the Manufacturing USA network (also referred to as the National Program Office or NPO).[63] Any federal agency may detail an employee of the federal government to the NPO without reimbursement.[64]

The office is responsible for:

- overseeing planning, management, and coordination of the Manufacturing USA program;
- coordinating with federal agencies whose missions contribute to or are affected by advanced manufacturing;
- preparing a strategic plan for the program at least once every three years;
- establishing procedures, processes, and criteria to maximize cooperation and coordinate program activities with those of other federal agencies;
- establishing a clearinghouse of public information related to the program;
- convening the Manufacturing USA network;

[62] NIST, *Charter of the Institute Directors Council Manufacturing USA*, NIST Advanced Manufacturing Series 600-1, November 2016, pp. 1-2, http://nvlpubs.nist.gov/nistpubs/ams/NIST.AMS.600-1.pdf.

[63] The Advanced Manufacturing National Program Office (AMNPO), hosted by NIST, serves as the National Office of the Manufacturing USA Network.

[64] 15 U.S.C. §278s(h)(6).

- working with federal agencies to explore and develop options for sponsoring or supporting a Manufacturing USA institute;
- working with federal agencies currently sponsoring or supporting a Manufacturing USA institute to develop and implement network-wide performance goals with measurable targets and timelines;
- helping develop pilot programs for implementation by institutes to address specific purposes of the program, including accelerating technology transfer and developing entrepreneurship programs;
- supporting the institutes' workforce development activities;
- identifying and disseminating best practices for workforce education and training across the network and enhancing collaboration among Manufacturing USA institutes in the development and implementation of such practices;
- collaborating with the Departments of Labor and Education, industry, career and technical education schools, local community colleges, universities, and labor organizations to provide input for the development of national certifications for advanced manufacturing workforce skills in the technology areas of the Manufacturing USA institutes; and
- coordinating with Manufacturing USA institutes to develop best practices for the membership agreements and coordination of similar project solicitations.[65]

Among the activities of the National Program Office is the provision of secure online collaboration services. The NPO created collaboration websites for each institute that expressed an interest, in addition to establishing network sites open to all institutes for cross-institute teams. The two active formal teams are (1) Communications and (2) Education and Workforce Development. The NPO uses these collaboration sites as a repository for best practice content and materials.

The NPO initially convened the network twice a year, hosting one of the two meetings at an institute and the other meeting in the Washington, DC, area (either at NIST or at the National Academies). These meetings were followed by a congressional briefing and a Congressional Manufacturing USA expo. Beginning in 2019, there was to be one network meeting per year and it was to be held in Washington, DC. Due to the COVID-19 pandemic there was no network meeting in 2020.

Grants to Certain Manufacturing USA Institutes for Public Service Activities

The original RAMI Act (incorporated in P.L. 113-235) prohibited the Department of Commerce from providing funding to Manufacturing USA institutes other than those established under the act. P.L. 116-92 provided the Secretary of Commerce the authority to award competitive grants for public service activities to Manufacturing USA institutes that do not receive funding under 15 U.S.C. §278s(e) (i.e., all the current institutes except NIIMBL). Grants for public service activities may be awarded to carry out workforce development, outreach to small and medium-sized manufacturers, and other activities the Secretary determines to be in the national interest and which are unlikely to receive private sector financial support.[66]

[65] 15 U.S.C. §278s(h)(2).

[66] 15 U.S.C. §278s(f).

Under this provision, Commerce awarded $3.4 million in grants to support the COVID-19 pandemic response, using funding provided under the Coronavirus Aid, Relief, and Economic Security (CARES) Act (P.L. 116-136) enacted in March 2020. Awards were made to expand production of medical countermeasure components (America Makes, $1.4 million); to train workers in the Pittsburgh and Detroit areas in computer numerical controlled (CNC) machine operations, industrial technology maintenance, welding, and robotics (LIFT, $1 million); to develop a safe method to use collaborative robots to automate much of the COVID-19 testing process (ARM, $600,000); and to develop and share a road map for organizations to follow for pandemic response and recovery (ARMI/BioFab USA, $400,000).[67]

The public service activities grant authority may serve as a useful tool in facilitating inter-institute cooperation—in areas such as workforce development, research and development, technology transfer, and manufacturing cluster development—as appropriations are provided.

