



April 2017

ADVANCED MANUFACTURING

Commerce Could
Strengthen
Collaboration with
Other Agencies on
Innovation Institutes

GAO Highlights

Highlights of [GAO-17-320](#), a report to congressional committees

Why GAO Did This Study

Since 2012, DOD and DOE have been establishing innovation institutes to promote the research, development, and commercialization of advanced manufacturing technologies. The RAMI Act of 2014 requires the Secretary of Commerce to establish a program, with eight specified purposes, that includes a network of manufacturing innovation institutes. Commerce, through a program office, is to coordinate this program—called Manufacturing USA.

The RAMI Act includes a provision for GAO to assess the program every two years, with a final assessment in 2024. This is GAO's first report in response to the statutory provision. Among other objectives, GAO examined (1) the status of the network and use of the institutes, (2) the extent to which performance measures are in place to assess progress toward achieving the statutory program purposes, and (3) the extent to which Commerce has taken steps to coordinate agencies contributing to the program.

GAO reviewed documentation and interviewed officials from Commerce, DOD, DOE, DOL, the Department of Education, and Manufacturing USA institutes; and held discussion groups with a nongeneralizable sample of institute member representatives.

What GAO Recommends

GAO recommends that Commerce work with all relevant federal agencies to fully identify roles and responsibilities for how agencies that do not sponsor institutes could contribute to the Manufacturing USA program. Commerce agreed, but suggested an alternative recommendation. GAO modified the recommendation to clarify its intent. View [GAO-17-320](#). For more information, contact John Neumann at (202) 512-3841 or neumannj@gao.gov, or Andrew Sherrill at (202) 512-7215 or sherrilla@gao.gov.

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Commerce Could Strengthen Collaboration with Other Agencies on Innovation Institutes

What GAO Found

As of December 2016, the Departments of Defense (DOD), Energy (DOE), and Commerce (Commerce) collectively had signed agreements to establish 11 manufacturing innovation institutes. Four of these institutes were established prior to enactment of the Revitalize American Manufacturing and Innovation Act of 2014 (RAMI Act), which requires Commerce to establish a network of institutes for manufacturing innovation. Since 2014, the network—called the Manufacturing USA network—has grown as DOD, DOE, and Commerce have established seven more institutes, and Commerce, DOD, and DOE plan to sponsor up to four more institutes. Each institute is a public-private partnership between the sponsoring federal agency and a nonfederal entity in charge of operations, with the nonfederal entity matching or exceeding the federal financial assistance. GAO's analysis of institute membership from May through September 2016 shows that about 780 members had joined the seven institutes that were operating during GAO's review (i.e., supporting research projects in their technology focus areas). Members receive a variety of benefits, such as access to intellectual property and networking opportunities.

Commerce, DOD, and DOE worked together to develop initial performance measures to track progress toward the Manufacturing USA program's statutory purposes. Additionally, DOD, working with Commerce and DOE, hired a consultant to review the Manufacturing USA program. The consultant's January 2017 report included recommendations on revised measures to track program progress. After considering the results of this review, Commerce plans to work with DOD and DOE to reach agreement on a revised set of measures. While Commerce may face challenges with assessing the program, such as the timeframe over which results may need to be measured, it has taken steps or has identified options to address these challenges.

Commerce has used a variety of mechanisms to coordinate the Manufacturing USA program. These mechanisms incorporate several key practices GAO has identified for enhancing and sustaining interagency collaboration. However, GAO found that the process used to develop a governance system that outlines agencies' responsibilities for contributing to the program did not include all relevant non-sponsoring agencies (agencies that do not sponsor institutes), or ensure that their roles and responsibilities for contributing to the program are fully identified. Specifically, non-sponsoring agencies, such as the Department of Labor (DOL)—which administers discretionary grant programs that can help increase the number of skilled workers in advanced manufacturing—were not actively involved in developing the governance system. Additionally, the governance system does not specify any responsibility for non-sponsoring agencies to provide information or expertise related to their activities to the program. A Commerce official told GAO that the governance system is subject to revision, but participation in the program is up to each agency. However, including all relevant agencies in the process of revising the system and fully identifying non-sponsoring agencies' roles and responsibilities could strengthen Commerce's efforts to leverage and coordinate agencies' contributions to the program, consistent with key practices for interagency collaboration.

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Abbreviations

3D	Three-dimensional
AFFOA	Advanced Functional Fabrics of America
AIM Photonics	American Institute for Manufacturing Integrated Photonics
America Makes	National Additive Manufacturing Innovation Institute
AMNPO	Advanced Manufacturing National Program Office
ARMI	Advanced Regenerative Manufacturing Institute
ATB-MII	Advanced Tissue Biofabrication Manufacturing Innovation Institute
CESMII	Clean Energy Smart Manufacturing Innovation Institute
Commerce	Department of Commerce

DMDII	Digital Manufacturing and Design Innovation Institute
DOD	Department of Defense
DOE	Department of Energy
DOL	Department of Labor
Education	Department of Education
IACMI	Institute for Advanced Composites Manufacturing Innovation
LIFT	Lightweight Innovations for Tomorrow
MEP	Hollings Manufacturing Extension Partnership
NextFlex	America's Flexible Hybrid Electronics Manufacturing Institute
NIIMBL	National Institute for Innovation in Manufacturing Biopharmaceuticals
NIST	National Institute of Standards and Technology
PCAST	President's Council of Advisors on Science and Technology
PowerAmerica	The Next Generation Power Electronics Manufacturing Innovation Institute
RAMI Act	Revitalize American Manufacturing and Innovation Act of 2014
RAPID	Rapid Advancement in Process Intensification Deployment
REMADE	Reducing Embodied-energy and Decreasing Emissions
RIME-MII	Robots in Manufacturing Environments Manufacturing Innovation Institute
WIOA	Workforce Innovation and Opportunity Act

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April 6, 2017

Congressional Committees

The manufacturing sector encompasses businesses across a variety of industries and plays a critical role in the U.S. economy and national defense. However, according to a June 2011 report from the President’s Council of Advisors on Science and Technology (PCAST), the share of U.S. economic activity from the manufacturing sector has declined over several decades, and the U.S. trade balance in advanced technology products, which was long a relative strength of the United States, shifted from a surplus to a deficit starting in 2001.¹ The report also stated that the United States has been steadily losing the research and development activities linked to manufacturing—along with associated high-skilled jobs—to other nations, as well as losing the competitiveness to manufacture products invented in the United States.

Beginning with its 2011 report, PCAST issued a series of reports that recommended a number of steps to increase U.S. competitiveness in advanced manufacturing—that is, manufacturing that uses innovative technology to improve products or processes. PCAST’s recommendations included that the federal government establish a national network of manufacturing innovation institutes as public-private partnerships to create a manufacturing research infrastructure to help bridge the gap between research and development activities and domestic production. In 2012, at the request of the President and using existing statutory authorities, the Department of Defense (DOD) established a pilot manufacturing innovation institute with co-funding and participation from the Department of Energy (DOE) and other agencies. This pilot institute focused on additive manufacturing technology.² In

¹Executive Office of the President, President’s Council of Advisors on Science and Technology, *Report to the President on Ensuring American Leadership in Advanced Manufacturing* (Washington, D.C.: June 2011). PCAST is an advisory group of the nation’s leading scientists and engineers appointed by the President.

²Additive manufacturing (also called three-dimensional, or 3D, printing) refers to a layer-by-layer approach for producing 3D objects from a digital model using materials such as metal powders, plastic, and foundry sand. Also, see GAO, *3D Printing: Opportunities, Challenges, and Policy Implications of Additive Manufacturing*, [GAO-15-505SP](#) (Washington, D.C.: June 24, 2015); and *Defense Additive Manufacturing: DOD Needs to Systematically Track Department-wide 3D Printing Efforts*, [GAO-16-56](#) (Washington, D.C.: Oct. 14, 2015).

2012, the President set forth a goal of establishing a network of up to 15 institutes. Also, in 2013, the National Science and Technology Council released a report outlining a preliminary design for the national network, citing the pilot manufacturing innovation institute as a benchmark for other institutes.³ Subsequently, using their existing statutory authorities, DOD and DOE established additional institutes, each with its own technological focus.

In December 2014, Congress passed, and the President signed into law, the Revitalize American Manufacturing and Innovation Act of 2014 (RAMI Act). Among other things, the RAMI Act requires the Secretary of Commerce to establish a program within the Department of Commerce's (Commerce) National Institute of Standards and Technology (NIST); the act refers to this program as the Network for Manufacturing Innovation program. In September 2016, the Secretary of Commerce announced a new public name for the program, Manufacturing USA; we use this name for the program in this report.⁴ According to the RAMI Act, the purposes of the program include stimulating U.S. leadership in advanced manufacturing research, innovation, and technology; accelerating development of an advanced manufacturing workforce; and creating and preserving jobs. The RAMI Act requires the Secretary of Commerce to establish, within NIST, a national program office to oversee and carry out the program; this office is known as the Advanced Manufacturing National Program Office (AMNPO).⁵ The RAMI Act specifies a number of functions for the national program office, such as establishing procedures, processes, and criteria as may be necessary and appropriate to maximize

³Executive Office of the President, National Science and Technology Council, Advanced Manufacturing National Program Office, *National Network for Manufacturing Innovation: A Preliminary Design* (Washington, D.C.: January 2013). The National Science and Technology Council was established by executive order on November 23, 1993. Exec. Order No. 12,881, 58 Fed. Reg. 62491 (Nov. 26, 1993). The principal functions of this cabinet-level council include coordinating the science and technology policy-making process and ensuring science and technology policy decisions and programs are consistent with the President's goals.

⁴The official name of the program remains the National Network for Manufacturing Innovation.

⁵In addition to serving as the national office for the Manufacturing USA program, AMNPO also operates under the National Science and Technology Council on cross-agency initiatives related to advanced manufacturing and hosts an interagency team with participation from federal agencies involved in advanced manufacturing, such as the Department of Defense, National Science Foundation, and National Aeronautics and Space Administration.

cooperation and to coordinate the activities of the program with programs and activities of other federal agencies whose missions contribute to or are affected by advanced manufacturing.⁶

As part of the program, the RAMI Act requires the Secretary of Commerce to establish a network of centers for manufacturing innovation (which we refer to as the Manufacturing USA network). There are two types of centers (which we refer to as Manufacturing USA institutes): those that receive financial assistance from Commerce under the RAMI Act and those that do not. Institutes that do not receive financial assistance from Commerce pursuant to the RAMI Act either (1) are considered institutes by the act because they were in existence and formally recognized pursuant to law or executive action as manufacturing innovation centers before the law's enactment or (2) are recognized by the Secretary of Commerce, at the institute's request, as an institute for manufacturing innovation for purposes of participating in the network and are substantially similar to those established by Commerce under the act. For example, under the RAMI Act the National Additive Manufacturing Innovation Institute is considered an institute and the Secretary of Commerce has recognized institutes established by DOD and DOE pursuant to their statutory authority as part of the network. Each institute is a public-private partnership between the sponsoring federal agency and a nonfederal entity (generally a nonprofit organization or university) in charge of the institute's operations. The institutes have members that include companies, nonprofit organizations, and academic institutions, among others.

The RAMI Act also contains a provision for GAO to assess not less frequently than once every 2 years the operation of the Manufacturing USA program and to provide a final assessment not later than December 31, 2024. The act requires that each assessment include, among other things, a review of the management, coordination, and industry utility of the program and an assessment of the extent to which the program has furthered the purposes described in the RAMI Act. This is our first report on this program in response to the statutory provision. This report examines (1) the status of establishing the Manufacturing USA network and the extent to which manufacturers and other entities have used the institutes; (2) how federal agencies manage the Manufacturing USA institutes and what challenges, if any, have been encountered to date; (3)

⁶15 U.S.C. § 278s(f)(2).

the extent to which performance measures are in place to help Commerce assess progress toward achieving the statutory purposes of the program; and (4) the extent to which Commerce has taken steps to coordinate the efforts of agencies that contribute to the Manufacturing USA program.

To obtain information on Manufacturing USA institute status, use, management, performance measures, and coordination, we reviewed Manufacturing USA program and institute documentation, including the cooperative agreements establishing the institutes; these agreements include amounts of federal and nonfederal financial assistance. We also interviewed Commerce, DOD, and DOE officials to obtain information about the institutes their agencies sponsor.⁷ In addition, we asked Manufacturing USA institute officials to respond to a structured set of questions related to their institute's (1) structure and funding; (2) industry use and data collection; (3) management, coordination, and challenges; and (4) program assessment; among other questions.⁸ We analyzed membership data provided by institute officials to obtain information on membership participation by manufacturers and other entities. We relied on institute officials to determine which of their members were from small or large manufacturers because there is no agreed-upon definition for manufacturers in each of these categories. We obtained information on membership levels, benefits, and rights from institute documentation and websites and verified its accuracy with institute officials.

We also held three discussion groups with 19 representatives of institute members to obtain their perspectives on various issues, such as how their organizations benefited from membership in a Manufacturing USA institute, and challenges related to institute operations. We held one group for small manufacturers comprised of four institute member

⁷Sponsoring agencies are those agencies that provide financial assistance to establish Manufacturing USA institutes. We collected information from Commerce, DOD, and DOE officials related to all of the institutes these agencies have sponsored or are in the process of sponsoring.

⁸Some institutes were operating (i.e., supporting research projects in their technology focus areas), while others were not yet operating as of the time of our review. As a result, we focused our detailed data collection from institute officials on the institutes that were operating as of the time of our review. We generally collected this information during site visits in which we examined the institutes' facilities and conducted interviews. However, for two institutes that another GAO team had recently visited, we obtained information collected by the other GAO team and written responses to our questions from institute officials.

representatives; one group for large manufacturers comprised of eight representatives; and one group for academic and nonprofit organizations comprised of seven representatives.⁹ We selected institute members for the discussion groups based on Manufacturing USA institute officials' recommendations, to provide a nongeneralizable sample of perspectives. Our selection is not representative of the full population of institute members and does not include entities that have not yet signed a membership agreement with an institute.

To obtain additional information on coordination of the efforts of agencies that contribute to the Manufacturing USA program, we interviewed Commerce, DOD, and DOE officials as well as officials from the Departments of Education (Education) and Labor (DOL). We included Education and DOL in the scope of our work because the RAMI Act includes as purposes of the program accelerating the development of an advanced manufacturing workforce and creating and preserving jobs. To evaluate Commerce's coordination of the agencies that contribute to the Manufacturing USA program, we compared Commerce's efforts against selected key practices for interagency collaboration that we have previously identified.¹⁰ We selected the key practices that were most relevant to Commerce's efforts to coordinate contributing agencies.

We conducted this performance audit from February 2016 to April 2017 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

⁹Due to scheduling, one of the eight member representatives in the discussion group for large manufacturers was from a nonprofit. However, for purposes of analysis, we included the perspectives of this representative with those of the representatives of academic and nonprofit organizations.

¹⁰GAO, *Results-Oriented Government: Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies*, [GAO-06-15](#) (Washington, D.C.: Oct. 21, 2005), and *Managing for Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, [GAO-12-1022](#) (Washington, D.C.: Sept. 27, 2012). Experts have defined an interagency mechanism for collaboration as any arrangement or application that can facilitate collaboration between agencies.

Background

This section provides information on the history of the Manufacturing USA program, the provisions of the RAMI Act, and the awards process and membership of the institutes.

Manufacturing USA Program History

The June 2011 PCAST report was followed in July 2012 by another report, prepared by the Advanced Manufacturing Partnership Steering Committee;¹¹ this report contained 16 recommendations to improve the manufacturing competitiveness of the United States.¹² One of the recommendations was to establish a national network of manufacturing innovation institutes as public-private partnerships. After DOD established the first such institute as a pilot institute in 2012, the National Science and Technology Council released its January 2013 report proposing a preliminary design for the network.¹³ This report envisioned a network of public-private partnerships to be supported with a co-investment of federal obligations ranging from \$70 million to \$120 million for each institute and equal or greater amounts in nonfederal pledges (also known as cost-share). The amount of investment would depend on such factors as the magnitude of the opportunity and maturity of the technology and would be distributed across 5 to 7 years. Total capitalization of an institute across this time period was envisioned to be \$140 million to \$240 million. The report also envisioned that an institute would become sustainable within 7 years of the public announcement of an award of financial resources to start up and operate the institute, and that the institute would provide long-term economic impact in its region and nationwide. Building on the July 2012 Advanced Manufacturing Partnership report, an October 2014 PCAST report provided 12 recommendations with further guidance

¹¹Led by its Steering Committee, the Advanced Manufacturing Partnership brings together the federal government, industry, universities, and other stakeholders to identify emerging technologies with the potential to create high-quality domestic manufacturing jobs and enhance U.S. global competitiveness.

¹²Executive Office of the President, President's Council of Advisors on Science and Technology, *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing* (Washington, D.C.: July 2012). The report states that each institute should receive support via a mixed funding model from industry, academia, and government, with government (federal or state) funding guaranteed for a minimum of 5 years with the potential of renewal for a total of 10 years.

¹³Advanced Manufacturing National Program Office, *National Network for Manufacturing Innovation: A Preliminary Design*.

on how the United States could sustain its lead in innovation.¹⁴ For example, one of the recommendations was to create—through the National Economic Council, the Office of Science and Technology Policy, and the implementing agencies and departments—a shared Manufacturing USA governance structure that includes input from various agencies as well as from private sector experts, organized labor, and academia.

RAMI Act Provisions

Under the RAMI Act, the purposes of the Manufacturing USA program are to

- improve the country’s manufacturing competitiveness and increase production of goods manufactured predominantly within the United States;
- stimulate U.S. leadership in advanced manufacturing research, innovation, and technology;
- facilitate transition of innovative technologies into scalable, cost-effective, and high-performing manufacturing capabilities;
- facilitate access by manufacturing enterprises to capital-intensive infrastructure;
- accelerate development of an advanced manufacturing workforce;
- facilitate peer exchange of and 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; and
- create and preserve jobs.

The RAMI Act requires the Secretary of Commerce to report annually to Congress, until December 31, 2024, on the program’s performance, including an assessment of Commerce’s institutes and an assessment of the participation in, and contributions to, the network by institutes

¹⁴Executive Office of the President, President’s Council of Advisors on Science and Technology, *Report to the President: Accelerating U.S. Advanced Manufacturing* (Washington, D.C.: October 2014).

established by other agencies.¹⁵ Annual reports are also to include an assessment of how well the program is meeting its statutory purposes.

The RAMI Act also contains a number of provisions related to collaboration between Commerce and other agencies. For example, in awarding financial assistance to establish institutes, the RAMI Act requires that the Secretary of Commerce, through AMNPO, collaborate with federal departments and agencies whose missions contribute to or are affected by advanced manufacturing. In addition, several of the functions of the AMNPO under the RAMI Act also pertain to collaboration. The functions that the RAMI Act identifies for the national office include:

- Overseeing the planning, management, and coordination of the program;
- Entering into memorandums of understanding with federal departments and agencies whose missions contribute to or are affected by advanced manufacturing, to carry out the program's statutory purposes;
- Developing, not later than 1 year after the date of enactment of the RAMI Act, and updating not less frequently than once every 3 years thereafter, a strategic plan to guide the program;
- Establishing such procedures, processes, and criteria as may be necessary and appropriate to maximize cooperation and coordinate 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;
- Establishing a clearinghouse of public information related to the activities of the program; and
- Acting as a convener of the network.

Additionally, the RAMI Act requires that, when developing and updating the strategic plan, the Secretary of Commerce solicit recommendations and advice from a wide range of stakeholders, including industry, small

¹⁵In February 2016, the AMNPO published its first annual report, which covered activities and accomplishments through fiscal year 2015. See also Executive Office of the President, National Science and Technology Council, Advanced Manufacturing National Program Office, *National Network for Manufacturing Innovation Program: Annual Report* (Washington, D.C.: February 2016), accessed March 2017, <https://www.manufacturingusa.com/sites/prod/files/docs/resource/2015-NNMI-Annual-Report.pdf>.

and medium-sized manufacturing enterprises, research universities, community colleges, and other relevant organizations and institutions on an ongoing basis. The RAMI Act also requires the Secretary of Commerce to ensure that the AMNPO incorporates NIST's Hollings Manufacturing Extension Partnership into Manufacturing USA program planning to ensure that the results of the program reach small and medium-sized entities.¹⁶

Manufacturing USA Institute Awards Process and Membership

DOD, DOE, and Commerce have provided competitive financial assistance for institutes using similar processes for soliciting applications and making awards.¹⁷ DOD and DOE have identified prospective technology focus areas through requests for information from nonfederal organizations and meetings with industry officials and other stakeholders. For Commerce institutes, the RAMI Act requires that the Secretary of Commerce ensure an open process that allows for consideration of all applications relevant to advanced manufacturing regardless of technology focus area. Subsequently, each of the sponsoring agencies released notices of intent announcing a competition for their new institutes and then released federal funding opportunity announcements. The federal funding announcements included goals and objectives for the institutes that were related to the Manufacturing USA program and to the agency mission. Potential applicants generally have had opportunities to ask clarifying questions via mechanisms such as webinars and e-mail. Applicants submitted pre-application concept papers, which were evaluated by subject matter experts in the government to determine, for example, the potential to fulfill a recognized national need. Based on these subject matter experts' review, the sponsoring agencies invited selected applicants to submit full proposals.¹⁸ Full proposals included detailed information—such as a business strategy, leadership and sustainment plan, and technology investment plan—and were evaluated by multi-agency source selection team. Ultimately, an official from the

¹⁶Under the NIST Hollings Manufacturing Extension Partnership (MEP) program, NIST partners with 51 nonfederal organizations called MEP centers, which are located in each of the 50 states and Puerto Rico. MEP centers provide services aimed at helping small and medium-sized U.S.-based firms grow and enhance their competitiveness. NIST MEP's goals are to enhance U.S. productivity and technological performance, as well as to strengthen the global competitiveness of manufacturing firms.

¹⁷DOE officials said the agency is required by Section 989 of the Energy Policy Act of 2005 to select institutes to fund through a competitive merit review process.

¹⁸DOE officials told us that applicants with a discouraged concept paper were still able to submit a full proposal.

sponsoring federal agency selected the winning applicant, after which the agency and the applicant negotiated an agreement, such as a cooperative agreement, to establish and manage the institute.¹⁹ These awards provided financial resources to start up and operate an institute focusing on the specific technology area.

The institutes provide members with access to shared facilities and equipment. Members can take advantage of these resources in a variety of ways, such as by collaborating on research related to the technology focus area of the institute. Membership is open to all U.S. industrial organizations, academic institutions, nonprofit organizations, and government agencies that want to further technology and education in a certain focus area.²⁰ Each institute has its own membership terms—including a range of costs, rights, and benefits—and required time commitment. Specific terms and conditions are detailed in formal membership agreements.

In 2016, the Manufacturing USA Network Included Eleven Established Institutes, and up to Four Additional Institutes Are Planned

As of December 2016, DOD, DOE, and Commerce collectively had established a total of eleven innovation institutes, which have become part of the Manufacturing USA network. Seven of these eleven institutes were operating (i.e., supporting research projects in their technology focus areas) as of December 2016. In addition, one DOD institute, two DOE institutes, and potentially one additional Commerce institute were in the process of being established through a competitive solicitation. Our analysis of institute membership between May 2016 and September 2016 shows that about 780 manufacturers and other entities, such as academic institutions and nonprofit organizations, have become members of the operating institutes. Institute members receive a variety of benefits and rights, such as networking opportunities.

¹⁹DOD entered into a Technology Investment Agreement with the entity responsible for managing one institute. Eleven federal agencies, including DOD and DOE, have statutory authority to use other transaction agreements. See also, GAO, *Federal Acquisitions: Use of 'Other Transaction' Agreements Limited and Mostly for Research and Development Activities*, [GAO-16-209](#) (Washington, D.C.: Jan. 7, 2016).

²⁰Under some cooperative agreements, foreign members are allowed if the agency approves such members and certain conditions are met.

Seven of Eleven Established Institutes in the Network Were Operating in 2016

As of December 2016, DOD, DOE, and Commerce collectively had established a total of eleven institutes that have become part of the Manufacturing USA network.²¹ Four institutes—three DOD institutes and one DOE institute—were established prior to the enactment of the RAMI Act in 2014. The remaining seven institutes were established after the enactment of the RAMI Act. Four of these institutes—Advanced Functional Fabrics of America, the Advanced Tissue Biofabrication Manufacturing Innovation Institute, the Clean Energy Smart Manufacturing Innovation Institute, and the National Institute for Innovation in Manufacturing Biopharmaceuticals—were established in 2016 and were not yet operating as of December 2016.²² However, all eleven institutes are part of the network. Appendix I provides additional information on the DOD and DOE institutes that were operating as of December 2016.

The institutes, which are located across the United States, focus on a wide variety of areas of advanced manufacturing, including additive manufacturing (three-dimensional, or 3D, printing), lightweight metals, integrated photonics circuits, novel fiber and textiles, and biopharmaceuticals. DOD, DOE, and Commerce plan to provide over \$800 million in financial assistance, generally through cooperative agreements, for the eleven established institutes they sponsor. According to DOD, DOE, and NIST officials, the agencies plan to distribute this assistance over a 5 to 7 year period, at the end of which they expect the institutes to be sustainable without guaranteed federal financial assistance. Award recipients have pledged about \$1.9 billion in nonfederal funds over the same 5 to 7 year period. However, the officials also said they expect the institutes will be eligible to receive additional federal financial assistance, such as competitively awarded grants for research.

According to the February 2016 Manufacturing USA program annual report, the seven institutes established by DOD are designed to overcome the challenge DOD faces when the existing industrial

²¹For the purposes of our analysis, we consider an institute to be established when the sponsoring federal agency signs an agreement, such as a cooperative agreement, with an award recipient to establish and manage the institute. Institute sponsoring agencies may use a different definition of established.

²²For the purposes of our analysis, we consider an institute to be operating when it is supporting research projects in its technology focus area. Institute sponsoring agencies may use a different definition of operating.

infrastructure is insufficient to develop and produce new and emerging technologies that hold strategic promise.²³ DOD considers its institutes to represent a key investment strategy for the department and its Manufacturing Technology program.²⁴ Table 1 provides an overview of the seven institutes DOD had established as of December 2016.

Table 1: Department of Defense Manufacturing USA Institutes Established as of December 2016

Institute	Location	Technology focus area	Date established	Federal obligations planned (dollars in millions) ^a	Nonfederal pledges (dollars in millions) ^{a,b}
National Additive Manufacturing Innovation Institute (America Makes)	Youngstown, OH	Additive manufacturing (3D printing) technologies	8/15/2012	55	55
Digital Manufacturing and Design Innovation Institute (DMDII)	Chicago, IL	Digital design and manufacturing	2/21/2014	70	106
Lightweight Innovations for Tomorrow (LIFT)	Detroit, MI	Lightweight metals manufacturing technology	2/21/2014	70	78
American Institute for Manufacturing Integrated Photonics (AIM Photonics)	Albany, NY	Integrated photonic circuit manufacturing	7/9/2015	110	503
America's Flexible Hybrid Electronics Manufacturing Institute (NextFlex)	San Jose, CA	Manufacturing advanced flexible electronics	8/28/2015	75	96
Advanced Functional Fabrics of America (AFFOA)	Cambridge, MA	Manufacturing novel fibers and textiles	3/26/2016 ^c	75	240
Advanced Tissue Biofabrication Manufacturing Innovation Institute (ATB-MII) ^d	Manchester, NH	Manufacturing and testing technologies in support of making human tissue and tissue-related products	12/19/2016	80	241

Source: GAO analysis of information provided in the February 2016 Manufacturing USA program annual report, and Department of Defense cooperative agreements and institutes. | GAO-17-320

Note: For the purposes of our analysis, we consider an institute to be established when the sponsoring federal agency signs an agreement, such as a cooperative agreement, with an award recipient to establish and manage the institute. Institute sponsoring agencies may use a different definition of established.

²³Advanced Manufacturing National Program Office, *National Network for Manufacturing Innovation Program: Annual Report* (2016).

²⁴Areas of Manufacturing Technology program investment include (1) advancing the maturity of manufacturing processes to bridge the gap from research and development advances to full-scale production and (2) sustaining and enhancing the skills and capabilities of the manufacturing workforce and promoting high levels of worker education and training.

^aPlanned federal and nonfederal financial assistance will generally be distributed over 5 to 7 years.

^bInstitutes may allow in-kind contributions as part of nonfederal pledges at certain membership levels.

^cAFFOA was not yet operating (i.e., supporting research projects in its technology focus area) as of December 2016 as its first call for projects was issued in late November 2016.

^dATB-MII is also called the Advanced Regenerative Manufacturing Institute (ARMI). The institute was not yet operating (i.e., supporting research projects in its technology focus area) as of December 2016.

DOE’s mission is to ensure America’s security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions. DOE officials told us that the three institutes established by DOE support this mission by focusing support on innovative, advanced manufacturing technologies that will enhance domestic advanced manufacturing competitiveness and create jobs for American workers by maintaining U.S. global competitiveness in clean energy manufacturing.²⁵ Table 2 provides an overview of the three institutes DOE had established as of December 2016.

Table 2: Department of Energy Manufacturing USA Institutes Established as of December 2016

Institute	Location	Technology focus area	Date established	Federal obligations planned (dollars in millions) ^a	Nonfederal pledges (dollars in millions) ^{a,b}
The Next Generation Power Electronics Manufacturing Innovation Institute (PowerAmerica)	Raleigh, NC	Wide bandgap semiconductor manufacturing	12/1/2014	70	76
Institute for Advanced Composites Manufacturing Innovation (IACMI)	Knoxville, TN	Advanced polymer composites manufacturing and recycling	6/1/2015	70	178
Clean Energy Smart Manufacturing Innovation Institute (CESMII)	Los Angeles, CA	Smart sensors and digital process controls manufacturing	12/20/2016 ^c	70	171

Source: GAO analysis of information provided in the February 2016 Manufacturing USA program annual report, and Department of Energy cooperative agreements and institutes. | GAO-17-320

Note: For the purposes of our analysis, we consider an institute to be established when the sponsoring federal agency signs an agreement, such as a cooperative agreement, with an award

²⁵DOE uses manufacturing innovation institutes to support the Clean Energy Manufacturing Initiative—a DOE initiative to strengthen U.S. clean energy manufacturing competitiveness and to increase U.S. manufacturing competitiveness across the board by boosting energy productivity and leveraging low-cost domestic energy resources. Within DOE, the institutes are managed by the Office of Energy Efficiency and Renewable Energy’s Advanced Manufacturing Office.

recipient to establish and manage the institute. Institute sponsoring agencies may use a different definition of established.

^aPlanned federal and nonfederal financial assistance is provided on an annual basis and will be distributed over 5 years.

^bInstitutes may allow in-kind contributions as part of nonfederal pledges at certain membership levels.

^cCESMII was not yet operating (i.e., supporting research projects in its technology focus area) as of December 2016.

In December 2016, the Secretary of Commerce announced the selection of an award recipient for the first institute sponsored by Commerce, the National Institute for Innovation in Manufacturing Biopharmaceuticals. According to Commerce, this institute is expected to help advance U.S. leadership in the biopharmaceutical industry, foster economic development, improve medical treatments, and ensure a qualified workforce. Table 3 provides an overview of the institute Commerce had established as of December 2016.

Table 3: Department of Commerce Manufacturing USA Institute Established as of December 2016

Institute	Location	Technology focus area	Date established	Federal obligations planned (dollars in millions) ^a	Nonfederal pledges (dollars in millions) ^{a,b}
National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL)	Newark, DE	Biopharmaceutical manufacturing innovation, as well as the development of standards to enable more efficient and rapid manufacturing capabilities	12/15/2016 ^c	70	129

Source: GAO analysis of Department of Commerce cooperative agreement and institute information. | GAO-17-320

Note: For the purposes of our analysis, we consider an institute to be established when the sponsoring federal agency signs an agreement, such as a cooperative agreement, with an award recipient to establish and manage the institute. Institute sponsoring agencies may use a different definition of established.