Coordination with the NIST Hollings Manufacturing Extension Partnership Program

The RAMI Act, as amended, requires the Secretary of Commerce to ensure that the National Program Office leverages the capabilities of the NIST Hollings Manufacturing Extension Partnership (MEP) program to meet the goals of the program. In particular, the Secretary is to ensure engagement of small- and medium-sized manufacturers (SMMs) in Manufacturing USA institutes and the availability of technical assistance to facilitate the deployment of the technologies developed by the institutes. In this regard, the Secretary is authorized to provide financial assistance to MEP centers to support the Manufacturing USA program by providing support services for SMMs and assistance with workforce development and technology transfer, among other things.[68]

In particular, the conference report accompanying the FY2020 National Defense Authorization Act noted:

> the importance of the Hollings Manufacturing Extension Partnership Program in providing education, guidance, and technical assistance to strengthen the cybersecurity of small- and medium-sized manufacturers that provide goods or services in the supply chain for the Department of Defense and encourage the Secretary of Defense to continue work with this program to strengthen the industrial base.[69]

Reporting Requirements

The RAMI Act, as amended, requires a number of reports.

- Each federal agency financially supporting a Manufacturing USA institute under 15 U.S.C. 278s(e) is required to report annually to the Secretary of Commerce on the finances and performance of the institute(s). The report is to include an accounting of expenditures of amounts awarded to each institute and a

[67] NIST, "Commerce Funds Manufacturing USA Pandemic Response Projects," press release, July 6, 2020, https://www.nist.gov/news-events/news/2020/07/commerce-funds-manufacturing-usa-pandemic-response-projects. "BioFabUSA has been initiated as a Manufacturing USA [Manufacturing Innovation Institute] (MII) and will be sustained by the Advanced Regenerative Manufacturing Institute (ARMI), a non-profit organization located in Manchester, New Hampshire." (BioFabUSA, "About Us," https://www.armiusa.org/about-us.)

[68] 15 U.S.C. §278s(h)(5).

[69] H.Rept. 116-333.

description of the performance of each institute with respect to its goals, plans, financial support, and accomplishments, as well as describing how the institute has furthered the purposes of the program.[70]

- The Secretary of Commerce is required to report annually to Congress on the performance of the institutes. This report is to assess how the program is meeting its statutory objectives and provide an accounting of funds. The report is also to include information on any waivers made for matching funding, as well as an assessment of the contributions to the program by Manufacturing USA institutes not funded under the statute.[71]
- The Comptroller General of the United States is to produce a triennial report to Congress through 2030 with an assessment of the program's management, coordination, and industry utility and the extent to which the program has furthered its statutory objectives. In addition, the report is to provide recommendations for legislative and administrative actions to improve the program and provide an assessment of the program's adoption of prior recommendations.[72]
- The Comptroller General is to provide to Congress a final assessment of the overall success of the program by December 31, 2030.[73]

Additional Program-Related Authorities

Other provisions of the RAMI Act, as amended, 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 institute;
- 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;

[70] 15 U.S.C. §278s(i)(1). The Department of Defense and Department of Energy are not required to submit reports under this requirement as they assert that none of their institutes were established under 15 U.S.C. §278s(e).

[71] 15 U.S.C. §278s(i)(2). The most recent report is the *Manufacturing USA: Report to Congress, Fiscal Year 2019*, November 2020, https://www.manufacturingusa.com/sites/manufacturingusa.com/files/2021-01/Manufacturing%20USA%20Annual%20ReportToCongress%20FY2019%20final.pdf.

[72] 15 U.S.C. §278s(i)(3)(A) and (B). Based on the December 20, 2019, enactment date of P.L. 116-92, the first triennial report is due in late 2022 or early 2023.