^aPlanned federal and nonfederal financial assistance is provided on an annual basis and will be distributed over 5 years.

^bInstitutes may allow in-kind contributions as part of nonfederal pledges at certain membership levels. However, based on NIIMBL's website as of March 2017, it is unclear what its membership levels are and the extent that the membership levels allow in-kind contributions.

^cNIIMBL was not yet operating (i.e., supporting research projects in its technology focus area) as of December 2016.

DOD, DOE, and Commerce Were in the Process of Sponsoring up to Four New Institutes as of December 2016

DOD, DOE, and Commerce were in the process of evaluating applications, selecting award recipients, and negotiating agreements to establish up to four additional institutes as of December 2016. The DOD-sponsored institute, the Robots in Manufacturing Environments Manufacturing Innovation Institute, will focus on robotic technologies in manufacturing, such as human robot interaction, learning, and mobility. The two DOE institutes, Rapid Advancement in Process Intensification Deployment and Reducing Embodied-energy and Decreasing Emissions, will have the following technology focus areas: (1) developing breakthrough technologies to boost domestic energy productivity and energy efficiency of manufacturing processes, and (2) reuse, recycling, and remanufacturing of materials. In addition, Commerce officials were considering whether to establish a second institute, subject to the availability of funds. This second Commerce-sponsored institute could address any area of advanced manufacturing as long as it does not duplicate the technology focus areas and programs of existing or announced federally-funded institutes. Table 4 provides an overview of the institutes that DOD and DOE were in the process of establishing as of December 2016.

Table 4: Department of Defense (DOD) and Energy (DOE) Manufacturing USA Institutes Being Established as of December 2016

Institute	Federal sponsor	Technology focus area	Status	Federal obligations planned (dollars in millions) ^a
Robots in Manufacturing Environments Manufacturing Innovation Institute (RIME-MII)	DOD	State-of-the-art application of collaborative robotic technologies in manufacturing	Application evaluation and award recipient selection	80
Rapid Advancement in Process Intensification Deployment (RAPID)	DOE	Technologies to increase the energy efficiency of manufacturing processes in industries such as oil, paper, and chemicals	Agreement negotiation	70
Reducing Embodied-energy and Decreasing Emissions (REMADE)	DOE	Technologies for reuse, recycling, and remanufacturing of materials such as metals, fibers, polymers, and electronic waste	Agreement negotiation	70

Source: GAO analysis of information provided by DOD and DOE. | GAO-17-320

Note: For the purposes of our analysis, we consider an institute to be established when the sponsoring federal agency signs an agreement, such as a cooperative agreement, with an award recipient to establish and manage the institute. Institute sponsoring agencies may use a different definition of established.

^aPlanned federal financial assistance will generally be distributed over 5 to 7 years.

About 780 Manufacturers and Other Entities Were Members of the Operating Institutes in 2016

Our analysis of institutes' membership data showed that about 520 manufacturers (mostly small manufacturers according to a Commerce official) were members of the seven DOD and DOE institutes that were operating as of December 2016.²⁶ In addition, about 260 other entities, including academic institutions, state government agencies, nonprofit organizations, and NIST's Hollings Manufacturing Extension Partnership centers were members of these institutes.²⁷ Some institute officials told us that additional members were pending. For example, America Makes officials told us that as of July 2016, they were processing 14 new member requests.

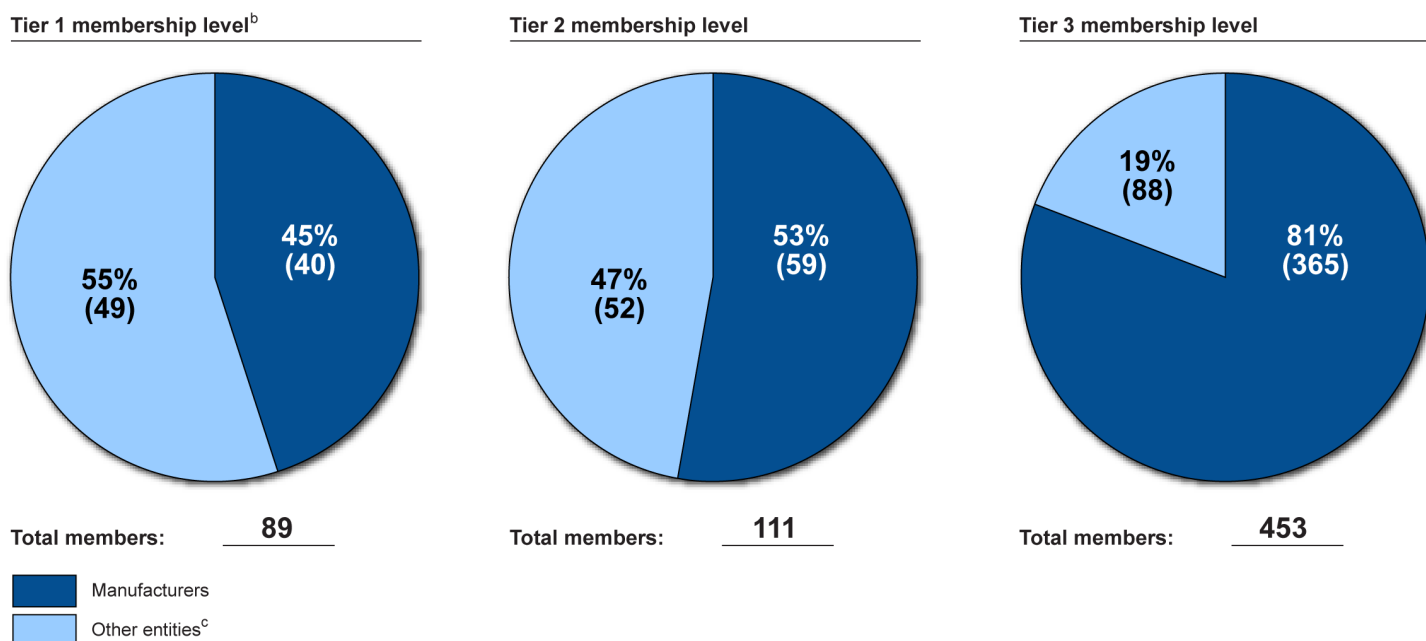
Manufacturers and other entities obtain a variety of benefits and rights, such as networking opportunities and intellectual property access, based on membership level. Each institute has developed a membership structure that provides different costs, benefits, and rights at each level. The number of membership levels ranges from 3 levels at one institute to 10 levels at another institute. For manufacturers, membership structures generally consist of 3 to 4 levels. For other entities, membership structures and the number of membership levels vary. At the highest membership levels, members have the greatest influence on the governance of the institute and the direction of research and development. Benefits and rights at those levels could include participation in technology roadmap development, greater access to intellectual property, and participation in determining the order in which projects are executed. Benefits and rights at lower membership levels could include assistance with navigating government contracts, collaboration with other members, access to member-only data, and participation in research and development projects. See appendix I for additional information on membership benefits and rights for DOD and DOE institutes that were operating as of December 2016.

²⁶We analyzed membership data between May 2016 and September 2016. For the purposes of this report, we refer to manufacturers and other private companies who are institute members as manufacturers.

²⁷Two pilot federal funding opportunities to provide technology acceleration assistance to small and medium-sized U.S. manufacturers resulted in awards to embed Hollings Manufacturing Extension Partnership center representatives in each established institute. NIST provided awards of approximately \$1 million each to five institutes to conduct projects that will run from October 1, 2016, through September 30, 2018. NIST anticipates providing awards of approximately \$300,000 to \$600,000 each to four additional institutes per year beginning in January 2017 and with a performance period of up to 2 years.

Figure 1 illustrates participation by manufacturers and other entities at the highest 3 levels of membership. At the highest 2 membership levels, which we denote as Tier 1 and Tier 2, participation by manufacturers and other entities is fairly evenly divided. At the membership level which we denote as Tier 3, manufacturers represent a larger proportion of participating members.

Figure 1: Participation by Manufacturers and Other Entities at the Highest Three Manufacturing USA Institute Membership Levels between May 2016 and September 2016^a



Source: GAO analysis of Manufacturing USA institute data. | GAO-17-320

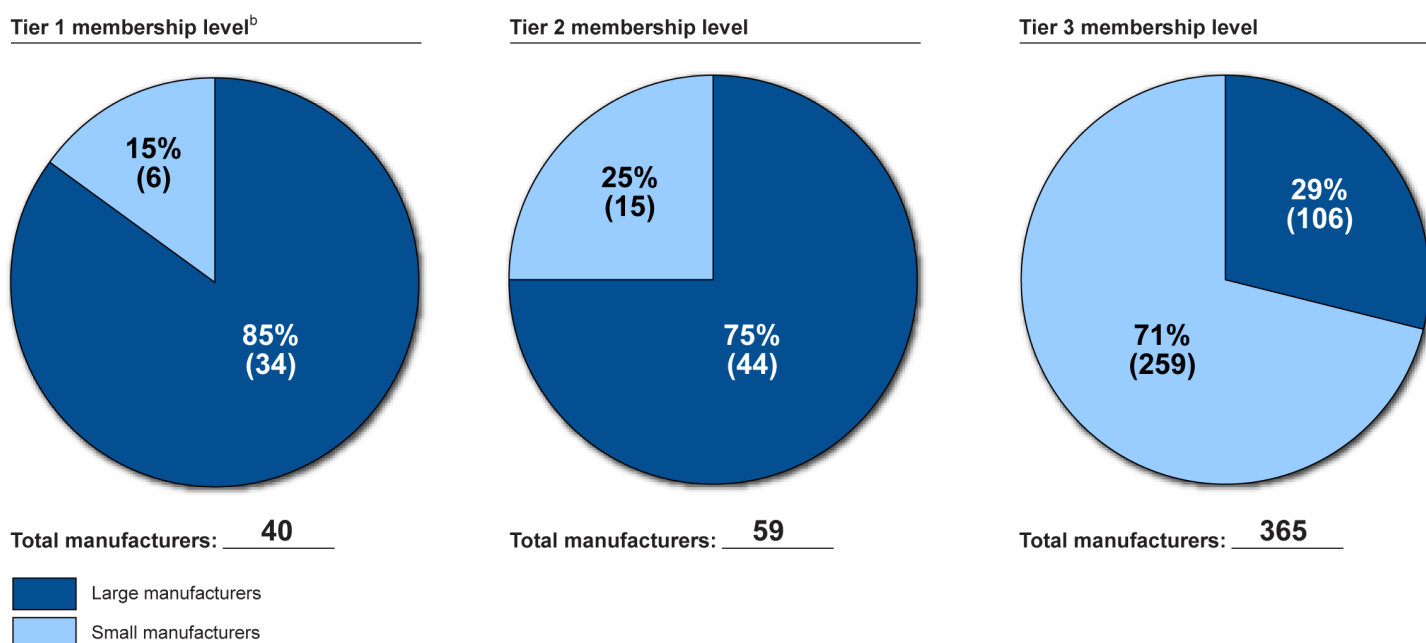
^aMembership data were provided for a particular point of time between May 2016 and September 2016 by program officials for each institute. About 650 manufacturers and other entities (of a total of about 780) are represented in the top three institute membership tiers. Manufacturers and other entities not included in the figure are in lower membership tiers.

^bThe highest level of membership is denoted as Tier 1.

^cOther entities include academic institutions, nonprofit organizations, government entities, and National Institute of Standards Technology Hollings Manufacturing Extension Partnership centers. For some institutes, other entities have lower membership fees than manufacturers.

Figure 2 illustrates participation by large and small manufacturers at the highest 3 levels of membership, which we denote as Tier 1, Tier 2, and Tier 3. Manufacturers who join Manufacturing USA institutes at a higher membership level are typically larger manufacturers.

Figure 2: Participation by Large and Small Manufacturers at the Highest Three Manufacturing USA Institute Membership Levels between May 2016 and September 2016^a



Source: GAO analysis of Manufacturing USA institute data. | GAO-17-320

Note: Each institute has its own definition of a large or small manufacturer. Institute officials generally said that large manufacturers have more than 500 employees. However, one institute considers large manufacturers to have more than 1,000 employees, and another institute does not base its definition on number of employees and instead considers large manufacturers as having annual revenue greater than \$1 billion.

^aMembership data were provided for a particular point of time between May 2016 and September 2016 by program officials for each institute.

^bThe highest level of membership is denoted as Tier 1. One institute has a separate tier for small and start-up manufacturers. Another institute has a separate tier for start-up manufacturers. These small and start-up manufacturers are not included in the figure. Also, their benefits and rights are less than those of the tiers shown in the figure.

Membership costs vary depending on the institute and type of entity. Some institutes allow membership costs to be provided by members as in-kind contributions. In-kind contributions can consist of items such as equipment, software, or facility space. Our analysis of institutes' membership data showed that for manufacturers, costs for the highest

membership level range from \$200,000 cash or in-kind annually, with at least a 3-year commitment, to \$5 million provided over a period of up to 5 years. Costs for the lowest membership level range from no fee, but with a 3-year commitment, to \$15,000 cash or in-kind annually, with at least a 3-year commitment. For other entities—institutes that delineate between manufacturers and other types of members—membership costs generally range from no fee, with a 1-year commitment, to \$5 million in expenditures, with a 5-year commitment. According to an institute official, in-kind contributions can attract more small manufacturers and other organizations to become members, and to become members at higher levels, than if membership costs were restricted to cash membership fees. See appendix I for additional information on membership costs for each institute.

During discussion groups with representatives of institute members, 19 representatives of manufacturers and other entities that are members of Manufacturing USA institutes provided their perspectives on how their organizations have benefited from institute membership. Representatives of institute members in each of the discussion groups identified some examples of benefits, including the following:

- **Small manufacturers.** All four representatives of small manufacturers identified networking opportunities as a benefit of institute membership. They told us they have established working relationships with other large and small manufacturers, and with suppliers, and that they obtained contracts they otherwise might not have been able to secure. One small manufacturer representative also said that, through networking, he had gained a more comprehensive understanding of his company's technology. Another small manufacturer representative said that, through networking, he has kept up with market trends and what other manufacturers are trying to achieve.
- **Large manufacturers.** Four of seven large manufacturer representatives cited acceleration of technology development as a benefit of institute membership. For example, three large manufacturer representatives stated that networking has helped accelerate the development of their technology by between 2 and 5 years, thereby shortening the time needed to get their products ready for commercial release.
- **Academic and Nonprofit.** Five of eight other entities' representatives said they have been able to strengthen their educational programs in ways that help prepare students to enter a certain manufacturing industry—for example, by adding material relevant to a particular

technology, such as semiconductors. One academic entity representative also said that some students work on institute projects that make the students more marketable upon graduation.

DOD and DOE's Operating Institutes Are Primarily Managed through Cooperative Agreements, and Institute Officials and their Members Identified Several Operating Challenges

DOD and DOE primarily use cooperative agreements to manage their Manufacturing USA institutes that were operating as of December 2016. These agreements include terms and conditions for the institutes, and the agencies seek to ensure these terms and conditions are met through meetings, reports, and other mechanisms. Manufacturing USA institute officials and institute member representatives identified various challenges related to institute operations.

DOD and DOE Primarily Rely on Cooperative Agreements to Manage Institutes and Use a Variety of Mechanisms to Ensure Terms and Conditions Are Met

DOD and DOE manage the Manufacturing USA institutes that were operating as of December 2016 primarily through cooperative agreements that define the terms and conditions that govern the relationships between the agencies and the institutes. For example, the cooperative agreements identify the amount of federal financial assistance agencies provide to each institute and the period of performance for the institute to carry out work under the agreement. According to AMNPO officials, the sponsoring federal agency determines the federal financial assistance provided through these cooperative agreements, and this amount can be up to \$120 million, which is matched or exceeded by funding from private industry and other nonfederal sources over a 5- to 7-year period. Cooperative agreements may also address other aspects of the relationships, including how facilities and infrastructure will be established, how research projects will be determined, and how projects will be managed. In addition, the cooperative agreements may require Manufacturing USA institutes to develop governance plans that define types of membership, establish sustainability goals, and help manage intellectual property.

According to institute and agency officials, DOD and DOE have established mechanisms to ensure that their Manufacturing USA

institutes meet the terms and conditions specified in the cooperative agreements. Institute officials told us that DOD and DOE may conduct weekly, monthly, and quarterly meetings with each of their institutes. For example, officials from one DOD institute said that DOD officials perform program management functions through weekly teleconferences with the institute's executive director, executive staff, and finance staff. Similarly, officials from one DOE institute said that a DOE Technology Manager conducts weekly teleconferences with the institute's management staff.²⁸ Institute officials said that DOD's program managers may conduct monthly visits to their institutes, and DOE officials conduct monthly meetings with their institutes to assess progress toward achieving key goals specified in the cooperative agreements. DOD and DOE also host quarterly meetings for the institute directors and program managers of their respective institutes, at which they discuss a variety of topics. For example, DOD officials said the focus of their quarterly meetings is to ensure their institutes are on track to being sustainable. Finally, DOD and DOE have reporting requirements for the institutes they have sponsored. The cooperative agreements all contain requirements for reports to be submitted to the sponsoring agency, such as expenditure reports, progress reports, technical roadmaps, and presentations from program reviews. For example, DOD officials said their Manufacturing USA institutes are required to report semi-annually on their progress toward becoming sustainable. DOD uses semi-annual program management review presentations to assess its Manufacturing USA institutes' sustainability plans and progress toward implementing these plans. In addition, DOE officials said that they require their institutes to report on sustainability along with other program milestones through quarterly technical reviews.

Institute Officials and Member Representatives Identified Several Operating Challenges

Manufacturing USA institute officials and the institute member representatives we spoke with identified several operating challenges faced by the institutes. These included:

- **Negotiating agreements and approving projects.** Officials from three DOD institutes and one DOE institute described challenges related to negotiating and approving membership and project

²⁸DOE technology managers work with contracting officers to help oversee the agency's institutes. DOE technology managers' responsibilities may include attending meetings, participating in on-site program reviews, and providing input on documents submitted by institute officials for DOE approval.

agreements.²⁹ For membership agreements, there are challenges in negotiating rights to any intellectual property created; for example, potential members may be hesitant to share these rights with the institute. These negotiation challenges can cause schedule delays for institute operations. For project agreements, there are challenges in negotiating the terms and conditions of the agreements and with the amount of time it takes for sub-recipients and sponsoring agencies to review and approve the agreements. Some institutes have taken steps to address these challenges. For example, one DOD institute used language from another DOD institute's membership agreement to avoid schedule delays that could result from developing its own. In addition, one DOD institute has increased the amount of time allocated for the development of project agreements.

- **Meeting cost-share requirements.** Representatives of two academic institutions and two small manufacturers expressed concerns about cost-share requirements for institute participation. For example, one representative said universities are not capable of providing the amount of cash some institutes require under their membership agreements, and another representative said it is a challenge for small manufacturers to participate in some institutes because of the cost-share requirements. However, according to an institute official, the possibility of providing in-kind contributions could help some small manufacturers and other organizations address these concerns.
- **Ensuring institute sustainability.** Going forward, as institutes reach the end of the period of performance for their agreements, officials from all DOD institutes identified the sustainability of the institutes as a challenge, although they told us several different reasons for their concerns:
 - *Amount of federal financial assistance.* Officials from all DOD institutes said the amount of federal financial assistance provided under their cooperative agreements may not be enough for the institutes to become sustainable over the 5- to 7-year period of performance.
 - *Length of federal financial assistance.* Officials from three DOD institutes said the 5- to 7-year period of performance for their cooperative agreements may not be sufficient to become sustainable.

²⁹A project agreement defines the relationship between the Manufacturing USA institute and the member responsible for implementing a project.

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- *Collaborating with foreign-owned organizations.* Officials from two DOD institutes expressed concerns about constraints on collaborating with foreign-owned organizations because these constraints affect their sustainability plans. For example, officials from one DOD institute said that the institute's cooperative agreement requires DOD approval for foreign-owned organizations' participation and that DOD may not provide approval, limiting potential sources of institute funding.
 - *Type of activities funded.* Some DOD institute officials said that the cooperative agreements require them to carry out activities that do not contribute to sustainability. For example, a senior official from one DOD institute said that education and workforce development activities are required as a project component under the institute's cooperative agreement, but these activities make only a minor contribution to the institute's sustainability.

Institute officials identified several options for how they might address sustainability challenges. For example, officials from one DOD institute said they will base their decision about which type of activities to fund, after federal financial assistance ends, on which ones help make the institute sustainable as well as on the availability of funds from nonfederal sources. Similarly, another DOD institute official said that the institute may stop funding education and workforce development activities after federal financial assistance under the cooperative agreement ends. Further, officials from one DOD institute said they may not require the same level of scrutiny on collaborating with foreign-owned organizations after federal financial assistance under their cooperative agreement ends.

Commerce, DOD, and DOE Have Developed Performance Measures and Commerce Is Taking Steps to Address Potential Challenges in Assessing Program Progress

AMNPO led a collaboration with DOE and DOD to develop an initial set of performance measures to assess the Manufacturing USA program's progress toward furthering its eight statutory purposes. AMNPO, DOE, and DOD continue to work together to improve agreed upon performance measures for the institutes. Commerce also has taken steps or has identified options to address challenges in measuring program performance.

Commerce, DOD, and DOE Developed an Initial Set of Performance Measures for the Program

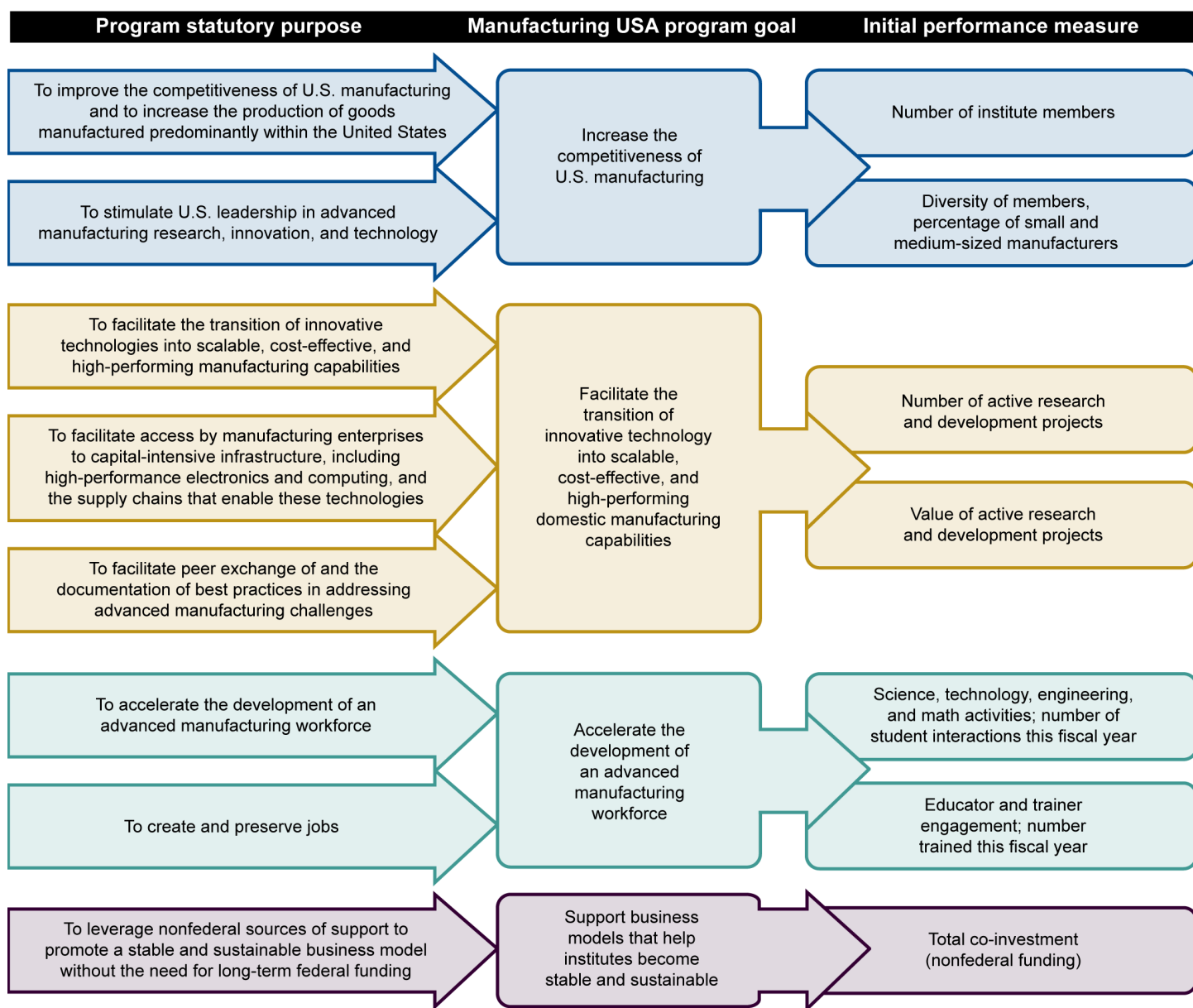
AMNPO led a collaboration with DOE and DOD to develop guidance for Manufacturing USA institutes and sponsoring agencies that included initial performance measures that could be used to track progress toward achieving the eight statutory purposes of the Manufacturing USA program.³⁰ The performance measures outlined in this guidance relate to the four program goals for Manufacturing USA that were established in the program's first strategic plan, published in February 2016.³¹ In developing the strategic plan, AMNPO officials said they worked with other agency officials, including DOD and DOE officials, to develop Manufacturing USA program goals that aligned with the initial measures

³⁰Common Principles and Practices Series, Advanced Manufacturing National Program Office, *Guidance on Institute Performance Metrics* (Washington, D.C.: August 2015). According to Commerce, this 2015 guidance culminated two years of discussions involving staff, office directors, and department leadership. For the institutes that receive financial assistance from Commerce pursuant to the RAMI Act, the law requires the Secretary of Commerce to develop and implement metrics-based performance measures to assess the effectiveness of the activities funded by the award. 15 U.S.C. § 278s(d)(4)(C)(ii). However, the RAMI Act does not require the Secretary to establish performance measures for institutes funded by other federal agencies that participate in the network.

³¹Executive Office of the President, National Science and Technology Council, Advanced Manufacturing National Program Office, *National Network for Manufacturing Innovation Program: Strategic Plan* (Washington, D.C.: February 2016), accessed March 2017, <https://www.manufacturingusa.com/sites/prod/files/docs/resource/2015-NNMI-Strategic-Plan.pdf>.

as well as with the program’s statutory purposes. Figure 3 describes the relationship between the program’s statutory purposes, program goals, and initial institute performance measures.

Figure 3: Relationship between the Manufacturing USA Program’s Statutory Purposes, Program Goals, and Initial Institute Performance Measures



Source: GAO analysis of information provided by the Department of Commerce’s Advanced Manufacturing National Program Office. | GAO-17-320

Institutes are only required to report on measures that have been agreed upon with their sponsoring agencies. According to AMNPO officials, reporting on institute performance is the responsibility of the respective “funding agency” (i.e., the sponsoring agency). Also, the RAMI Act does not include reporting requirements for institutes sponsored by DOD and DOE.³² However, as noted previously, the RAMI Act requires the Secretary of Commerce to report annually to Congress on the performance of the program, including an assessment of how well the program is meeting the purposes identified in the RAMI Act.

AMNPO, DOD, and DOE told us that they are working together to consider whether any revisions may be warranted to these initial performance measures. Specifically, in coordination with AMNPO and DOE, DOD hired an external consultant to conduct an assessment of the Manufacturing USA program design and progress made toward achieving program objectives, and recommend areas where Manufacturing USA and its institutes could enhance programs. In January 2017, the external consultant reported on the results of its review.³³ Among other recommendations, the report recommended developing measures to evaluate Manufacturing USA program performance using a phased approach. For example, the report recommended developing measures at the program level for two phases:

1. start-up support and shared services provision (i.e., the phase in which the program provides support to individual institutes in their establishment and delivers services applicable to all the institutes); and
2. long-term outcomes (i.e., the phase in which the program tracks the achievement of program goals on a manufacturing sector-wide and national basis).

AMNPO officials told us that they plan to incorporate the results of this review into a set of revised performance measures. They also told us that, subsequently, they plan to work with DOD and DOE to reach

³²The RAMI Act requires recipients of financial assistance from Commerce under the act to submit annual reports to the Secretary of Commerce that, among other things, describe the institute’s performance consistent with the metrics-based performance measures the Secretary is required to develop and implement to assess the effectiveness of the activities funded by the financial assistance agreement.

³³Deloitte Touche Tohmatsu Limited, *Manufacturing USA: A Third-Party Evaluation of Program Design and Progress* (January 2017).

agreement on these revised measures to allow the Secretary of Commerce to report the data collected on the revised measures in the Manufacturing USA annual report to Congress for fiscal year 2017. This annual report is expected to be issued in May 2017.

Commerce Has Taken Steps or Has Identified Options to Address Challenges in Measuring Program Performance

Institute officials identified challenges related to measuring progress toward achieving the Manufacturing USA program's statutory purposes, including measuring outcomes within a short timeframe, and Commerce has taken steps to address these challenges. First, institute officials told us that some of the program's statutory purposes are difficult to measure. In particular, some institute officials told us that measuring the number of jobs created or preserved may not be feasible because, for example, there are challenges with associating the number of jobs created and preserved directly to an institute's activities. Second, several institute officials also said that the timeline associated with measuring progress toward achieving the program's statutory purposes may be too short. For example, institutes are relatively new and generally still in the process of establishing mechanisms to collect meaningful data related to many of the program purposes. Further, measuring economic impact and job creation, for example, requires performance measures with lagging indicators that will not be measurable until years into the future, according to institute officials. AMNPO officials told us that they tried to address these challenges in the first Manufacturing USA program annual report by including information on some leading indicators of success among institutes that had available data, such as the level of involvement by industry and academia and amount of cost-share. Also, as mentioned above, AMNPO officials plan to incorporate the results of the recent external consultant review, which recommended developing measures that assess progress during the program's initial start-up phase in addition to long-term outcome measures. For example, the consultant's report suggested developing long-term outcome measures that relate to achievement of program goals on a manufacturing sector-wide and nationwide basis, such as increased economic competitiveness, macroeconomic results, and workforce results.

Agencies may also face challenges collecting performance information from institutes after their cooperative agreements end, and Commerce has identified options to continue collecting this information. Institutes currently track and report information required by their sponsoring agency and cooperative agreements. Under the DOE cooperative agreements we reviewed, financial assistance recipients are to continue to report annually for five years beyond the project period on the utilization and impact of

the institute and technical progress in implementing and deploying the technologies on the institute's roadmap.³⁴ Conversely, DOD officials told us the cooperative agreements the agency entered into before December 2016 do not require their institutes to continue to report on performance after the agreements' period of performance ends. According to AMNPO officials, one way to continue collecting this information is for institutes to voluntarily continue providing performance information to federal agencies, including Commerce. However, in the absence of ongoing federal financial support from their funding agencies for the efforts and expense of collecting and providing data, the officials said that institutes may be reluctant to continue reporting on performance. AMNPO officials told us of another option to ensure continued performance reporting but said that they did not have plans in place to use it. Specifically, the officials said the Secretary of Commerce could establish a requirement for institutes funded by other agencies to submit performance reports to Commerce after their cooperative agreements end as a condition of their continued network participation because the Secretary has the statutory authority to recognize those institutes for the purpose of participating in the network. AMNPO officials said they anticipate that institutes will choose to remain in the network and continue to voluntarily report to AMNPO because the institutes value the services and other benefits they receive from participating.

Commerce Used Various Mechanisms to Help Coordinate the Manufacturing USA Program, but It Has Not Included All Relevant Agencies in Fully Identifying Roles and Responsibilities

AMNPO uses a variety of collaborative mechanisms to coordinate the efforts of the agencies that contribute to the Manufacturing USA program, including a network governance system that defines some roles and responsibilities for agencies that sponsor institutes as well as for agencies that do not sponsor institutes (non-sponsoring agencies). However, the process for developing the governance system did not include all relevant non-sponsoring agencies or ensure that their roles and responsibilities are fully identified.