[73] 15 U.S.C. §278s(i)(3)(C).

- the Secretary of Commerce to use, with the consent of a covered entity[74] and with or without reimbursement, land, services, equipment, personnel, and facilities of such covered entity; and
- the Secretary of Commerce to collaborate with other federal agencies to identify and leverage existing resources at those agencies to assist Manufacturing USA institutes in carrying out the purposes of the program. In particular, the statute specifies collaborative activities at
  - the Department of Labor, relating to labor and apprenticeships;
  - the Department of Commerce Economic Development Administration relating to regional innovation, such as the Regional Innovation Strategies program;
  - the Department of Education relating to workforce development, education, training, and retraining;
  - the Department of Defense relating to procurement and other authorities of the Department of Defense;
  - the Food and Drug Administration relating to biopharmaceutical manufacturing;
  - the National Science Foundation, including the Advanced Technological Education program;
  - the National Aeronautics and Space Administration relating to procurement, workforce development, education, training, and retraining;
  - the Department of Energy relating to development of clean energy technologies and other authorities of DOE; and
  - the Department of Agriculture relating to outreach to rural communities.[75]

In addition, the RAMI Act, as amended, authorizes collaboration with other federal programs that the Secretary determines to be appropriate for supporting the activities of Manufacturing USA institutes.[76]

The RAMI Act, as amended, also specifies that the provisions of 35 U.S.C. Chapter 18, Patent Rights in Inventions Made with Federal Assistance, shall apply to any funding agreement[77] awarded to new or existing institutes. This chapter of the U.S. Code is widely known as the Bayh-Dole Act and is formally titled the University and Small Business Patent Procedures Act of 1980.

Authorization of Appropriations

The RAMI Act, as amended, authorizes appropriations of $5 million for the NIST Industrial Technical Services account for FY2015 through FY2019, and amounts as may be necessary for

[74] 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.

[75] 15 U.S.C. § 278s(j).

[76] 15 U.S.C. § 278s(j)(7)(J).

[77] As defined in 18 U.S.C. Chapter 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."

FY2020 through FY2030, to carry out the Manufacturing USA program. It also authorizes appropriations of $70 million for the Department of Energy to carry out the program for FY2020 through FY2022, and $84 million for FY2023 and FY2024.

Issues for Congressional Oversight of the Manufacturing USA Program

While the RAMI Act, as amended, establishes the Manufacturing USA program, and sets forth its purposes, structure, authorizations, and operation, a number of issues remain that Congress might opt to consider as the program is implemented.

Purposes and Activities of the Manufacturing USA Network

The concept of a **network** of institutes working in cooperation, collaborating, and sharing best practices has been a central tenet of Manufacturing USA from the beginning, embodied in President Obama's proposed National Network for Manufacturing Innovation, in the National Science and Technology Committee report *National Network for Manufacturing Innovation: A Preliminary Design*, in the RAMI Act's direction to establish a Network for Manufacturing Innovation (NMI), and in the FY2020 NDAA's direction to establish a Manufacturing USA network.

Though the RAMI Act, as amended, requires the Secretary of Commerce to "establish a network of Manufacturing USA institutes," it does not specify the purpose(s) or required activities of the network. The authorities given the National Program Office offer some insight into congressional intent for the network. Specifically, the act directs the NPO to, among other things:

- work with sponsoring agencies to develop and implement network-wide performance goals with measurable targets and timelines, and
- identify and disseminate best practices for workforce education and training across the network and further enhance collaboration among Manufacturing USA institutes in developing and implementing such practices.

Congress may opt to consider providing additional authorities or guidance with respect to the network's purposes and activities.

Number of Institutes, Technology Foci, and Appropriations

When President Obama first put forth the concept for what has become the Manufacturing USA program, he sought $1 billion in mandatory funding to support an initial network of 15 institutes, later proposing a mature network goal of 45 institutes in 10 years. In his FY2015 budget request, President Obama sought $2.4 billion in discretionary funding to establish up to 45 institutes.