³⁴The project period is defined as the time period during which an institute project is being conducted. We reviewed the cooperative agreements for the DOE sponsored institutes that were operating as of December 2016—PowerAmerica and IACMI.

Various Mechanisms Support Coordination of the Manufacturing USA Program

AMNPO has used a variety of mechanisms to enhance coordination among the institutes and agencies that contribute to the Manufacturing USA program. These mechanisms incorporate several key practices for enhancing and sustaining interagency collaboration. As our prior work has found, an interagency mechanism for collaboration is any arrangement or application that can facilitate collaboration between agencies.³⁵ One of these mechanisms is the December 2016 Manufacturing USA network charter.³⁶ The charter says that AMNPO is responsible for supporting network functions, which include establishing the network; facilitating intra-network collaboration; fostering robust communication between the network and external stakeholders; and sustaining, strengthening, and growing the network. The charter also identifies several subfunctions for each of these functions. For example, the facilitating intra-network collaboration function includes, among other subfunctions, establishing forums for network collaboration, information exchange, and knowledge management; facilitating the organization and sharing of lessons learned and best practices across the network; and facilitating network-level discussions among institutes regarding management of technology interfaces and technology gaps.

Another mechanism that AMNPO has developed is the Manufacturing USA strategic plan. AMNPO collaborated with federal agencies that contribute to the Manufacturing USA program to develop the strategic plan; these agencies included the Department of Agriculture, Commerce, DOD, Education, DOE, the National Aeronautics and Space Administration, and the National Science Foundation. According to the strategic plan, agencies and institutes participating in the Manufacturing USA program collectively work toward achieving program goals. For example, to work toward the program goal of accelerating the development of an advanced manufacturing workforce, the strategic plan states that the network can help institutes navigate opportunities for federal financial assistance that could support their efforts, including workforce development programs such as those authorized by the

³⁵[GAO-12-1022](#).

³⁶According to Commerce and DOE, the Manufacturing USA network charter was commissioned by the National Science and Technology Council Subcommittee on Advanced Manufacturing, developed by an interagency team consisting of agencies with institute and network sponsorship roles, and approved by the Manufacturing USA Deputies—leaders of the National Science and Technology Council’s Subcommittee on Advanced Manufacturing.

Workforce Innovation and Opportunity Act, as amended.³⁷ AMNPO officials told us that AMNPO has an ongoing effort to help institutes navigate such opportunities. The strategic plan also identified other opportunities for the network to enhance coordination across agencies that contribute to the Manufacturing USA program, such as by serving as a clearinghouse for information about workforce support.

AMNPO also uses mechanisms such as hosting teleconferences, convening in-person meetings, and using technologies that allow it to collaborate with representatives of different agencies and institutes. For example, according to AMNPO officials, AMNPO hosts monthly teleconferences with directors from DOD and DOE institutes and senior deputies from DOD and DOE and convenes in-person, semi-annual Manufacturing USA network meetings that include institute and agency staff. For instance, an August 2016 Manufacturing USA network meeting included discussions on a public name for the program, communications, and establishing a Directors Council. According to AMNPO officials, the Manufacturing USA Directors Council will further facilitate cooperation and collaboration among the institutes. The officials said AMNPO has hosted other meetings, such as a workforce development workshop that included workforce leaders from all institutes; subject matter experts; Hollings Manufacturing Extension Partnership center officials; and agency officials from Education, the National Science Foundation, Commerce, DOD, and DOE. AMNPO also recently launched a web-based shared services platform that allows institutes to share best practices and that allows agencies that participate in the Manufacturing USA network to share information with the institutes. AMNPO officials told us they are working with the institutes to provide content for this system and expect to continue working with them to ensure information is current and useful.

A further coordination mechanism is a governance system that defines roles and responsibilities for agencies contributing to the Manufacturing USA program. According to Commerce, the process for developing the October 2015 governance system document for the Manufacturing USA network was initiated by the National Science and Technology Council's Subcommittee on Advanced Manufacturing, and represented a joint effort

³⁷Pub. L. No. 113-128, 128 Stat. 1425 (2014) (codified as amended in scattered sections of the U.S. Code). Enacted in 2014, the Workforce Innovation and Opportunity Act (WIOA) brought numerous changes to existing federal employment and training programs, including establishing performance accountability measures that apply across six WIOA-designated core programs.

between Commerce, DOD, and DOE.³⁸ The governance system identifies the Manufacturing USA network functions and subfunctions for which agencies that sponsor Manufacturing USA institutes, as well as those that do not sponsor institutes (non-sponsoring agencies), are responsible, accountable, informed, and consulted.³⁹ For example, under the governance system, as part of the facilitating intra-network collaboration function, AMNPO and the agencies that sponsor institutes are responsible for providing situational awareness to individual institutes regarding key contextual landscape issues, such as industrial developments. Alternatively, as part of the function to sustain, strengthen, and grow the network, AMNPO and the agencies that sponsor institutes are responsible for identifying and helping to establish long-term nonfinancial support mechanisms for the program, which the governance document notes should provide valuable nonfinancial support to help institutes succeed and thrive. Non-sponsoring agencies are responsible for one general function: promoting advanced manufacturing to a variety of external stakeholders such as Congress to raise awareness about the Manufacturing USA institutes.

³⁸The Subcommittee on Advanced Manufacturing serves as a forum for information-sharing, coordination, and consensus-building among agencies regarding federal policy, programs, and budget guidance for advanced manufacturing. It was re-established on March 2, 2015, to fulfill a statutory requirement for the Director of the Office of Science and Technology Policy to establish or designate a committee responsible for planning and coordinating federal programs and activities in advanced manufacturing research and development. According to the subcommittee's charter, the following departments and agencies are represented: Department of Agriculture, Commerce, DOD, Education, DOE, Department of Health and Human Services, Department of Homeland Security, DOL, National Aeronautics and Space Administration, National Science Foundation, and Small Business Administration. The charter for the Subcommittee on Advanced Manufacturing expired as of March 1, 2017.

³⁹In addition to sponsoring and non-sponsoring agencies, the governance system defines roles and responsibilities for Executive Office of the President entities, including the National Economic Council, Office of Management and Budget, and Office of Science and Technology Policy. The functions identified in the governance system generally align with those identified in the December 2016 network charter.

The Process for Developing the Governance System Did Not Include All Relevant Non-sponsoring Agencies or Ensure That Their Roles and Responsibilities Are Fully Identified

Although the governance system was developed by an interagency team, the process used to develop the governance system did not ensure that all relevant non-sponsoring agencies were included or that their roles and responsibilities for contributing to the Manufacturing USA program were fully identified.

Specifically, the process used to develop the governance system did not include working with all relevant agencies that could contribute to the Manufacturing USA program. As described above, agencies that contributed to the development of the governance system included Commerce, DOD, and DOE. An AMNPO official told us that non-sponsoring agencies had an opportunity to comment on the governance system but were not involved in its development. According to Commerce, only the institute-sponsoring agencies were involved in developing the governance system because the governance document was chartered by the National Science and Technology Council as a reference for how Manufacturing USA institutes are to be involved in the network. Thus, non-sponsoring agencies, such as DOL the National Science Foundation, the National Aeronautics and Space Administration, and the Department of Homeland Security, among others, were not involved in developing the governance system despite having missions that contribute to or are affected by advanced manufacturing.⁴⁰ For example, DOL's mission is to foster, promote, and develop the welfare of the wage earners, job seekers, and retirees of the United States; improve working conditions; advance opportunities for profitable employment; and assure work-related benefits and rights. In support of this mission, DOL is a member of the National Science and Technology Council's Subcommittee on Advanced Manufacturing, according to the subcommittee's charter, and DOL has created resources to assist with the development of programs that support secondary to post-secondary career pathways related to advanced manufacturing. The governance system itself does not specify which non-sponsoring agencies are responsible for contributing to the Manufacturing USA program; rather, it broadly identifies non-sponsoring agencies as agencies not acting in a lead funding role and that are providing other types of support to an institute in the network.

⁴⁰According to Commerce, all agencies were invited to be a part of Manufacturing USA, and from the origin in 2012, DOD, DOE, Commerce, Education, the National Science Foundation, and the National Aeronautics and Space Administration were principal members of the interagency team. Commerce noted that while there were efforts made to outreach and engage DOL, DOL was not a principal agency involved in the program.

Furthermore, in developing the governance system, the process Commerce, DOD, and DOE used did not include fully identifying how non-sponsoring agencies could contribute to the Manufacturing USA program. For example, the governance system does not specify any responsibility for non-sponsoring agencies to provide information or expertise related to their activities to the program. Rather, where the governance system indicates a role for non-sponsoring agencies, it generally indicates that such agencies are to be informed and consulted.⁴¹ However, some non-sponsoring agencies may be implementing programs or other activities that could contribute to the Manufacturing USA program. For example, DOL administers workforce development programs that are carried out by state agencies and local workforce development boards.⁴² According to DOL officials, state workforce development boards could work with Manufacturing USA institutes to develop sector partnership strategies, which help employers in an industry address shared goals and hiring needs. In addition, DOL administers discretionary grant programs, which can help increase the number of skilled workers in advanced manufacturing. Financial assistance provided under these discretionary grant programs is being used to support some Manufacturing USA institutes' education and workforce development activities, including:

- The Trade Adjustment Assistance Community College and Career Training grant program, which provided nearly \$2 billion to strengthen manufacturing programs at community colleges;⁴³ and

⁴¹The governance system indicates that non-sponsoring agencies are responsible for certain subfunctions under the general function of promoting advanced manufacturing to a variety of external stakeholders. However, the governance system does not identify a role for non-sponsoring agencies for the function of facilitating value-added, intra-network collaboration and related subfunctions, as well as certain other subfunctions.

⁴²For more information on Workforce Innovation and Opportunity Act core programs and requirements for state plans, see GAO, *Workforce Innovation and Opportunity Act: Selected States' Planning Approaches for Serving Job Seekers and Employers*, [GAO-17-31](#) (Washington, D.C.: Nov. 15, 2016).

⁴³In April 2014, DOL announced the availability of \$450 million in grants under the Trade Adjustment Assistance Community College and Career Training program. These grants were the final installment of a \$2 billion, 4-year initiative. In addition, the program has created a free and open online library called SkillsCommons, which includes free materials for job-driven workforce development. These materials were produced by community colleges across the nation and are available at <http://www.skillscommons.org/>.

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- The American Apprenticeship Initiative grant program, which will provide \$175 million to train and hire 34,000 new apprentices in advanced manufacturing over the next five years.

Information or expertise related to other agencies' programs, such as these, if provided to AMNPO, could help it support the institutes with navigating opportunities for federal financial assistance.⁴⁴

Our work has shown that collaborative mechanisms, such as the Manufacturing USA program's governance system, benefit from certain key features, including the clarity of roles and responsibilities and ensuring that the relevant participants are included in the collaborative effort.⁴⁵ Specifically, key collaboration practices call for clarifying the roles and responsibilities of all participating agencies and determining whether all relevant participants have been included. By agreeing on and clearly defining the roles and responsibilities of their members as well as documenting decisions, such as in a memorandum of understanding, collaborating agencies can clarify which agency will do what, organize their joint and individual efforts, and facilitate decision making. Moreover, the RAMI Act identifies several AMNPO functions pertaining to coordination, such as establishing procedures, processes, and criteria as may be necessary and appropriate to maximize cooperation and coordinate the activities of the Manufacturing USA program with the programs and activities of other federal departments and agencies whose missions contribute to or are affected by advanced manufacturing.⁴⁶

An AMNPO official acknowledged that the governance system will require revision as the network evolves. The official said that in revising the system, AMNPO will work with sponsoring agencies to further define roles and responsibilities. However, the official said that other agencies participate in the program as it aligns with their respective missions and

⁴⁴In commenting on a draft of this report, Commerce, DOD, and DOE noted efforts to collaborate with DOL outside of the Manufacturing USA network governance system. For example, Commerce stated that information about DOL programs and activities has been broadly shared with the Manufacturing USA institutes. DOD noted that DOL representatives have been active in the education and workforce development component of Manufacturing USA. DOE commented that DOE manufacturing programs routinely interface with DOL representatives regarding workforce issues in energy and manufacturing.

⁴⁵[GAO-12-1022](#) and [GAO-06-15](#).

⁴⁶The RAMI Act does not specifically identify which agencies have such missions or how they should contribute to the program.

AMNPO cannot prescribe functions and subfunctions for other federal agencies participating in the Manufacturing USA network. However, without ensuring that all relevant agencies have been included in the process of developing the governance system and that non-sponsoring agencies' roles and responsibilities have been fully identified, AMNPO may miss opportunities to leverage and coordinate the efforts of non-sponsoring agencies in contributing to the Manufacturing USA program consistent with key practices for interagency collaboration and effective implementation of AMNPO's functions under the RAMI Act.

Conclusions

In an effort to revitalize the U.S. manufacturing sector and increase U.S. competitiveness in advanced manufacturing, Congress passed and the President signed into law the RAMI Act, which requires the Secretary of Commerce to establish a network of institutes for manufacturing innovation, among other things. In establishing this Manufacturing USA network, AMNPO, in collaboration with DOD and DOE, has taken steps to establish institutes and measure progress toward the statutory purposes of the program. AMNPO has also worked with other sponsoring and non-sponsoring agencies to coordinate agencies' contributions to the network through efforts that incorporate a number of the key practices we have identified to enhance and sustain interagency collaboration.

However, while Commerce, DOD, and DOE worked together to develop a governance system that outlines agencies' roles and responsibilities, the process for developing the system did not ensure that all relevant non-sponsoring agencies were included or that their roles and responsibilities for contributing to the Manufacturing USA program were fully identified. Working with other agencies to revise the governance system, including ensuring that all relevant agencies are involved in the process to fully identify non-sponsoring agencies' roles and responsibilities, would strengthen AMNPO's efforts to leverage and coordinate agencies' contributions to the Manufacturing USA program, consistent with key practices for interagency collaboration, and would improve implementation of its function to coordinate the program.

Recommendation for Executive Action

To enhance interagency collaboration in the Manufacturing USA program, the Secretary of Commerce should direct the Director of NIST to work with all non-sponsoring agencies whose missions contribute to or are affected by advanced manufacturing to revise the Manufacturing USA governance system to ensure the roles and responsibilities for how these agencies could contribute to the Manufacturing USA program are fully identified.

Agency Comments and Our Evaluation

We provided a draft of this report for review and comment to Commerce, DOD, Education, DOE, and DOL. We received the following comments:

- Commerce provided written comments, which are reproduced in appendix II. Commerce stated it agreed with the intent of our recommendation and that it will convene an extended team for revising the governance model. Commerce provided other comments related to the role and responsibility of the Department, interagency engagement, performance metrics, as well as other comments on the recommendation which are described below.
- DOD provided written comments, which are reproduced in appendix III. DOD also stated that it agreed with the intent of our recommendation and expanding the network governance model to better define roles and responsibilities of non-sponsoring agencies. DOD provided other comments in areas similar to Commerce's comments, as described below.
- In an email from an audit analyst in its Office of the Chief Financial Officer, DOE provided general comments, which we discuss below.
- Commerce, DOD, and DOE provided technical comments, which we incorporated as appropriate.
- Officials from Education and DOL stated via email that they had no comments on the report.

Commerce, DOD, and DOE provided several comments related to our recommendation.

- Commerce agreed with the intent of our recommendation but requested revisions to the wording of the recommendation because NIST has no authority to compel participation by DOL and Education in the Manufacturing USA program or to define roles and responsibilities for these agencies. Relatedly, Commerce and DOD said that Commerce has no authority to coordinate other agencies in their programs or any management responsibilities for institutes sponsored by other agencies. We recognize that Commerce has no authority to coordinate other agencies' programs, to manage the institutes that they sponsor, or to compel agency participation in the program. We believe that our report correctly characterizes improved coordination as a collaborative effort between Commerce and other agencies. The focus of the recommendation in our draft report was not for NIST to compel agency participation or unilaterally define their roles and responsibilities but rather for NIST to work with non-sponsoring agencies in an interagency collaborative effort to identify

their roles and responsibilities. As our report noted, one of the functions of AMNPO specified in the RAMI Act is to establish procedures, processes and criteria as may be necessary and appropriate to maximize cooperation and coordinate the program's activities with programs and activities of the other federal agencies whose missions contribute to or are affected by advanced manufacturing. In response to Commerce's comments, we clarified our recommendation to make clear that NIST should engage non-sponsoring agencies in an interagency collaboration to fully identify their roles and responsibilities for contributing to the program.