Today there are 16 Manufacturing USA institutes funded by DOD, DOE, and NIST using funds from discretionary appropriations. DOD and DOE have relied upon their other existing authorities to establish their institutes. As initially conceived and articulated in *National Network for Manufacturing Innovation: A Preliminary Design*, the technology focus of each institute was

to be defined by the proposing teams, and driven by the needs of industry, the opportunities created by new technologies, and the programmatic needs of the federal partners.[78]

To date, 15 of the 16 institutes (all but the NIST-sponsored NIIMBL) have been funded by mission agencies. Because these agencies relied on existing authorities and general appropriations, the technology focus for each competition was identified by the agency based on their agencies' immediate and near-term needs, in contrast to being selected by proposers based on industrial needs and technological opportunity. This approach departs from the original concept and fundamentally changes the criteria by which the technology foci are chosen, potentially resulting in outcomes less relevant to U.S. industrial technology leadership and competitiveness. With respect to the remaining institute, NIIMBL, NIST ran an open competition (i.e., without a pre-selected technology focus).[79]

Moving forward, among the topics Congress may opt to consider are:

- **How many additional institutes, if any, should be established? How should the technology focus of each be determined?**
  In addition to the 16 existing Manufacturing USA institutes, Congress has directed NIST to establish a Manufacturing USA institute focused on semiconductor manufacturing, subject to the availability of appropriations.[80] More generally, the original NMMI proposal in the FY2015 budget was for 45 institutes. China has closely followed Manufacturing USA and has opened 16 manufacturing institutes, with plans to establish 40 by 2025. Congress may opt to consider whether the current number of institutes is adequate to meet the goals of the program and whether additional centers should be established.

- **What criteria should be used in determining the technology foci of new institutes?**
  All but one of the current institutes' technology foci were determined by the sponsoring agency. Congress could allow agencies to select the technology foci of new institutes; it could mandate the establishment of institutes with particular technology foci (such as the mandated new institute on semiconductor manufacturing); or it could direct, as it did in the case of the NIST institute, that the technology foci of institutes be put forth by proposers in open competitions. Alternatively, Congress could continue to use a combination of these approaches. Congress could also provide guidance to agencies on the criteria to be used in selecting the technology foci of institutes, such as meeting industrial needs, exploiting emerging technological opportunities, addressing global competitiveness challenges, and supporting agency missions such as national security and energy efficiency.

- **What funding approaches and mechanisms should be used to establish new institutes and to support the renewal of existing institutes?**

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[78] *National Network for Manufacturing Innovation: A Preliminary Design*, Advanced Manufacturing National Program Office, National Science and Technology Council, Executive Office of the President, January 2013.

[79] "A proposed Institute in any area of advanced manufacturing will be considered so long as it does not duplicate the technical scope and programs of existing federally funded [Manufacturing USA] Institutes." (NIST, "Announcement of Federal Funding Opportunity (FFO), National Network for Manufacturing Innovation (NNMI) Institute Awards," http://nist.gov/amo/upload/NNMI2016FFO.pdf.)

[80] National Defense Authorization Act for Fiscal Year 2021 (H.R. 6395, 116th Congress), enacted by Congress on January 1, 2021, over the veto of President Trump. For more information on semiconductor manufacturing, see CRS Report R46581, *Semiconductors: U.S. Industry, Global Competition, and Federal Policy*, by Michaela D. Platzer, John F. Sargent Jr., and Karen M. Sutter.

Existing institutes have been funded through annual discretionary appropriations. President Obama originally proposed a single mandatory $1 billion appropriation to fund 15 institutes, then proposed a $2.4 billion discretionary appropriation to establish up to 45 institutes. The use of annual appropriations may provide greater congressional control and direction to agencies in the establishment and oversight of new and existing institutes. However, federal agencies often are given discretion in the use of annual appropriations, and a presidential administration might opt to use such funding for other priorities.[81] A single appropriations account dedicated to supporting Manufacturing USA institutes, funded through a one-time advance appropriation, might reduce funding uncertainties.[82] While such an appropriation might be made to a single agency for operation of the program and funding of institutes, Congress could mandate a joint agency approach in the determination of technology foci, selection of institutes, and management of the network.