- Commerce also proposed an alternative recommendation, commenting that it would be constructive for GAO to recommend that the Secretary of Commerce connect with counterparts at DOL and Education. While our report provides more detailed information on several DOL programs and activities that could potentially contribute to the Manufacturing USA program (relative to other non-sponsoring agencies), we provide this information as illustrative examples. Because we believe collaboration on Manufacturing USA network governance roles and responsibilities should include all relevant non-sponsoring agencies, we did not adjust our recommendation to specifically focus on DOL or Education.
- Commerce also noted that the first generation of the Manufacturing USA governance system was focused on how institutes would work with the network and program, so the responsible entities that developed it were limited to Commerce, DOD, and DOE. Commerce further stated that our recommendation speaks to a next generation of the Manufacturing USA governance with a broader scope. We modified our report to more clearly reflect that Commerce, DOD, and DOE were the agencies initially involved in developing the governance system as chartered by the National Science and Technology Council. However, we do not believe the scope of the governance system as evidenced by documentation provided to us during our review is substantially different than that envisioned by our recommendation. For example, as we noted in our report, the governance system assigns responsibility for certain subfunctions to non-sponsoring agencies.
- Finally, DOD stated it would work with the interagency team to assist in reaching out to all agencies whose missions contribute to or are affected by advanced manufacturing, and that it supports expanding the network governance model. In its general comments, DOE agreed that additional coordination with other governmental agencies would

be useful, and would further serve to reduce potential inefficiencies and redundancies in federal investments.

Commerce and DOD also provided general comments in three areas (1) roles and responsibilities of the Department of Commerce, (2) interagency engagement, and (3) performance metrics.

- **Roles and responsibilities.** Commerce and DOD provided comments regarding the roles and responsibilities of Commerce that were also related to the comments on our recommendation and are discussed above. Commerce and DOD also emphasized the nature of (1) the AMNPO as an interagency team hosted at NIST, and (2) the Manufacturing USA institutes as public-private partnerships, owned and managed by an industry-led consortium, with the sponsoring federal agency providing a minority of funding. We made several edits to reflect these points. Commerce and DOD also commented that present non-federal funding is over a 2 to 1 match to federal financial assistance. We believe we accurately present information on these relative contributions in our report.
- **Interagency engagement.** Commerce and DOD stated that all agencies were invited to be part of the Manufacturing USA program, and noted that a number of agencies, including some non-sponsoring agencies, have been members of the interagency team. Commerce and DOD also stated that GAO correctly stated that DOL was not a principal agency involved with the program; although, Commerce noted attempts had been made to reach out to DOL and both agencies discussed providing information on DOL initiatives to the Manufacturing USA institutes. We added information to our report to acknowledge these efforts. Other comments Commerce provided regarding interagency engagement through the Manufacturing USA governance system are discussed above.
- **Performance metrics.** Commerce and DOD stated that there is agreement on the initial set of performance measures for the Manufacturing USA program and that information on each of these measures will be provided in the upcoming Manufacturing USA annual report (for fiscal year 2016). In the draft report, we included information on the extent to which all DOD and DOE institutes planned to provide information on all of the initial performance measures for the Manufacturing USA program. This information was based on documentation provided to us during the course of our review, which showed that not all DOD institutes planned to report data on all of the initial performance measures. In response to the comments received from Commerce and DOD, we followed up with

DOD. A DOD official responsible for overseeing DOD's Manufacturing USA institutes said via email that DOD recently tasked the institutes to provide data in support of these measures for aggregation in the fiscal year 2016 report. Therefore, we revised our report to remove information related to a difference in the extent to which DOD and DOE planned to have all their institutes report on all the initial measures. In its comments on our draft report DOD also provided information on other information DOD collects from its institutes consistent with its mission, and emphasized that performance measures included in our report are only initial metrics which could evolve over time. We did not make any additional changes based on these comments as we believe these concepts are already reflected in our report.

Finally, Commerce and DOD commented on the title of our draft report, which was Advanced Manufacturing: Commerce Needs to Strengthen Collaboration with Other Agencies on Innovation Institutes, indicating a preference for a more descriptive report title. In its general comments, DOE stated that the draft title overstated the severity of the issue. We believe that Commerce as well as other institute-sponsoring and non-sponsoring agencies have worked collaboratively in implementing the Manufacturing USA program; however, our report identified an opportunity to further strengthen this collaboration. We adjusted our report title and believe that it appropriately highlights this area where collaboration could be strengthened.

We are sending copies of this report to the appropriate congressional committees; the Secretaries of Commerce, Defense, Education, Energy, and Labor; and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff members have any questions about this report, please contact John Neumann at (202) 512-3841 or neumannj@gao.gov, or Andrew Sherrill at (202) 512-7215 or sherrilla@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IV.

A handwritten signature in black ink, appearing to read "John Neumann", with a long horizontal flourish extending to the right.

John Neumann
Director, Natural Resources and Environment

A handwritten signature in black ink, appearing to read "Andrew Sherrill", written in a cursive style.

Andrew Sherrill
Director, Education, Workforce, and Income Security Issues

List of Committees

The Honorable Richard Shelby
Chairman
The Honorable Jeanne Shaheen
Ranking Member
Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
United States Senate

The Honorable John Thune
Chairman
The Honorable Bill Nelson
Ranking Member
Committee on Commerce, Science, and Transportation
United States Senate

The Honorable John Culberson
Chairman
The Honorable José Serrano
Ranking Member
Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
House of Representatives

The Honorable Lamar Smith
Chairman
The Honorable Eddie Bernice Johnson
Ranking Member
Committee on Science, Space, and Technology
House of Representatives

Appendix I: Information on Operating Manufacturing USA Institutes as of December 2016

This appendix provides additional information on each of the five Department of Defense (DOD) and two Department of Energy (DOE) Manufacturing USA institutes that were operating as of December 2016. This information includes, among other things, background information on the institute, such as its budget and technology focus, as well as data on the number of members and membership benefits, rights, and fees. The institutes are listed in chronological order based on the date of the cooperative agreement with their sponsoring agency.

National Additive Manufacturing Innovation Institute (America Makes)

About: America Makes is the flagship Manufacturing USA institute. Its mission is to accelerate the adoption of additive manufacturing technologies, also known as three-dimensional, or 3D, printing, in the U.S. manufacturing sector.

Location: Youngstown, Ohio, facility opened in October 2012. A satellite center is located at the University of Texas, El Paso.

First cooperative agreement: Signed August 2012. America Makes is operated by the National Center for Defense Manufacturing and Machining, a 501(c)(3) nonprofit organization that has a cooperative agreement with the Air Force Research Laboratory.

Budget: America Makes was established as a pilot institute in August 2012 for the Manufacturing USA program with \$30 million in planned federal obligations and \$40 million in pledged nonfederal cost-share. This amount was later increased to a combined \$110 million in planned federal obligations (\$55 million) and pledged nonfederal cost-share (\$55 million).

Second cooperative agreement: Signed February 2016 between the National Center for Defense Manufacturing and Machining and the Air Force Research Laboratory for up to approximately a combined additional \$76 million in planned federal obligations (\$50 million) and pledged nonfederal cost-share (\$26 million). As of June 2016, the second cooperative agreement consists of one \$9 million project.

Technology portfolio: About 60 projects, such as a project to streamline the design and improve the materials for the production of customized ankle-foot orthoses, and another project to accelerate the U.S. metal-

casting industry with the adoption of America Makes technologies into their operations.¹

Membership: About 175 members from industry, academia, government, nonprofit organizations, and Hollings Manufacturing Extension Partnership centers.²

Summary of membership fees, benefits, and rights: America Makes provides three membership levels with different fees, benefits, and rights associated with each level. The three membership levels and their associated fees are as follows:

- *Platinum (lead):* \$200,000 cash or in-kind annually, with the intention of at least a 3-year commitment
- *Gold (full):* \$50,000 cash or in-kind annually, with the intention of at least a 3-year commitment
- *Silver (supporting):* \$15,000 cash or in-kind annually, with the intention of at least a 3-year commitment

Table 5 provides an overview of America Makes membership benefits and rights. Specific terms and conditions are further detailed in the formal membership agreement.

Table 5: Summary of National Additive Manufacturing Innovation Institute (America Makes) Membership Benefits and Rights

Benefits and rights	Platinum (lead)	Gold (full)	Silver (supporting)
Incubator acceleration package	√	X	X
Complimentary silver membership for gifting	√	Discounted fee	X
Embed employee at America Makes	√	Fee-based	X
Use of America Makes facilities for research and development	√	√	X
Governance board seat	√	√	X
Technology roadmap participation	√	√	X
Deployment and strategy consultation	√	Discounted fee	Fee for service
Sponsor an internship	√	√	√
Attend semi-annual members-only program management reviews	√	√	√
Serve on America Makes' advisory committees, working groups	√	√	√

¹As of July 2016.

²As of June 2016.

Benefits and rights	Platinum (lead)	Gold (full)	Silver (supporting)
Platform to socialize research results	√	√	√
Poster session participation	√	√	√
Technical presentations and workshops	√	√	√
Training discount	√	√	√
Government contract navigation assistance	√	√	√
Copies of the Wohler's Report (state of the industry progress report)	√	√	√
Coordinated access to the additive manufacturing supply chain	√	√	√
Participate in America Makes directed project calls	√	√	√
Lead project teams in America Makes project calls	√	√	√
Access to America Makes intellectual property	√	√	√
Access to member-only data	√	√	√
Platform to collaborate with industry and peers	√	√	√
Access to new research and development funding through networking and resources	√	√	√

Legend: √ indicates benefit or right and X indicates no benefit or right.

Source: GAO analysis of information provided by America Makes. | GAO-17-320

Digital Manufacturing and Design Innovation Institute (DMDII)

About: DMDII's mission is to digitize American manufacturing. By capturing data at every stage of the production process—and by deploying specially designed software and other digital tools—manufacturers can efficiently share and revise their digital designs.

Location: Chicago, Illinois, facility opened in May 2015. Two chapters were opened in Quad Cities and Rockford, Illinois.

Cooperative agreement: Signed February 2014. DMDII is managed by UI LABS, a 501(c)(3) nonprofit organization that has a cooperative agreement with the Army Contracting Command Redstone.

Budget: \$176 million from federal and nonfederal financial assistance

- \$70 million in planned federal obligations
- \$106 million pledged nonfederal cost-share

Technology portfolio: About 50 projects, such as a project to use 3D models to enhance product quality, reduce communication errors, and reduce development times throughout the supply chain, and another

project to fill the gap between design and manufacturing with the information necessary to enable services for machine motion control.³

Membership: About 260 members from industry, academia, government, nonprofit organizations, and Hollings Manufacturing Extension Partnership centers.⁴

Summary of membership fees, benefits, and rights: DMDII provides three membership levels for industry, four membership levels for academic and nonprofit organizations, and two government membership levels with different fees, benefits, and rights associated with each level. The industry, academic and nonprofit, and government membership levels and their associated fees are as follows:

- **Industry:**
 - Tier 1: \$400,000 cash annually and at least \$3 million in expenditures for additional projects with a 5-year commitment
 - Tier 2: \$200,000 cash annually with a 5-year commitment
 - Tier 3: \$500 cash annually with a 5-year commitment
- **Academic and nonprofit:**
 - Tier 1: \$5 million in expenditures with a 5-year commitment
 - Tier 2: \$2 million in expenditures with a 5-year commitment
 - Tier 3: \$1 million in expenditures with a 5-year commitment
 - Tier 4: \$500 cash annually with a 5-year commitment
- **Government:**
 - U.S. government: Obligations as specified in the cooperative agreement
 - State and local government: At least \$5 million in expenditures with a 5-year commitment

Tables 6, 7, and 8 provide an overview of DMDII membership benefits and rights for industry, academic and nonprofit, and government members, respectively. Specific terms and conditions are further detailed in the formal membership agreement.

³As of July 2016.

⁴As of September 2016.

Table 6: Summary of Digital Manufacturing and Design Innovation Institute (DMDII) Industry Membership Benefits and Rights

Benefits and rights	Tier 1	Tier 2	Tier 3
Seat on executive committee	√	2 seats to represent all Tier 2 industry partners	1 seat to represent all Tier 3 industry partners
Seat on technical advisory committee	√	√	X
Help steer the institute's agenda	√	√	X
Royalty-free use of intellectual property from all enterprise projects for internal research and development and internal operations worldwide	√	Not including internal operations worldwide	X
Participation in research and development projects	√	√	√
Networking opportunities	√	√	√

Legend: √ indicates benefit or right and X indicates no benefit or right.
Source: GAO analysis of information provided by DMDII. | GAO-17-320

Table 7: Summary of Digital Manufacturing and Design Innovation Institute (DMDII) Academic and Nonprofit Membership Benefits and Rights

Benefits and rights	Tier 1	Tier 2	Tier 3	Tier 4
Seat on executive committee	All academic members cannot exceed one-third of total committee membership	2 seats to represent all Tier 2 academic partners, but all academic members cannot exceed one-third of total committee membership	1 seat to represent all Tier 3 academic partners, but all academic members cannot exceed one-third of total committee membership	X
Seat on technical advisory committee	√	√	1 seat to represent all Tier 3 academic partners	1 seat to represent all Tier 4 academic partners
Help steer the institute's agenda	√	√	√	X
Royalty-free use of intellectual property from all enterprise projects for internal research and development and internal operations worldwide	√	√	X	X
Participation in research and development projects	√	√	√	X
Networking opportunities	√	√	√	√

Legend: √ indicates benefit or right and X indicates no benefit or right.
Source: GAO analysis of information provided by DMDII. | GAO-17-320

Table 8: Summary of Digital Manufacturing and Design Innovation Institute (DMDII) Government Membership Benefits and Rights

Benefits and rights	U.S. Government	State and Local Government
Seat on executive committee	4 seats	1 seat
Seat on technical advisory committee	Up to 6 seats	X
Help steer the institute's agenda	√	√
Networking opportunities	√	√

Legend: √ indicates benefit or right and X indicates no benefit or right.
 Source: GAO analysis of information provided by DMDII. | GAO-17-320

Lightweight Innovations for Tomorrow (LIFT)

About: LIFT's mission is to accelerate the development of new manufacturing processes for products using lightweight metals, including aluminum, magnesium, titanium, and advanced high-strength steel alloys.

Location: Detroit, Michigan, facility opened in January 2015. Satellite locations are in Columbus, Ohio; Ann Arbor, Michigan; Worcester, Massachusetts; and Golden, Colorado.

Cooperative agreement: Signed February 2014. LIFT is managed by the American Lightweight Materials Manufacturing Innovation Institute, a 501(c)(3) nonprofit organization that has a cooperative agreement with the Office of Naval Research.

Budget: \$148 million from federal and nonfederal financial assistance

- \$70 million in planned federal obligations
- \$78 million in pledged nonfederal cost-share

Technology portfolio: About 30 projects, either initiated or under development, in the areas of melt and powder processing, thermomechanical processing, joining and assembly, coatings, and agile tooling, such as developing and deploying thin wall ductile iron castings for high-volume production.⁵ LIFT also sponsored a Purdue-designed Indy 500 Grand Prix for high school students to engineer, build, test, and market vehicles using lightweight metals.

⁵As of June 2016.

Membership: About 90 members from industry, academia, government, nonprofit organizations, and a Hollings Manufacturing Extension Partnership center.⁶

Summary of membership fees, benefits, and rights: LIFT provides nine membership levels with different fees, benefits, and rights associated with each level. The nine membership levels and their associated fees are as follows:

- *Gold:* \$350,000 annually, of which at least \$100,000 is provided in cash, with the intention of at least a 5-year commitment
- *Silver:* \$150,000 annually, of which at least \$50,000 is provided in cash, with the intention of at least a 5-year commitment
- *Bronze:* \$25,000 cash annually, with the intention of at least a 5-year commitment
- *In-Kind members* (e.g., equipment, software, or engineering service providers): \$150,000 in-kind annually, with the intention of at least a 5-year commitment
- *Small manufacturers and start-ups:* For small manufacturers with 251 to 500 employees, the fee is \$5,000 cash annually, with the intention of at least a 5-year commitment; for small manufacturers with 1 to 250 employees, the fee is \$2,500 cash annually, with the intention of at least a 5-year commitment; and for start-ups with fewer than 50 employees and less than 5 years in business, the fee is \$1,000 cash annually, with the intention of at least a 5-year commitment
- *Research partners:* \$10,000 cash annually, with the intention of at least a 5-year commitment. The annual in-kind fee varies based on the level of participation.
- *Trade association:* Annual cash and in-kind fees vary based on the level of participation, with the intention of at least a 5-year commitment
- *Professional society:* \$50,000 in-kind annually, with the intention of at least a 5-year commitment
- *Education and workforce:* Annual cash and in-kind fees vary based on the level of participation, with the intention of at least a 5-year commitment

⁶As of June 2016.

Table 9 provides an overview of LIFT membership benefits and rights across the nine membership levels. Specific terms and conditions are further detailed in the formal membership agreement.

Table 9: Summary of Lightweight Innovations for Tomorrow (LIFT) Membership Benefits and Rights

Benefits and rights	Gold	Silver	Bronze	In-kind member	Small manufacturer and start-up	Research partner	Trade association	Professional society	Education and workforce
Submit project ideas	√	√	√	√	√	√	√	X	X
Participation in project prioritization	√	√	X	X	X	X	√	X	X
Ability to lead a project	√	√	X	√	X	X	√	X	X
Access to all technical information and reports	√	√	√	√	√	√	√	X	X
Non-exclusive royalty-free license to intellectual property ^a	√	√	X	X	X	X	X	X	X
Member on the Lift Executive Advisory Council	1 from each Gold tier manufacturer	3 on a rotational basis	1 on a rotational basis	X	1 on a rotational basis	X	X	X	X
25 percent fee reduction on proprietary company-sponsored projects	√	X	X	X	X	X	X	X	X
Access to graduates of university-funded programs	√	√	√	√	√	√	√	X	X
Access to workforce development network	√	√	√	√	√	√	√	√	√

Legend: √ indicates benefit or right and X indicates no benefit or right.

Source: GAO analysis of information provided by LIFT. | GAO-17-320

^aThis benefit and right pertains to two types of intellectual property: shared pre-competitive research intellectual property, which is conceived or authored solely or jointly by a party during the performance of shared pre-competitive research, and American Lightweight Materials Manufacturing Innovation Institute-pooled intellectual property, which is conceived or authored solely by the institute during the performance of the institute's internal research.

The Next Generation Power Electronics Manufacturing Innovation Institute (PowerAmerica)

About: PowerAmerica’s mission is to develop advanced manufacturing processes that will enable large-scale production of wide bandgap semiconductors, which allow power electronic components to be smaller, faster, and more efficient than silicon-based devices.

Location: Raleigh, North Carolina, facility opened in January 2015.

Cooperative agreement: Signed December 2014. PowerAmerica is led by North Carolina State University, which has a cooperative agreement with DOE’s Office of Energy Efficiency and Renewable Energy.

Budget: \$140 million from federal and nonfederal financial assistance

- \$70 million in planned federal obligations
- \$70 million in pledged nonfederal cost-share

Technology portfolio: About 30 projects, such as a project developing a medium voltage fast charger for electric vehicles.⁷ Another project involves working with an existing silicon wafer fabrication facility to update its capabilities to allow for the production of wide bandgap semiconductor devices—specifically silicon carbide wafers. This affords PowerAmerica members an opportunity to accelerate their research by producing and testing wide bandgap devices at the facility.

Membership: About 30 members from industry, academia, government, and a Hollings Manufacturing Extension Partnership center.⁸

Summary of membership fees, benefits, and rights: PowerAmerica provides seven membership levels with different fees, benefits, and rights associated with each level.⁹ The seven membership levels and their associated fees are as follows:

- *Full sustaining:* \$500,000 annually (\$250,000 of which may be met by in-kind contributions), with a 3-year commitment.¹⁰ In general, the in-

⁷As of July 2016.

⁸As of July 2016.

⁹PowerAmerica allows some small companies, who may not be able to afford a cash commitment, to become members by providing only in-kind contributions.

¹⁰Voting rights are determined by the first \$250,000 made in cash.

kind contribution should be made within the membership year; however, the member may defer 25 percent of the in-kind contribution for up to 6 months into the following membership year.

- *Full member*: \$100,000 cash annually with a 3-year commitment
- *Affiliate member*: \$50,000 cash annually with a 3-year commitment
- *Startup member*: \$10,000 cash annually with a 3-year commitment
- *Academic member*: \$10,000 cash annually with a 3-year commitment
- *Federal lab*: No fee, but involves a 3-year commitment
- *Associate member*: No fee, but involves a 3-year commitment

Table 10 provides an overview of PowerAmerica membership benefits and rights across the seven membership levels. Specific terms and conditions are further detailed in the formal membership agreement.

Table 10: Summary of The Next Generation Power Electronics Manufacturing Innovation Institute (PowerAmerica) Membership Benefits and Rights

Benefits and rights	Full sustaining	Full member	Affiliate member	Startup member	Academic member	Federal lab	Associate member
Access to member-only data and research	√	√	√	√	√	√	X
Access to new research and development funding through the institute	√	√	√	√	√	√	X
Eligible to receive funding from open innovation fund	√	√	√	√	√	√	X
Open platform to connect with industry and academics	√	√	√	√	√	√	√
Access to students for internships	√	√	√	√	√	X	X
Member advisory committee seats	1 seat	1 seat	1 seat	1 seat	1 seat	X	X
Executive committee seats	1 seat guaranteed	Must be appointed by member advisory committee	Must be appointed by member advisory committee	Must be appointed by member advisory committee	Must be appointed by member advisory committee	X	X
Voting points ^a	25	10	5	1	1	1	X

**Appendix I: Information on Operating
Manufacturing USA Institutes as of December
2016**

Benefits and rights	Full sustaining	Full member	Affiliate member	Startup member	Academic member	Federal lab	Associate member
Technology roadmap participation	√	√	√	√	√	X	X
Use of institute facilities	√	√	√	√	√	√	X
Favorable terms for licensing intellectual property	First option for exclusive commercial license	Second option for exclusive commercial license	Third option for exclusive commercial license	Third option for exclusive commercial license	Third option for exclusive commercial license	X	X
Fund an enhancement project ^b	√	√	√	√	√	X	X
Advertisement on website	√	√	√	√	√	√	√

Legend: √ indicates benefit or right and X indicates no benefit or right.

Source: GAO analysis of information provided by PowerAmerica. | GAO-17-320

^aMembers vote on projects that have gone through the PowerAmerica call for projects process and that can be funded by industry membership fees.

^bEnhancement projects are projects funded by industry that are beyond the core funding of the grant. They are nonproprietary so that all of the members can benefit from the research (as opposed to other industry-funded projects performed using standard research agreements that have full overhead and in which the company would own intellectual property generated).

Institute for Advanced Composites Manufacturing Innovation (IACMI)

About: IACMI's mission is to accelerate the development and adoption of cutting-edge manufacturing technologies for low-cost, energy-efficient manufacturing of advanced polymer composites for vehicles, wind turbines, compressed gas storage, and other applications.

Location: Oak Ridge, Tennessee, facility opened in June 2015. Geographic extensions are located in Dayton, Ohio (compressed gas storage); Golden, Colorado (wind turbines); West Lafayette, Indiana (design and simulation); and Detroit, Michigan (vehicles). IACMI has also signed memorandums of understanding with the Carbon Recycling Technology Center in Port Angeles, Washington, and the Composite Prototyping Center in Plainview, New York.

Cooperative agreement: Signed June 2015. IACMI is managed by the Collaborative Composite Solutions Corporation, a 501(c)(3) nonprofit organization that has a cooperative agreement with DOE's Office of Energy Efficiency and Renewable Energy.

Budget: \$250 million from federal and nonfederal financial assistance

- \$70 million in planned federal financial obligations
- \$180 million in pledged nonfederal cost-share

Technology portfolio: About three projects, such as a project optimizing carbon fiber production to enable high-volume manufacturing of lightweight automotive components, and another project developing thermoplastic material to lower production costs and improve recyclability of wind turbine blades.¹¹

Membership: About 140 members from industry, academia, government, nonprofit organizations, and a Hollings Manufacturing Extension Partnership center.¹²

Summary of membership fees, benefits, and rights: IACMI provides four membership levels with different fees, benefits, and rights associated with each level. The four membership levels and their associated fees are as follows:

- *Charter:* \$5 million provided over a period of up to 5 years (at least 50 percent cash and \$100,000 overhead annually)
- *Premium:* \$1 million provided over a period of up to 5 years (at least 50 percent cash and \$20,000 overhead annually)
- *Resource:* \$5,000 cash annually for industry members with 500 or fewer employees, government agencies, and educational institutions; \$10,000 cash annually for industry members with over 500 employees; as well as a resource contribution and a 1-year commitment
- *Consortium:* \$5,000 cash annually for industry members with 500 or fewer employees, government agencies, and educational institutions; and \$10,000 cash annually for industry members with over 500 employees; involves a 1-year commitment

Table 11 provides an overview of IACMI membership benefits and rights. Specific terms and conditions are further detailed in the formal membership agreement.

¹¹As of July 2016.

¹²As of June 2016.

Table 11: Summary of Institute for Advanced Composites Manufacturing Innovation (IACMI) Membership Benefits and Rights

Benefits and rights	Charter	Premium	Resource	Consortium
Cash contribution eligible for match subject to available funds	√	√	X	X
Leverage significant intellectual and resources capabilities	√	√	X	X
Influence in creation and direction of IACMI	√	X	X	X
Participation in governance	All charters have 1 seat on the board and elect 1 representative for the technical advisory board	1 representative for the board and 1 representative for the technical advisory board	X	1 small manufacturer for the board and 1 small and 1 large company representative for the technical advisory board
Additional benefits for Premium, Resource, and Consortium members				
Enterprise-wide proprietary projects	X	√	X	X
Right to use unique modification to their technology	X	X	√	X
Exposure to potential customers	X	X	√	X
Participate in projects to improve their products	X	X	√	X
Opportunities to engage and build key relationships to fuel company's growth within the composites ecosystem	X	X	X	√
Participate in workshops, road mapping, and members meetings	X	X	X	√

Legend: √ indicates benefit or right and X indicates no benefit or right.
 Source: GAO analysis of information provided by IACMI. | GAO-17-320

American Institute for Manufacturing Integrated Photonics (AIM Photonics)

About: AIM Photonics' mission is to advance integrated photonic circuit manufacturing technology development while simultaneously providing access to state-of-the-art fabrication, packaging, and testing capabilities for small-to-medium enterprises, academia, and the government.

Location: Albany, New York, facility operations began in July 2015. Institute officials said the Rochester, New York, facility will be the location for the test, assembly, and packaging operations. Also, AIM Photonics has satellite hubs at the University of Rochester, Rochester Institute of Technology, State University of New York Polytechnic Institute, Massachusetts Institute of Technology, Columbia University, University of Arizona, and University of California Santa Barbara.

Cooperative agreement: Signed July 2015. AIM Photonics is managed by the Research Foundation of the State University of New York, a 501(c)(3) nonprofit organization that has a cooperative agreement with the Air Force Research Laboratory.

Budget: \$612 million federal and nonfederal financial assistance

- \$110 million in planned federal obligations
- \$503 million in pledged nonfederal cost-share

Technology portfolio: Institute officials said that the portfolio contains about 10 projects, such as a project pertaining to 3D displays, and another project through AIM Photonics' AIM Academy to study industry skills gap and employment needs.¹³

Membership: About 30 members from industry, academia, and government.¹⁴

Summary of membership fees, benefits, and rights: AIM Photonics provides four membership levels for industry and three membership levels for academic and nonprofit organizations with different fees, benefits, and rights associated with each level. The industry and academic and nonprofit membership levels and their associated fees are as follows:

¹³As of May 2016.

¹⁴As of June 2016.

- **Industry:**

- *Tier 1:* \$1 million cash annually (may include cash and in-kind with a minimum of \$100,000 cash through 2020), increasing to full cash by 2021
- *Tier 2:* \$500,000 cash annually (may include cash and in-kind with a minimum of \$100,000 cash through 2020), increasing to full cash by 2021
- *Tier 3:* \$100,000 or greater amount cash annually (may include in-kind through 2020)
- *Industry observer:* \$2,500 cash annually, with a 1-year commitment

- **Academic and nonprofit:**

- *Tier 1:* In-kind and tangible and intangible contributions as provided in the membership agreement (such as software licenses, hardware, services, and expertise)
- *Tier 2:* In-kind as provided in the membership agreement (such as software licenses, hardware, or services and overhead costs)
- *Academic observer:* No fee, with 1-year commitment

Tables 12 and 13 provide an overview of AIM Photonics' membership benefits and rights for industry and academic and nonprofit, respectively. Specific terms and conditions are further detailed in the formal membership agreements.

Table 12: Summary of American Institute for Manufacturing Integrated Photonics (AIM Photonics) Industry Membership Benefits and Rights

Benefits and rights	Tier 1	Tier 2	Tier 3	Industry Observer
Leadership Council	Right to designate 1 candidate to serve on the council, which provides the member the opportunity to provide input on the institute direction and strategy	Representation with an opportunity to serve on the council based on the total number of Tier 2 industry members and a selection process	Representation with an opportunity to serve on the council based on the total number of Tier 3 industry members and a selection process	X
Right to receive results and licenses to intellectual property from certain projects and project segment(s) in which a member is a participant	√	√	√	X
Right to propose certain institute, industry, government interest, and service projects	√	√	√	X
Right to participate in workforce development and road mapping activities	√	√	√	Right to participate in road mapping activities only
Technology working groups	Right to participate in all technology working groups	Right to participate for certain project segments	Right to participate for a certain project segment	X
Right to send reimbursed assignees to AIM Photonics shared facilities	Up to 3	Up to 1	X	X
Right to send nonreimbursed assignees to AIM Photonics shared facilities	√	√	√	X
Participation in annual meeting and access to quarterly newsletter	√	√	√	√

Legend: √ indicates benefit or right and X indicates no benefit or right.

Source: GAO analysis of information provided by AIM Photonics. | GAO-17-320

Table 13: Summary of American Institute for Manufacturing Integrated Photonics (AIM Photonics) Academic and Nonprofit Membership Benefits and Rights

Benefits and rights	Tier 1	Tier 2	Academic Observer
Leadership Council	Representation with an opportunity to serve on the council based on the total number of academic members and a selection process	Representation with an opportunity to serve on the council based on the total number of academic members and a selection process	X
Right to receive results and licenses to intellectual property from certain projects and/or project segment(s) in which a member is a participant	√	√	No right to participate in projects other than educational support
Right to propose certain institute, industry, government interest, and service projects	√	√	X
Right to participate in workforce development and road mapping activities	√	√	Right to participate in road mapping activities only
Technology working groups	Right to participate in all technology working groups	Right to participate for certain project segments	X
Participation in annual meeting and access to quarterly newsletter	√	√	√

Legend: √ indicates benefit or right and X indicates no benefit or right.

Source: GAO analysis of information provided by AIM Photonics. | GAO-17-320

America’s Flexible Hybrid Electronics Manufacturing Institute (NextFlex)

About: NextFlex’s mission is to pioneer a new era of advanced flexible hybrid electronics manufacturing in the United States. Flexible hybrid electronics combine the ability to add electronics to materials that are part of our everyday lives, to create lightweight, low-cost, flexible, conformable, and stretchable smart products.

Location: San Jose, California, facility opened in August 2016.