- **Should there be any limit on the number of times an institute's award may be renewed?**
  The RAMI Act directed that consideration be given to whether a proposed institute could function without long-term federal funding. Under P.L. 116-92 this provision was removed and a provision was added for the renewal of funding, subject to a rigorous merit review. No limit was set on the number of renewals an institute could receive. Congress could opt to consider whether to set a limit on the number of renewals an institute is eligible to receive or require increased cost sharing over time.

Recognition as a Manufacturing USA Institute, Network Participation, and Reporting Requirements

The RAMI Act, as amended, provides three pathways for recognition of institutes and, by extension, membership in the Manufacturing USA network. Currently, all 16 DOD-, DOE-, and NIST-sponsored institutes are recognized as Manufacturing USA institutes and participate in the network. However, some assert that the DOD and DOE institutes, by virtue of their establishment under non-RAMI Act authorities, can opt whether to identify as Manufacturing USA institutes and participate in the network.[83] This may create uncertainties about the composition and stability of the network, potentially reducing the network's efficacy.

In addition, some assert that the DOD- and DOE-sponsored institutes are not subject to various requirements placed upon Manufacturing USA institutes under the RAMI Act, as amended, including the act's provisions regarding required activities, performance measurement, transparency, and accountability, as well as obligations related to financial and performance reporting to the Secretary of Commerce. The absence of a harmonized approach to financial

[81] For example, President Trump requested no funding for DOE Manufacturing USA institutes in his FY2021 budget request. (Department of Energy, *Department of Energy FY 2021 Congressional Budget Request, Volume 3 Part 1*, p. 168, February 2020, https://www.energy.gov/sites/prod/files/2020/04/f73/doe-fy2021-budget-volume-3-part-1.pdf.)

[82] For more information on advance appropriations, see CRS Report R43482, *Advance Appropriations, Forward Funding, and Advance Funding: Concepts, Practice, and Budget Process Considerations*, by Jessica Tollestrup and Kate P. McClanahan.

[83] The exception is America Makes (previously the National Additive Manufacturing Innovation Institute), as the RAMI Act, as amended, specifically identifies it as a Manufacturing USA institute. The NIST-sponsored NIIMBL institute was established under the authorities of the RAMI Act, as amended, and is therefore designated as a Manufacturing USA institute.

accounting and performance measurement may impede the ability of the Comptroller General, the National Academies, and Congress to assess the effectiveness of the institutes and the network.

If Congress intends the DOD- and DOE-sponsored institutes to be permanently recognized as Manufacturing USA institutes; participants in the network; and accountable to the required activities, performance measurement, transparency, accountability, and financial and performance reporting requirements of the RAMI Act, as amended, it may opt to provide additional statutory clarity.

Establishment of Performance Goals: Long-Term and Short-Term

In its May 2019 assessment of the Manufacturing USA program, the Government Accountability Office (GAO) found that the National Program Office and institute-sponsoring agencies have established "long-term goals and objectives based on the statutory purposes of the Manufacturing USA program and have also developed initial performance measures for the network" but noted that they have not "developed near-term network-wide performance goals with measurable targets and time frames that would demonstrate the progress over time of the Manufacturing USA program." While the NPO sets goals and associated performance metrics for institutes established under the RAMI authority, there is no authority for it to do so for institutes established by agencies using non-RAMI authorities. The NPO reports goals and detailed performance metrics only for institutes established under RAMI authorities. If Congress seeks goals and performance measures for all institutes, it may opt to use its oversight authority to explore these limitations and to consider statutory changes to require such reporting of all institutes.