Cooperative agreement: Signed August 2015. NextFlex is managed by FlexTech Alliance, Inc., a 501(c)(6) nonprofit organization that has a cooperative agreement with the Air Force Research Laboratory.

Budget: \$171 million in federal and nonfederal financial assistance

- \$75 million in planned federal obligations
- \$96 million in pledged nonfederal cost-share

Technology portfolio: About 13 projects, such as a project to develop a flexible smart wound dressing with oxygen release and sensing capability, and a project to develop a flexible and stretchable monitoring sensor network to improve aerospace fuel efficiency and flight safety.¹⁵

Membership: About 45 members from industry, academia, government, and nonprofit organizations.¹⁶

Summary of membership fees, benefits, and rights: NextFlex provides four membership levels for industry, three membership levels for academic and nonprofit organizations, and a government membership level with different fees, benefits, and rights associated with each level. The industry, academic and nonprofit, and government membership levels and their associated fees are as follows:¹⁷

- **Industry:**
 - *Tier 1:* \$150,000 cash and \$250,000 in-kind annually, with the intention of at least a 3-year commitment
 - *Tier 2:* \$50,000 cash and \$50,000 in-kind annually, with the intention of at least a 3-year commitment
 - *Tier 3:* \$10,000 cash annually and in-kind encouraged, with the intention of at least a 3-year commitment
 - *Observer:* \$2,500 cash annually and in-kind encouraged, with the intention of at least a 3-year commitment
- **Academic and nonprofit:**
 - *Tier 1:* \$15,000 cash and \$600,000 in-kind annually, with the intention of at least a 3-year commitment
 - *Tier 2:* \$7,500 cash and \$300,000 in-kind annually, with the intention of at least a 3-year commitment

¹⁵As of September 2016.

¹⁶As of September 2016.

¹⁷At most membership levels, funds can be partially in-kind.

- *Tier 3*: \$2,500 cash annually and in-kind encouraged, with the intention of at least a 3-year commitment
- **Federal Government:**
 - No annual membership fee
 - In-kind contributions, which are not required, can be cash in support of the institute

Tables 14, 15, and 16 provide an overview of NextFlex membership benefits and rights for industry, academic and nonprofit, and government members, respectively. Specific terms and conditions are further detailed in the formal membership agreement.

Table 14: Summary of America’s Flexible Hybrid Electronics Manufacturing Institute (NextFlex) Industry Membership Benefits and Rights

Benefits and rights	Tier 1	Tier 2	Tier 3	Observer ^a
Technical working groups	√	√	√	By invitation
Online member portal	√	√	√	Limited
Networking	√	√	√	Limited
Project funding	√	√	√	X
Intellectual property evaluation license	√	√	√	X
Education/workforce development program	√	√	√	Limited
Member discounts	√	√	√	Limited
Governing Council seats	1 vote each	1 vote for every 3 Tier members, up to 3 votes	1 vote for Tier when 15 Tier members is reached	X
Technical Council seats ^b	1 vote each	1 vote each	X	X

Legend: √ indicates benefit or right and X indicates no benefit or right.

Source: GAO analysis of information provided by NextFlex. | GAO-17-320

^aReserved for start-ups with less than \$5 million in gross annual revenue, fewer than 20 employees, and unaffiliated with nonqualifying entity; 3 years maximum.

^bParticipants each have a primary representative on the NextFlex Technical Council, plus other representatives to be involved in sub-committees or working groups.

Table 15: Summary of America’s Flexible Hybrid Electronics Manufacturing Institute (NextFlex) Academic and Nonprofit Membership Benefits and Rights

Benefits and rights	Tier 1	Tier 2	Tier 3
Technical working groups	√	√	By invitation
Online member portal	√	√	Limited
Networking	√	√	Limited
Project funding	√	√	√
Intellectual property evaluation license	√	√	X
Education/workforce development program	√	√	√
Member discounts	√	√	Limited
Governing Council seats	1 vote for every 3 Tier members, up to 3 votes	1 vote for Tier 2 when 15 Tier members is reached	X
Technical Council seats ^a	1 vote each	1 vote each	X

Legend: √ indicates benefit or right and X indicates no benefit or right.

Source: GAO analysis of information provided by NextFlex. | GAO-17-320

^aParticipants each have a primary representative on the NextFlex Technical Council, plus other representatives to be involved in sub-committees or working groups.

Table 16: Summary of America’s Flexible Hybrid Electronics Manufacturing Institute (NextFlex) Federal Government Membership Benefits and Rights

Benefits and rights	Federal Government
Technical working groups	√
Online member portal	√
Networking	√
Project funding	X
Intellectual property evaluation license	√
Education/workforce development program	√
Member discounts	√
Governing Council seats	Up to 25 percent
Technical Council seats ^a	Up to 25 percent

Legend: √ indicates benefit or right and X indicates no benefit or right.

Source: GAO analysis of information provided by NextFlex. | GAO-17-320

^aParticipants each have a primary representative on the NextFlex Technical Council, plus other representatives to be involved in sub-committees or working groups.

Appendix II: Comments from the Department of Commerce



UNITED STATES DEPARTMENT OF COMMERCE
Office of the Secretary
Washington, D.C. 20230

March 15, 2017

Mr. John Neumann
Director, Natural Resources and Environment
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548


Dear Mr. Neumann:

Thank you for the opportunity to review and comment on the Government Accountability Office's (GAO) draft report titled *Advanced Manufacturing: Commerce Needs to Strengthen Collaboration with Other Agencies on Innovation Institutes* (GAO-17-320). On behalf of the Department of Commerce, I have enclosed our comments on the draft report.

The Department of Commerce accepts the GAO recommendation for engaging the Department of Labor and the Department of Education. The Department of Commerce asks for revised wording, as Commerce's National Institute of Standards and Technology has no authority to compel participation by these agencies or to define responsibilities for these agencies.

If you have any questions, please contact Dr. Kent Rochford, Acting Director, National Institute of Standards and Technology, at (301) 975-2300.

Sincerely,


Ellen Herbst

Enclosure

**Department of Commerce's Comments on
GAO Draft Report titled *Advanced Manufacturing: Commerce Needs to Strengthen
Collaboration with Other Agencies on Innovation Institutes*
(GAO-17-320)**

The Department of Commerce has reviewed the draft report, and we offer the following comments for the Government Accountability Office's (GAO) consideration.

General Comments

The Department appreciates the deep engagement of the GAO staff in the study of the Manufacturing USA program and the subsequent assessment. The Department suggests the GAO consider a more descriptive report name, from "Advanced Manufacturing" to "Assessment of the Manufacturing USA Program – the National Network for Manufacturing Innovation."

The draft report has three primary conclusions and one recommendation. The Department would like to provide clarifying comments on each, in addition to a number of factual and editorial feedbacks in the Technical Response Memorandum.

1) Role and responsibility of The Department

The report extensively reviews the management and coordination activities of the Advanced Manufacturing National Program Office (AMNPO), which is the interagency team hosted at NIST. Manufacturing USA is unlike most other Federal programs where a single agency is managing a solely federally funded activity. The Department wishes to highlight that Manufacturing USA is a public-private partnership, composed of a network of institutes – each of which is owned and managed by an industry-led consortium, with a Federal agency sponsor providing a minority of funding (presently non-Federal sourcing is over 2:1 match to Federal sourcing).

There is some confusion in the report on the management authorities of the Department. The Department has no authorities to coordinate other agencies in their programs or any management responsibilities for institutes sponsored by other agencies. All of the institutes at the time of the GAO study were sponsored by either the Department of Defense or Department of Energy.

2) Interagency engagement

The interagency coordination of Manufacturing USA was through the White House National Science and Technology Council (NSTC). All agencies were invited to be a part of Manufacturing USA, and from the origin in 2012, the Departments of Defense, Energy, Commerce, Education, NSF, and NASA were principal members of the interagency team. The GAO is correct that the Department of Labor was not a principal agency involved in the program. There were numerous outreach and engagements by the AMNPO and the Department with the Department of Labor, and information about Department of Labor programs and activities was broadly shared with Manufacturing USA institutes.

The GAO correctly noted that the Manufacturing USA network governance roles and responsibilities matrix was developed jointly by the Departments of Commerce, Defense, and Energy, but cited this as an indication other agencies were excluded. To clarify, this governance

document was chartered by the White House NSTC group as a reference for how Manufacturing USA institutes are to be involved in the network. This is why only institute-sponsoring agencies were involved, and why responsibilities were not assigned to other agencies. GAO's inference of a broader scope for governance of the program would clearly necessitate the participation of other non-institute sponsoring agencies. Manufacturing USA leaders from the Department, Defense, and Energy are in agreement that the governance document can be expanded in scope to include all other agencies with programs and activities aligned with this program. The AMNPO interagency team warmly accepts the recommendation from the GAO and will convene a broad meeting when new administration leaders for these agencies are in place.

3) Performance metrics

The GAO report raised questions on whether non-Commerce-sponsored institutes would provide reporting information on their respective contributions in advancing the program goals, as required under the RAMI Act. Manufacturing USA leaders from the Department, Defense, and Energy met to discuss this report finding and believe this is a GAO misunderstanding from a wide-ranging discussion of metrics development work. A common set of measures was developed and approved in 2015. Only a subset of these was reported in the first annual report because most of the institutes (seven at that time) were in the formation stage with no values to report. The Department, Defense, and Energy leaders of the Manufacturing USA program are in complete agreement on reporting metrics, and a full set of measures will be provided in the upcoming annual report.

Comments on Recommendations

The GAO made one recommendation to the Department of Commerce in the report.

GAO Current Recommendation

To enhance interagency collaboration in the Manufacturing USA program, the Secretary of Commerce should direct the Director of NIST to work with all non-sponsoring agencies whose missions contribute to or are affected by advanced manufacturing to revise the Manufacturing USA governance system, and ensure that it fully identifies the roles and responsibilities for how these agencies could contribute to the Manufacturing USA program.

Commerce Response: The Department of Commerce agrees with the intent of this recommendation. The first generation of the Manufacturing USA governance was focused on how institutes would work with the network and program, so the responsible entities who developed it were limited to the Department, Defense, and Energy. The GAO's recommendation speaks to a next generation of the Manufacturing USA governance with a broader scope, to define the roles and responsibilities for all entities who have programs and activities aligned with the Manufacturing USA program. The Manufacturing USA Program Office at NIST warmly receives this idea and will convene an extended team for revising the governance model. All agencies will be invited to participate, and invitees will certainly include the Department of Labor.

The program office at NIST is ready and eager to involve the Department of Labor, and other agencies, in the Manufacturing USA program. It would be constructive for GAO to recommend

that the Secretary of Commerce connect with his counterparts at the Departments of Labor and Education.

Proposed GAO Recommendation:

To enhance interagency collaboration in the Manufacturing USA program, the Secretary of Commerce should reach out to all agencies whose missions contribute to or are affected by advanced manufacturing, in particular the Department of Labor and Department of Education, for greater participation in the Manufacturing USA program. The Manufacturing USA program office should expand the network governance model to provide for participation by non-sponsoring agencies to the Manufacturing USA program.

Appendix III: Comments from the Department of Defense



ACQUISITION,
TECHNOLOGY
AND LOGISTICS

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

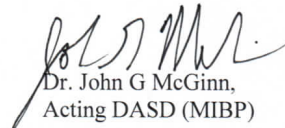
Mr. John Neumann
Director, Natural Resources & Environment
U.S. Government Accountability Office
441 G Street, NW
Washington DC 20548

Dear Mr. John Neumann,

This is the Department of Defense (DoD) response to the GAO Draft Report GAO 17-320, "ADVANCED MANUFACTURING," dated February 14, 2014 (GAO Code 100627).

Attached is DoD's proposed response to the subject report. My point of contact is Tracy Frost who can be reached at tracy.g.frost.civ@mail.mil and phone 571-372-2476.

Sincerely,



Dr. John G McGinn,
Acting DASD (MIBP)

**Department of Defense's Comments on
GAO Draft Report entitled "Advanced Manufacturing"
(GAO-17-320)**

The Department of Defense has reviewed the draft report and we offer the following comments for the Government Accountability Office's (GAO) consideration.

General Comments

The Department of Defense appreciates the deep engagement of the GAO staff in the study of the Manufacturing USA program and the subsequent assessment. The Department of Defense suggests the GAO consider a more descriptive report name, from "Advanced Manufacturing" to "Assessment of the Manufacturing USA Program – the National Network for Manufacturing Innovation".

The draft report has three primary conclusions and one recommendation. While there are no specific actions that are focused on the Department of Defense, Defense supports the Department of Commerce's comments and is providing additional clarifying comments that support DOC's comments.

A Technical Response Memorandum is also included which addresses factual and editorial feedback.

1) Role and responsibility of Commerce

DoD agrees with the following comment provided by the Department of Commerce:

The RAMI Act gives the authority to the Department of Commerce to establish a Network for Manufacturing Innovation Program with the management and coordination activities performed by the Advanced Manufacturing National Program Office (AMNPO), which is the interagency team hosted at National Institute of Standards and Technology. Currently the network is comprised of 14 manufacturing innovation institutes which are part of Manufacturing USA.

Manufacturing USA is a public-private partnership, composed of a network of institutes – each of which is owned and managed by an industry-led consortium, with a federal agency sponsor providing a minority of funding (presently non-federal sourcing is over 2:1 match to federal sourcing). Each agency led institute was competitively awarded using each agency's acquisition processes.

The Department of Commerce has no authorities to coordinate other agencies in their programs or any management responsibilities for institutes sponsored by other agencies. All of the institutes at the time of the GAO study were sponsored by either the Department of Defense or Department of Energy.

2) Interagency engagement

DoD agrees with the following comment provided by the Department of Commerce:

DoD Formal Comments on GAO-17-320

No agency is excluded from engaging with Manufacturing USA. All agencies were invited to be a part of Manufacturing USA, and from the origin in 2012 the Department of Defense, Energy, Commerce, Education, NSF and NASA were principal members of the interagency team. While the Department of Labor was not a principal agency involved in the program, representatives of the Department of Labor have been active in the Education and Workforce Development component of Manufacturing USA. Additionally a former Assistant Secretary of Labor is the Education and Workforce Development director at a DoD led institute and she has assisted the Manufacturing USA network in awareness of Department of Labor initiatives that can impact the institutes.

With respect to governance roles, DoD supports the expansion of the scope of the governance document to include all other agencies with programs and activities aligned with this program.

3) Performance metrics

DOD Manufacturing USA institutes do in fact collect each of the seven initial performance measures. DOD intends to provide DOC (lead agency) DOD-institute information on each of the initial metrics in the 2nd Manufacturing USA Annual Report (for FY 16). In addition, we collect other measures consistent with the DOD mission during our semi-annual performance management reviews, including:

- Progress toward sustainability
- Obligation and expenditures (against DOD benchmarks)
- Success stories
- Issues and challenges
- Government or industry-directed projects through the Institute
- Significant changes in governance
- Membership trends
- DOD technology transition opportunities

We would also emphasize that these are only initial metrics. As the Manufacturing USA institutes continue to evolve, discussions will also continue across Commerce, Energy, and Defense on how these metrics should be measured, if additional metrics should be added, and whether any changes to the existing initial metrics are in order.

Comments on Recommendations

The GAO made one recommendation to the Department of Commerce in the report.

GAO Current Recommendation

DoD Formal Comments on GAO-17-320

To enhance interagency collaboration in the Manufacturing USA program, the Secretary of Commerce should direct the Director of NIST to work with all non-sponsoring agencies whose missions contribute to or are affected by advanced manufacturing to revise the Manufacturing USA governance system, and ensure that it fully identifies the roles and responsibilities for how these agencies could contribute to the Manufacturing USA program.

DoD Response:

The Department of Defense agrees with the intent of this recommendation. DoD will work with the interagency team to assist in reaching out to all agencies whose missions contribute to or are affected by advanced manufacturing, in particular the Department of Labor and Department of Education, for greater participation in the Manufacturing USA program. DoD also supports expanding the network governance model to better define the roles and responsibilities of non-sponsoring agencies and fully identify how these agencies could contribute to the Manufacturing USA program.

DoD Formal Comments on GAO-17-320

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contacts

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Staff Acknowledgments

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