The Role of the Federal Government After FY2030

The RAMI Act, as amended, provides authorization of appropriations to NIST for Manufacturing USA through FY2030, and requires the Comptroller General of the United States to make a final assessment of the overall success of the program by December 31, 2030. No specifications are made in the act for a federal role after 2030. As the program progresses, Congress may opt to consider whether to continue the Manufacturing USA program beyond FY2030 or to allow it to expire.

Institute Financial Sustainability

An ongoing question related to the Manufacturing USA institutes is their ability to become financially self-sustaining. As some of the first institutes were approaching the end of their initial funding awards, the amendments to the RAMI Act under the FY2020 NDAA authorized the agencies to renew institute awards subject to merit review. In addition, the act eliminated a RAMI Act provision requiring consideration be given to whether a proposed institute could function without long-term federal funding.

In its 2019 evaluation of the Manufacturing USA program, GAO noted that each of the institutes had undertaken sustainability planning at varying levels of detail and with a focus on different revenue-generating activities. Among the various revenue-generating activities identified were the use of existing or planned facilities to enable members to conduct research and to test new technology and new manufacturing processes; organizing industry gatherings; providing consulting services for manufacturing technology transition and commercialization; developing manufacturing and business solutions that could be licensed for a fee; hosting education and workforce trainings; and developing fee-based workforce training curricula and skills

certifications. The institutes' strategies also included revenue from public and private contracts competed for on an individual project basis, including with the federal government.[84]

In its report, GAO noted that institutes articulated both positive and negative aspects associated with the potential end of federal baseline funding.

On the positive side, institutes noted that the end of federal baseline funding (and accompanying obligations) would alleviate delays caused by government review and allow more outreach to international companies. While opening institutes to wider international participation might provide increased revenues, potentially help U.S. companies sell in overseas markets, and increase U.S. manufacturing companies' adoption of new technologies, the institutes also voiced concerns that taking on additional international companies as members "could divert their institutes' focus away from increasing U.S. competitiveness" and that such members might take an institute's knowledge outside the United States.[85]

The institutes also noted other downsides, including the possible need to "focus more on short-term research projects for private industry use rather than projects that advance the manufacturing innovation ecosystem as a whole," and decreased resources to maintain leading edge technical capabilities and to provide support for workforce education and training.[86]

Congress may opt to consider whether the concerns expressed by the institutes regarding the implications potentially associated with an elimination of federal baseline funding might detract from or undermine the ability of the Manufacturing USA program to achieve its intended purposes. Congress might explore approaches to eliminating or decreasing such potential adverse effects and to identify mechanisms and approaches that might increase the ability of institutes to become financially viable over time.

Is There a Need for the Manufacturing USA Program?

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

Some analysts view the U.S. manufacturing sector as vibrant and healthy without a need for the Manufacturing USA program. 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%).[87] As noted in the introduction, between March 2010 and November 2019, manufacturing employment added approximately 1.4 million jobs, growing to 12.9 million, where it remained until COVID-19-related closures hit in March 2020.[88] Many analysts attribute the previous long-term trend in U.S.

[84] U.S. Government Accountability Office, *Advanced Manufacturing: Innovation Institutes Have Demonstrated Initial Accomplishments, but Challenges Remain in Measuring Performance and Ensuring Sustainability*, GAO-19-409, May 2019, pp. 40-41.

[85] Ibid., p. 43.

[86] Ibid., pp. 42-43.

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

[88] 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.

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.

Some analysts have argued 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."[89]

From these perspectives, some analysts may conclude that the Manufacturing USA program is either unnecessary or counter to inexorable trends.

Other analysts believe that the U.S. manufacturing sector is at risk of losing market share and employment to foreign competitors, and that the Manufacturing USA program can strengthen U.S. manufacturing. Concerns expressed by 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;
- focused efforts by China and 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);
- concerns about the vulnerability of manufacturing supply chains outside the United States—especially for critical supplies such as pharmaceuticals and semiconductors—to disruptions in the event of a trade dispute, pandemic, or military conflict and to other risks such as product tampering and intellectual property theft; 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.[90]

Some analysts assert that outside the Manufacturing USA program the federal government provides little support for manufacturing-focused U.S. based R&D activities. According to these analysts, 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

[89] Lawrence Summers, "Lawrence H. Summers on the Economic Challenge of the Future: Jobs," *Wall Street Journal*, July 7, 2014.

[90] See, for example, CRS Report R41898, *Job Creation in the Manufacturing Revival*, by Marc Levinson.

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."[91]

In support of President Obama's original proposal for a National Network for Manufacturing Innovation (NNMI), the Information Technology and Innovation Foundation, a Washington, DC-based think tank, asserted that an NNMI-like program would address two issues important to U.S. manufacturing competitiveness: technology and talent. It also argued that spillovers from successful innovations resulting from a firm's investments could yield substantial benefits captured by competitors, producing a market failure that results in underinvestment in manufacturing R&D and innovation. Further, the report cited 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—that 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."[92]

China's *Made in China 2025* national industrial strategy proposed a $300 billion investment in advanced manufacturing over five years in support of its short term goal of becoming more self-sufficient in manufacturing in industries such as aerospace, computer chips, robotics, pharmaceuticals, and electric vehicles, and its long-term goal of becoming the global manufacturing and innovation leader by 2049.[93] Further, in pursuit of these goals, China has stated its intention of creating 40 manufacturing innovation institutes by 2025.[94] By the end of 2020, China had established 16 institutes (see **Table 2**). The technology focus areas of most of the Chinese manufacturing institutes mirror those of the Manufacturing USA institutes, while the balance are based on priorities articulated in *Made in China 2025*. Investments in these institutes has been estimated to be between 10 and 200 times the level of U.S. funding provided for the Manufacturing USA institutes. According to NIST, China's advanced manufacturing goals are to increase "the Chinese domestic content of core materials to 40% by 2020 and 70% by 2025," and to provide support for indigenous innovation and intellectual property; domestic brands; secure, controllable standards; and localization of production and data.[95]

[91] 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.

[92] David M. Hart, Stephen Ezell, Robert D. Atkinson, *Why America Needs a National Network for Manufacturing Innovation*, Information Technology and Innovation Foundation, December 2012.

[93] *Made in China 2025* is a highly detailed 10-year "guide for China's manufacturing strategy" to "transform China into the global manufacturing leader before the centennial of the founding of New China." The report identifies scores of principles, policies, and programs China believes will enable the achievement of the goals outlined in the report.

[94] NIST, presentation by NIST Office of Advanced Manufacturing Director Mike Molnar to the NIST Visiting Committee on Advanced Technology, *Manufacturing USA: An Update on Program Status, Congressional Reauthorization and Key 2020 Initiatives*, February 12, 2020, https://www.nist.gov/document/manufacturing-usa-current-status-and-future-plans.

[95] Ibid.

Table 2. China Manufacturing Institutes

Center	Location	Established	Focus
Power Battery Manufacturing Innovation Center	Beijing	2016	Batteries for cars, scooters, buses, etc.
The National Institute of Additive Manufacturing	Xi'an, 31 regional centers	2016	Metals, polymers and composites, ceramics, and construction (direct jetting of concrete and polymers).
The National Information Optoelectronics Innovation Center	Wuhan	2017	Optoelectronics industry innovation platform; next-generation networks, data center optical interconnects, and 5G; core chip technology and advanced package integration.
National Printing and Flexible Display Innovation Center	Guangdong	2018	High resolution, very large, active matrix organic LED displays.
The National Integrated Circuit and Intelligent Sensor Innovation Center	Shanghai	2018	Five nanometer and below integrated circuits.
National Robot Innovation Center	Shenyang, Liaoning; Harbin, Heilongjiang	2018	Integrated national robotic industry innovation base.
National Innovation Institute of Digital Design and Manufacturing	Wuhan	2018	CRS unable to identify any specific foci of this institute.
Lightweight Materials Technology Institute	Beijing	2018	CRS unable to identify any specific foci of this institute.
Smart Sensor Innovation Center	Jiading District, Shanghai	2018	Sensor design integration; advanced manufacturing, packaging, and testing processes; materials; processes; devices; and Internet of Things application solutions.
National Advanced Rail Transportation Equipment Innovation Center	Changsha, Hunan	2019	Green energy, multi-energy hybrid drives, new energy storage systems, high efficiency drive systems and permanent magnet motor electric drives.
National Intelligent Connected Vehicle Innovation Center	Huairou District, Beijing	2019	Cross-vehicle, cross-communication terminals, cross-chip modules, cross-security platform interconnection application demonstrations, and technology roadmaps,
National Agriculture Machine Innovation Center	Luoyang, Henan	2019	CRS unable to identify any specific foci of this institute.
National Advanced Functional Fiber Innovation Center	Shanghai	2019	Nanofibers, polyamide fiber, big data, intelligent manufacturing, flame retardant and functional fiber polymerization and spinning.
National Rare Earth Functional Materials Innovation Center	Jiangxi and Inner Mongolia	2020	Rare earth magnet, luminescence, catalyst, alloy, and other functional materials, as well as resource recycling and utilization.
National Integrated Circuit Characteristic Process and Packaging Test Innovation Center	Shanghai suburb, Jiangsu province	2020	Advanced packaging and system integration.

Center	Location	Established	Focus
National High Performance Medical Device Innovation Center	Shenzhen	2020	High-performance medical devices for prevention, diagnosis, treatment and rehabilitation.

Source: CRS analysis of NIST, "NIST Update: Visiting Committee on Advanced Technology" presentation by Under Secretary of Commerce for Standards and Technology and NIST Director Walter G. Copan, October 28, 2019, https://www.nist.gov/document/1copan-v21pdf; Donghua University, "Party Secretary Liu Chenggong Conducts Investigation in Suzhou to Deepen Cooperation," September 11, 2020, http://english.dhu.edu.cn/22/a6/c5367a271014/pagem.htm; China Legislation Standard, "China Sets Up National Innovation Center of Rare Earth Functional Materials," August 4, 2020, http://www.cnstandards.net/index.php/china-sets-up-national-innovation-center-of-rare-earth-functional-materials; Ourjiangsu, "Jiangsu Unveils Second National Manufacturing Innovation Center," May 11, 2020, http://www.ourjiangsu.com/a/20200511/1589166687536.shtml; National Advanced Functional Fiber Innovation Center, "Advanced Functional Fiber Innovation Center Participated in the Online Campus Job Fair for the Chemical Fiber Industry," http://www.naffic.cn/en/centernews; *China's Industry*, "National High-Performance Medical Device Innovation Center Settled in Guangdong," May 16, 2020, http://www.chinasindustry.com/240.html; Teller Report, "National Advanced Rail Transit Equipment Innovation Center Unveiled in Zhuzhou, Hunan," November 5, 2020, https://www.tellerreport.com/business/2020-11-05-national-advanced-rail-transit-equipment-innovation-center-unveiled-in-zhuzhou—hunan-chinanews-com.S1gVzPzWtv.html; Lingzhi Technology, "The National Intelligent Sensor Innovation Center settled in Shanghai," August 17, 2018, http://en.lingzhitech.com/698.html.

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 a Manufacturing USA 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.[96]

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

[96] 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.

technologies, asserting that such interventions skew technology development and competition by replacing the decisions of companies, capital providers, and researchers with the judgment of government officials (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 Manufacturing USA program should be performed by the private sector; that Manufacturing USA would be ineffective or counterproductive; that the funds that would go to Manufacturing USA should be used instead 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 and regulations.

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 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.

Some may question whether additional federal funding would produce more innovation and whether and how the U.S. manufacturing base would effectively absorb such innovations.

When considered in the context of the overall U.S. economy, manufacturing output, or federal spending, the scale of Manufacturing USA program may seem relatively small. Nevertheless, both proponents and opponents of Manufacturing USA may see the current program as opening the door to future increases in funding for Manufacturing USA 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.

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